3^{rd} Meeting of the Academic Council

on

3^{rd} July, 2021

ANURAG UNIVERSITY
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ITEM 1

CONFIRMATION OF THE MINUTES OF THE 2nd MEETING OF THE ACADEMIC COUNCIL HELD ON 10.05.2021

Item 1: The Minutes of the 2nd meeting of the Academic Council 9was circulated to all the members. The Department of Electronics and Communication Engineering has offered the following comment:

In resolution 2.5, No. 3, first line should appear as "To offer BTech (ECE) Honors in AI for Signal Processing" instead of "To offer BTech (ECE) Honors in Signal Processing".

The same has been incorporated in the minutes and the revised minutes placed below for confirmation.

MINUTES OF THE ONLINE MEETING OF THE SECOND ACADEMIC COUNCIL HELD ON 10TH MAY, 2021 AT 10.30 AM

Members Present / Absent

S. No	Name of the Member	Designation	Present/ Absent
1	Dr. S Ramachandram, Vice Chancellor	Chairperson	Present
2	Dr. V Vijay Kumar, Dean, R& D and Chairperson, BoS, CSE	Member	Present
3	Dr. G Vishnu Murthy, Dean, School of Engineering	Member	Present
4	Dr. M Mutha Reddy, Dean, Examinations	Member	Present
5	Dr. PVN Prasad, Dean, Academic & Planning and Chairperson, BoS, EEE	Member	Present
6	Dr. Vasudha Bakshi, Dean, School of Pharmacy and Chairperson, BoS, Pharmacy	Member	Present
7	Dr. AV Sita Rama Raju, Chairperson, BoS, Mechanical Engineering & Director, IQAC	Member	Present
8	Dr. S Madhu, Head, Department of Mechanical Engineering	Member	Present
9	Dr. S Sathees Kumaran, Head, Department of ECE	Member	Present
10	Dr. M Anil Kumar, Head, Department of EEE	Member	Present
11	Dr. KS Reddy, Head, Department of IT & Chairperson, BoS, IT	Member	Present
12	Dr. M Mukunda Vani, Head, Department of Chemical Engineering & Chairperson, BoS Chemical Engineering	Member	Present

13	Dr. K Ramachandra Reddy, Chairperson, BoS, Civil Engineering	Member	Present
14	Dr. B Narender, Head, Department of Civil Engineering	Member	Present
15	Dr. G Sabitha, Chairperson, BoS, Business Management	Member	Present
16	Dr. Vishnu Vandana, Head, Department of Business Management	Member	Present
17	Dr. GS Anantha Lakshmi, Head, Department of English & Chairperson, BoS, English	Member	Present
18	Dr. V Srinivasa Rao, Chairperson, BoS, Mathematics	Member	Present
19	Dr. K Shiva Reddy, Head, Department of Mathematics	Member	Present
20	Dr. Savita Belwal, Head, Department of Chemistry & Chairperson, BoS Chemistry	Member	Present
21	Dr. M Srinivas Reddy, Head, Department of Physics &Chairperson, BoS Physics	Member	Present
Governing Body Nominees			
22	Dr. Shanta Thoutam, Innovation Director, T-Hub	Member	Present
23	Prof. E Sai Baba Reddy, Former Rector & Prof, Dept. of Civil Engineering, Jawaharlal Nehru Technological University, Hyderabad	Member	Present
24	Prof. BN Bhandari, Professor Dept. of ECE, Jawaharlal Nehru Technological University, Hyderabad	Member	Present
25	Dr. B Satyanarayana Reddy, MD, Nosch Labs, Hyderabad	Member	Present
Student Nominees			
26	Shri. Yeluri Kushal Vidya Mohanji, CSE III Year	Member	Present
27	Ms. B Sravanthi, ECE III year	Member	Present
Sponsoring Body Nominees			
28	Dr. P Rajeshwar Reddy, Chairman, GECT	Member	Present
29	Mrs. S Neelima, Managing Trustee, GECT	Member	Present
30	Mr. Palla Anurag, Trustee, GECT	Member	Present
31	Dr. KS Rao, Director AGI & Chairperson, BoS ECE	Member	Present
32	Dr. M Srinivasa Rao, Associate Professor, English, AGI	Member	Present
Vice - Chancellor Nominees			
33	Dr. M Sikindar Baba, Associate Professor, Department of Mechanical Engineering & Controller of Examination	Member	Present
34	Dr. Lakshmi Ramana, Associate Professor, Department of English	Member	Present
Registrar			

35	Dr. S Sameen Fatima, Registrar and Head, Dept of AI and Chairperson, BoS, AI	Member Secretary/ Member	Present
Invited Members			
36	Dr. UB Desai, Chancellor, Anurag University	Invitee	Present
37	Dr. Narayana Reddy, Dean and Professor, School of Agriculture	Invitee	Present
38	Dr. Anupama Ragireddy, Academic Coordinator, Anurag College of Engineering, Aushapur	Invitee	Present

On behalf of Anurag University, the Registrar welcomed all the members of the Academic Council and invitees to the second meeting of the Academic Council.

The Chairman, GECT, Dr.Palla Rajeshwar Reddy gave an overview of the accomplishments of Anurag University in the last academic year and thanked the teaching and non-teaching staff members for the same. He singled out two major achievements. One, increase in admission of students with around 1500 student enrolments across programmes. Two, substantial increase in placements and recruiters, with 5 companies offering over 100 placements each. The overall placements were around 1000 with better packages from the recruiters, compared to the previous years. He congratulated the entire placement team for their good performance. He added that these achievements would build the confidence in all the stakeholders, including students, teachers and parents. Though the institution has delivered its best during the pandemic, he opined that online teaching-learning methods need to be improved further by constantly updating oneself and establishing a Centre for Educational Technologies. He suggested that a committee be formed to look into the matter. He also stated that in the last academic year, new programs and additional sections were added in the School of Engineering. This academic year it is planned to start new programs in the School of Engineering, Agriculture, and Liberal Arts. In addition to M.Tech (AI) and MTech(Data Science) in the School of Engineering, a BTech Honors and Minor in (Cyber Security) can be offered with the help of the Police Department. Further, two or three programs each in BSc, BA, B.Com. and BBA can be offered in line with the requirements of the National Education Policy, 2020, with an exit option after 3, 4 and 5 years. To name a few, BSc (Agriculture), BSc (Maths, Statistics, AI), BSc (Maths, Statistics, Data Science). He also added that a new building is coming up which will help us in expansion and the girls' hostel was shifted out of its old premises, vacating the building, which can be used for starting undergraduate programs in Sciences, Arts and Commerce.

The Chancellor congratulated the teaching and non-teaching staff for their contributions to the growth of Anurag University. He also appreciated many academic and infrastructural initiatives that were undertaken. He concurred with the proposal to start new programs in Sciences and Liberal Arts, in addition to the existing disciplines. While appreciating introduction of Honors and Minor at BTech level, he suggested that the extra credits required to earn an Honors/Minor degree may be reduced to 16, from

18 to encourage students to opt for it. He also suggested that new Centres may be created, which would promote research, consultancy, in addition to helping in the teaching-learning process. To name a few, Education Technologies Centre, AI Centre, Cyber Security Centre, Public Policy/International Policy Centre. He cited the example of IIT, Bombay, where standalone Centres created earlier are now offering full-fledged MTech programs. He also expressed his pleasure on 50 students joining the PhD program. He explained the need for strengthening the research in Data Science as India is data-rich and it is likely that the number of data-dependent applications would grow. He further emphasised the need for training the students in the area of Cyber Security as there is a tremendous scope for employment. He also appreciated that Pharmacy was one of the strong schools of Anurag University and it can be strengthened further.

The Vice Chancellor also congratulated the teaching and non-teaching staff members for their contributions towards the growth of Anurag University in the last year. He also informed that there is a proposal to set up a Centre for Education Technologies to train teachers in online teaching to ensure better learning outcomes. He welcomed all the members, including two special invitees: Dr. Narayana Reddy, Professor, School of Agriculture & Dr. Anupama Ragireddy, Academic Coordinator, Anurag College of Engineering, Aushapur. The Vice Chancellor then took up the following agenda items for discussion:

Item 1: Confirmation of the Minutes of the 1st Meeting of the Academic Council held on 25.07.2020

Resolution 1: It was resolved to confirm the Minutes of the 1st Meeting of the Academic Council held on 25.07.2020

Item 2: Action taken on the decisions of the 1st Academic Council meeting

The Council noted the details of the action taken on the decisions of the 1st Academic Council meeting presented by the Vice Chancellor.

Item 3: Presentation of the Minutes of the Board of Studies (BoS), including course structure and syllabi, by the respective Chairpersons for discussion and approval.

Resolution 2: The following resolutions were made department-wise:

1. **Department of Artificial Intelligence (AI)**

Resolution 2.1(a): Resolved to approve the minutes of the Board of Studies including the following:

1. BTech (AI) Course Structure for 4 years and the syllabus for the 2nd Year.
2. BTech (AI&ML) Course Structure for 4 years and the syllabus for the 2nd Year.

3. BTech Honours in Cyber Security will be offered by the Department of Information Technology for BTech (AI) and BTech (AI&ML) branch students of 2020-21 batch onwards from the academic year 2021-22.
4. MTech (AI) Course Structure.
5. Starting PhD program under Computer Science and Engineering with specialization in Artificial Intelligence

Resolution 2.1(b): Resolved to recommend the following:

1. Considering growing importance of Artificial Intelligence and its potential for employment opportunities, the Department of AI will offer BTech Minor in AI (Artificial Intelligence) for BTech students of other departments. Accordingly, Chairperson, BoS (AI) is requested to prepare the scheme and syllabus of the same for approval in the next Academic Council Meeting.

2. Department of Chemical Engineering (Chem)

Resolution 2.2: Resolved to approve the minutes of the Board of Studies, including the following:

1. BTech (Chem) Course Structure for 4 years and the syllabus for the 2^{nd} Year.
2. To offer BTech (Chem) Honors in Green Tech. & Sustainability Engineering for BTech (Chem) students admitted in or after 2020-21 batch onwards from the academic year 2021-22.
3. To offer BTech Minor in Material Science & Engineering to students of other departments of 2020-21 batch onwards from the academic year 2021-22.
4. The structure for the proposed BTech Honors and Minor.

3. Department of Civil Engineering (Civil)

Resolution 2.3(a): Resolved to approve the minutes of the Board of Studies, including the following:

1. BTech (Civil) Course Structure for 4 years and the syllabus for the 2^{nd} Year.
2. MTech (Structural Engineering) Course Structure and syllabus.
3. To offer BTech (Civil) Honors in Smart City Planning and Development for the students of BTech (Civil) of 2020-21 batch onwards from the academic year 2021-22.
4. To offer BTech Minor in Smart City Planning to BTech students of other departments of 2020-21 batch onwards from the academic year 2021-22.
5. The structure for the proposed BTech Honors and Minor.

Resolution 2.3(b): Resolved to recommend the following:

1. To explore the possibility of offering the following post graduate programmes during the academic year 2021-22.
    a. MTech (Construction Technology and Management)
    b. MTech (Transportation Engineering)

4. Department of Computer Science & Engineering (CSE)

Resolution 2.4. Resolved to approve the minutes of the Board of Studies, including the following:

1. BTech (CSE) Course Structure for 4 years and the syllabus for the 2nd Year.
2. BTech (CSE with specialization in Cyber Security) Course Structure for 4 years and the syllabus for the 2nd Year.
3. BTech (CSE with specialization in Data Science) Course Structure for 4 years and the syllabus for the 2nd Year.
4. MTech (CSE) Course Structure and syllabus.
5. To start MTech (Data Science) from 2021-22.
6. To offer BTech Honors in Data Science for B.Tech (CSE), BTech (CSE with specialization in Cyber Security) and BTech (IT) students of 2020-21 batch onwards from the academic year 2021-22.
7. To offer BTech Minor in Computer Science and Engineering for BTech students belonging to departments other than CSE, IT and AI of 2020-21 batch onwards from the academic year 2021-22.
8. The structure for proposed BTech Honors and Minor.

5. Department of Electronics & Communication Engineering (ECE)

Resolution 2.5: Resolved to approve the minutes of the Board of Studies, including the following:

1. BTech (ECE) Course Structure for 4 years and the syllabus for the 2ndYear.
2. MTech (Embedded Systems) & MTech (VLSI) Course Structure and syllabus.
3. To offer BTech (ECE) Honors in AI for Signal Processing, BTech (ECE) Honors in Circuits & VLSI, and BTech (ECE) Honors in Embedded Systems & IoT for BTech (ECE) students of 2020-21 batch onwards from the academic year 2021-22.
4. To offer BTech Minor in Robotics for BTech students of other departments of 2020-21 batch onwards from the academic year 2021-22.
5. The structure for proposed BTech Honors and Minor.

6. Department of Electrical & Electronics Engineering (EEE)

Resolution 2.6: Resolved to approve the minutes of the Board of Studies, including the following:

1. BTech (EEE) Course Structure for 2^{nd}, 3^{rd} and 4^{th} years and the syllabus for the 2^{nd} Year.
2. MTech (Electrical Power Systems) Course Structure and syllabus.
3. To offer BTech (EEE) Honors in Electric Vehicles, and BTech (EEE) Honors in Smart Grids for BTech (EEE) students of 2020-21 batch onwards from the academic year 2021-22.
4. To offer BTech Minor in Electric Vehicles for BTech students of other departments of 2020-21 batch onwards from the academic year 2021-22
5. The structure for the proposed BTech Honors and Minor.

7. Department of Information Technology (IT)

Resolution 2.7(a): Resolved to approve the minutes of the Board of Studies, including the following:

1. BTech (IT) Course Structure for 4 years and the syllabus for the 2^{nd} Year.
2. To offer BTech Honors in Cyber Security for BTech (CSE), BTech (CSE with specialization in DS), BTech (IT), BTech (AI), BTech (AIML) students of 2020-21 batch onwards from the academic year 2021-22.
3. To offer BTech Minor in Information Technology for BTech students belonging to departments other than CSE, IT and AI of 2020-21 batch onwards from the academic year 2021-22
4. The structure for the proposed BTech Honors and Minor.

Resolution 2.7(b): Resolved to recommend the following:

1. Considering growing importance of Cyber Security and its potential for employment opportunities, the Department of IT will offer MTech (Cyber Security). Accordingly, Chairperson, BoS (IT) is requested to prepare the scheme and syllabus of the same for approval in the next Academic Council Meeting.

8. Department of Mechanical Engineering (Mech)

Resolution 2.8: Resolved to approve the minutes of the Board of Studies, including the following:

1. BTech (Mech) Course Structure for 4 years and the syllabus for the 2nd Year.
2. MTech (Machine Design) Course Structure and syllabus.
3. To offer BTech (Mech) Honors in Additive Manufacturing for BTech (Mech) students of 2020-21 onwards from the academic year 2021-22.
4. To offer Minor in 3D Printing for BTech students of other departments of 2020-21 batch onwards from the academic year 2021-22.
5. The structure for the proposed BTech Honors and Minor.

Item 4: Presentation of the "Amendments to the PhD Rules & Regulations" by Dean, R&D.

Resolution 3: It was resolved to include one external member in the Departmental Research Committee (DRC) from reputed educational institutions / industry nominated by Hon. Vice-Chancellor and ratify the formation of the Departmental Research Committees.

Resolution 4: It was resolved to include Research Paper Writing Process (RPWP) Course in place of Research Methodology course (100 Marks, 4credits), a common course to all the candidates admitted into the PhD program.

Item 5: Appointments Done (for information)

The Council noted the appointments of (i) Dr. P.V.N Prasad, Professor, Dept. of Electrical and Electronics Engineering as Dean, Academic & Planning; (ii) Dr. A. V. Sita Rama Raju, Professor, Dept. of Mechanical Engineering as Director, Internal Quality Assurance Cell (IQAC); and (iii) Dr. N. Venkata Ramana, Advisor to team, Universal India Private Limited as the Co-supervisor of Shri. Ramanujam IVR, PhD scholar in the Dept. of Civil Engineering.

Item 6: Redistribution of total credits and credit allocation for 'Comprehensive Viva-Voce' and 'Technical Paper Writing' in MTech program.

Resolution 5: The proposal to introduce Comprehensive Viva-Voce/Technical Paper Writing and redistribution of credits was not agreed to. However, it was resolved that a student should earn a total of 68 credits (Semester 1:21, Semester 2: 21, Semester 3: 12, Semester 4: 14) for the completion of MTech degree for the batches commencing from the academic year 2021-22.

Item 7: Any other matter with the permission of the Chair

Resolution 6: It was resolved to establish: (i) School of Agriculture, and (ii) Schools of Liberal Arts & Sciences from the academic year 2021-22.

Resolution 7: It was resolved to approve “in-principle” drafting of the Anurag University Start-up Policy, as requested by Head, Department of Business Management. Accordingly, Head is requested to submit a detailed proposal for further action and approval.

Resolution 8: It was resolved that IQAC will follow-up with all the stakeholders concerned and ensure complete preparedness for accreditation by both NBA and NAAC.

The meeting ended with a vote of thanks by the Registrar.

ITEM 2

ACTION TAKEN ON THE DECISIONS TAKEN IN THE 2nd MEETING OF ACADEMIC COUNCIL

Item 2: The following are the decisions taken in the 2nd meeting of the Academic Council and the action taken on them. The same is placed before the Academic Council for information and directions, if any.

Resolution 1: It was resolved to confirm the Minutes of the 1st Meeting of the Academic Council held on 25.07.2020

Action Taken: No action required.

Resolution 2: The minutes of the BoS in various faculties in the School of Engineering, program structure, syllabus for the programs proposed to be offered from the Academic Year 2021-22 were approved.

Action Taken: The same has been adopted into practice.

Resolution 3: It was resolved to include one external member in the Departmental Research Committee (DRC) from reputed educational institutions / industry nominated by Hon. Vice-Chancellor and ratify the formation of the Departmental Research Committees.

Action Taken: Accordingly, the Departmental Research Committees (DRCs) have been constituted.

Resolution 4: It was resolved to include Research Paper Writing Process (RPWP) Course in place of Research Methodology course (100 Marks, 4credits), a common course to all the candidates admitted into the PhD program.

Action Taken: Research Paper Writing Process (RPWP) Course has been included in place of Research Methodology course.

Resolution 5: The proposal to introduce Comprehensive Viva-Voce/Technical Paper Writing and redistribution of credits was not agreed to. However, it was resolved that a student should earn a total of 68 credits (Semester 1:21, Semester 2: 21, Semester 3: 12, Semester 4: 14) for the completion of MTech degree for the batches commencing from the academic year 2021-22.

Action Taken: The same has been adopted into practice.

Resolution 6: It was resolved to establish: (i) School of Agriculture, and (ii) Schools of Liberal Arts & Sciences from the academic year 2021-22.

Action Taken: The School of Agriculture has been established and the Dean and a professor have been appointed. Establishment of the Schools of Liberal Arts & Science is in process.

Resolution 7: It was resolved to approve "in-principle" drafting of the Anurag University Start-up Policy, as requested by Head, Department of Business Management. Accordingly, Head is requested to submit a detailed proposal for further action and approval.

Action Taken: A committee under the chairpersonship of Mr Lingireddy Ramakrishna Reddy, President, Auropro Systems (IT Company) and Member, BoM, Anurag University, has been set up to draft the policy.

Resolution 8: It was resolved that IQAC will follow-up with all the stakeholders concerned and ensure complete preparedness for accreditation by both NBA and NAAC.

Action Taken: Accordingly, the Director, IQAC has been communicated to take necessary steps.

ITEM 3

New academic programs proposed to be offered in and revised intake for academic year 2021-22

Existing Courses and Additional Intake

1. School of Agriculture

Program Level	Program	Specialisation	Intake approved for 2020-21	Intake applied for 2021-22
UG	B.Sc / B.Sc Honors	Agriculture	60	360

2. School of Engineering

Program Level	Program	Specialization	Intake approved for 2020-21	Intake applied for 2021-22
UG (Engg & Tech)	B. Tech	Chemical Engineering	60	60
		Civil Engineering	180	180
		Computer Science and Engineering	360*	540
		Electrical and Electronics Engineering	120	120
		Electronics & Communication Engineering	240	240
		Information Technology	180	180
		Mechanical Engineering	240	240
		Artificial Intelligence	120	120
		Artificial Intelligence with Machine Learning	60	120
		Computer Science & Systems Engineering	60	60
		Construction Technology & Management	60	60
		Computer Science and Engineering with Data Science	60	120
		Computer Science and Engineering with Cyber Security	60	120
Total			**1800**	**2160**
Postgraduate (Engg & Tech)	M. Tech	Computer Science and Engineering	36	36
		Structural Engineering	36	36
		VLSI System Design	36	36
		Embedded Systems	24	24
		Power Electronics & Electrical Drives	36	36
		Electrical Power Systems	18	18
		Machine Design	24	24

Total			210	210
Research	Ph. D	Chemical Engineering	04	04
		Civil Engineering	10	10
		Computer Science and Engineering	20	20
		Electrical & Electronics Engineering	10	10
		Electronics and Communication Engg.	20	20
		Information Technology	06	06
		Mechanical Engineering	10	10
		Mathematics	10	10
		Physics	10	10
		Chemistry	10	10
		English	10	10
Total			**120**	**120**

* The intake increased to 420 from 360 for the AY 2020-21. Ratification is sought for the same.

3. School of Liberal Arts

Program Level	Program	Specialization	Intake approved for 2020-21	Intake applied for 2021-22
UG	B.Com / B.Com Honors	Bachelor of Commerce	60	60
		Financial Technologies (FINTEC)	60	60
Total			**120**	**120**

4. School of Management

Program Level	Program	Specialization	Intake approved for 2020-21	Intake applied for 2021-22
Under Graduate	BBA	Digital Marketing	120	240
		Supply Chain Management		
		Business Analytics		
		Fintech		
PG	MBA	**Existing Specialisations**	120	240
		Finance		
		Marketing		

		Human Resource Management		
		New Specialisations		
		Operations Management		
		Business Analytics		
Research	Ph.D	Management	10	10

5. School of Pharmacy

Program Level	**Program**	**Specialization**	**Intake approved for 2020-21**	**Intake applied for 2021-22**
UG	B.Pharm	B. Pharmacy	**100**	**100**
PG	M.Pharm	Pharmacology	15	15
		Pharmaceutics	15	15
		Industrial Pharmacy	15	15
		Pharmaceutical Analysis	15	15
Total			**60**	**60**
UG	Pharma-D	Pharma-D	**30**	**30**
PG	Pharma-D (PB)	Pharma-D (PB)	**10**	**10**
Research	Ph.D	Pharmacy	**15***	**15**

6. School of Sciences

Program Level	**Program**	**Specialization**	**Intake approved for 2020-21**	**Intake applied for 2021-22**
Under Graduate	B.Sc	Maths, Physics, Computer Science	60	60
	B.Sc	Maths, Physics, Chemistry	60	60
	B.Sc	Maths, Statistics, Computer Science	60	60
Total			**180**	**180**

New Courses Proposed for 2021-22

Level	Programme	Specialization	Intake
School of Engineering			
PG (Engg & Tech)	M. Tech	Robotics and Automation	18
		Artificial Intelligence	18
		Cyber Security	18
		Data Science	18
		Digital Manufacturing	18
		Construction Technology & Management	18
		Total	**108**
Research	Ph.D	CSE with Specialization Artificial Intelligence	**10**
School of Liberal Arts			
UG	B.A. (Hons)	Mass Media & Communication	80
		Journalism & Mass Communication	80
		Total	**160**
UG	B.A / B.A (Hons)	Economics	160
		Business Economics	160
		Total	**320**
UG	B.Com. / B.Com. (Hons)	Computers	**280**
		Finance, Accounting and Taxation	
		Investment Management	
		Banking Financial Services	
		E Commerce	
		International Business	
		Business Analytics	
School of Pharmacy			
PG	M.Pharm.	Pharmaceutical Analysis & Regulatory Affairs	**15**
School of Sciences			
UG	B.Sc / B.Sc Honors	B.Sc. (Data Science)	160
		B.Sc. (Artificial Intelligence)	160
		Total	**320**
Grand Total			**1213**

ITEM 4

Presentation of the minutes of the Board of Studies (BoS), along with the course structure and syllabi of the programs to be offered by the School of Engineering from the academic year 2021-22, in:

Artificial Intelligence

The Department of Artificial Intelligence (AI), Anurag University sent email on 04-May- 2021, to all BoS members for the e-approval of the course structure and syllabus for M.Tech (AI) to be started from the academic year 2021 and Syllabus of B.Tech Minor in artificial intelligence

M.TECH (AI) I YEAR I SEM [5T+ 2L+1AC+1RM]

S. No	Category	Course Title	Hours Per Week			Credits
			L	T	P	
1	PCC-I	Algorithms for AI	3	0	0	3
2	PCC-II	Foundations of Machine Learning	3	0	0	3
3	PCC-III	Deep Learning and Neural Networks	3	0	0	3
4	PEC-I	1. Information Security 2. Digital Image Processing 3. Bio Inspired Algorithms 4. Knowledge Representation and Reasoning 5. Principles of Internet of Things 6. Applications of AI in e-governance (Industry oriented)	3	0	0	3
5	PEC-II	1. Block Chain Technology 2. Game Theory 3. Object Oriented Programming(Java) 4. Computer Systems 5. Social Network Analysis 6. Information Retrieval System	3	0	0	3
6	PCC	Research Methodology	2	0	0	2
7	AC	Audit Course 1. English for Professionals 2. Essential English and Employability Skills 3. Technical and Business Communication	2	0	0	0
8	PCC I-Lab	Foundations of Machine Learning Lab	0	0	4	2
9	PCC II-Lab	Deep Learning and Neural Networks Lab	0	0	4	2
		Total	**19**	**0**	**8**	**21**

M.Tech (AI) I YEAR II SEM [5T+ 2L]

S. No	Category	Course Title	Hours Per Week L	T	P	Credits
1	PCC-IV	Natural Language Processing	3	1	0	4
2	PCC-V	Data Wrangling and Visualization	3	1	0	4
3	PEC-III	1. Cloud Computing 2. Computer Vision 3. Computer based Optimization techniques 4. Web Mining 5. Foundations of Software Engineering 6. Sentiment Analysis	3	0	0	3
4	PEC-IV	1. Big Data 2. Mobile Applications & Development 3. Predictive Analytics with R 4. NoSQL Databases 5. Design and Analysis of Algorithms 6. Web Technologies	3	0	0	3
5	PEC IV Lab	1. Big Data Lab 2. Mobile Applications & Development Lab 3. Predictive Analytics with R Lab 4. NoSQL Databases Lab 5. Design and Analysis of Algorithms Lab 6. Web Technologies Lab	0	0	4	2
6	PCC-IV Lab	Natural Language Processing Lab	0	0	4	2
7	OEC	Communication Skill	3	0	0	3
		Total	**15**	**2**	**8**	**21**

M.Tech (AI) II YEAR I SEM

S. No	Category	Course Title	Hours Per Week			Credits
			L	T	P	
1		Dissertation	0	0	24	12
		Total	**0**	**0**	**24**	**12**

M.Tech (AI) II YEAR II SEM

S. No	Category	Course Title	Hours Per Week			Credits
			L	T	P	
2		Dissertation	0	0	28	14
		Total	**0**	**0**	**28**	**14**

w.e.f. 2021-2022

M.Tech (AI) I Year - I Sem	L	T / P / D	C
	3	0	3

Algorithms for AI

Prerequisites: Any programming language

Course Objectives:
To introduce the fundamental ideas of AI algorithms for processing and recognition of patterns, namely: dimensionality, distance metrics, clustering, error calculation, hill climbing, linear regression and discrete learning

Course Outcomes:
At the end of the course, the student will be able to
1. Normalize data and understand its significance,generate random number, use distance metrics
2. Cluster data and do error handling
3. Understand fundamentals of machine learning algorithms
4. Understand optimization and regression

Unit-I
Introduction to AI: Relationship to Human Brains, Modeling Input and Output, Classification and Regression, Time Series, Training
Normalization: What is Normalization? Reciprocal Normalization and Denormalization, Range Normalization and Denormalization

Unit-II
Distance Metrics: Vectors, Euclidean Distance, Manhattan Distance, Chebyshev Distance
Random Number Generation: Pseudorandom Number Generation, Linear Congruential Generator (LCG), Multiply With Carry (MWC), Mersenne Twister, Monte Carlo Method

Unit-III
K-Means Clustering: Clustering, Centroid, Unsupervised Training, K-Means
Error Calculation: Supervised Training, Sum of Squares Error (SSE), Mean Squares (MSE), Root Mean Squares, Data Sets

Unit-IV
Towards Machine Learning: Training a Polynomial, Greedy Random Training, RBF Functions, RBF Network Model
Optimization Training: Hill Climbing, Simulated Annealing, Nelder Mead

Unit-V
Discrete Optimization: Discrete vs. Continuous, The Knapsack Problem, The Traveling Salesman Problem
Linear Regression: Linear Regression, Generalized Linear Model (GLM), Link Function

Books:

1. Jeff Heaton, Artificial Intelligence for Humans, Volume 1_ Fundamental Algorithms. Heaton Research, Inc.
2. Steven S. Skiena. The Data Science Design Manual.Springer. 2017

Reference Books:

1. Myatt Glenn J, Johnson Wayne P.Making Sense of Data I. John Wiley & Sons. 2007
2. Myatt, Glenn J. Making Sense of Data II. John Wiley & Sons. 2007

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Foundations of Machine Learning

Course Objectives:
The main objective of this course is to teach the principles and foundations of machine learning algorithms

Course Outcomes:
At the end of the course, the student will be able to
1. Understand Basics of Machine Learning and its limitations
2. Understand Machine Learning Algorithms: supervised, unsupervised, bio-inspired
3. Understand Probabilistic Modeling and Association Rule Mining

Unit-I
Introduction: What does it mean to learn, Some canonical Learning Problems, The Decision Tree Model of Learning, Formalizing the Learning Problem [Reference 1], ID3 Algorithm [[Reference 2]
Limits of Learning: Data Generating Distributions, Inductive Bias, Not Everything is learnable, Underfitting and Overfitting, Separation of training and test Data, Models, parameters and Hyperparameters, Real World Applications of Machine Learning [Reference 1]
Geometry and Nearest Neighbors: From Data to Feature Vectors, k-Nearest Neighbors, Decision Boundaries, k-means Clustering, High Dimensions [Reference 1]

Unit-II
The Perceptron: Bio-inspired Learning, The Perceptron Algorithm, Geometric Interpretation, Interpreting Perceptron Weights, Perceptron Convergence and Linear Separability, Improved Generalization, Limitations of the Perceptron [Reference 1]
Practical Issues: Importance of Good Features, Irrelevant and Redundant Features, Feature Pruning and Normalization, Combinatorial Feature Explosion, Evaluating Model Performance, Cross Validation, Hypothesis Testing and Statistical Significance, Debugging Learning Algorithms, Bias Variance tradeoff [Reference 1]

Unit-III
Linear Models: The Optimization Framework for Linear Models, Convex Surrogate Loss Functions, Weight Regularization, Optimization and Gradient Descent, Support Vector Machines [Reference 1]
Probabilistic Modeling: Classification by Density Estimation, Statistical Estimation, Naïve Bayes Models, Prediction [Reference 1]

Unit-IV
Neural Networks: Bio-inspired Multi-Layer Networks, The Back-propagation Algorithm, Initialization and Convergence of Neural Networks, Beyond two layers, Breadth vs Depth, Basis Functions [Reference 1]

Unit-V

Unsupervised Learning: Clustering Introduction, Similarity and Distance Measures, Agglomerative Algorithms, Divisive Clustering, Minmum Spanning Tree [Reference 2]

Association Rules: Introduction, large Itemsets, Apriori Algorithm [Reference 2]

Text Books:

1. A Course in Machine Learning (CIML). Hal Daume III, 2017 (freely available online)
   http://ciml.info/
2. Data Mining: Introductory and Advanced Topics. Margaret H Dunham, Pearson Education, 2003

Reference Books:

1. Hands on Machine Learning with SciKit-Learn, Keras and Tensor Flow.AurélienGéron.O'Reily, 2019
2. Machine Learning with Python Cookbook. Chris Albo, O'Reily, 2018
3. Introduction to Machine Learning with Python: A guide. Andreas C Miller, Sarah Guido. O'Reily, 2017

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Foundations of Machine Learning - Lab

Objective:
The main objective of this laboratory is to put into practice the various machine learning algorithms for data analysis using Python and Weka.

ML Toolkits
Students are expected to learn
1. Scikit-learn(https://scikit-learn.org/) an open source machine learning Python library that supports supervised and unsupervised learning. It also provides various tools for model fitting, data preprocessing, model selection and evaluation, and many other utilities.
2. Weka (http://www.cs.waikato.ac.nz/ml/weka/)is another widely used ML toolkit.

Datasets
1. The sklearn.datasets package embeds small toy datasets. It includes utilities to load these datasets. It also includes methods to load and fetch popular reference datasets and features some artificial data generators. Students are expected to study and make use of these datasets
2. Weka also has provides various data sets.

References:

1. scikit-learn user guide.https://scikit-learn.org/stable//_downloads/scikit-learn-docs.pdf
2. Ian Witten, Eibe Frank, and Mark Hall, Chris Pal. DATA MINING: Practical Machine Learning Tools and Techniques, 4th Edition. Morgan Kaufmann.

Exercises
1. Write a Python program using Scikit-learn to split the iris dataset into 70% train data and 30% test data. Out of total 150 records, the training set will contain 120 records and the test set contains 30 of those records. Print both datasets
2. Write Python program to use sklearn'sDecisionTreeClassifier to build a decision tree for the sklearn's datasets. Implement functions to find the importance of a split (entropy, information gain, gini measure)
3. Write a Python program to implement your own version of the K-means algorithm. Then apply it to different datasets and evaluate the performance.
4. Design a perceptron classifier to classify handwritten numerical digits (0-9). Implement using scikit or Weka.
5. Write a Python program to classify text as spam or not spam using the Naïve Bayes Classifier
6. Use WEKA and experiment with the following classifiers: Association Rule Mining (Apriori), Agglomerative and Divisive Clustering.

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Deep Learning and Neural Networks

Course Objectives:

The main objective of this course is to introduce Deep Learning and Neural Networks using Keras.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the basics of deep learning
2. Understand the usage of tensors in deep learning
3. Understand gradient based optimization
4. Concepts on Neural networks and variants
5. Use Python deep-learning framework Keras, with Tensor-Flow as a backend engine.

Unit-I

Introduction: History, Hardware, Data, Algorithms

Neural Networks, Data representations for neural networks, Scalars (0D tensors), Vectors (1D tensors), Matrices (2D tensors), 3D tensors and higher-dimensional tensors, Key attributes,.

Unit-II

Manipulating tensors in Numpy,The notion of data batches, Real-world examples of data tensors, Vector data, Timeseries data or sequence data, Image data, Video data

Tensor operations: Element-wise operations, Broadcasting, Tensor dot,. Tensor reshaping, Geometric interpretation of tensor operations, A geometric interpretation of deep learning,

Unit-III

Gradient-based optimization, Derivative of a tensor operation, Stochastic gradient descent,. Chaining derivatives: the Backpropagation algorithm

Unit-IV

Neural networks: Anatomy, Layers, Models, Loss functions and optimizers

Unit-V

Introduction to Keras, Keras, TensorFlow, Theano, and CNTK

Recurrent neural networks: A recurrent layer in Keras, Understanding the LSTM and GRU layers

Text Book:

1. François Chollet. Deep Learning with Python. Manning Publications, 2018

Reference Books:

1. AurélienGéron. Hands on Machine Learning with SciKit-Learn, Keras and Tensor Flow.O’Reily, 2019

2. Andrew W. Trask. Grokking Deep Learning. Manning Publications, 2019

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Deep Learning and Neural Networks Lab

Objectives: The main objective of this lab is to develop deep learning models using Keras

Deep Learning Tools
Students are expected to learn Keras deep-learning framework (https://keras.io), which is open source and free to download. They should have access to a UNIX machine; though it's possible to use Windows, too. It is also recommended that they work on a recent NVIDIA GPU

Exercises:

Note: The exercises should following **Keras workflow** consisting of four steps
1. Define your training data: input tensors and target tensors
2. Define a network of layers (or *model*) that maps your inputs to your targets
3. Configure the learning process by choosing a loss function, an optimizer, and some metrics to monitor
4. Iterate on your training data by calling the fit() method of your model

Exercise 1:
Dataset:
IMDB dataset, a set of 50,000 highly polarized reviews from the Internet Movie Database. They're split into 25,000 reviews for training and 25,000 reviews for testing, each set consisting of 50% negative and 50% positive reviews. The IMDB dataset comes packaged with Keras
Binary Classification Task:
Build a network to classify movie reviews as positive or negative, based on the text content of the reviews.

Exercise 2:
Dataset:
Reuters dataset, a set of short newswires and their topics, published by Reuters in 1986. It's a simple, widely used toy dataset for text classification. There are 46 different topics; some topics are more represented than others, but each topic has at least 10 examples in the training set. Reuters dataset comes packaged as part of Keras.
Single-label Multi class Classification Task:
Build a network to classify Reuter's newswires into 46 mutually exclusive topics. Each data point should be classified into only one category (in this case, topic),. The problem is more specifically an instance of *single-label, multiclass classification*.

Exercise 3:
Dataset:
The Boston Housing Price dataset has an interesting difference from the two previous examples. It has relatively few data points: only 506, split between 404 training samples and 102 test samples. And each *feature* in the input data (for example, the crime rate) has a different scale. For instance, some values are proportions, which take values between 0 and 1; others take values between 1 and 12, others between 0 and 100, and so on.

Regression Task:
The two previous examples were classification problems, where the goal was to predict a single discrete label of an input data point. Another common type of machine-learning problem is *regression*, which consists of predicting a continuous value instead of a discrete label. You'll attempt to predict the median price of homes in a given Boston suburb in the mid-1970s, given data points about the suburb at the time, such as the crime rate, the local property tax rate, and so on.

2. More exercises can be defined on similar lines.

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Information Security

Prerequisites: Not required

Course Objectives:
The Main Objective of this course is to introduce Basics of Information Security and Cryptography along with Implementations of security in different layer.

Course Outcomes:
At the end of the course, the student will be able to
1. Demonstrate information security, in both management aspect and technical aspect.
2. Design symmetric and asymmetric cryptography applications.
3. Describe the importance of security in the real world through Applications
4. Illustrate various types of Intruders and Viruses
5. Understand of various types of security incidents and attacks, and learn methods to prevent, detect and react incidents and attacks..

UNIT-I
Information Security: Introduction, History of Information security, What is Security, CNSS Security Model, Components of Information System, Balancing Information Security and Access, Approaches to Information Security Implementation, The Security Systems Development Life Cycle.

UNIT-II
Cryptography: Concepts and Techniques, symmetric and asymmetric key cryptography, steganography, Symmetric key Ciphers: DES structure, DES Analysis, Security of DES, variants of DES, Block cipher modes of operation , AES structure, Analysis of AES , Key distribution Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Analysis of RSA, Diffie-Hellman Key exchange.

UNIT III:
Message Authentication and Hash Functions: Authentication requirements and functions, MAC and Hash Functions, MAC Algorithms: Secure Hash Algorithm, Whirlpool, HMAC, Digital signatures, X.509, Kerberos.

UNIT-IV:
Security at layers (Network, Transport, Application):IPSec, Secure Socket Layer(SSL), Transport Layer Security(TLS), Secure Electronic Transaction(SET), Pretty Good Privacy(PGP), S/MIME.

UNIT-V:
Intruders, Virus and Firewalls: Intruders, Intrusion detection, password management, Virus and related threats, Countermeasures, Firewall design principles, Types of firewalls.

Text Books:
1. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, 4th Edition, Cengage Learning.

2. William Stallings, Cryptography and Network Security, 7th Edition, 2017 Pearson Education.

Reference Books:

1. C K Shyamala, N Harini, Dr T R Padmanabhan, Cryptography and Network Security, 1st Edition, Wiley India,
2. Bernard Menezes, Network Security and Cryptography: Cengage Learning
3. AtulKahate, Cryptography and Network Security, 2nd Edition, McGraw Hill.

Reference Links:

1. http://www.cs.iit.edu/~cs549/cs549s07/lectures.htm
2. http://williamstallings.com/Extras/Security-Notes/
3. http://williamstallings.com/NetworkSecurity/styled/

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Digital Image Processing

Prerequisites: Mathematics

Course Objectives:

1. To introduce the concepts of image processing and basic analytical methods to be used in image processing.
2. To familiarize students with image enhancement and restoration techniques
3. To introduce segmentation and morphological processing techniques

Course Outcomes:

At the end of the course, the students will be able to:

1. Understand the fundamental concepts of digital image processing system.
2. Analyze the image noise models and enhancement techniques.
3. Comprehend the different image segmentation and restoration methodologies.
4. Analyze the concepts of colour image processing.
5. Apply morphological operations on binary images.

UNIT-I

Introduction: Definition, Pixel, Digital image representation, Types of images, Fundamental steps in image processing, image processing applications. Digital image processing operations – Basic relationships and distance metrics, Classification of image processing operations- Arithmetic operations, Logical operations.

UNIT – II

Image Enhancement and Restoration – Image quality and Need for image enhancement, image enhancement point operations, Histogram based techniques. Categories of Image Degradations- Image Restoration in the presence of noise only- Mean filters, order statistics filters.

UNIT-III

Image Segmentation: Introduction, classification of image segmentation algorithms, detection of discontinuities, edge detection- stages in edge detection, types of edge detectors, First-order edge detection operators, second-order derivatives filters, edge operator performance, edge linking algorithms, principle of thresholding.

UNIT –IV

Colour image processing: introduction, devices of colour imaging, colour image storage and processing, colour models-RGBColour Model, HSI Colour Models, HSV Colour Model, Colour Quantization, Image filters for colour images.

UNIT –V:

Image Morphology: Need for morphological processing Morphological operators: Erosion, Dilation, Opening & Closing, Hit-or-Miss transform, Basic morphological algorithms, Gray-scale morphology

Text Books:

1. S. Sridhar, Digital Image Processing, Oxford University Press, 2nd edition 2016.
2. D. Forsyth and J. Ponce, Computer Vision: A Modern Approach, Prentice Hall, 2ndEdition, 2015.
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.
4. Gonzalez R.C., Woods R.E, Digital image processing, Pearson, Prentice-Hall of India Pvt.Ltd. New Delhi, 3rd Edition, 2018

5. Jan Erik Solem, Programming Computer Vision with Python, O'Reilly ,1st Edition, 2012

Reference Books:

1. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine Vision, 4th Edition, Cengage Learning, 2013
2. Fundamentals of Digital Image Processing, by Anil K. Jain, Prentice- Hall of India Pvt. Ltd, New Delhi, 2002
3. Prince, Simon JD. Computer Vision: Models, Learning and Inference, Cambridge University Press, 1st Edition, 2012.

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Bio Inspired Algorithms

Pre-requisites: Not required

Course Objectives:

1. To Introduce algorithms based on nature
2. To Introduce evolutionaryalgorithms which allow multiple, potential solutions to compete, breed, and evolve

Course Outcomes:

At the end of the course, student will be able to:

1. Develop a population of solutions using nature inspired algorithms
2. Solving TSP using genetic algorithm
3. Understand speciation and genetic programming
4. Model grouping instinct in software using particle swarm and ant colony optimization
5. Understand cellular automation

UNIT - I

Population of solutions, Evaluate the effectiveness of the members of a population using scoring, Generate solutions for next generation using crossover and mutation

UNIT – II

GeneticAlgorithms, Optimization of fixed-length arrays through evolution, travelling salesman problem, predict iris species

UNIT – III

Genetic Programming, solution array foran evolutionary algorithm not a fixed length.Represent computer programs as trees to produce other programs. Speciation – divide population into different species

UNIT – IV

Particle Swarm Optimization – model grouping instinct in software to find best solution. Ant Colony Optimization – simulate the program to create pheromone trails to find an optimal solution.

UNIT –V

Cellular Automation – simple rules to produce patterns – human based genetic algorithm. Modeling problems – data science using nature inspired algorithms.

Text Book:

1. Jeff Heaton, Artificial Intelligence for Humans, Volume 2: Nature-Inspired Algorithms, 2014, Heaton Research, Inc., All Rights Reserved

Reference Book:

1.StephanOlariu, Albert Y. Zomaya, Handbook of Bioinspired Algorithms and Applications Chapman & Hall/CRC, 2006

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Knowledge Representation and Reasoning

Course Objectives:
The course introduces the principles of logic-based knowledge representation and reasoning, as well as other important symbolic approaches to representing and reasoning about knowledge, to represent uncertain or incomplete knowledge.

Course Outcomes:
At the end of the course student will be able to:
1. Understands theoretical knowledge about principles for logic-based representation and reasoning.
2. Understands production systems, frames, inheritance systems and approaches to handling uncertain or incomplete knowledge.

UNIT-I

Introduction: The Key Concepts: Knowledge, Representation, and Reasoning, The Role of Logic
The Language of First-Order Logic: Introduction, The Syntax, The Semantics, Interpretations, Denotation, Satisfaction and Models

UNIT -II

Expressing Knowledge: Knowledge Engineering,Vocabulary, Basic Facts, Complex Facts, Terminological Facts ,Entailments, Abstract Individuals, Other Sorts of facts
Resolution: The Propositional Case, Resolution Derivations, An Entailment Procedure, Handling Variables and Quantifiers, First-Order Resolution, Answer Extraction, Skolemization,
Equality.

UNIT -III

Reasoning with Horn Clauses: Horn Clauses, Resolution Derivations with Horn Clauses,
SLD Resolution, Goal Trees, Computing SLD Derivations, Backward Chaining, Forward
Rules in Production Systems: Production Systems: Basic Operation, Working Memory, Production Rules, An Example, Conflict Resolution

UNIT -IV

Object-Oriented Representation: Objects and Frames, A Basic Frame Formalism, Generic and Individual Frames, Inheritance, Reasoning with Frames, An Example: Using Frames to Plan a Trip, Inheritance: Inheritance Networks, Strict Inheritance, Strategies for Defeasible Inheritance, The Shortest Path Heuristic, Problems with Shortest Path, Inferential Distance, A Formal Account of Inheritance Networks

UNIT -V

Vagueness, Uncertainty, and Degrees of Belief:Noncategorical Reasoning, Objective Probability, The Basic Postulates, Conditional Probability and Independence, Subjective Probability, From Statistics to Belief, A Basic Bayesian Approach, Belief Networks, An Example Network, Influence Diagrams,Dempster–Shafer Theory, Vagueness, Conjunction and Disjunction, Rules, A Bayesian Reconstruction

Text Book:

1. Ronald J. Brachman, Hector J. Levesque. Knowledge Representation And Reasoning, Morgan Kauffman, Elsevier, Inc., 2004

Reference Book:

1. Stephen Lucci Danny Kopec. Artificial Intelligencein the 21ST Century. Mercury Learning and Information. 2016

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Principles of Internet of Things

Pre-requisites: Computer Networks, Python Programming

Course Objectives:

This course introduces Internet of Things and its applications in various Domains along with implementation of IOT with Arduino and Raspberry PI.

Course Outcomes:

At the end of the course, student will be able to:

1. Summarize the concepts of Internet of Things.
2. Interpret Domain specific Internet of Things Applications.
3. Develop programs for interfacing using Raspberry Pi.
4. Design basic IoTapplications using Arduino.
5. Recite the fundamentals of Robotics.

UNIT - I

Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs.

UNIT – II

Domain specific applications of IoT: Home automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and lifestyle.

UNIT - III

IoT Physical Devices and Endpoints: Introduction to Raspberry Pi-Interfaces (serial, SPI, I2C), Programming Raspberry PI with Python- Controlling LED with Raspberry PI, interfacing an LED and Switch with Raspberry PI and Interfacing a light sensor (LDR) with Raspberry PI.

UNIT - IV

Programming Arduino: Introduction, Arduino Boards, Programming-variables, if, loops, functions, digital inputs and outputs, the serial monitor, arrays and strings, analog inputs and outputs, using libraries, Arduino data types and commands. Programming Arduino Uno with Arduino- Controlling LED with Arduino, interfacing an LED and Switch with Arduino and Interfacing a light sensor (LDR) with Arduino.

UNIT - V

Introduction to Robotics: Classification, Advantages and Disadvantages, Components, Robot Joints, Robot Coordinates, Characteristics, Applications.Robotics Kinematics-Matrix representations.Actuators-Characteristics, Types of Actuators.Sensors-characteristics, types of sensors. (10 hours) Academic Project Work Submission using the Above Concepts.

Text Books:

1. ArshdeepBahga and Vijay Madisetti, Internet of Things - A Hands-on Approach, Universities Press, 2015.

2. Simon Monk, Programming Arduino Next Steps: Going Further with Sketches, Second Edition,2019.
3. Saeed B. Niku, Introduction to Robotics Analysis, Application, Pearson Education Asia,2001.

Reference Books:

1.The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).
2. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O'Reilly (SPD), 2014.

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Applications of AI in e-governance
(INDUSTRY ORIENTED)

The syllabus will be finalized after discussion with the industry

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Block Chain Technology

Prerequisites: Object Oriented Programming Through Java, Basic Knowledge Of Computer Securityand Data Structures

Course Objectives:

This course introduces Block Chain and its types, Design and Deployment through Ethereum, and Applications of Block Chain.

Course Outcomes:

At the end of the course, student will be able to:

1. Summarize types and applications of Blockchain
2. Illustrate the design and deployment of smart contract through Ethereum
3. Apply DApps through Truffle IDE
4. Apply Hyper Ledger Fabric model in different Networks
5. Categorize different Business Applications of Blockchain

UNIT I:
What is Blockchain: Definition, history,Digital Money to Distributed Ledgers.Why Blockchain: Properties of Blockchain, Requirements for consensus protocols, Proof of Work (PoW), Proof of Stake (PoS),Zero Knowledge Proofs, Byzantine Models, hashing, Merkle Tree,Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork ,Types of Blockchain.

UNIT II:
Ethereum Solidity: Introduction, Datatype, operator, enum, arrays, loops, Mapping, Structure, State Modifiers, Exception Handling in Solidity, Inheritance, Events, Self Destruction, ERC Tokens, Constructors, Libraries, Compile and Deploy the Smart Contract

UNIT III:
Truffle IDE: Creating user interface, textboxes, radio buttons, drop down list, developing a DApp, Publish the DApp Connecting to DApp, truffle migrate, truffle test. Multichain: Chain code (go) and MultiChain, Privacy and Permissions in MultiChain ,Mining in MultiChain, Multiple configurable Blockchains using MultiChain ,Setting up a Private Blockchain, Blockchain Bytes.

UNIT IV:
Hyperledger (go Lang): Introduction, architecture, Consensus, API, frameworks, setting up Development Environment using Composer, Developing and Testing business networks, Hyperledger Fabric Model Various ways to create Hyperledger Fabric Blockchain Network.

UNIT V:
Blockchain transforming business, Blockchain in governance.

Case Studies: Supply chain management, real estate, healthcare, Government sectors, bitcoin.

Text Book:

1. Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.

Reference Books :

1. BlockchainTechnology:ChandramouliSubramanian,Asha A George,Abhilash K A and MeenaKarthikeyan,Published by University Press
2. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos Blockchain by Melanie Swa, O'Reilly
3. Philipp Hacker, IoannisLianos (2019). **Regulating Blockchain: Techno-Social and Legal Challenges**, OUP Oxford. (ISBN-13: 978-0198842187).

Reference Links:

1. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
2. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits - https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html

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GameTheory

Prerequisites: Applied Mathematics

Course Objectives

1. To introduce some strategic considerations to take into account making their choices.
2. To learn basic concepts of game theory.
3. To apply game theoretic models to real world problems.

Course Outcomes:

At the end of this course, students will be able to:

1. Solve strategic games between two and more agents in non-cooperative scenario.
2. Analyze and solve both simultaneous-moves and sequential-moves games.
3. Learn different methods to solve games.

UNIT – I

Introduction: Game Theory, Games and Solutions Game Theory and the Theory of Competitive Equilibrium, Rational Behavior, The Steady State and Deductive Interpretations, Bounded Rationality Terminology and Notation Nash Equilibrium- Strategic Games, Nash Equilibrium Examples Existence of a Nash Equilibrium, Strictly Competitive Games, Bayesian Games: Strategic Games with Imperfect Information

UNIT – II

Mixed, Correlated, and Evolutionary Equilibrium: Mixed Strategy Nash Equilibrium Interpretations of Mixed Strategy Nash Equilibrium Correlated Equilibrium Evolutionary EquilibriumRationalizability and Iterated Elimination of Dominated Actions-Rationalizability Iterated Elimination of Strictly Dominated Actions, Iterated Elimination of Weakly Dominated Action**s**

UNIT – III

Knowledge and Equilibrium: A Model of Knowledge Common Knowledge, Can People Agree to Disagree? , Knowledge and Solution Concepts, The Electronic Mail Game

UNIT – IV

Extensive Games with Perfect Information: Extensive Games with Perfect Information Subgame Perfect Equilibrium Two Extensions of the Definition of a Game The Interpretation of a Strategy , Two Notable Finite Horizon Games , Iterated Elimination of Weakly Dominated Strategies Bargaining Games -Bargaining and Game Theory , A Bargaining Game of Alternating Offers Subgame Perfect Equilibrium Variations and Extensions

UNIT – V

Repeated Games : The Basic Idea Infinitely Repeated Games vs.\ Finitely Repeated Games Infinitely Repeated Games: Definitions Strategies as Machines Trigger Strategies: Nash Folk Theorems Punishing for a Limited Length of Time: A Perfect Folk Theorem for the Limit of Means Criterion Punishing the Punisher: A Perfect Folk Theorem for the Overtaking Criterion Rewarding Players Who Punish: A Perfect Folk Theorem for the Discounting Criterion The Structure of Subgame Perfect Equilibria Under the Discounting Criterion Finitely Repeated Game.

Text Books:

1. M. J. Osborne and A. Rubinstein, A course in Game Theory, MIT Press
2. Roger Myerson, Game Theory, Harvard University Press
3. D. Fudenberg and J. Tirole, Game Theory, MIT Press

Reference Books:

1. J. von Neumann and O. Morgenstern, Theory of Games and Economic Behavior, New York:n John Wiley and Sons.
2. R.D. Luce and H. Raiffa, Games and Decisions, New York: John Wiley and Sons.,
3. G. Owen, Game Theory, (Second Edition), New York: Academic Press,

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Object Oriented Programming (JAVA)

Prerequisites: Not required

Course Objectives:

This course introduces object oriented programming concepts, implementation of packages and

Interfaces and design of Graphical User Interface using applets and swing controls.

Course Outcomes:

At the end of the course, the students will be able to:

1. Understand the Object Oriented Programming concepts
2. Design programs using package and interfaces.
3. Apply the concepts of Exceptions and multithreading.
4. Develop GUI applications and AWT using Frames .
5. Design the programs using Applet and JDBC Concepts.

UNIT -I

Java Basics: History of Java, Java buzzwords, data types, variables, scope and life time of variables, arrays, operators, expressions, control statements, type conversion and costing, simple java program, concepts of classes, objects, constructors, methods, access control, this keyword, static keyword,garbage collection, overloading methods and constructors, parameter passing, recursion, nested and inner classes, Strings.

UNIT- II

Inheritance –Introduction, forms of inheritance- specialization, specification, construction, extension, limitation, combination, Member access rules, super uses, using final with inheritance

Polymorphism- method overriding, abstract classes, Object class Packages and Interfaces : Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, differences between classes and interfaces, File, Byte Streams, Character Streams.

UNIT- III

Exception handling - Concepts of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes. Package java.util- The Collection Interface, list interface, Queue interface, The Collection class: LinkedListClass, HashSetClass.TreeSetClass, StringTokenizer, Date, Random, Scanner.

Multi threading: Differences between multi threading and multitasking, thread life cycle, creating threads, thread priorities, synchronizing threads, inter thread communication.

UNIT- IV

Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes.

AWT: class hierarchy, component, container, panel, window, frame, graphics class, Layout Manager – layout manager types – boarder, grid, flow, card and grib bag.

UNIT- V

AWT controls: Labels, button, scrollbars, text components, check box, check box groups, choices, menu bar.
Applets – Concepts of Applets, differences between applets and applications, life cycle of an applet, create applets, passing parameters to applets.
JDBC Connectivity: JDBC Type 1 to 4 Drivers, connection establishment, QueryExecution.

Text Books:

1. Java- The Complete Reference, Seventh Edition, Herbert Schildt, Tata McGraw Hill, Year of Publication:2017
2. Database Programming with JDBC&JAVA, Second Edition,GeorgeReese, O'ReillyMedia, Year of Publication:2009

Reference Books:

1. Understanding OOP with Java, updated edition, T. Budd, Pearson Education.
2. Thinking in Java Fourth Edition, Bruce Eckel
3. Introduction to Java programming, Y. Daniel Liang, Pearson Education

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COMPUTER SYSTEMS

Prerequisites: Not required.
Course Objectives:

In this course, students will learn Basic concepts of Computer Networks and Operating Systems and its implementation.

Course Outcomes:

At the end of the course, students will be able to:
1. Illustrate the functionalities of various network models
2. Compare various congestion control mechanisms to improve the QoS of networking.
3. Summarize operating system and process management concepts.
4. Apply process scheduling and synchronization related issues.
5. Analyze effectively memory management concepts.

UNIT I

Networks and Data Communications: A simple view of Data Communications, Basic Data Communication concepts, Networks, Standards.

UNIT II

Ethernet and TCP/IP Networking: TCP/IP,OSI and other communication Protocol Models, Program Applications vs Networks Applications, The Physical and Data Link Layers, The Network Layer, The Transport Layer, IP Addresses, Domain Name and DNS Services, Quality of Service, Alternative Protocols.
Communication Channel Technology**:** The Fundamental of Signal Technology, Transmission Media and Signaling Methods, Alternative Technologies.

UNIT III

Operating Systems: The Barebones Computer System, Operating Systems-Concepts, Services, Organization, Types of Computer Systems.

The User View of Operating Systems: Purpose of User Interface, User Functions and Program Services, Types of User Interface, Services to Programs.

Unit IV

File Management: The Logical and Physical view of File, Logical File Access Methods, Physical File Storage, File Systems, Volume, Disks, Partitions and Storage Pools, The Directory Structure, Network File Access, Storage Area Networks, File Protections.

Unit V

The Internal of Operating Systems: Fundamental OS Requirements, The Bootstrap, Processes and Threads, Basic Loading and Execution Operations, CPU Scheduling and Dispatching, Memory Management, Virtual Storage, Secondary Storage Scheduling, Network Operating System Services, Other Operating System Issues, Virtual Machine.

Text Books:

1. Irv Englander, The Architecture of Computer Hardware and Systems Software: An Information Technology Approach, Wiley India Private Limited; Second edition

Reference Books:

1. Behrouz A. Forouzan, Data Communications and Networking, 4^{th} Edition, The McGraw-Hill Companies, Inc, 2007.
2. A. S. Tanenbaum , Computer Networks, 5^{th} Edition, Pearson Education/ PHI, New Delhi,2011.
3. India. Tanveer Siddiqui, US Tiwary, Natural Language Processing and Information Retrieval,Oxford University Press, 2008
4. Operating System Concepts, 9th edition Peter B. Galvin, Greg Gagne, AbrahamSilberschatz, John Wiley & Sons, Inc.
5. Modern Operating Systems -By Andrew S. Tanenbaum (PHI)
6. Operating Systems 5th Edition, William Stallings, Pearson Education India

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Social Network Analysis

Course Objectives:

This course introduces Social Network Properties, Evolution of Social Network and Applications in different social network platforms.

Course Outcomes:

After Completion of the course, the students should be able to

1. Work on the internals components of the social network
2. Model and visualize the social network
3. Mine the behavior of the users in the social network
4. Predict the possible next outcome of the social network
5. Apply social network in real time applications

UNIT I

Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.

UNIT II

Visualizing Online Social Networks - A Taxonomy of Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix- Based Representations- Node-Link Diagrams - Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.

UNIT III

Mining Communities - Aggregating and reasoning with social network data, Advanced Representations – Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks.

UNIT IV

Evolution in Social Networks – Framework - Tracing Smoothly Evolving Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing - Algorithms and Systems for Expert Location in Social Networks - Expert Location without Graph Constraints - with Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction – Bayesian Probabilistic Models - Probabilistic Relational Models.

UNIT V

Applications: A Learning Based Approach for Real Time Emotion Classification of Tweets, A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments, Explaining Scientific and Technical Emergence Forecasting, Social Network Analysis for Biometric Template Protection

Text Books:

1. Ajith Abraham, Aboul Ella Hassanien, VáclavSnášel, ―Computational Social Network Analysis: Trends, Tools and Research Advances‖, Springer, 2012
2. BorkoFurht, ―Handbook of Social Network Technologies and Applications‖, Springer, 1 st edition, 2011

Reference Books:

1. Charu C. Aggarwal, ―Social Network Data Analytics‖, Springer; 2014
2. Giles, Mark Smith, John Yen, ―Advances in Social Network Mining and Analysis‖, Springer, 2010.
3. Guandong Xu , Yanchun Zhang and Lin Li, ―Web Mining and Social Networking – Techniques and applications‖, Springer, 1st edition, 2012
4. Peter Mika, ―Social Networks and the Semantic Web‖, Springer, 1st edition, 2007.
5. PrzemyslawKazienko, NiteshChawla,‖Applications of Social Media and Social Network Analysis‖, Springer,2015

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InformationRetrievalSystems

Course Objectives:
This course introduces the fundamental issues of information retrieval with theoretical foundations.

Course Outcomes:
At the end of the course, the student will be able to

1. Understand indexing and querying in information retrieval systems
2. Describe the different models for information retrieval
3. Explain text classification and clustering
4. Understand web searching.

Unit-I

Boolean retrieval: An example information, Building an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval.
The term vocabulary and postings lists: Document delineation and character sequence decoding, Determining the vocabulary of terms, Faster postings list intersection via skip pointers, Positional postings and phrase queries.
Dictionaries and tolerant retrieval: Search structures for dictionaries, Wildcard queries, Spelling correction.
Index construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Other types of indexes.

Unit-II

Index compression: Statistical properties of terms in information retrieval, Dictionary compression, Postings file compression.
Scoring, term weighting and the vector space model: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, Variant tf-idf functions.
Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction.
Evaluation in information retrieval: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance.

Unit-III

Relevance feedback and query expansion: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation.

XML retrieval: Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. data-centric XML retrieval.
Probabilistic information retrieval: Basic probability theory, The Probability Ranking Principle, The Binary Independence Model.
Language models for information retrieval: Language models, The query likelihood model.

Unit-IV

Text classification and Naive Bayes: The text classification problem, Naive Bayes text classification, The Bernoulli model, Properties of Naive Bayes, Feature selection.
Vector space classification: Document representations and measures of relatedness in vector spaces, Rocchio classification, k nearest neighbor, Linear versus nonlinear classifiers.
Flat clustering: Clustering in information retrieval, Problem statement, Evaluation of clustering, k-means.
Hierarchical clustering: Hierarchical agglomerative clustering, Single-link and complete-link clustering, Group-average agglomerative clustering, Centroid clustering, Divisive clustering.

Unit-V

Matrix decompositions and latent semantic indexing: Linear algebra review, Term-document matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing.
Web search basics: Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling.
Web crawling and indexes: Overview, Crawling, Distributing indexes, Connectivity servers.
Link analysis: The Web as a graph, PageRank, Hubs and Authorities.

Text Book:

1. Christopher D. Manning, PrabhakarRaghavan, HinrichSchütze, An Introduction to Information Retrieval, Cambridge University Press, Cambridge, England, 2008

Reference Books:

1. David A. Grossman, Ophir Frieder, Information Retrieval – Algorithms and Heuristics, Springer, 2nd Edition (Distributed by Universities Press), 2004.
2. Gerald J Kowalski, Mark T Maybury. Information Storage and Retrieval Systems, Springer, 2000
3. SoumenChakrabarti, Mining the Web : Discovering Knowledge from Hypertext Data, Morgan-Kaufmann Publishers, 2002

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Research Methodology

Course Objectives:

1. To introduce research, methodology and steps involved in research
2. To learn to define a problem, and research hypothesis.
3. To learn the importance of literature survey, gaps and challenges
4. To learn to write technical report, paper and thesis
5. To know about intellectual property rights, ethics in research and plagiarism

UNIT-I

Meaning of Research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Approaches to Research, Quantitative vs. Qualitative Approach, Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs Theoretical Research, Importance of reasoning in research.

UNIT-II

Problem Formulation, Understanding Modeling & Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes

UNIT-III

Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results

UNIT-IV

Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents

UNIT-V

Intellectual property rights (IPR) - patents-copyrights-Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science

Text Books:

1. Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011
2. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers

Reference Books:

1. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3^{rd}Edition,Elsevier Inc.
2. Michael P. Marder," Research Methods for Science", Cambridge University Press, 2011
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age". Aspen Law & Business; 6 edition July 2012

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Natural Language Processing

Prerequisites: Machine Learning and Python programming

Course Objective:

The main objective of this course is to introduce NLP, morphological processing, syntactic parsing, information extraction, probabilistic NLP and classification of text using Python's NLTK Library.

Course Outcomes:

At the end of the course the student will be able to

1. Write Python programs to manipulate and analyze language data
2. Understand key concepts from NLP and linguistics to describe and analyze language
3. Understand the data structures and algorithms that are used in NLP
4. Classify texts using machine learning and deep learning

Unit-I

Language Processing and Python: Computing with Language: Texts and Words, A Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Back to Python: Making Decisions and Taking Control, Automatic Natural Language Understanding [Reference 1]

Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet [Reference 1]

Unit-II

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting: From Lists to Strings. [Reference 1]

Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, How to Determine the Category of a Word [Reference 1]

Unit-III

Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers [Reference 1]

Deep Learning for NLP: Introduction to Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks, Classifying Text with Deep Learning [Reference 2]

Unit-IV

Extracting Information from Text

Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction. [Reference 1]

Unit-V

Analyzing Sentence Structure

Some Grammatical Dilemmas, What's the Use of Syntax. Context-Free Grammar, Parsing with Context-Free Grammar, [Reference 1]

Text Books:

1. Natural Language Processing with Python. Steven Bird, Ewan Klein, and Edward Lope, O'Reily, 2009

2.Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Akshay Kulkarni, AdarshaShivananda, Apress, 2019

Reference Books:

1. Allen James, Natural Language Understanding, Benjamin/Cumming,1995.
2. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

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Natural Language Processing (Lab)

Objective: The main objective of this laboratory is to write programs that manipulate and analyze language data using Python.

Python Packages

Students are expected to know/ learn the following Python NLP packages

- NLTK (www.nltk.org/ (http://www.nltk.org/))
- Spacy (https://spacy.io/)
- TextBlob (http://textblob.readthedocs.io/en/dev/
- Gensim (https://pypi.python.org/pypi/gensim)
- Pattern (https://pypi.python.org/pypi/Pattern)

Datasets:

1. NLTK includes a small selection of texts from the Project Gutenberg electronic text archive, which contains some 25,000 free electronic books, hosted at *http://www.gutenberg.org/*.
2. The Brown Corpus contains text from 500 sources, and the sources have been categorized by genre, such as *news*, *editorial*, and so on (*http://icame.uib.no/brown/bcm-los.html*).
3. Wikipedia Articles

Or any other dataset of your choice

Text Book:

Jacob Perkins. Python 3 TextProcessing withNLTK 3 Cookbook. Packt Publishing. 2014

Exercises:

1. Text segmentation: Segment a text into linguistically meaningful units, such as paragraphs, sentences, or words. Write programs to segment text (in different formats) into tokens (words and word-like units) using regular expressions. Compare an automatic tokenization with a gold standard
2. Part-of-speech tagging: Label words (tokens) with parts of speech such as noun, adjective, and verb using a variety of tagging methods , e.g., default tagger, regular expression tagger, unigram tagger, and n-gram taggers.
3. Text classification: Categorize text documents into predefined classes using Naïve Bayes Classifier and the Perceptron model
4. Chunk extraction, or partial parsing: Extract short phrases from a part-of-speech tagged sentence. This is different from full parsing in that we're interested in standalone chunks, or phrases, instead of full parse trees
5. Parsing: parsing specific kinds of data, focusing primarily on dates, times, and HTML. Make use of the following preprocessing libraries:
   - dateutilwhich provides datetime parsing and timezone conversion
   - lxml and BeautifulSoupwhich can parse, clean, and convert HTML

- charade and UnicodeDammitwhich can detect and convert text character encoding

6. Sentiment Analysis: Using LibrariesTextBlob and nltk, give the sentiment of a document

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Data Wrangling and Visualization

Prerequisites: Python Programming

Course Objectives:

1. To introduce the basic concepts of data wrangling using Python
2. To obtain the input data from a variety of sources
3. To extract the data and convert it into representations suitable for data analytics
4. To visualize the data

Course Outcomes: At the end of this course, students will be able to:

1. Use the pandas library
2. Load, store data in different file formats
3. Clean and prepare the data
4. Plot and Visualize data
5. Do data aggregation

UNIT-I

Getting started with pandas: Introduction to pandas Data Structures, Series, Data Frame, Index Objects. Data Loading, Storage, and File Formats: Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data to Text Format, Working with Delimited Formats, JSON Data

UNIT-II

Data Loading, Storage, and File Formats:XML and HTML: Web Scraping, Binary Data Formats: Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Web APIs, Interacting with Databases

UNIT-III

Data Cleaning and Preparation:Handling Missing Data, Filtering Out Missing Data, Filling In Missing Data, Data Transformation, Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers, String Manipulation, String Object Methods, Regular Expressions

UNIT-IV

Plotting and Visualization: A Brief matplotlib API Primer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot,Saving Plots to File, matplotlib Configuration, Plotting with pandas and seaborn, Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots, Facet Grids and Categorical Data, Other Python Visualization Tools, Conclusion

UNIT-V

Data Aggregation and Group Operations:GroupBy Mechanics, Iterating Over Groups, Selecting a Column or Subset of Columns, Grouping with Dicts and Series, Grouping with Functions, Grouping by Index Levels, Data Aggregation, Column-Wise and Multiple Function Application, Returning Aggregated Data Without Row Indexes, Pivot Tables and Cross-Tabulation

Text Books:

1. Wes McKinney. Python for Data Analysis: Data Wrangling with pandas, NumPy and IPython. O'Reilly, 2017, 2nd Edition
2. Jacqueline Kazil and Katharine Jarmul.Data Wrangling with Python. O'Reilly, 2016

Reference Books:

3. Data Science Essentials in Python: Collect, Organize, Explore, Predict, Value. Dmitry Zinoriev, The Pragmatic Programmers LLC, 2016
4. TyeRattenbury, Joseph M. Hellerstein, Jeffrey Heer, Sean Kandel, and Connor Carreras.Principles of Data Wrangling: Practical Techniques for Data Preparation.O'Reilly, 2017
5. Python Data Analytics – Data Analysis and Science using Pandas, matplotlib and the Python Programming Language. Fabio Nelli, Apress, 2015

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Cloud Computing

Prerequisites: Computer organization and computer networks.

Course Objectives:

1. To understand the concepts of virtualization and its benefits
2. To impart fundamental concepts in the area of cloud computing.
3. To impart knowledge in applications of cloud computing.

Course Outcomes:

At the end of the course, the students will be able to:

1. Compare and contrast various cloud architectures.
2. Learn & Implement Virtualization.
3. Analyze and design storage mechanisms.
4. Apply security mechanism for the Cloud.
5. Discuss Disaster recovery in Cloud.

Unit I:

Introduction to Virtualization: Objectives of virtualization, history of virtualization, benefits of virtualized technology, the virtual service desk, what can be virtualized, related forms of computing, cloud computing, software as a service – SaaS, grid computing, utility computing, virtualization processes.Virtualization Technologies-I: Ubuntu (server edition),Altiris, Windows server, Software virtualization, VMware, Intel virtualization, Red Hat virtualization, Soft grid application, Linux virtualization, Desktop virtualization, Hardware virtualization, Resource virtualization, Processor virtualization, Application virtualization.

Unit II:

Virtualization Technologies-II: Storage virtualization, Virtualization density, Para-virtualization, OS virtualization, Virtualization software, Data Storage virtualization, Intel virtualization technology, Thinstall virtualization suite, Net framework virtualization, Windows virtualization on Fedora, Storage virtualization technologies, Virtualization level, Security monitoring and virtualization, Oracle virtualization.

Unit III:

Virtualization and Storage Management: The heart of cloud computing-virtualization, defining virtualization, why virtualize, what can be virtualized, where does virtualization happen, how does virtualization happen, on the road to storage virtualization, improving availability using virtualization, improving performance through virtualization, improving capacity through virtualization, business value for virtualization.

Unit IV:

Introduction to Cloud Computing: Cloud Introduction and overview- Components, Infrastructure and Services, Why Use Cloud Computing, Benefits and Limitations, Cloud Application Architectures, Cloud Infrastructure Models, Cloud Computing Technology- Hardware & Software Infrastructure

Cloud Computing Architecture: Requirements, Introduction to Cloud Computing Architecture, various kinds of Cloud Computing Architecture, Grid Computing, Transactional Computing, On Demand Computing, and Distributed Computing.

Unit V:

Security: Security issues in Cloud Computing - Data Security, Network Security, and Host Security

Disaster Recovery: Disaster Recovery Planning, Disasters in the Cloud, Disaster Management.

Scaling a Cloud Infrastructure- Capacity Planning, Cloud Scale.

Case Studies: Amazon S3, Google APP Engine, IBM Clouds, Oracle OBIEE

Text Books:

1. Ivanka Menken, Gerard Blokdijk ,Cloud Computing Virtualization Specialist Complete Certification Kit - Study Guide Book, 2009.
2. George Reese, Cloud Application Architectures Building Applications and Infrastructure in the Cloud, O'Reilly Media Press, 2009.

Reference Books:

1. Anthony T. Velte, Tobe J. Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Publication Person Education, 2009
2. Tom Clark, Storage Virtualization: Technologies for Simplifying Data Storage and Management, Addison-Wesley, 2005
3. Curtis Brian J.S. Chee, Cloud Computing Technologies and Strategies of the Ubiquitous Datacenter, 2010

Web Resource:

1. https://bibliotech2803.files.wordpress.com/2018/04/cloud-application-architectures-oreilly-media.pdf

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COMPUTER VISION

Prerequisite: Digital Image Processing.

Course Objectives:

1. To introduce fundamentals of image formation.
2. To introduce the major ideas, methods, and techniques of computer vision and pattern recognition
3. To develop an appreciation for various issues in the design of computer vision and object recognition systems

Course Outcomes:
At the end of the course, the students will be able to:
1. Demonstrate knowledge and understanding of Human and computer vision systems.
2. Understand current approaches to image formation and image modeling.
3. Analyze and design a range of algorithms for image processing and computer vision
4. Develop and evaluate solutions to problems in computer vision

Unit-I:

Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Unit-II:

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT

Unit-III:

Shape Representation and Segmentation: Shape Representation and Segmentation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and Wavelet Descriptors, Medial Representations, Multiresolution analysis.

Unit-IV:

Object Recognition: Hough transforms and other simple object recognition Methods, Shape Correspondence and Shape Matching, Shape priors for recognition.

Unit-V:

Motion Estimation: Regularization Theory, Optical Computation, Stereo Vision, Motion Estimation, Structure from Motion.

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

Reference Books:

`1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition,Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992

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Computer Based Optimization Techniques

Course Objectives:
This course introduces Linear Programming, various optimization techniques and their implementation.

Unit -I
Linear Programming: Mathematical formulation of Linear Programming problem, Canonical and standard forms of Linear Programming problem, Solution by Graphical and Simplex methods, Revised Simplex method, Two phase & Big M – method, Duality, Primal – Dual relationship, Dual Simplex method

Unit- II
Special Types of Linear Programming Problem: Transportation problem, Northwest corner method, Stepping stone method, Unbalanced transportation problem, Assignment problem, The Hungarian method

Unit- III
Integer Programming: Integer Linear Programming problem, Mixed Integer Linear Programming problem, Cutting Plane method, Branch and Bound Technique

Unit- IV
Dynamic Programming: Bellman's Principle of optimality, General theory of solving multistage decision problems using Dynamic Programming, Application of General Theory to specific problems such as the Traveling Salesman problem

TextBooks:
1. Christos H. Papadimitriou and Kenneth Steiglitz: Combinatorial Optimization (Algorithms and Complexity).
2. F S Hillier and G J Lieberman, Introduction to Operations Research, 7th edition, McGraw Hill, 2000
3. H A Taha, Operations Research – An Introduction, 8th Edition, Pearson Prentice Hall, 2007

Reference Books:
1. G Hadley, Linear Programming, Narosa Publishing
2. Harvir Singh Kasana and K D Kumar, Introductory Operations Research: Theory andApplications, Springer Science & Business Media, 2004

Suggested Assignments
Computer implementation of
1. Simplex method and its various other forms
2. Northwest corner method, Stepping stone method
3. Hungarian method
4. Cutting plane method
5. Recursive solution of travelling salesman problem using Dynamic Programming

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Web Mining

Prerequisite: Basic knowledge in database management system.

Course Objectives:

This course Introduces basics of Web Mining with different algorithms and its applications.

Course Outcome:

Student will be able to

1. Differentiate between Data Mining and Web Mining.
2. Apply the Classification and Clustering techniques for different data sets.
3. Determine models for Information retrieval methods.
4. Illustrate Web hyperlink analysis algorithms.
5. Invent and analyze patterns in clickstream and associated data collected.

Unit-I:

Introduction: Data Mining, Web Mining, World Wide Web, A Brief History of the Web and the Internet, Major issues in Data Mining.

Data Pre-processing: Needs for Pre-processing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction.

Mining Frequent Pattern: Associations and Correlations: Basic Concepts, Mining various kinds of Association Rules, Apriori Algorithm.

Unit-II:

Supervised Learning: Basic Concepts, Decision Tree Induction, Naïve Bayesian Classification, Support Vector Machines, K-Nearest Neighbor Learning.

Unsupervised Learning: Basic Concepts, K-means Clustering, Hierarchical Clustering, DBSCAN: Density-Based Spatial Clustering of Applications with Noise.

Unit-III:

Information Retrieval and Web Search: Basic Concepts of Information Retrieval, Information Retrieval Methods – Boolean Model, Vector Space Model and Statistical Language Model, Relevance Feedback, Evaluation Measures.

Web Search and Web Spamming: Meta search: Combining Multiple Rankings, Content Spamming, Link Spamming, Hiding Techniques, Combating spam.

Unit-IV:

Link Analysis : Link Analysis – Social Network Analysis, Co-Citation and Bibliographic Coupling, Page Rank Algorithm, HITS Algorithm

Web Crawling – A Basic Crawler Algorithm- Breadth First Crawlers, Preferential Crawlers, Implementation Issues – Fetching, Parsing, Stopword Removal, Link Extraction, Spider Traps, Page Repository, Universal Crawlers, Focused Crawlers, Topical Crawlers.

Unit-V:

Web Usage Mining – Data Collection and Preprocessing, Data Preprocessing, Data Modeling for Web Usage Mining, Discovery and Analysis of Web usage Patterns, Recommender Systems and Collaborative, Query Log Mining.

Text Books:

1. Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data by Bing Liu , Second Edition,Springer Publications, 2011.
2. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Second Edition, Elsevier, 2007.

Reference Books:

1. ArunK.Pujari , Data Mining Techniques,2nd Edition, Universities press, 2008.
2. Web Mining: Applications and Techniques by Anthony Scime,Idea Group Publishing, 2005.
3. www.w3.org

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Foundations of Software Engineering

Prerequisite: Any programming language

Course Objectives:

The main objective of this course is to introduce the basics of software engineering, types of software development projects in software industry and phases in the software development.

Course Outcomes:

At the end of this course, students will be able to:

1. Understand the emergence of software engineering and types of software development projects
2. Assess merits and demerits of software life cycle models and selecting appropriate model for a project
3. Learn the software project management practices and techniques essential for successful completion of a project
4. Learn the steps or phases involved in software development processes and its related artifacts
5. Learn about Agile Software Development practices and DevOps

UNIT- I

Introduction: Evolution from an Art Form to an Engineering Discipline, Software Development Projects, Emergence of Software Engineering: Notable Changes in Software Development Practices, Computer Systems Engineering

UNIT-II

Software Life Cycle Models: A Few Basic Concepts, Waterfall Model and its Extensions – (Iterative, V Model, Prototyping, Incremental, Evolutionary Model), Rapid Application Development (RAD), Spiral Mode, Comparison of Different Life Cycle Models and Selecting an Appropriate Life cycle Model for a Project

UNIT-III

Software Project Management: Software Project Management Complexities. Responsibilities of a Software Project Manager, Project Planning, Metrics for Project Size Estimation; Project Estimation Techniques: Introduction to COCOMO—A Heuristic Estimation Technique. Introduction to Halstead's Software Science—An Analytical Technique; Scheduling - Critical Path Method (CPM).PERT Charts. Gantt Charts; Risk Management, Software Configuration Management

Unit – IV

Phases of Software Development Processes, Requirements Analysis and Specification phase– Software Requirements Specification (SRS) Document, Functional requirements and Non Functional Requirements, Software Design phase – Cohesion and Coupling, Function Oriented Design (Data Flow Diagrams) and Object Oriented Design (Object Modelling using UML), Coding phase - Coding Standards and Guidelines. Code Review, .Software Documentation, Debugging, Testing Phase - Design Test Cases, Black-box Testing, White-Box Testing, Integration Testing, Smoke Testing, and Deployment Phase – Deployment Diagram, and Software Maintenance

Unit –V

Roles and Responsibilities – Business owner, Product Manager, Designers, Backend, Frontend, Quality Assurance, DevOps.Agile Development Methodologies- The agile philosophy, agile process models, agile project management, SCRUM, SPRINT

Text Books:

1. Rajib Mall (2014), Fundamentals of Software Engineering, PHI Learning
2. Olga Filipova, RuiVilao (2018) Software Development from A to Z_ A Deep Dive Into All the Roles Involved in the Creation of Software

Reference Books:

1. Pressman, R. S., (2009), Software Engineering: A Practitioner's Approach, Tata McGrawHill
2. Jalote, P., (2005), An Integrated Approach to Software Engineering, Narosa Publishing House
3. McConnell, S., (2014), Code Complete: A Practical Handbook of Software Construction (2nd Ed.), Microsoft Press
4. Ahmed, A., (2011), Software Project Management: A Process-Driven Approach, Auerbach Publications 6. Beck, K., (2002), Test Driven Development: By Example, Addison-Wesley Professional
5. Williams, L. & Kessler, R., (2002), Pair Programming Illuminated, Addison-Wesley Professional

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Sentiment Analysis

Course Objectives:

The main objective of this course is to Introduce Sentiment Analysis, Sentiment Classifications, Aspect based sentiment analysis and Sentiment Lexicon generation.

Course Outcomes:

After completion of the course, students would be able to:

1. Define Sentiment analysis.
2. Classify Sentiment in document.
3. Explain Aspect Based Sentiment analysis.
4. Generate Sentiment Lexicon.
5. Summarize Comparative Opinions.

Unit – I

Introduction: Sentiment Analysis Applications, Sentiment Analysis Research, Sentiment Analysis as mini NLP.The Problem of Sentiment Analysis: Definition of Opinion, Opinion Summarization, Affect, Emotion and Mood, Different Types of Opinions.Document Sentiment Classification: Supervised Sentiment Classification, Unsupervised Sentiment Classification, Sentiment Rating Prediction

Unit-II

Document Sentiment Classification: Cross-Domain Sentiment Classification, Cross-Language Sentiment Classification, Emotion classification of Documents.

Sentence Subjectivity and Sentiment Classification: Subjectivity, Sentence Sentiment Classification, Dealing with Conditional Sentences, Dealing with Sarcastic Sentences, Cross-language Subjectivity and Sentiment Classification, Using Discourse Information for Sentiment Classification, Emotion classification of sentences.

Unit-III

Aspect-based Sentiment Analysis: Aspect Sentiment Classification, Rules of sentiment Composition, Negation and SentimentAspect and Entity Extraction: Aspect Extraction, Entity, Opinion Holder and Time Extraction, Coreference Resolution and Word Sense Disambiguation.

Unit-IV

Sentiment Lexicon Generation: Dictionary-based Approach, Corpus-based Approach, Desirable and Undesirable Facts.Analysis of Comparative Opinions: Problem Definitions, Identifying the Preferred Entity Set, Entity and Aspect Extraction.Opinion Summarization and Search: Aspect based opinion summarization, Contrastive view summarization

Unit-V

Opinion Summarization and Search: Summarization of Comparative Opinions, Opinion Search, Existing Opinion retrieval Techniques.Mining Intentions: Problem of Intention Mining, Intention Classification, Fine-Grained Mining of Intentions.Opinion

Spam Detection: Types of Spam and Spamming, Supervised Spam Detection, Unsupervised Spam Detection, Group Spam Detection.

Text Books:

1. Sentiment Analysis – Mining Opinions, Sentiments, and Emotions in Text, Bing Liu, Cambridge University Press, 2015.
2. Sentiment Analysis and Opinion Mining, Bing Liu, Morgan and Claypool Publishers, 2012.

Reference Books:

1. Sentiment Analysis in Social Networks by Federico Alberto Pozzi, ElisabettaFersini, Enza Messina, Bing Liu, Morgan Kaufmann publications, 2017.
2. Foundations of Statistical Natural Language Processing 1st Edition, by Christopher D. Manning, HinrichSchütze, The MIT Press Cambridge, Massachusetts London, England, 1999
3. Natural Language Processing with Python, by Steven Bird, Ewan Klein and Edward Loper.

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Big Data

Prerequisites: Database management system, Java and Linux

Course Objectives:

This Course introduces Overview of Big Data, HADOOP, Map-Reduce Fundamentals and NoSQL databases.

Course Outcomes:

After completion of the course, students would be able to

1. Identify need of big data and various analytical tools
2. Analyze various components HDFS
3. Apply several data intensive tasks using Map-Reduce paradigm
4. Demonstrate the applications of Enterprise Data Science and data visualization tools [
5. Compare various NoSQL databases

UNIT – I

Getting an overview of Big Data: Introduction to Big Data, Structuring Big Data, Types of Data, Elements of Big Data, Big Data Analytics, Advantages of Big Data Analytics. Introducing Technologies for Handling Big Data: Distributed and Parallel Computing for Big Data, Cloud Computing and Big Data, Features of Cloud Computing, Cloud Deployment Models, Cloud Services for Big Data, Cloud Providers in Big Data Market.

UNIT – II

Understanding Hadoop Ecosystem: Introducing Hadoop, HDFS and MapReduce, Hadoop functions, Hadoop Ecosystem.Hadoop Distributed File System- HDFS Architecture, Concept of Blocks in HDFS Architecture, Namenodes and Datanodes, Features of HDFS. MapReduce.

Introducing HBase- HBase Architecture, Regions, Storing Big Data with HBase, CombiningHBase and HDFS, Features of HBase, Hive, Pig and Pig Latin, Sqoop, ZooKeeper, Flume, Oozie.

UNIT- III

Understanding MapReduce Fundamentals and HBase: The MapReduceFramework ,Exploring the features of MapReduce, Working of MapReduce, Techniques to optimize MapReduce Jobs, Hardware/Network Topology, Synchronization, File system, Uses of MapReduce, Role of HBase in Big Data Processing- Characteristics of HBase.

Understanding Big Data Technology Foundations: Exploring the Big Data Stack, Data Sources Layer, Ingestion Layer, Storage Layer, Physical Infrastructure Layer, Platform Management Layer, Security Layer, Monitoring Layer, Visualization Layer.

UNIT – IV

Storing Data in Databases and Data Warehouses: RDBMS and Big Data, Issues with Relational Model, Non – Relational Database, Issues with Non Relational Database, Polyglot Persistence, Integrating Big Data with Traditional Data Warehouse, Big Data Analysis and Data Warehouse.

UNIT – V

NoSQL Data Management: Introduction to NoSQL, Characteristics of NoSQL, History of NoSQL, Types of NoSQL Data Models- Key Value Data Model, Column Oriented Data Model, Document Data Model, Graph Databases, Schema-Less Databases, Materialized Views, CAP Theorem.

Text Book:

1. BIG DATA, Black Book TM, DreamTech Press, 2016 Edition.

Reference Books:

1. Seema Acharya, SubhasniChellappan , "BIG DATA and ANALYTICS", Wiley publications, 2016
2. Nathan Marz and James Warren, "BIG DATA- Principles and Best Practices of Scalable Real-Time Systems", 2010

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Big Data Lab

Objectives:

- Installation and understanding of working of HADOOP
- Understanding of MapReduce program paradigm.
- Writing programs in Python using MapReduce
- Understanding working of Pig, Hive
- Understanding of working of Apache Spark Cluster

1. Setting up and Installing Hadoop in its two operating modes:
    - Pseudo distributed,
    - Fully distributed.
2. Implementation of the following file management tasks in Hadoop:
    - Adding files and directories
    - Retrieving files
    - Deleting files
3. Implementation of Word Count Map Reduce program
    - Find the number of occurrence of each word appearing in the input file(s)
    - Performing a MapReduce Job for word search count (look for specific keywords in a file)
4. Map Reduce Program for Stop word elimination:
    - Map Reduce program to eliminate stop words from a large text file.
5. Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record-oriented. Data available at: https://github.com/tomwhite/hadoop- book/tree/master/input/ncdc/all.
    - Find average, max and min temperature for each year in NCDC data set?
    - Filter the readings of a set based on value of the measurement, Output the line of input files associated with a temperature value greater than 30.0 and store it in a separate file.
6. Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data.
7. Write a Pig Latin script for finding TF-IDF value for book dataset (A corpus of eBooks available at: Project Gutenberg)
8. Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.
9. Install, Deploy & configure Apache Spark Cluster. Run apache spark applications using Scala.
10. Perform Data analytics using Apache Spark on Amazon food dataset, find all the pairs of items frequently reviewed together.

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Mobile Applications and Development

Prerequisites: Object Oriented Programming (Java).

Course Objectives:

- To facilitate students to understand android SDK.
- To help students to gain a basic understanding of Android application development
- To inculcate working knowledge of Android Studio development tool

Course Outcomes:

After completion of the course, students would be able to

1. Analyze the architecture of android and current trends in mobile operating systems.
2. Apply suitable software tools and APIs for the design of User Interfaces to a particular mobile application.
3. Design applications for mobile devices using SQLite Database.
4. Apply the location-based services in android applications.
5. Summarize the Monitoring changes to the phone, network, data connectivity and SIM states.

UNIT I:

Introduction To Android: Features of Android, The development framework: Understanding the Android Software Stack, Android Application Architecture; the Dalvik Virtual Machine, Creating First Android Application, Types of Android Applications, Android Development Tools: The Android Virtual Device Manager, Android Emulator, The Dalvik Debug Monitor Service.

UNIT II:

Creating applications and Activities: Introduction to the application Manifest File, Using the Manifest Editor, Externalizing Resources: Creating Resources - Simple Values, Drawables, Layouts, Menus, Animations.The Android Activity Life cycle.Building User Interfaces: Fundamental Android UI design, Introducing Layouts: Defining Layouts, Using Layouts to Create Device Independent User Interfaces, Optimizing Layouts.

UNIT III:

Databases and Content Providers: Introduction to Android Databases, Introducing SQLite, Content Values and Cursors, working with SQLite Databases - Introducing the SQLiteOpenHelper, querying a Database, Extracting Values from a Cursor, Adding, Updating, and Removing Rows, Creating Content Providers, Using Content Providers

- Introducing the Content Resolver, Querying Content Providers, Adding, Deleting, and Updating Content

UNIT IV:

Maps and Location based services: Using the location-based services, selecting a Location Provider, selecting a Location provider, finding current location; Creating Map-Based Activities: Introducing Map View and Map Activity, Creating a Map-Based Activity, Maps and Fragments

UNIT V:

Telephony and SMS: Using telephony - Initiating Phone Calls, Accessing Telephony Properties and Phone State, Monitoring Changes in Phone State Using the Phone State Listener, Introducing SMS and MMS - Using SMS and MMS in Your Application, Sending SMS and MMS from Your Application Using Intents, Sending SMS Messages Using the SMS Manager.

Text Book:

1. Reto Meier, Professional Android 4 Application Development, 1^{st}Edition, Wrox Press, Wiley Publishing, 2014.

Reference Books:

1. Pradeep Kothari, Android Application Development (with Kitkat Support), Black Book, 2014, Dreamtech Press publisher, Kogent Learning Inc., 2014
2. Erik Hellman, Android Programming: Pushing the Limits, 1st Edition, Wiley Publications, 2014.
3. Mike Wolfson, Android Developer Tools Essentials, O'Reilly Edition, 1st Edition, 2013.

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Mobile Application and Development Lab

Course Outcomes:
At the end of this Mobile Application Development Lab course, students will be able to:
1. Develop user interfaces for the Android platform.
2. Implement various mobile applications using Emulators.
3. Create a database for mobile applications using SQLite Database.
4. Perform location-based services in android applications.
5. Create telephony and SMS for android applications.

List of Experiments:

1. Develop an Application that Uses GUI Components, Font and Colors
2. Develop an Application that Uses Layout Managers and Event Listeners.
3. Develop a Native Calculator Application.
4. Write an Application that Draws Basic Graphical Primitives on The Screen.
5. Develop an Application that Makes Use of Database.
6. Develop a Native Application that Uses GPS Location Information.
7. Implement an Application that Writes Data to The SD Card.
8. Implement an Application that Creates an Alert Upon Receiving A Message.
9. Write a Mobile Application that Creates Alarm Clock

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Predictive Analytics with R Programming

Prerequisites: Basics of Statistics, Machine Learning andBasic knowledge in any Programming language

Course Objectives:
The main objective of this course is to introduce basics of R Programming and usage of R to visualize result in terms of Graphics and Tables.

Course Outcomes:
After successful completion of the course, students should be able to

1. Understand the basics in R programming in terms of constructs, control statements, functions,
2. Access online resources for R and import new function packages into the R workspace
3. Import, review, manipulate and explore ,summarize data-sets in R
4. Apply the R programming from a statistical perspective
5. Apply R Graphics and Tables to visualize results of various Statistical operations on data.

Unit I
Basics of R: Introduction, R-Environment Setup, Help functions in R, Vectors – Scalars – Declarations
Basic Data Types: Vectors – Scalars – Declarations, Creating and Naming Vectors, Vector Arithmetic, Vector Sub setting,
Matrices**:**Creating matrices – Matrix operations – Applying Functions to Matrix Rows and Columns – Adding and deleting rows and columns – Vector/Matrix Distinction – Arrays -Class.

Unit II
Factors: Introduction to Factors: Factor Levels, Summarizing a Factor, Ordered Factors, Comparing Ordered Factors, Common functions used with factors
Data Frame: Creating Data Frames – Matrix-like operations in frames – Merging Data Frames – Applying functions to Data frames – Sub setting of Data Frames, Extending Data Frames, Sorting Data Frames.
Lists: Creating a Named List, Accessing List Elements, Manipulating List Elements, Merging Lists, Converting Lists to Vectors, applying functions to lists
Conditionals and Control Flow:Arithmetic and Boolean operators and values, Relational Operators, Relational Operators and Vectors, Logical Operators, Logical Operators and Vectors, Conditional Statements.

Unit III
Iterative Programming in R: Introduction, While Loop, For Loop, Looping Over List. Functions in R: Introduction, Writing a Function in R, Nested Functions, Function Scoping, Recursion, Loading an R Package, Mathematical Functions in R, Cumulative Sums and Products, Calculus in R, Input and Output Operations.

Unit IV
Apply Family in R : Introduction, Using Apply in R, Using Lapply in R, Using Sapply, Using Tapply in R: Split Function, Using Mapply in R,
Charts and Graphs : Introduction, Pie Chart: Chart Legend, 3D Pie Chart, Bar Chart, Box Plot, Histogram, Line Graph: Multiple Lines in Line Graph, Scatter Plot.

Unit V
Data Interfaces: Introduction, CSV Files: Syntax, Importing a CSV File, Excel Files: Syntax, Importing an Excel file, Binary Files: Syntax, XML Files, Web Data, Databases.
Statistical Applications: Introduction, Basic Statistical Operations, Linear Regression Analysis, Chi-Squared Goodness of Fit Test, Chi-Squared Test of Independence, Multiple Regression, Time Series Analysis.

Text Book:

1. K G Srinivas ,G M Siddesh "Statistical programming in R", Oxford Publications.

Reference Books:

1. Mark Gardener, Beginning R: The Statistical Programming Language, Wrox
2. Y. Anchang Zhao: R and Data Mining: Examples and Case Studies . Elsevier in December 2012
3. Avril Coghlan : A Little Book of R For Time Series

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Predictive Analytics with R Programming Lab

Prerequisites: Not required

Course Objectives :

1. To learn and apply R programming
2. To Get exposure on various R data types
3. To apply appropriately the iterative programming concepts
4. To apply visualization tools
5. Understand and apply regression models for Predictive Analytics

Course Outcomes :

Student will able to :

1. Install and Explore R environment
2. Apply appropriate data types and operators
3. Apply iterative programming concepts using various R functions
4. Visualize data insights using data visualization
5. Analyze data with Regression Model.

List of Programs:

1. Installation and Environment set up R and Rstudio
2. Experiments on Vector Arithmetic operations
3. Experiments on Matrices operations
4. Experiments on Arrays
5. Experiments on Factors
6. Experiments on Data Frames
7. Experiments on List operations
8. Experiments on Logical operations and Conditional Statements
9. Experiments on looping over lists
10. Experiments on nested functions and function scoping
11. Experiments on mathematical functions
12. Experiments on statistical functions in R
13. Experiments on lapply, sapply and apply functions.
14. Experiments on data visualization using charts and graphs
15. Experiments on Predictive Analytics using regression models

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NoSQL Databases

Prerequisites: Database Management System.

Course Objective:
The main objective of this course is to cover core concepts of NoSQL databases, along with an example database for each ofthe key-value, document, column family, and graph databases

Course Outcomes:
At the end of the course the student will be able to
1. Understand the need for NoSQL databases and their characteristics
2. Understand the concepts of NoSQL databases
3. Implement the concepts of NoSQL databases using four example databases: Redis for key-value databases, MongoDB for document databases, Cassandra for column-family databases, and Neo4J for graph databases.

UNIT-I

Why NoSQL: The Value of Relational Databases, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL
Aggregate Data Models: Aggregates, Column-Family Stores, Summarizing Aggregate-Oriented Databases
More Details on Data Models: Relationships, Graph Databases, Schemaless Databases, Materialized Views, Modeling for Data Access

UNIT-II

Distribution Models: Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication
Consistency: Update Consistency, Read Consistency, Relaxing Consistency, Relaxing Durability, Quorums

UNIT-III

Version Stamps: Business and System Transactions, Version Stamps on Multiple Nodes
Map-Reduce: Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations

UNIT-IV

Key-Value Databases: What Is a Key-Value Store, Key-Value Store Features, Suitable Use Cases, When Not to Use

Document Databases: What Is a Document Database, Features, Suitable Use Cases, When Not to Use

UNIT-V

Column-Family Stores: What Is a Column-Family Data Store, Features, Suitable Use Cases, When Not to Use
Graph Databases: What Is a Graph Database, Features, Suitable Use Cases, When Not to Use

Text Book:

1. Pramod J. Sadalage, Martin Fowler.NoSQL Distilled, Addison Wesley 2013

Reference Books:

1. Luc Perkins, Eric Redmond, Jim R. Wilson. Seven Databases in Seven Weeks. The Pragmatic Bookshelf, 2018
2. Guy Harrison. Next Generation Databases: NoSQL, NewSQL, and Big Data.Apress, 2015

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NoSQL Databases Lab

Objective:
The main objective of this lab is to become familiar with the fourNoSQL databases: Redis for key-value databases, MongoDB for document databases, Cassandra for column-family databases, and Neo4J for graph databases

NoSQL Databases:
Redis (http://redis.io)
MongoDB (http://www.mongodb.org)
Cassandra (http://cassandra.apache.org)
Neo4j (http://neo4j.com)

Exercises:

1. Installation of NoSQL Databases: Redis,MongoDB, Cassandra, Neo4j on Windows & Linux
2. Practice CRUD (*Create*, *Read*, *Update*, and *Delete)* operations on the four databases: Redis,MongoDB, Cassandra, Neo4j
3. Usage of Where Clause equivalent in MongoDB
4. Usage of operations in MongoDB – AND in MongoDB, OR in MongoDB, Limit Records and Sort Records. Usage of operations in MongoDB – Indexing, Advanced Indexing, Aggregation and Map Reduce.
5. Practice with ' macdonalds ' collection data for document oriented database. Import restaurants collection and apply some queries to get specified output.
6. Write a program to count the number of occurrences of a word using MapReduce

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Design and Analysis of Algorithms

Prerequisites: Data Structures

Course Objectives:

- To teach paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.
- To make students understand how the worst-case time complexity of an algorithm is defined, how asymptotic notation is used to provide a rough classification of algorithms.
- To explain different computational models (e.g., divide-and-conquer), order notation and various complexity measures (e.g., running time, disk space) to analyze the complexity/performance of different algorithms.
- To teach various advanced design and analysis techniques such as greedy algorithms, dynamic programming & Know the concepts of tractable and intractable problems and the classes P, NP and NP-complete problems.

Course Outcomes:

At the end of this course, students will be able to:

1. Formulate the knowledge of algorithm analysis and its notations that are applied on the problems solved by divide and conquer paradigm.
2. Design the major graph algorithms for model engineering problems and knowledge of the greedy paradigm
3. Apply the dynamic-programming paradigm and recite algorithms that employ this paradigm.
4. Illustrate the concept of back tracking, branch and bound paradigm for real time problems.
5. Analyze the complexity of problems and differentiate that in terms of P and NP problems with examples.

UNIT I

Introduction: Algorithm, Pseudo code for expressing algorithms, Performance Analysis-Space complexity, Time complexity, Asymptotic Notation- Big oh notation, Omega notation, Theta notation and Little oh notation, Disjoint Sets- disjoint set operations, union and find operations

Divide and conquer: General method, applications-Binary search, Quick sort, Merge sort.

UNIT II

Graphs: breadth first search, depth first search, spanning trees, connected and bi connected components.Greedy method: General method, applications-

Job sequencing with deadlines, 0/1 knapsack problem, Minimum cost spanning trees, Single source shortest path problem.

UNIT III

Dynamic Programming: General method, Multi stage graph, applications-Matrix chain multiplication, Optimal binary search trees, 0/1 knapsack problem, All pairs shortest path problem, Travelling sales person problem.

UNIT IV

Backtracking: General method, applications-n-queen problem, sum of subsets problem, graph colouring, Hamiltonian cycles.
Branch and Bound: General method, applications - Travelling sales person problem,0/1 knapsack problem- LC Branch and Bound solution, FIFO Branch and Bound solution.

UNIT V

Lower Bound Theory: Comparison Trees, NP-Hard and NP-Complete problems: Basic concepts, non-deterministic algorithms, NP - Hard and NP Complete classes, Clique Decision Problem(CDP), Node cover decision problem.

Text Books:

1. Ellis Horowitz, SatrajSahni and Rajasekharam, Fundamentals of Computer Algorithms, Galgotia publications pvt.Ltd, Second Edition, 2007.
2. Thomas H. Cormen,Charles E. Leiserson,Ronald L. Rivert and Clifford Stein, Introdution to Algorithms, Third Edition ,PHI Learning Private Limited , Eastern Economy Edition, 2008.

Reference Books:

1. Aho, Ullman and Hopcroft, Design and Analysis of algorithms, Pearson education, Reprint 2002
2. R.C.T. Lee, S.S. Tseng, R.C.Chang and T.Tsai,Introduction to Design and Analysis of Algorithms A strategic approach, Mc Graw Hill,2005.
3. Allen Weiss, Data structures and Algorithm Analysis in C++,Third edition, Pearson education.

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Design and Analysis of Algorithms Lab

Course Objectives: The course should enable the students to:

1. Learn how to analyze a problem and design the solution for the problem.
2. Design and implement efficient algorithms for a specified application.
3. Strengthen the ability to identify and apply the suitable algorithm for the given real world problem.

Week-1: Quick Sort:Sort a given set of elements using the quick sort method and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the 1st to be sorted and plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.
Week-2: Merge Sort: Implement merge sort algorithm to sort a given set of elements and determine the time required to sort theelements. Repeat the experiment for different values of n, the number of elements in the list to be sortedand plot a graph of the time taken versus n. The elements can be read from a file or can be generatedusing the random number generator.
Week-3: Implement 0/1 Knapsack problem using Dynamic Programming.
Week-4: From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra'salgorithm.
Week-5: Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.
Week-6: Perform various tree traversal algorithms for a given tree.
Week-7: Print all the nodes reachable from a given starting node in a digraph using BFS method.
Week-8: Check whether a given graph is connected or not using DFS method.
Week-9: Find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm.

Text Books:

1. Levitin A, "Introduction to the Design And Analysis of Algorithms", Pearson Education, 2008.
2. Goodrich M.T.,RTomassia, "Algorithm Design foundations Analysis and Internet Examples", JohnWileyn and Sons, 2006.
3. Base Sara, Allen Van Gelder ," Computer Algorithms Introduction to Design and Analysis",Pearson, 3rd Edition, 1999.

Web References:

1. http://www.personal.kent.edu/~rmuhamma/Algorithms/algorithm.html
2. ttp://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=IntroToAlgorithms
3. http://www.facweb.iitkgp.ernet.in/~sourav/daa.html

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Web Technologies

Pre-requisites: Basics of Object Oriented programming, Java

Course Objectives:

This course introduces an in-depth understanding of the tools and Web technologies necessary for business application design and development. The course covers client side scripting like HTML, JavaScript and server side scripting like servlets, JSPs and also XML and web servers and database interfacing.

Course Outcomes:

At the end of this course, students will be able to:

1. Design static web pages and provide client side authentication.
2. Prepare Static Web pages With Validations.
3. Develop new tag sets using XML mechanism.
4. Design and develop web applications using JSP and MVC architecture.
5. Understand database connectivity and retrieving data using client/server database.

UNIT I

Introduction to Web: Understanding Internet and Web, Web Architecture, Web servers, protocols: HTTP, Introduction HTML: History of HTML, WWW, HTML Basics: Elements, Attributes, Tags, Tables, Forms, Frames.div and span tags.HTML5

UNIT II

CSS: Introduction to cascading style sheet, Types of style sheets, page layout, selectors, pseudo classes and elements.CSS3

JAVA SCRIPT: Introduction to scripting, control structures, conditional statements, Arrays functions, objects. JS framework (ReactJS)

HTML DOM: Predefined object (Window, Location, History, and Navigator). Events, DOM Node methods, Navigation, creating nodes, adding nodes, inserting nodes, removing & Replaces Nodes, Form object and Elements, DHTML with Java Script. front end frameworks(bootstrap)

UNIT III

XML: Basics of XML, Elements, Attributes, validation, Name space.

XML Scheme Languages: Introduction to DTD, internal and external DTD, Elements of DTD, DTD Limitations, XML Schema, Schema structure, Elements, parsing XML: XML DOM, Document node, element node, Text node, Java and DOM, Navigating DOM Tree.

UNIT IV

AJAX: Introduction, Environment, Asynchronous communication, process steps, sending and Retrieving Information, Ajax with XML.

Servlets : Introduction, Lifecycle, Generic and HTTP servlet, passing parameters to servlet, HTTP servlet Request & Response interfaces, Deploying web Applications, Session Tracking: Hidden form fields, cookies, URL- Rewriting, session.

UNIT V

JSP: Introduction, Difference Between servlets & JSP, Anatomy of JSP page, JSP elements: Directives, comments, Expressions, scriptlets, Declaration, Implicit JSP objects, using Action elements.

JDBC: Introduction, JDBC Drivers, Loading Driver, establishing connection, Executing SQL statement in JSP pages, MVC architecture.

Text Book:

1. Uttam K. Roy, Web Technologies, 8th Impression, Oxford Publication, 2014.

Reference Books:

1. Thomas Powell, "The Complete Reference HTML and CSS", 5th Edition, Tata McGraw Hill, 2010.
2. Thomas Powell, Fritz Schneider, "The Complete Reference JavaScript 2.0", 3rd Edition, Tata McGraw Hill, 2012.

w.e.f. 2021-2022

M.Tech (AI) I Year - II Sem

L	T / P / D	C
0	4	2

Web Technologies Lab

Course Objectives: This course will impart knowledge of the following:

1. Client server architecture and developing a static web application
2. Client-side data validation using Java Script
3. Dynamic web application creation using server side technologies
4. Fully functional web application building using MVC architecture.

Course Outcomes:

At the end of this course, students will be able to:

1. Design static web pages and provide client side authentication.
2. Develop new tag sets using XML mechanism.
3. Understand database connectivity and retrieving data using client/server database.
4. Design dynamic web pages and develop web applications using MVC architecture.

Week-1:

Design the following static web pages required for an online book store web site.

1) HOME PAGE:

2) LOGIN PAGE:

Week -2:

Design the student REGISTRATION PAGE:

Week- 3:

Apply internal and external CSS (Cascading Style Sheets) for week1&2 pages.

Week -4:

VALIDATION:

Write JavaScript to validate the following fields of the above registration page.

Week -5:

Design the catalogue page.

Week -6:

Write an XML file which will display the Book information which includes the following: Write a Document Type Definition (DTD) to validate the above XML file.

Week -7:

Develop week(1-5) using bootstrap

Week -8:

Write a program to display the HELLO WORLD message using servlet.

Week -10:

Write a program to create cookies and retrieval using servlet.

Week -11:

Write a program to display the HELLO WORLD message using JSP

Week -12:

Convert all above static web pages into the JSP pages.

Week -13:
Using registration form. Authenticate the user when he submits the login form using the user name and password from the database
Week -14
Create tables in the database which contain the details of items (books in our case like Book name , Price, Quantity, Amount)) of each category. Modify your catalogue page (week 4)in such a way that you should connect to the database and extract data from the tables and display them in the catalogue page using JDBC.
Week -15
Implement week -10 in MVC architecture.

B.Tech Minor
in
Artificial Intelligence

Department of Artificial Intelligence
ANURAG UNIVERSITY
Hyderabad, Medchal (Dist),
Telangana – 500 088
www.anurag.edu.in | hodai@anurag.edu.in

B.Tech Minor in Artificial Intelligence

S No	Course Category	Subject Name	Hours per Week			Credits
			L	T	P	
1	PCC	Fundamentals of Artificial Intelligence	3	0	3	4.5
2	PCC	Data Wrangling and Visualization	3	0	3	4.5
3	PCC	Machine Learning	3	0	3	4.5
4	PEC	**SELECT ANY ONE**				
		Data Structures in Python	3	0	3	4.5
		Database Management Systems	3	0	3	4.5
		Optimization	3	0	3	4.5
		Data Science	3	0	3	4.5
		Computer Vision	3	0	3	4.5
		Natural Language Processing	3	0	3	4.5
		Deep Learning	3	0	3	4.5
TOTAL CREDITS						**18**

Note:

- PCC - Professional Core Course
- PEC - Professional Elective Course
- Students can take the above courses or new or equivalent courses recommended by the internal BoS members
- BTech Minor courses can be taken through MOOCs or through department
- One has to obtain a minimum of 18 credits for the award of BTech Minor in AI
- Except lateral entry students, all the other students can take these courses starting from BTech II year I semester. However, students admitted through lateral entry can take these courses starting from BTech II year II semester

B.Tech. AI Minor	L	T/D/P	C
	3	3	4.5

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE

Course Objectives:

1. The main objective of this course is to introduce the basic concepts of artificial intelligence, its foundations
2. To analyze various search strategies in intelligent systems
3. To apply search algorithms in games
4. To learn various representations of logic and knowledge
5. To understand production systems and its components

Course Outcomes: At the end of this course, students will be able to:

1. Understand Strong AI and Weak AI and identify problems applicable to AI
2. Compare and contrast various uninformed and informed search algorithms to find an optimal solution for a given problem
3. Apply appropriate search algorithms for winning games
4. Learn various representations applicable to logic and knowledge useful in reasoning
5. Learn to apply appropriate inference methods in production or expert systems

Unit 1: Overview of Artificial Intelligence: Introduction. The Turing Test, Strong AI versus Weak AI, Heuristics, Identifying Problems Suitable for AI, Applications and Methods, Early History of AI, Recent History of AI to the Present, AI In the New Millennium

Unit 2 : Uninformed Search: Introduction: Search in Intelligent Systems, State-Space Graphs, Generate-and-Test Paradigm, Blind Search Algorithms, Implementing and Comparing Blind Search Algorithms **Informed Search:** Introduction, Heuristics, Informed Search Algorithms – Finding Any Solution, The Best-First Search, The Beam Search, Additional Metrics for Search Algorithms, Informed Search – Finding An Optimal Solution,

Unit 3: Search Using Games: Introduction, Game Trees and Minimax Evaluation, Minimax With Alpha-Beta Pruning, Variations and Improvements To Minimax, Games of Chance and the Expectiminimax Algorithm

Unit 4: Logic in Artificial Intelligence: Introduction, Logic and Representation, Propositional Logic, Predicate Logic – Introduction, Several Other Logics, Uncertainty and Probability **Knowledge Representation:** Introduction, Graphical Sketches and the Human Window, Graphs and the Bridges of Königsberg Problem, Search Trees, Representational Choices, Production Systems, Object Orientation, Frames, Semantic Networks

Unit 5: Production Systems: Introduction, Background, Production Systems and Inference Methods, Production Systems and Cellular Automata, Stochastic Processes and Markov Chains, Basic Features and Examples of Expert Systems

Text Book:

1. Stephen Lucci, Danny Kopec. Artificial Intelligence in the 21st Century. A Living Introduction. Mercury Learning and Information. 2nd Edition. 2016

Reference Books:

2. Russell, Norvig: Artificial Intelligence, A Modern Approach, Pearson Education, Second Edition. 2004
3. Rich, Knight, Nair: Artificial Intelligence, Tata McGraw Hill, Third Edition 2009
4. Saroj Kaushik. Artificial Intelligence. Cengage Learning. 2011

Lab:

1. Installation of Python Idle and Introduction to Interactive Shell with Mathematical Operations.
2. Implement if-else in Python for Rock-Paper-Scissor Game.
3. Implement while loop in Python for Guess the Word Game
4. Implement strings in Python for Caesar Cipher Algorithm.
5. Implement for loop in Python Script for Generation of Password for a System.
6. Implement functions in Python for Tower of Hanoi.
7. Implement Bagels game in Python using in-built Functions.
8. Implement File Handling operations in Python for Team Chooser Game.

B.Tech. AI Minor	L	T/D/P	C
	3	3	4.5

DATA WRANGLING AND VISUALIZATION

Prerequisites: Python Programming

Course Objectives:

5. To introduce the basic concepts of data wrangling using Python
6. To obtain the input data from a variety of sources
7. To extract the data and convert it into representations suitable for data analytics
8. To visualize the data

Course Outcomes: At the end of this course, students will be able to:

6. Use the pandas library
7. Load, store data in different file formats
8. Clean and prepare the data
9. Plot and Visualize data
10. Do data aggregation

UNIT-I

Getting started with pandas: Introduction to pandas Data Structures, Series, Data Frame, Index Objects. Data Loading, Storage, and File Formats: Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data to Text Format, Working with Delimited Formats, JSON Data

UNIT-II

Data Loading, Storage, and File Formats:XML and HTML: Web Scraping, Binary Data Formats: Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Web APIs, Interacting with Databases

UNIT-III

Data Cleaning and Preparation: Handling Missing Data, Filtering Out Missing Data, Filling In Missing Data, Data Transformation, Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers, String Manipulation, String Object Methods, Regular Expressions

UNIT-IV

Plotting and Visualization: A Brief matplotlib API Primer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot,Saving Plots to File, matplotlib Configuration, Plotting with pandas and seaborn, Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots, Facet Grids and Categorical Data, Other Python Visualization Tools, Conclusion

UNIT-V

Data Aggregation and Group Operations:GroupBy Mechanics, Iterating Over Groups, Selecting a Column or Subset of Columns, Grouping with Dicts and Series, Grouping with Functions, Grouping by Index Levels, Data Aggregation, Column-Wise and Multiple Function Application, Returning Aggregated Data Without Row Indexes, Pivot Tables and Cross-Tabulation

Text Books:

3. Wes McKinney. Python for Data Analysis: Data Wrangling with pandas, NumPy and IPython. O'Reilly, 2017, 2nd Edition

4. Jacqueline Kazil and Katharine Jarmul. Data Wrangling with Python. O'Reilly, 2016

Reference Books:

6. Data Science Essentials in Python: Collect, Organize, Explore, Predict, Value. Dmitry Zinoriev, The Pragmatic Programmers LLC, 2016

7. TyeRattenbury, Joseph M. Hellerstein, Jeffrey Heer, Sean Kandel, and Connor Carreras. Principles of Data Wrangling: Practical Techniques for Data Preparation. O'Reilly, 2017

8. Python Data Analytics – Data Analysis and Science using Pandas, matplotlib and the Python Programming Language. Fabio Nelli, Apress, 2015

Lab:

1. Write programs to use the pandas data structures: Frames and series as storage containers and for a variety of data-wrangling operations

2. Write programs to parse text files, CSV, HTML, XML and JSON documents and extract relevant data. After retrieving data check any anomalies in the data, missing values etc.

3. Write programs for reading and writing binary files

4. Write programs for searching, splitting, and replacing strings based on pattern matching using regular expressions

5. Design a relational database for a small application and populate the database. Using SQL do the CRUD (create, read, update and delete) operations.

6. Create a Python MongoDB client using the Python module pymongo. Using a collection object practice functions for inserting, searching, removing, updating, replacing, and aggregating documents, as well as for creating indexes

7. Use matplotlib and draw plots using the datasets

8. Write programs to Split a pandas object into pieces using one or more keys (in the form of functions, arrays, or DataFrame column names), calculate group summary statistics, like count, mean, or standard deviation, or a user-defined function, Compute pivot tables and cross-tabulations

Chemical Engineering

Department of Chemical Engineering

Minutes of Board of Studies Meeting

The Department of Chemical Engineering, Anurag University, circulated the structure and syllabus of B. Tech Chemical Engineering with **Honors degree** (Green Technology and Sustainability Engineering) and B. Tech **Minors degree** to be offered by Chemical Engineering department to other branches of Engineering (Material Science and Engineering) through email and approval for the same was received by 1st July 2021.

The following are the members:

S. No.	Name & Details of Members	Designation
1	Dr. M. Mukunda Vani, HOD, Chemical Engineering, AU	Chairperson of BOS
2	Dr. Narasimha Mangadoddy, Professor, Dept. of Chemical Engineering, IITH	Member - Outside Subject Expert
3	Dr. G. Prabhakar Reddy, Professor, OUCT, Hyderabad	Member - Outside Subject Expert
4	Dr. A. Ramesh Babu, Assoc. Professor, BITS Pilani Hyderabad Campus	Member - Outside Subject Expert
5	Dr. S. Sridhar, Senior Principal Scientist, CSIR-Indian Institute of Chemical Technology	Member – Industry Expert
6	Dr. Ravi K Gujjula, Chief General Manager –Technical, Andhra Pradesh State Skill Development Corporation,	Member – Industry Expert
7	Dr. N. Anil, Assoc. Prof, Dept. of Chemical Engineering	Member
8	Dr. B. Venkataramana Reddy, Asst. Prof, Dept. of Chemical Engineering, AU	Member
9	Mrs. M. Shireesha, Asst. Prof, Dept. of Chemical Engineering, AU	Member
10	Dr. P. Nagarjuna Reddy, Managing Director, REVIN LABS Pvt Ltd	Member - Alumni

HOD
Dr. M MukundaVani
Chemical Engg Department

Department of Chemical Engineering

Honors Degree Course Structure

S.No	Course Category	Course Title	L	T	P	Credits
1	PCC	Fuel Cell Technology and Batteries	3	0	0	3.0
2	PCC	Sustainable Materials and Green Buildings	3	0	0	3.0
3	PW	Project Work	0	0	12	6.0
Total			**03**	**00**	**12**	**12.0**

Note:

1. It is mandatory for the student to take two theory courses and one project work course in offline mode to acquire 12 credits and the remaining 6 credits (Total 18 credits) can be obtained from the following NPTEL courses to get the honor degree.
2. The student should opt any one course given in the cluster of subjects. i.e., he /she cannot choose more than one from the given cluster and claim for credits.

S. No.	Course Title	Source	No. of Weeks	Credits	Links	Institution	Discipline
1(cluster-I)	Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts	NPTEL	12	3	https://nptel.ac.in/courses/127/105/127105018/	IIT-Kharagpur	Civil Engineering
	Sustainable Engineering Concepts and Life Cycle Analysis	NPTEL	8	2	https://nptel.ac.in/courses/105/105/105105157/	IIT-Kharagpur	Civil Engineering
2	Waste to Energy Conversation	NPTEL	8	2	https://nptel.ac.in/courses/103/107/103107125/	IIT-Roorkee	Chemical Engineering
3	Technologies for Clean and Renewable Energy Production	NPTEL	8	2	https://nptel.ac.in/courses/103/107/103107157/	III-Roorkee	Chemical Engineering
4(cluster-II)	Advanced Green Manufacturing Systems	NPTEL	12	3	https://nptel.ac.in/courses/110/104/110104119/	IIT-Kanpur	Management
	Sustainability Through Green Manufacturing Systems: An Applied Approach	NPTEL	8	2	https://nptel.ac.in/courses/112/104/112104225/	IIT-Kanpur	Mechanical Engineering
5	Organic Farming for Sustainable Agricultural Production	NPTEL	8	2	https://nptel.ac.in/courses/126/105/126105014/	IIT-Kharagpur	Department of Agricultural and Food Engineering
6	Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems	NPTEL	8	2	https://nptel.ac.in/courses/103/103/103103206/	IIT-Guwahati	Chemical Engineering
7	Energy Resources Economics and Environment	NPTEL	12	3	https://nptel.ac.in/courses/109/101/109101171/#	IIT-Bombay	Department of Energy Science and Engineering
8(cluste	Strategies for Sustainable Design	NPTEL	12	3	https://nptel.ac.in/courses/124/106/	IIT-Hyderabad	Department of Design &

r- III)					124106157/ #		Department of Climate change
	System Design for Sustainability	NPTEL	12	3	https://nptel.ac.in/courses/107/103/107103081/#	IIT Guwahati	Department of Design Engineering
9	Energy Resources and conversion processes	NPTEL	15	4	https://onlinecourses.swayam2.ac.in/nou20_cs09/preview	Indira Gandhi National Open University	Computer science and engineering

ANURAG UNIVERSITY

III-Year B.Tech (Honors)-CHEM - I-Semester

L T/P/D C
3 0 3

FUEL CELL TECHNOLOGY AND BATTERIES

Unit-I: Overview of Fuel cells: what is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

Unit-II: Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others. Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.

Unit-III: Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operation conditions: pressure, temperature, flow rates, humidity. Fuel processing: Direct and in-direct internal reforming, reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal, Using renewable fuels for SOFCs.

Unit-IV: Batteries: Principles of operation, electrochemical principles and reactions battery electrolytes factors affecting battery performance. Primary batteries: introduction, Zinc-carbon batteries, Magnesium and Aluminum batteries, Lithium Primary batteries and Alkaline-Manganese batteries.

Unit-V: Secondary batteries: introduction, Lead-Acid batteries, Iron electrode batteries, industrial and aerospace Nickel-cadmium batteries and Lithium – Ion batteries and applications of batteries.

TEXT BOOKS:

1. Hoogers., Fuel Cell Technology Hand Book, CRC Press, 2003.
2. Karl Kordesch& Gunter Simader, Fuel Cells and Their Applications, VCH Publishers,
3. NY, 2001.
4. F. Barbir, PEM Fuel Cells: theory and Practice, 2ndEd, Elsevier/Academic Press, 2013.
5. Linden, D.; Reddy, T.B , Handbook of Batteries, McGraw-Hill, 2002
6. Ronald Dell, David Anthony James Rand, Understanding Batteries, Royal Society of Chemistry, 2001

REFERENCES:

1. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, 2003.
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY 2006.

III-Year B.Tech (Honors)-CHEM - II-Semester

L	T/P/D	C
3	0	3

Sustainable Materials and Green Buildings

UNIT I: Introduction, Embodied energy, Operational energy in Building and Life cycle energy. Ecological foot print, Bio-capacity and calculation of planet equivalent

UNIT II: Role of Material: Carbon from Cement, alternative cements and cementations material, Alternative fuel for cements for reduction in carbon emission. Sustainability issues for concrete, Role of quality, minimization of natural resource utilization, High volume fly ash concrete, geo-polymer concrete etc. concrete with alternative material for sustainability'

UNIT III:

Reduction in water consumption in concrete, Recycled aggregate, Energy for grinding crushing of cement aggregate etc. and reduction. Operational energy in building role of materials and thermal conductivity, Clay Bricks, Types kilns, Comparative energy performance emission performance and financial performance, Indoor air quality

UNIT IV: Paints, Adhesive and sealants for use in building, Volatile organic content (VOC) emission issues and indoor air quality for Sustainability and Health hazard Operational energy reduction and net zero building, Optimization for design of building for energy efficiency and example of optimization through use of Evolutionary genetic algorithm Radiation budget, Surface water balance, Effects of trees and microclimatic modification through greening,

UNIT V :Use of Building Integrated Photo Voltaic (BIPV) and other renewable energy in buildings, basic concepts and efficiency, Energy codes ECBC requirement, Concepts of OTTV etc., Green Performance rating, requirements of LEED, GRIHA etc.

TEXT BOOKS:

1. Newman, J. and Choo, Ban Sang, Advanced Concrete Technology-Processes, 1 st Edition, Elsevier, 2003.

2. Newman, J. and Choo, Ban Sang, Advanced Concrete Technology-Constituent Materials, 1st Edition, Elsevier, 2003.

3. Ministry of Power, Energy Conservation Building Code 2018, Revised Version, Bureau of Energy Efficiency, 2018

REFERENCES:

1. Architectural Energy Corporation, Building Envelope Stringency Analysis, International Institute for Energy Conservation, 2004.

2. McQuiston, F.C., and Parker, J.D. Heating, Ventilating, and Air Conditioning, Analysis and Design, Fourth Ed. John Wiley & Sons, Inc,1994.

ONLINE COURSES –SYLLABUS

1a) Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts

12 weeks, 3 credits

Week 1: Sustainability Concepts – Innovations and Challenges
Week 2: Environmental Measurements from Different Disciplines
Week 3: Ecology, Population & Environmental Chemistry
Week 4: Physical Process in Environment
Week 5: Environmental Biological Concepts
Week 6: Environmental Risk Assessments with Concepts of EIA and LCA
Week 7: Water – Quantity and Quality
Week 8: Water Treatment Basics
Week 9:Basics of Wastewater Collection, Treatment & Resource Recovery
Week 10:Basics of Solid Waste, Soil and Noise Pollution
Week 11:Basics of Air Pollution Issues – Global and Local
Week 12: Case Studies and Course Wrap-up

1b) Sustainable Engineering Concepts and Life Cycle Analysis

8 weeks, 2 credits

Week 1: An Introduction to Sustainability Concepts and Life Cycle Analysis (Introduction, Material flow and waste management, What it all means for an engineer? Water energy and food nexus)
Week 2: Risk and Life Cycle Framework for Sustainability (Introduction, Risk, Environmental Risk Assessment, Example Chemicals and Health Effects, Character of Environmental Problems)
Week 3: Environmental Data Collection and LCA Methodology (Environmental Data Collection Issues, Statistical Analysis of Environmental Data, Common Analytical Instruments, Overview of LCA Methodology - Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools)
Week 4: Life Cycle Assessment – Detailed Methodology and ISO Framework (Detailed Example on LCA Comparisons, LCA Benefits and Drawbacks, Historical Development and LCA Steps from ISO Framework)
Week 5: Life Cycle Inventory and Impact Assessments (Unit Processes and System Boundary Data Quality, Procedure for Life Cycle Impact Assessment, LCIA in Practice with Examples, Interpretation of LCIA Results)
Week 6: Factors for Good LCA Study (ISO Terminologies, LCA Steps Recap, Chemical Release and Fate and Transport, and Green Sustainable Materials)
Week 7: Design for Sustainability (Environmental Design for Sustainability: Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis)
Week 8: Case Studies (e.g., Odour Removal for Organics Treatment Plant, Comparison of Hand Drying Methods, Biofuels for Transportation, Kerosene Lamp vs. Solar Lamp, Bioplastic etc.).

2) Waste to Energy Conversation

8 weeks, 2 credits

Week 1: Introduction, characterization of wastes.
Week 2: Energy production form wastes through incineration, energy production through gasification of wastes.
Week 3: Energy production through pyrolysis and gasification of wastes, syngas utilization. Week 4: Densification of solids, efficiency improvement of power plant and energy production from waste plastics.
Week 5: Energy production form wastes Plastic,gas clean-up.
Week 6: Energy production from organic wastes through anaerobic digestion and fermentation, Introduction to microbial fuel cells
Week 7: Energy production from wastes through fermentation and transesterification
Week 8: Cultivation of algal biomass from wastewater and energy production from algae

3) Technologies for Clean and Renewable Energy Production

8 weeks, 2 credits

Week 1: Introduction, Characterization of coal and conventional routes for energy production from coal
Week 2: Cleaner routes for energy production from coal
Week 3: Characterization of crude oil and conventional routes for crude oil utilization
Week 4: Cleaner routes for energy production form petroleum crude
Week 5: Cleaner energy production from gaseous fuels
Week 6: Solar and wind energy production
Week 7: Production of hydro and geothermal energy
Week 8: Energy production from biomass and wastes and energy conservation

4a) Advanced Green Manufacturing Systems

12 weeks, 3 credits

Week 01 : Introduction to Advanced Green Manufacturing Systems
Week 02 : Statistics in sustainability (for quantication)
Week 03 : Optimization for sustainability Week 04 : Optimization for sustainability continued
Week 05 : Design of Experiments for Green Manufacturing Systems
Week 06 : Value EngineeringGreen
Week 07 : Plan Design for Sustainability and Maintenance
Week 08 : Green transportation models
Week 09 : Green Manufacturing techniques
Week 10 : Life Cycle Assessment (software demonstration)
Week 11 : Sustainable Manufacturing facility development
Week 12 : Design of Higher Education for Sustainable development

4b) Sustainability through Green Manufacturing Systems: An Applied Approach

8 weeks, 2 credits

Week 1: The concept of sustainability, manufacturing, operations, processes, practices
Week 2: Simulation models for manufacturing, validation, verification, output analysis
Week 3: Life Cycle Analysis (LCA) and sustainability framework
Week 4: Basic modeling for factory simulation
Week 5: Green manufacturing modeling
Week 6: Productivity and Sustainability
Week 7: Laboratory demonstration, and renewable sources of energy
Week 8: Developing a green smart factory.

5) Organic Farming for Sustainable Agricultural Production

8 weeks, 2 credits

Week 01 : Organic Farming: Concepts and principles of organic farming.
Week 02 : Key indicators of sustainable agriculture, organic farming and climate change
Week 03: Input management; compost production, vermicomposting, Compost quality, Compost utilization and marketing.
Week 04 :Organic crop management: field crops, horticulture and plantation crops.
Week 05 : Plant protection measures, biopesticides, natural predators, cultural practice.
Week 06 :Rotation design for organic system, Transition to organic agriculture, farming system.
Week 07:Quality analysis of organic foods, Antioxidants and their natural source, organic food and human health.
Week 08 :Standards of organic food and marketing.

6) Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems

8 weeks, 2 credits

Week 1: Solar Energy: Basics and Concepts
Week 2: Concentrating and Non-concentrating Solar Collectors
Week 3: Thermal Energy Storage Systems and Solar Energy Utilization Methods
Week 4: Wind Energy: Basics and Concepts
Week 5: Characteristics and Power Generation from Wind Energy
Week 6: Biomass, Broad Classifications, Compositions, Characteristics, Properties, Structural Components
Week 7: Biomass Residues, Utilisation through Conversion Routes: Biological, Chemical and Thermo Chemical, Bioconversion into Biogas, Mechanism

Week 8: Bioconversion of Substrates into Alcohols, Thermo Chemical Conversion of Biomass, Conversion to Solid, Liquid and Gaseous Fuels, Pyrolysis, Gasification, Combustion, Chemical Conversion Processes

7) Energy Resources Economics and Environment

12 weeks, 3 credits

Week 1: Energy Flow Diagram ,Global Trends in Energy Use, India and World-Disaggregation by supply, end use, Energy and Environment, The Kaya Identity, Emission Factor.

Week 2: Energy and Quality of Life, Energy Inequality, Energy Security, Introduction to Country Energy Balance assignment.
Week 3: Energy Economics - Simple Payback Period, Time Value of Money- discount rate, Criteria for Assessing Energy Projects –(Net Present Value (NPV), Benefit/Cost Ratio (B/C), Inflation, Internal Rate of Return (IRR).
Week 4: Resources & Reserves Growth Rates in Consumption, Estimates of Duration of Fossil Fuels, McKelvey Diagram, Peak oil, Hubbert's model.
Week 5: Materials used in renewable energy (Kuznet's Curve, Betting on the planet, Simon's Change), Non Renewable Energy Economics (Hotelling's Rule).
Week 6: Preferences and Utility, Utility and Social Choice.
Week 7: Public and private goods / bads, Demand curves , Externalities.
Week 8: Financing Energy – Debt/ Equity- Sources of funds, innovative financing models.
Week 9: Input Output Analysis.
Week 10: Primary Energy Analysis, Net Energy Analysis, Examples, Energy Cost of Energy, Life Cycle Analysis of Bioenergy.
Week 11: Net Energy Examples, Energy Policy.
Week 12: Energy Policy Examples, Practice problems solution.

8a) Strategies for Sustainable Design

12 weeks, 3 credits

Week 1: Definitions and Perspectives on Sustainability in Industrial Design and Built Environments.
Week 2: ESE Aspects of Sustainability and Climate Change Mitigation.
Week 3: Current National and International Scenario of SD and Dependence on Energy.
Week 4: Impact of Pollutions and Design Processes with Alternative Solutions for Health of Ecosystem.
Week 5: Environmental Impact Assessment and Lifecycle Analysis.
Week 6: Policy, Growth, Development and 3R's for Consumption.
Week 7: NBC, ECBC, and SA Methods such as GRIHA.
Week 8: UN SDG and System Design tools such as SPSS, MSDS by LeNS.
Week 9: Vernacular and Responsive Design using Net-Zero Energy, Lighting, Ventilation, Views, etc., for Human Comfort.
Week 10: Design for Sustainability and Nature as Inspiration.
Week 11: International Conventions, Laws and Emerging Technologies for SD Week 12: SD Case Studies and Summary.

8b) System Design for Sustainability

12 weeks, 3 credits

Week 1: Basics - What is sustainability, sustainable development and why do we need it?
Week 2: Basics - Evolution of sustainability within Design.
Week 3: Product Life Cycle Design – Methods & Strategies.
Week 4: Product Life Cycle Design – Software Tools.
Week 5: Sustainable Product-Service System Design – Definition, Types & Examples.
Week 6: Sustainable Product-Service System – Transition Path and Challenges.
Week 7: Designing for Sustainable Product-Service System – Methods and Tools.
Week 8: Designing for Sustainable Product-Service System – Methods and Tools.
Week 9: Designing for Sustainable Product-Service System – Methods and Tools.
Week 10: Other Design for Sustainability Tools and approaches.
Week 11: Design for Sustainability – Engineering Design Criteria and Guidelines.
Week 12: Summary - Connecting the threads.

9) Energy Resources and conversion processes

15 weeks, 4 credits

Week 1 .Introduction to Energy and its Various Forms.
Week 2. Conventional Energy Sources.
Week 3. World Scenario of Energy Sources.
Week 4.Renewable Energy Scenario:Hydro Power.
Week 5. Biomass Energy.
Week 6. Biogas Energy.
Week 7. Solar Energy.
Week 8. Wind Energy.
Week 9. Other Forms of Renewable Energy.
Week 10 Principles of Energy Conversion.
Week 11. Fuels and Their Characteristics.
Week 12. Combustion of Fuels.
Week 13. life cycle analysis.
Week 14. Environmental Impacts of Energy Conversion.

Department of Chemical Engineering

Minor Degree Course Structure

Material Science and Engineering

S. No.	Course Code	Course Title	L	T	P	Credits
1	PCC	Material Characterization	3	1	0	4.0
2	PCC	Introduction to Composites	3	1	0	4.0
3	PCC	Material Science Lab	0	0	3	1.5
Total			**6**	**2**	**3**	**9.5**

Note:

1. It is mandatory for the student to take two theory courses and one laboratory course in offline mode to acquire 9.5 credits and the remaining 8.5 credits (Total 18) will be obtained from the following NPTEL courses.
2. The student should opt any one course given in the cluster of subjects. i.e., he /she cannot choose more than one from the given cluster and claim for credits.
3. It is mandatory to complete one course given in the cluster-I as a pre-requisite before going for any other course. If completed in their regular curriculum, it can be omitted.

S. No.	Course Title	Source	No. of Weeks	Credits	Links	Discipline	Institute
1 (Cluster-I)	Introduction to Material Science and Engineering	NPTEL	12	3	https://nptel.ac.in/courses/113/102/113102080/	Metallurgy and Material Science	IIT Delhi
	Basics of Materials Engineering	NPTEL	12	3	https://swayam.gov.in/nd1_noc20_me78/preview	Mechanical Engineering	IIT Madras
	Materials Science and Engineering	NPTEL	8	2	https://onlinecourses.nptel.ac.in/noc20_mm09/	Metallurgy and Material science & Mining Engineering	IIT Roorkee
2	Physics of Materials	NPTEL	40 lectures	--	https://nptel.ac.in/courses/113/106/113106040/	Metallurgy and Material Science	IIT Madras
3	Fundamentals of Material Processing -I	NPTEL	8	2	https://nptel.ac.in/courses/113/104/113104073/	Metallurgy and Material Science	IIT Kanpur
4	Corrosion Part-I	NPTEL	8	2	https://nptel.ac.in/courses/113/104/113104082/	Metallurgy and Material Science	IIT Kanpur
5 (Cluster-II)	Nanotechnology, Science & Applications	NPTEL	8	2	https://nptel.ac.in/courses/113/106/113106093/	Metallurgy and Material Science	IIT Madras
	Structural analysis of Nano-materials	NPTEL	4	1	https://nptel.ac.in/courses/113/107/113107081/	Metallurgy and Material Science	IIT Roorkee
6	Advanced Materials & Processes	NPTEL	12	3	https://nptel.ac.in/courses/113/105/113105081/	Metallurgy and Material Science	IIT Kharagpur
7	Electrochemical technology in pollution control	NPTEL	8	2	https://nptel.ac.in/courses/103/108/103108162/	Chemical Engineering	IISc Bangalore
8	Fundamentals of Electronic	NPTEL	8	2	https://nptel.ac.in/courses/113/106/113106065/	Metallurgy and	IIT Madras

	materials and devices					Material Science	
9	Phase transformations and Heat treatment	NPTEL	31 lectures	--	https://nptel.ac.in/courses/113/101/113101003/	Metallurgy and Material Science	IIT Bombay
10 (Cluster – III)	Science & Technology of Polymers	NPTEL	48 hours	--	https://nptel.ac.in/courses/113/105/113105028/	Metallurgy and Material Science	IIT Kharagpur
	Polymers: Concepts, Properties, Uses and Sustainability	NPTEL	12	3	https://swayam.gov.in/nd1_noc20_ch41/preview	Chemical Engineering	IIT Madras
11	Fuels, Refractory and Furnaces	NPTEL	42 hours	--	https://nptel.ac.in/courses/113/104/113104008/	Metallurgy and Material Science	IIT Kanpur
12	Dealing with Materials Data: Collection, Analysis and Interpretation	NPTEL	12	3	https://nptel.ac.in/courses/113/101/113101096/	Metallurgy and Material Science	IIT Bombay
13	Solar Photovoltaics- Principles, Technologies & Materials	NPTEL	8	2	https://nptel.ac.in/courses/113/104/113104084/	Physics	IIT Roorkee
14	Dynamic Behaviour of Materials	NPTEL	12	3	https://swayam.gov.in/nd1 _noc20_me89/preview	Mechanical Engineering	IIT Guwahati
15	Surface Engineering of Nanomaterials	NPTEL	8	2	https://onlinecourses.nptel.ac.in/noc20_mm10/	Metallurgy and Material Science	IIT Roorkee
16	Carbon Materials and Manufacturing	NPTEL	12	3	https://nptel.ac.in/courses/113/106/113106099/	Metallurgy and Material Science	IIT Mandi
17	Properties of Materials (Nature and Properties of Materials : III)	NPTEL	8	2	https://onlinecourses.nptel.ac.in/noc20_mm13/	Metallurgy and Material Science	IIT Kanpur
18	Diffusion in Multicomponent Solids	NPTEL	12	3	https://onlinecourses.nptel.ac.in/noc20_me28/	Metallurgy and Material Science	IIT Kanpur

19	Non - Metallic Materials	NPTEL	12	3	https://onlinecourses.nptel.ac.in/noc21_mm14/preview	Metallurgy and Material science & Mining Engineering	IIT Kharagpur

ANURAG UNIVERSITY

B.Tech (Minor) - III-Year I-Semester

L	T/P/D	C
3	1	4

MATERIAL CHARACTERIZATION

Unit I

Introduction to materials and Techniques, Chemical bonding, fundamentals of crystallography, reciprocal lattice, X ray diffraction, diffraction theory, atomic scattering factor, integrated intensity of diffracted beams, temperature factor, line broadening.

Unit II

Techniques: Laue, powder & rotating crystal technique; mode of bonding, crystal types, density of packing, atomic stacking, inter-atomic voids, coordination polyhedron, Pauling's rules, symmetry elements, space & point groups, group theoretical formulation. Phase identification, indexing and lattice parameter determination, Analytical line profile fitting using various models.

Unit III

Neutron diffraction; Reflection High energy electron Diffraction (RHEED), Low energy Electron Diffraction (LEED), Introduction to Microscopes, Optical microscopy (OM), Transmission Electron Microscopy (TEM); Basic Electron scattering, Concepts of resolution, TEM instruments, Various imaging modes, Analysis of micrographs, Electron Energy Loss Spectroscopy.

Unit IV

Scanning Electron Microscopy, Rutherford backscattering spectrometry, Atomic Force Microscopy, Scanning Probe Microscopy. UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy.

Unit V

Thermal analysis tools, Thermometry and dilatometry, calorimetry, differential scanning calorimetry (DSC), DTA, Temperature modulated calorimetry, Thermomechanical analysis, DMA and DETA, Thermogravimetry.

Textbooks and Reference:

1. Materials Characterization Techniques, S Zhang, L. Li and Ashok Kumar, CRC Press (2008)

2. Elements of X-Ray Diffraction, B. D. Culity (Addison Wesley)

3. Physical Methods for Metal Characterization, Pej Flewitt (Institute of Physics Pub.)

ANURAG UNIVERSITY
B.Tech-(Minor) - III-Year II-Semester

L T/P/D C

3 1 4

INTRODUCTION TO COMPOSITES

Unit I
Introduction, terminology, engineering properties, Basics of composite materials, Different type of Fibers

Unit II
Matrix materials, Short fiber composites, Theories of Stress transfer, Orthotropic lamina

Unit III
Concept of Tensor, General Anisotropic material, Specially Orthotropic material under plane stress, Stress- Strain transformation

Unit IV
Strain displacement relations, Relations for stress and strain along thickness of laminate, Composite laminates and Failure initiation in composite laminates

Unit V
Quasi-isotropic laminates, Maximum Stress and Strain theory, Application of Composites

Textbook:

1. Analysis & Performance of Fiber Composites: Bhagwan D. Agarwal & Lawrence J. Broutman.

ANURAG UNIVERSITY
B.Tech--(Minor) - IV-Year I-Semester

MATERIAL SCIENCE LAB

L	T/P/D	C
-	3	1.5

List of Experiments

1. Preparation and study of microstructures of metals – I
2. Preparation and study of microstructures of metals - II
3. Preparation and study of microstructures of ceramics
4. Preparation and study of microstructures of polymers
5. Preparation of polymeric membranes – I
6. Preparation of polymeric membranes - II
7. Preparation of polymeric membranes - III
8. Determining thermal conductivity of composite materials
9. Determining thermal conductivity of ceramic material
10. Determining thermal conductivity of polymer

Text Books:

1. V. Raghavan Materials Science and Engineering: A First Course, 5th Edition Prentice Hall India, 2004.
2. William D. Callister, David G. Rethwisch Materials Science and Engineering: An Introduction, Wiley Publisher.
3. Unit Operations of Chemical Engineering, 6th ed., W.L. McCabe, J.C. Smith and P. Harriot, McGraw-Hill, New York, 2001

NPTEL COURSES

1.Cluster – I

Course Name: Introduction to Material Science and Engineering

12 weeks, 3 credits

Week 1 - Crystallography I

Week 2 - Crystallography II + Structure of Solids I

Week 3 - Structure of Solids II

Week 4 - Structure of Solids III

Week 5 - Defects in Crystalline Solids I

Week 6 - Defects in Crystalline Solids II

Week 7 - Phase Diagrams I

Week 8 - Phase Diagrams II + Diffusion

Week 9 - Phase Transformations I

Week 10 - Phase Transformations II + Mechanical Behaviour of Materials I

Week 11 - Mechanical Behaviour of Materials II

Week 12 - Mechanical Behaviour of Materials III + Fracture

Course Name: Basics of Materials Engineering

12 weeks, 3 credits

Week 1: Introduction, Crystal Structure

Week 2: Imperfections in solids

Week 3: Imperfections in solids contd.

Week 4: Mechanical properties of materials

Week 5: Failure of Materials

Week 6: Failure of Materials contd.

Week 7: Basics of Fracture Mechanics

Week 8: Fatigue failure theories

Week 9: Fatigue failure theories

Week 10: Phase diagrams

Week 11: Phase diagrams contd.

Week 12: Thermal Processing and Heat Treatment of Steels

Course Name: Materials Science and Engineering

8 weeks 2 credits

Week 1: Lattice, Crystal structures, Miller indices for planes and directions.

Week 2: Microscopes, microstructures and quantitative metallography.

Week 3: Defects, diffusion and phase diagram.

Week 4: Equilibrium phase diagram, lever rule, phase transformation.

Week 5: Iron-carbon phase diagram, TTT and CCT curves, heat treatments.

Week 6: Introduction to mechanical properties, cold and hot working.

Week 7: Strengthening mechanism Fracture, and Fatigue.

Week 8: Creep, ceramics and plastic, NDT techniques, alloy designation.

2.Course Name: Physics of Materials

40 lectures -- credits

1. Introduction and Approach, Properties of materials and some important relationships, Free electron theory of metals, Drude model Electronic Conductivity, Drude model Thermal Conductivity - Ratio the Wiedemann Franz Law

2. Maxwell Boltzmann Statistics, Limitations of the Drude model, Elementary quantum mechanics: History and Significant concepts, The Drude Sommerfeld model, Fermi Dirac statistics, Density of states, Fermi Energy and Fermi Surface, Improvements over Drude model, remaining limitations.

3. Specific heat, phonons, Real space Vs Reciprocal space, Diffraction condition and its significance for electron energy, Wigner Seitz cells, Brillouin zones, Band Theory, Density of occupied states, the origin of anisotropy

4. Electrons and Holes, Classification of semiconductors, Direct Band gap, indirect Band gap, opto electronic materials, Magnetic properties, superconductivity, Meissner effect, Bose Einstein Statistics, BCS theory, High temperature superconductors, physics of nano scale materials

3.Course Name: Fundamentals of Material Processing -I

8 weeks 2 credits

Week 1: Introduction to Solidification, Thermodynamics and Kinetics (Homogeneous Nucleation)

Week 2: Heat Flow (Single Crystal; Unidirectional Heat flow)

Week 3: Composition Variation- Plane Front Solidification

Week 4: Composition Variation- Cellular solidification in Single phase alloys

Week 5: Plane front solidification of polyphase alloys; Fluid Flow

Week 6: Introduction to Powder Processing; Powder characterization

Week 7: Powder Characterization; Powder Fabrication; Powder Consolidation

Week 8: Powder compaction; Sintering

4.Course Name: Corrosion Part-I

8 weeks 2 credits

Week 1: Introduction: Definitions, Different forms of Environmental degradation, Cost of Corrosion, Electrochemical Nature, Aims

Week 2: Thermodynamics of Corrosion: Process at Interface, Free Energy and Electrochemical Potential, EMF Series

Week 3: Thermodynamics of Corrosion: Nernst Relationship, Important Reactions, Cell Potential, Reference Electrodes

Week 4: Thermodynamics of Corrosion: Pourbaix diagram and its important in metal corrosion, Calculation of Pourbaix diagram for Al, Cu, Ni and Fe. Kinetics of Corrosion: Current Density and Corrosion Rate, Corrosion Rate Expressions, Exchange Current Density

Week 5: Kinetics of Corrosion: Polarization, Activation, Concentration and Resistance polarization

Week 6: Mixed potential theory for understanding common corrosion of metals and alloys: Fundamental, Applications to Active metals

Week 7: Mixed potential theory for understanding common corrosion of metals and alloys: Passivation, Application of mixed potential theory in passivating metals

Week 8: Corrosion protection: Electrochemical ways: Sacrificial anode, Impressed current cathodic protection, Anodic protection.

5.Cluster – II

Course Name: Nanotechnology, Science & Applications

8 weeks 2 credits

Week 1: Introduction, History of Nanomaterials Top- down approach, bottom-up approach to synthesize nanomaterials

Week 2: Thermodynamic considerations

Week 3: Inverse Hall Petch relationship

Week 4: Optical effects

Week 5: Super-plasticity

Week 6: Magnetic effects, Ferroelectric effects at nanoscale

Week 7: Severe Plastic Deformation

Week 8: Nanocomposites, Bulk nanoscale structures

Course Name: Structural analysis of Nano-materials

4 weeks 1 credit

Week 1: Introduction: Fundamental concepts of atomic structure and interatomic bonding, Structure of materials, Defects in structure of materials, Phase diagram: Determination of phases, Transformation of phases.

Week 2: Basic properties: Metals, Basic properties: Ceramics, Basic properties: Polymers, Selection of nanomaterials, Structure property relationship of advanced nanomaterials.

Week 3: Introduction to X-Ray Spectroscopy, Di-raction direction and methods of XRD, Determination of crystal structures by XRD Pattern, Precise parameter measurements, Orientation of single crystals.

Week 4: Qualitative analysis by di-raction, Quantitative analysis by di-raction, Microscopic structural analysis of nanomaterials-I, Microscopic structural analysis of nanomaterials-II, Other characterization used.

6.Course Name: Advanced Materials & Processes

12 weeks 3 credits

Week 1: Introduction to metastable and functional alloys

Week 2: Bulk Metallic glasses Part I: Fundamental concepts

Week 3: Bulk Metallic glasses Part II: Mechanical and Functional properties

Week 4: Shape memory alloys and Pseudo-elasticity

Week 5: Shape memory alloys: Applications and case studies

Week 6: Introduction to high temperature materials

Week 7: Superalloys: Alloy design, Microstructure and Properties

Week 8: Nano-materials Part I

Week 9: Nano-materials Part II

Week 10: Soft and hard magnetic materials

Week 11: Non-equilibrium Processes, Single Crystal Growth, Rapid Solidification, Inert Gas Condensation

Week 12: Advanced Functional Alloys

7.Course Name: Electrochemical technology in pollution control

8 weeks 2 credits

Week 1: Atomic and Molecular structure

Week 2: Properties of solutions

Week 3: Electrochemical methods-1

Week 4: Electrochemical methods-2

Week 5: Electrochemical methods-3

Week 6: Ion selective electrodes and Electrochemical sensors

Week 7: Process waste handling and Electroplating

Week 8: Batteries and fuel cells and ZLD

8.Course Name: Fundamentals of Electronic materials and devices

8 weeks 2 credits

Week 1: Semiconductor basics

Week 2: Intrinsic semiconductors

Week 3: Extrinsic semiconductors

Week 4: Junctions - introduction

Week 5: Junctions - continued

Week 6: Transistors

Week 7: Optical properties and optoelectronic devices

Week 8: Optoelectronic devices – continued

9.Course Name: Phase transformations and Heat treatment

31 lectures -- credits

Part 1: Preliminaries (Thermodynamics and kinetics: 6 modules – about 6 lecture hours)

Part 2: Interfaces (4 modules – about 6 lecture hours)

Part 3: Nucleation and growth (4 modules – about 8 lecture hours)

Part 4: Solid-Solid phase transformations I (Precipitation, massive transformations, and martensitic transformations – 5 modules: about 8 lecture hours)

Part 5: Solid-Solid phase transformations II (Spinodal decomposition and ordering – 2 modules: about 6 lecture hours)

Part 6: Heat treatment (About 6 modules: about 6 lecture hours)

Part 7: Miscellaneous topics (Grain growth, recrystallisation, and coarsening – 3 modules: about 4 lecture hours)

Part 8: Classification of transformations (1 module – about 2 lecture hours)

Part 9: Annotated bibliography (Supplementary information

10.Cluster – III

Course Name: Science & Technology of Polymers

48 hours -- credits

1. Basic concepts on polymers

2. Polymer raw materials

3. Polymerization principles and processes (step, chain and other polymerizations, polymer kinetics)

4. Polymerization techniques

5. Polymer manufacture (unit operations, polymer reactors, polymer isolation, handling and storage)

6. Polymer structure and property

7. Polymer characterization

8. Polymer modification

9. Multicomponent polymeric materials (polymer miscibility, polymer blends and alloys, filled plastics, polymer composites)

10. Polymer compounding and fabrication (polymer additives, Compounding processes, fabrication techniques, post fabrication operations)

11. Polymer testing (sample preparation, testing standards and methods, analysis of polymer and additives)

12. Polymer applications: Biodegradable polymers, biomedical polymers, conducting polymers

13. Problems with polymers (thermo oxidative degradation, fire hazards, toxicity, effluent disposal, feedstock scarcity)

Course Name: Polymers: Concepts, Properties, Uses and Sustainability

12 weeks 3 credits

Week 1: What are polymers? What are their unique features? Why are polymers so common?, Polymers: Molecular structure, Process, structure, property, Biopolymers, Molecular weight and distribution, Polymerization, Macromolecular nature

Week 2: Simple concepts related to single macromolecule, Renewable sources for polymers, Polymerization / depolymerization, States of interest, Application based terms

Reuse and repurpose, Molecular conformations, Size, mobility and flexibility, Polyelectrolytes

Week 3: Molecular arrangements and states of polymers, Structures in biopolymers, Amorphous / crystalline states, Orientation, Interactions, Kinetics of crystallization

Glass transition

Week 4: Polymeric systems of different kind, States in environment, Liquid crystalline polymers, Copolymers, Blends

Week 5: Blends, copolymers and composites, Microstructure in polymers, Composites

Stress strain response, Additives for polymeric systems, Blends / composites in recycling

Physical / chemical crosslinking, Mechanical properties

Week 6: Physico-chemical, mechanical and electrical properties of polymers, Physical and chemical aging, Solutions: properties, Conducting polymers, Dielectric response

Plasticity, Properties of composites

Week 7: Viscoelasticity in polymers, Viscoelasticity: introduction, Thermal response, Viscoelasticity: characterization, Viscoelasticity – simple models, Dynamic mechanical analysis, Damping Applications, Time Temperature superposition, Impact and energy absorption

Week 8: Viscoelasticity in polymers / Interaction of polymers with other materials, Testing for applications, Properties of blends, Biomimetic polymers, Advanced mechanics, Viscoelastic response: examples, Polymer packaging, Porous polymers / membranes, Polymer at interfaces, Diffusion in polymers

Week 9: Interaction of polymers with other materials / Polymers processing and recycling

Techniques, Compatibilizers, Biopolymer applications, Adhesives and Paints, Dissolution and recovery, Polymerization kinetics, Polymerization reactors, Polymer processing

Week 10: Polymers processing and recycling techniques, Flow simulations, Processing for recycling, Recycle, up-down cycling, Flow behaviour – rheology, Crosslinking

Conversion of polymers

Week 11: Polymers processing and recycling techniques, Rheology and entanglement

Rheological models, Rheology and processing, Absorption and leaching, Swelling of polymers, Viscosity for polymer processing

Week 12: Polymeric materials in nature, Microplastics, aerosols, sediments, Biodegradation of polymers, Biodegradable polymers

11.Course Name: Fuels Refractory and Furnaces

42 hours -- credits

1. Conventional and newer sources of energy

2. Characterization of fuels: Analysis and calorific value with problems

3. Principles of conversion of fuels: Carbonization, Gasification and Hydrogenation

4. Principles of fuel combustion and Numerical problems

5. Classification of refractories and their service properties

6. Manufacture of common refractory like silica, alumina, fireclay, dolomite, magnesite

7. Types of furnaces and their role in high temperature, applications

8. Fluid flow in furnaces: macroscopic energy balance and its application to Design of chimney and flow measuring devices

9. Heat transfer in furnaces: Conduction, convection and radiation with suitable examples to design refractory lining, and heating of load through flame and convection

10. Flame temperature and heat utilization; concept of available heat and fuel consumption

11. Principles of waste heat recovery and design of heat exchangers and burners

12. Heat balance diagrams with illustrations

13. Fuel economy in industrial furnaces, Oxygen addition to combustion process, Energy efficient operation of furnaces with illustrations

14. Instrumentation and control in furnaces

15. Concept of carbon credit (carbon-offset) and its relationship with energy efficiency

12.Course Name: Dealing with Materials Data: Collection, Analysis, and Interpretation

12 weeks 3 credits

Week 1: Introduction: basic probability and statistics

Week 2: Introduction: basic R

Week 3: Presenting data: inaccuracies and error and its propagation.

Week 4: R for descriptive data analysis

Week 5: Probability distributions

Week 6: Probability distributions using R.

Week 7: Processing of experimental data using R.

Week 8: Fitting functions to data: regression, testing significance of fit

Week 9: R for graphical handling of data and fitting

Week 10: Basics of design of experiments

Week 11: Bayesian inference and its uses

Week 12: Case studies using R.

13.Course Name: Solar Photovoltaics: Principles, Technologies & Materials

8 weeks 2 credits

Week 1: Introduction and Solar radiation fundamentals

Week 2: Basic physics of semiconductors

Week 3: Carrier transport, generation and recombination in semiconductors

Week 4: Semiconductor junctions

Week 5: Essential characteristics of solar photovoltaic devices

Week 6: First Generation Solar Cells

Week 7: Second Generation Solar Cells

Week 8: Third Generation Solar Cells

14.Course Name: Dynamic Behaviour of Materials

12 weeks 3 credits

Week 1: Introduction: dynamic deformation and failure

Week 2: Introduction to waves: elastic waves; types of elastic waves; reflection, refraction, and interaction of waves

Week 3: Plastic waves and shock waves: Plastic waves of uniaxial stress, uniaxial strain, and combined stress; Taylor's experiments; shock waves

Week 4: Shock wave induced phase transformation; Explosive-material interaction and detonation.

Week 5: Experimental techniques for dynamic deformation: intermediate strain rate tests; split Hopkinson pressure bar; expanding ring test; gun systems.

Week 6: Review of mechanical behaviour of materials (especially metals): Elastic and plastic deformation of metals; dislocation mechanics.

Week 7: Plastic deformation of metals at high strain rates: Empirical constitutive equations; relationship between dislocation velocity and applied stress; physically based constitute equations.

Week 8: Plastic deformation in shock waves: Strengthening due to shock wave propagation; dislocation generation; point defect generation and deformation twinning.

Week 9: Strain localization/shear bands: Constitutive models; metallurgical aspects

Week 10: Dynamic Fracture: Fundamentals of fracture mechanics; limiting crack speed, crack branching and dynamic fracture toughness; spalling and fragmentation.

Week 11: Dynamic deformation of materials other than metals: Polymers; ceramics; composites

Week 12: Applications: Armor applications; explosive welding and forming.

15.Course Name: Surface Engineering of Nanomaterials

8 weeks 2 credits

Week 1: Tribology & its classification, Friction tribology, Wear & corrosion, Lubrication, Effect of tribology on surface of nanomaterials.

Week 2: Conventional surface engineering, Types of surface modifications, Physical modifications, Chemical modifications, Applications of surface engineering towards nanomaterials.

Week 3: Deposition and surface modification methods, Physical vapor deposition, Chemical vapor deposition, Advanced surface modification practices, Advantages of deposition for surface modification.

Week 4: Synthesis, processing and characterization of nano-structured coatings, Functional coatings, Advanced coating practices, Characterization of nano-coatings, Applications of nano-coatings,

Week 5: Need of advanced methods for surface and coating testing, Size dependency in nanostructures of nanocoating, Size effect in electrochemical properties of nanostructured coatings, Size effect in mechanical properties of nanostructured coatings, Size effect in physical and other properties of nanostructured coatings.

Week 6: Thin films for surface engineering of nanomaterials, Sputtering techniques, Evaporation processes, Thin film deposition through gas phase techniques, Liquid phase techniques.

Week 7: Microencapsulation: Processes, Microencapsulation: Kinetics of release, Plating of nanocomposite coatings, Advantages of microencapsulation over other conventional methods.

Week 8: Current trends in surface modification of nanomaterials, Modified Nanomaterials: In-use for consumer products, Main problems in synthesis of modified nanomaterials

16.Course Name: Carbon Materials and Manufacturing

12 weeks 3 credits

Week 1: Introduction to materials and manufacturing, mathematical representation of material properties, introduction to carbon, carbon on the Earth and in outer space, carbon in technology and economy, carbon isotopes, carbon atomic structure and hybridization

Week 2: Diamond, graphite, carbyne and curved carbons, classification of carbon allotropes, conversion of one allotropic form into another, phase diagram of carbon

Week 3: Engineering carbons, graphite crystal structure, stacking faults and rhombohedral graphite, graphite ore processing, synthetic graphite production from needle coke.

Week 4: Kish graphite, polymer-derived graphite, Highly Oriented Pyrolytic Graphite (HOPG), pyrolysis of gaseous hydrocarbons, kinetics of graphitization, polymer-derived carbon: coking and charring mechanism

Week 5: Microstructure of non-graphitizing carbon, glass-like carbon: introduction, properties and industrial manufacturing, pyrolysis of polymers and other solid hydrocarbons, microfabrication with glass-like carbon

Week 6: Photolithography, X-Ray and Nano-Imprint Lithography, conversion of microfabricated structure into carbon, activated carbon: introduction, properties and industrial manufacturing.

Week 7: Carbon black: introduction, properties and industrial manufacturing, carbon fibre: introduction and properties, melt spinning of petroleum pitches, electrospinning, and viscoelasticity.

Week 8: Carbonization of polyacrylonitrile (PAN) fibers, mechanical property testing methods for carbon fibers, defects in carbon fibers, Carbon Fiber Reinforced Plastic (CFRP), machining of CFRPs

Week 9: Carbon/ carbon, carbon/ metal, and carbon/ concrete composites: Manufacture and Properties, graphene: introduction and crystal structure, graphene history and nomenclature, Chemical Vapor Deposition (CVD) of graphene.

Week 10: Graphene CVD parameter optimization, defects in graphene, (n,m) notations, carbon nanotube: introduction and properties, vapor phase growth of carbon nanotube

Week 11: Vapor deposited diamond, diamond-like carbon, X-Ray Diffraction analysis of carbon, Raman spectroscopy of carbon, Transmission Electron Microscopy of carbon

Week 12: Gas adsorption isotherms and surface area analysis of porous carbons, numerical problem solving, large-scale industrial applications of carbon materials, micro and nano-scale applications of carbon materials, rigid and flexible carbon devices, device characteristics and challenges, supply chain of industrial carbons, summary, and overview.

17.Course Name: Properties of Materials (Nature & properties of materials-III)

8 weeks 2 credits

Week 1: Introduction and Basic Elasticity

Week 2: Mechanical testing and plastic deformation

Week 3: Plastic deformation mechanisms

Week 4: Strengthening mechanisms

Week 5: Electrical properties of metals

Week 6: Quantum mechanics and band theory

Week 7: Semiconductor properties

Week 8: Thermal properties

18.Course Name: Diffusion in Multicomponent Solids

12 weeks 3 credits

1: Basics of thermodynamics: laws of thermodynamics, concept of chemical potentials and criteria for equilibrium

Week 2: Refresher on Solution Thermodynamics and Phase Stability

Week 3: Phenomenology of multicomponent diffusion and various frames of reference used for measuring diffusion fluxes

Week 4: Solving diffusion equation for various boundary conditions including solution of multicomponent diffusion equation

Week 5: Self diffusion, impurity diffusion, interdiffusion and intrinsic diffusion; Experimental determination of interdiffusion and intrinsic diffusion coefficients

Week 6: Point defects in crystalline solids and mechanisms of diffusion

Week 7: Random walk, diffusivity, and correlation effects in diffusion

Week 8: Derivation of correlation factors in some crystalline lattices

Week 9: Derivation of fundamental driving forces for diffusion: chemical potential gradients and atomic mobilities; cross effects in multicomponent diffusion driven by defect mechanisms

Week 10: Interrelation between multicomponent diffusion coefficients, atomic jump frequencies and thermodynamic factors

Week 11: Multiphase diffusion, diffusion structures and phase diagrams

Week 12: Experimental determination of activation energies for diffusion; Fast diffusion paths: Grain boundary and pipe diffusion

19.Course Name: Non - Metallic Materials

12 weeks 3 credits

Week 1: Module – 1 Polymer materials

Classification of non-metallic materials. Applications of ceramics, glass, carbonaceous materials, polymers, and composites. Understanding on polymer structures

Characteristics and applications of polymers, Processing of polymers, Polymer composites and issues related to recycling.

Week 2: Module – 2 Defects, and reaction kinetics of non – metallic materials, carbonaceous materials

Defects in crystalline materials: Point, line, planar and three dimensional defects, Non – stoichiometry in non – metallic materials, Laws of thermodynamics, reaction kinetics (Part – I and 2), Phase diagram and microstructure evolution of selected non – metallic materials, Carbonaceous materials

Week 3: Module – 3 Diffusion, phase transformation in non – metallic materials, glass and glass – ceramics, Fundamentals of diffusion, Fick's laws, their solution and applications, Phase transformation of non – metallic materials, Introduction to glass and amorphous solids, Specialty glasses Glass – ceramics

Week 4: Module –4 Mechanical properties of non –metallic and composite materials Mechanical properties of non – metallic materials, stress – strain response, elastic, anelastic and plastic deformation, Brittle and ductile materials, fracture mechanics, strengthening of materials, Fatigue, creep and nano-scale properties, Composite materials: Particle – reinforced composites, and fiber reinforced composites, Structural composite

Week 5: Module –5 Electrical, magnetic and thermal properties of non – metallic materials, Dielectric and piezoelectric behavior, Ferroelectric behavior of non-metallic materials and ferroelectric thin film for non – volatile memory applications, Magnetic properties: Origin of magnetism, para, dia, ferro and ferrimagnetism, Ceramic magnets and their applications, Thermal properties: Specific heat, heat conduction, thermal diffusivity, thermal expansion, thermoelectricity.

Week 6: Module –6 Optical and Electrochemical properties of non - metallic materials Optical properties: Refractive index, Absorption and transmission of electromagnetic radiation, LASERS, Introduction to electrochemistry: Galvanic cells, Cell potentials and Gibbs energy, Concentration dependence, Introduction to electrochemical methods: cyclic voltammetry, electrochemical impedance spectroscopy, Electrochemical storage, rechargeable batteries, Fuel cell and Energy harvesting

Week 7: Module –7 Processing of non – metallic materials, Sintering and microstructure development

Preparation of ceramic powders: auto-combustion, sol-gel synthesis, microwave assisted hydrothermal synthesis, Introduction to sintering, sintering mechanism, Solid state sintering and microstructure development. Liquid phase sintering and microstructure development, specialty sintering, and reactive sintering, Processing of glass and amorphous/non-crystalline solids.

Week 8: Module –8 Thin film growth and fabrication of devices, Fundamental of thin film growth, growth mechanism and kinetics, Various thin film growth techniques: thermal evaporation, CVD, sputtering, chemical solution deposition. Processing of semi-conducting devices, Process of ceramic devices, Organic electronic materials: conducting polymers, semi-conducting organic materials, applications.

Week 9: Module –9 Characterization of structure, composition and microstructure of non – metallic materials, Introduction to spectroscopic techniques for material characterization, Thermal analyses, Infra-red and Raman spectroscopy, UV – VIS and X-ray photoelectron spectroscopy, Optical and scanning electron microscopy

Week 10: Module – 10 Measurement of the mechanical, electrical, thermal, magnetic and optical properties of non – metallic materials. Measurement of mechanical properties, fracture toughness, MOR, hardness, Measurement of electrical properties: Electrical conductivity, carrier mobility, carrier concentration, hysteresis, fatigue, time dependent dielectric breakdown, Thermal analysis techniques: Thermo-gravimetry, calorimetry, Measurement of magnetic properties, Measurement of optical properties

Module –11 Corrosion and degradation of non – metallic materials, Fundamentals of corrosion, corrosion of ceramic materials, Degradation of polymers: swelling and dissolution, bond rupture, weathering, Case study: Artificial total hip replacement, Design of ceramics, Finishing of ceramics

Module – 12 Economic, Environmental and societal issues, Economic, Environmental and societal issues in non – metallic materials science and engineering : An Introduction, Component design, Materials and manufacturing techniques, Recycling issues in non – metallic materials Science, Fly – ash based glazed wall tiles: A case study.

Civil Engineering

DEPARTMENT OF CIVIL ENGINEERING

4th Board of Studies Meeting

Held on 19th June 2021 virtually

Minute of Meeting

Dt. 19th June 2021

The 4th Board of Studies (BoS) meeting was held virtually on Saturday, 19th June 2021 at 11:00 AM in the conference hall of the Department of Civil Engineering. The following members were present.

S. No	Name of the Members	Position
1	Dr. K. R. C. Reddy, Professor, AU.	Chairperson
2	Dr. B. Narender, Assoc. Professor & HOD, AU.	Member
3	Dr. R. Pradeep Kumar, Professor, IIIT Hyd.	Member
4	Dr. K. Srinivasa Raju, Professor BITS Pilani-Hyd.	Member
5	Dr. P. Rajasekhar, Professor, OU, Hyd.	Member
6	Dr. P. Pradeep Kumar, Assoc. Professor, AU	Member
7	Dr. K. Madhusudan Reddy, Assoc. Professor, AU	Member
8	Dr. K. J. N. Sai Nitesh, Asst. Professor, AU	Member
9	Dr. Radhika K S, Asst. Professor, AU	Member
10	Dr. Sambit Kumar Beura, Asst. Professor, AU	Member
11	Dr. Hemanth Kr. Chinthapalli, Asst. Professor, AU	Member
12	Mr. Naveen Kr. Chaturvedi, Asst. Professor, AU	Member
13	Mr. Basavaraj Ashok B Patil, Asst. Professor, AU	Member

The chairman has welcomed the members of BoS and presented the outline of the agenda of the meeting. The draft copies of ‘course structure’ and ‘syllabus’ of all programs, which were to be discussed, have been circulated among all the members a day before for their ready reference. At the outset the members have expressed satisfaction and happiness over the draft copies that are being circulated in advance. However they made some comments in some courses. The chairman has initiated the discussion as per the agenda and the comments made by the expert members are taken as **observations** and the actions taken are shown as **resolutions** and are given below as ‘**minute of meeting**’.

Item I: M. Tech. (Structural Engineering) Course Structure and Syllabus

Observation 1: The expert members have strongly suggested to develop the structural dynamics laboratory.
Resolution: Few experiments in 'virtual smart structures and dynamics lab', can be performed by virtual mode but for other experiments need the costly equipment. The decision is left to the management for further action.
Observation 2: It is suggested to include case studies related to civil engineering in the open elective courses 'Machine Learning' and 'Business Analysis'
Resolution: The decision is left to the respective BoS to make necessary corrections.
Observation 3: To take care that the syllabus of 'Computer Oriented Numerical Methods' is not overlapping with the syllabus of mathematics courses that was covered in the under graduation.
Resolution: The syllabus of 'Computer Oriented Numerical Methods' is referred to the mathematics department and sought their corrections.
Observation 4: The expert members have suggested to changes the sequence of topics in the CAD lab in such a way that one can become self-sustained in the field of core profession.
Resolution: The topics of hands on training in the analysis and design of various structure are being changed to suit to the professional engineers.

Item II: M. Tech. (Construction Technology and Management) Course Structure and Syllabus

Observation 1: The members have suggested few minor corrections in the syllabus of few courses.
Resolution: The syllabus is changed accordingly by incorporating the corrections.
Observation 2: It is suggested to include a topic on 'international laws' related to contracts.
Resolution: The syllabus of 'Construction Contracts and Law' is changed by including a law related to international federation in Unit III.

Item III: B. Tech. 'Honors' in 'Smart City Planning and Development'

Observation 1: The members felt that the courses 'Intelligent Transport Systems' and 'Metro Systems and Engineering' are belongs to same stream and hence suggested to change by merging it to one course. And they suggested to include another course on 'water resources' and 'waste water management'
Resolution: As per the experts observation, a new course 'Smart Transportation Systems' introduced by replacing 'Intelligent Transport Systems' and 'Metro Systems and Engineering' and a new course also introduced as 'Integrated Waste Management for Smart Cities'.
Observation 2: The experts feel that the credits given to 'Project Work' are too high in comparison to the credits given to the course work.
Resolution: The decision is left to the central committee of 'Anurag University'

Item IV: B. Tech. 'Minor Degree' in 'Smart City Planning'

Observation 1: It is observed that the courses 'Surveying and Geomatics' and 'Geospatial Technology' belongs to the same stream and hence suggested to replace the 'Surveying and Geomatics' theory and laboratory with another course on 'water resources' and 'waste water management' and by including 'Environmental Engineering Laboratory'

Resolution: As per the suggestion, the courses of 'Surveying and Geomatics' theory and lab courses are replaced with a course 'Integrated Waste Management for Smart Cities' and 'Environmental Engineering Laboratory'

Observation 2: It is also observed that the 'Intelligent Transportation System' can be replaced with the same course as that of the Honors degree.

Resolution: As per the suggestion the 'Intelligent Transportation System' course is replaced with 'Smart Transportation Systems'

ANURAG UNIVERSITY

M. Tech. Structural Engineering

COURSE STRUCTURE AND SYLLABUS

R 21 Regulations

I - SEMESTER

S. No	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P/D	
1		Advanced Structural Analysis	3	0	0	3
2		Theory of Elasticity	3	0	0	3
3		Structural Dynamics	3	0	0	3
4		**Professional Elective 1** 1. Advanced Concrete Technology 2. Water Retaining Structures 3. Advanced Foundation Design 4. Design of Masonry Structures	3	0	0	3
5		**Professional Elective 2** 1. Stability of Structures 2. Retrofitting and Rehabilitation Structures 3. High Rise Structures 4. Soil Structure Interaction	3	0	0	3
6		Research Methodology	2	0	0	2
7		Construction Engineering Laboratory	0	0	4	2
8		Virtual Smart Structures and Dynamics Laboratory	0	0	4	2
Total			**17**	**0**	**8**	**21**

II - SEMESTER

S. No	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P/D	
1		Finite Element Method	3	1	0	4
2		Earthquake Resistant Design of Structures	3	1	0	4
3		**Professional Elective 3** 1. Theory of Plates 2. Bridge Engineering 3. Industrial Structures 4. Composite Structures	3	0	0	3
4		**Professional Elective 4** 1. Prestressed Concrete 2. Functional Planning and Building Services	3	0	0	3

		3. Nonlinear Structural Analysis 4. Design of Substructures				
5		**Open Elective Courses** 1. English for Professionals 2. Essential English and Employability Skills 3. Technical and Business Communication	3	0	0	3
6		**Audit Course**	3	0	0	0
7		CAD Laboratory	0	0	4	2
8		Seminar	0	0	4	2
Total			**18**	**8**	**8**	**21**

III - SEMESTER

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	**T**	**P/D**	
1		Dissertation Phase – I	0	0	24	12
Total			**0**	**0**	**24**	**12**

IV - SEMESTER

Sr. No	Course Code	Course Name	Teaching Scheme			Credits
			L	**T**	**P/D**	
1		Dissertation Phase – II	0	0	28	14
Total			**0**	**0**	**28**	**14**

ANURAG UNIVERSITY

M. Tech. Structural Engineering

LIST OF COURSES

S. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P/D	
Core Courses						
1		Advanced Structural Analysis	3	0	0	3
2		Theory of Elasticity	3	0	0	3
3		Structural Dynamics	3	0	0	3
4		Finite Element Method	3	1	0	4
5		Earthquake Resistant Design of Structures	3	1	0	4
6		Research Methodology	2	0	0	2
Professional Elective Courses (Any Four)						
7		Advanced Concrete Technology	3	0	0	3
8		Water Retaining Structures	3	0	0	3
9		Advanced Foundation Design	3	0	0	3
10		Design of Masonry Structures	3	0	0	3
11		Stability of Structures	3	0	0	3
12		Retrofitting and Rehabilitation Structures	3	0	0	3
13		High Rise Structures	3	0	0	3
14		Soil Structure Interaction	3	0	0	3
15		Theory of Plates	3	0	0	3
16		Bridge Engineering	3	0	0	3
17		Industrial Structures	3	0	0	3
18		Composite Structures	3	0	0	3
19		Prestressed Concrete	3	0	0	3
20		Functional Planning and Building Services	3	0	0	3
21		Nonlinear Structural Analysis	3	0	0	3
22		Design of Substructures	3	0	0	3
Audit Courses (Any One)						
23		Business Analytics	3	0	0	3
24		Industrial Safety	3	0	0	3
25		Machine Learning	3	0	0	3
26		Cost Management of Engineering Projects	3	0	0	3
27		Computer Oriented Numerical Methods	3	0	0	3

28		Waste to energy	3	0	0	3
Open Elective Courses (Any One)						
29		English for Professional	3	0	0	0
30		Essential English and Employability Skills	3	0	0	0
31		Technical and Business Communication	3	0	0	0
Laboratory Courses						
32		Construction Engineering Laboratory	0	0	4	2
33		Virtual Smart Structures and Dynamics Laboratory	0	0	4	2
34		CAD Laboratory	0	0	4	2
Seminar & Dissertation						
35		Seminar	0	0	4	2
36		Dissertation Phase – I	0	0	24	12
37		Dissertation Phase – II	0	0	28	14

ANURAG UNIVERSITY

M. Tech. I Year I- Sem. (Structural Engineering)

ADVANCED STRUCTURAL ANALYSIS

Course Objectives:

- To use the matrix algebra for the analysis of simple structures.
- To provide the knowledge of structural idealization.
- To provide the knowledge of analysis of skeletal structures such as trusses, beams and frames

Course Outcomes: At the end of the course the students will be able to

CO 1: Explain the application of the matrix methods for simple elements

CO 2: Employ the matrix methods for the analysis of plane frame structures

CO 3: Examine the stiffness method for the analysis of beams

CO 4: Evaluate the analysis of framed and grid structures by stiffness method

CO 5: Develop method of analysis of critical elements of a structure

UNIT-I

Analysis of springs and bar systems: Degree of indeterminacy of plane & space structures (static and kinematics), stiffness matrix of a spring element, analysis of spring systems, discretization, assembly of global stiffness matrix, stiffness matrix of a bar element, analysis of bar systems, discretization and analysis of tapered bar structures.

UNIT-II

Analysis of plane trusses: Global local coordinate systems, stiffness matrix of a truss element in local axis, transformation matrix, stiffness matrix in global axis, forces in the members, steps in the analysis, application to plane trusses with not more than 3 DOF, analysis of trusses involving elements with too short and too long members, pre stressing forces and with change of temperature.

UNIT-III

Analysis of beams: Stiffness matrix of a beam element equivalent nodal load vector due to point load, udl and a couple, steps in the analysis, application to the problems with not more than three DOF, analysis of beams with spring/sinking of support.

UNIT-IV

Analysis of plane frames: Stiffness matrix of a plane frame element in local axis, steps in the analysis, transformation matrix, stiffness matrix of a plane frame element in global axis, application to frames with not more than three DOF.

Analysis of Grids: Stiffness matrix of a plane grid element in local axis, steps in the analysis, transformation matrix, stiffness matrix of a grid element in global axis, application to grids of not more than three DOF.

UNIT-V

Advanced topics: Use of symmetry and anti-symmetry, analysis of trusses with inclined supports, beams with shear deformations, beams with hinged ends. Banded matrix, semi band width, band minimization techniques

Text books:

1. Matrix methods of structural analysis by P.N. Godbole, R.S. Sonparote, S.U. Dhote, PHI Learning pvt. Ltd., Delhi.
2. Matrix analysis of framed structures by William Weacer, J. R. and James M. Gere, CBS Publishers and distributors, New Delhi.
3. Matrix structural analysis by J. L. Meek, McGraw Hill

References:

1. Introduction to finite elements in engineering by T. R. Chandrupatla, A.D. Belegundu, Prentice Hall.
2. Matrix methods of structural analysis by M. B. Kanchi, Wiley Eastern Limited.

ANURAG UNIVERSITY
M. Tech. I Year I- Sem. (Structural Engineering)

THEORY OF ELASTICITY

Course Objectives:
To impart knowledge on the basic concepts of theory of elasticity, and solve the Structural Engineering problems

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the strain displacement relations and compatibility equations
CO 2: Apply the compatibility equations to solve the problems on beams
CO 3: Analyze the 2D problems by applying compatibility equations
CO 4: Evaluate the analysis of 3D problems
CO 5: Develop the solutions to torsional problems by energy equations

UNIT-I
Introduction: Elasticity - notation for forces and stress - components of stresses - components of strain - Hooks law. Plane stress and plane strain analysis – Two dimensional co-ordinate system-differential equations of equilibrium - boundary conditions – Strain Displacement Relations - compatibility equations –Airy’s stress function.

UNIT - II
Two dimensional problems in rectangular coordinates - solution by polynomials - Saint-Venants principle - determination of displacements - bending of simple beams – Simple Supported and Cantilever Beam.

UNIT - III
Two dimensional problems in polar coordinates - stress distribution symmetrical about an axis - pure bending of curved bars - strain components in polar coordinates - displacements for symmetrical stress distributions Edge Dislocation - general solution of two-dimensional problem in polar coordinates - application to Plates with Circular Holes-solid and hollow – Rotating Disk.
Bending of Prismatic Bars: Stress function - bending of cantilever - circular cross section - elliptical cross section - rectangular cross section.

UNIT - IV
Analysis of stress and strain in three dimensions - principal stress - stress ellipsoid - director surface- determination of principal stresses Stress Invariants - max shear stresses Stress Tensor – Strain Tensor- Homogeneous deformation - principal axes of strain-rotation.
General Theorems: Differential equations of equilibrium - conditions of compatibility - determination of displacement - equations of equilibrium in terms of displacements - principle of super position - uniqueness of solution - the reciprocal theorem Strain Energy.

UNIT - V

Torsion of Circular Shafts - Torsion of Straight Prismatic Bars– Saint Venant's Method - torsion of prismatic bars - bars with circular and elliptical cross sections – thin walled sections-Prandtl's membrane analogy - torsion of a bar of narrow rectangular bars - solution of torsional problems by energy method - torsion of shafts, tubes , bars etc. – Introduction and Applications of Elastic Solutions in Geomechanics.

TEXT BOOKS

1. Theory of Elasticity by Timoshenko, Mc-Graw hill Publications, 2017.
2. Advanced Mechanics of solids by L.S.Srinath, Tata Mc-GrawHill, 2017.

REFERENCES:

3. Theory of Elasticity by Y.C. Fung, Dover publications, Newyork, 2008.
4. Advanced Mechanics of Materials by Arthur P. Boresi, John Willey publishers, 2010
5. Continuum Mechanics by P.N. ChandraMouli, Yes Dee Publishers, 2004
6. Theory of Elasticity by Sadhu singh, KhannaPublishers, 2018.

ANURAG UNIVERSITY

M. Tech. I Year I- Sem. (Structural Engineering)

STRUCTURAL DYNAMICS

Course Objectives:
To impart knowledge on the fundamental of structural dynamics and their applications

Course Outcomes: At the end of the course the students will be able to

CO 1: understand the basic elements of vibration systems

CO 2: Illustrate the fundamentals of dynamic analysis

CO 3: Differentiate the multi degree freedom systems

CO 4: Evaluate the practical vibration analysis of continuous systems

CO 5: Formulate the deterministic earthquake response of systems

UNIT - I:

Theory of vibrations: Introduction - Elements of vibratory system - Degrees of Freedom - Continuous System - Lumped mass idealization - Oscillatory motion - Simple Harmonic motion - Vectorial representation of S.H.M. - Free vibrations of single degree of freedom system - undamped and damped vibrations - critical damping - Logarithmic decrement - Forced vibration of SDOF systems - Harmonic excitation - Dynamic magnification factor – Phase angle – Bandwidth

UNIT - II

Introduction to Structural Dynamics: Fundamental objectives of dynamic analysis - Types of prescribed loading - Methods of discretization - Formulation of equations of motion by different methods – Direct equilibration using Newton’s law of motion / D’Alembert’s principle, Principle of virtual work and Hamilton principle.

Single Degree of Freedom Systems: Formulation and solution of the equation of motion - Free vibration response - Response to Harmonic, Periodic, Impulsive and general dynamic loadings - Duhamel integral, Numerical evaluation of dynamic response- Central Difference Method and Newmark's Method, Concept of response spectrum.

UNIT - III

Multi Degree of Freedom Systems : Selection of the degrees of Freedom - Evaluation of structural property matrices - Formulation of the MDOF equations of motion - Undamped free vibrations - Solutions of Eigen value problem for natural frequencies and mode shapes - Analysis of Dynamic response – Normal co-ordinates - Uncoupled equations of motion - Orthogonal properties of normal modes – Modal Analysis- Mode super position procedure for damped forced vibrations

UNIT - IV

Practical Vibration Analysis: Introduction - Stodola method - Fundamental mode analysis - Analysis of second and higher modes - Holzer method - Basic procedure.

Continuous Systems: Introduction - Flexural vibrations of beams - Elementary case –

Derivation of governing differential equation of motion - Analysis of undamped free vibrations of beams in flexure - Natural frequencies and mode-shapes of simple beams with different end conditions - Principles of application to continuous beams.

UNIT - V

Deterministic Earthquake Response of Systems – Rigid Foundation, Types of Earthquake Excitation
– Response to Rigid – Soil Excitation, Lumped SDOF elastic systems – Lumped SDOF elastic system – Distributed Parameter Elastic Systems – SRSS, CQC combination of modal responses.

Text books:

1. Anil. K. Chopra, Dynamics of Structures, Pearson Education India, 2007.
2. Pankaj Agarwal and Manish Shrikhande,” Earthquake Resistant Design of Structures”, PHI, 2006.

References :

1. Ray W. Clough, Joseph Penzin, Dynamics of Structures, CBS Publishing, 2015.
2. Mario Paz,”Structural Dynamics: Theory And Computation”, CBS Publishing, 2004.
3. W.T. Thomson,Theory of vibrations ,CBS Publishers And Distributors Pvt Ltd, 2002.

ANURAG UNIVERSITY

M. Tech. I Year I- Sem. (Structural Engineering)

ADVANCED CONCRETE TECHNOLOGY

Professional Elective-I

Course Objectives:

Study the different types of admixtures, mix design, properties and applications of special concretes.

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the chemistry of cements and the use of chemical and mineral admixtures in concrete

CO 2: Use the mix design procedures of various codes to make an economical concrete

CO 3: Examine the preparation of high strength concrete

CO 4: support the NDT equipment to estimate the strength of concrete

CO 5: Develop the special and economical concrete

UNIT – I

Cement chemistry-Portland cement and its constituent phases-High temperature chemistry-The chemistry of Portland cement manufacture-Hydration of calcium silicate phases-Hydrated aluminates, ferrite and sulphate phases- Hydration of cement.

Admixtures: Classification of admixtures - Chemical and mineral admixtures - Influence of various admixtures on properties of concrete and their applications

UNIT –II

Mix Design of Concrete as per IS 10262-2019, ACI Method and DOE Method

Durability Properties - Permeability – chemical attack – Sulphate attack – Carbonation - Quality of water – marine conditions – Thermal properties of concrete – fire resistance – methods of making durable concrete

UNIT –III

High Strength Concrete – Micro structure – Manufacturing and Properties- Design of HSC Using Erintroy Shaklok Method- Ultra High Strength Concrete. High Performance Concrete- Requirements and properties of High-Performance Concrete-Design Considerations.

UNIT –IV

Concrete - Understanding the quasi-brittle nature of concrete - Failure of concrete under low stress - Micro— cracking, crack propagation - stress concentration at openings – Destructive, semi-destructive & Non-destructive testing methodology - Rebound hammer test – Ultrasonic Pulse Velocity (UPV) Test - Penetration resistance test - Pull-out Test - Pull-off Method - Break-off test - Cover Measurement

UNIT - V

Special Concrete: Self Compacting concrete – Polymer concrete – Fiber reinforced concrete – Reactive Powder concrete – Blended Concrete-RMC-Requirements and Guidelines – Advantages and Applications. Light weight concrete. Concrete mix design: Quality Control – Quality assurance – Quality audit.

Textbooks

1. A.M. Neville Properties of Concrete , ELBS publications, Fifth edition, 2012.
2. Shetty M.S., “Concrete Technology”, S.Chand and Company Ltd. Delhi, Seventh edition, 2013.

Refernces

1. Gambhir.M.L., “Concrete Technology”, Tata McGraw Hill, Publishing Co. Ltd NewDelhi, 2013.
2. Santhakumar .A.R.,” Concrete Technology”, Oxford University Press, NewDelhi2006.
3. Rajat Siddique Special Structural concretes, Galgotia Publications.
4. N.Krishna Raju Design of Concrete Mixes , CBS Publications, 5/e edition, 2018
5. P.K. Mehta Concrete: Micro Structure, Properties and Materials, Tata Mc-Graw Hill Publishing House Pvt. Ltd, fourth edition.

ANURAG UNIVERSITY

M. Tech. I Year I- Sem. (Structural Engineering)

WATER RETAINING STRUCTURES
Professional Elective-I

Course Objectives:

To understand the planning, behavior, analysis and design of water retaining structures

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the various forces induced in water retaining structure

CO 2: Employ the boundary conditions for the analysis of rectangular water tanks

CO 3: Evaluate the cracked design of tanks

CO 4: Estimate the earthquake analysis of overhead water tanks

CO 5: Design the elevated storage reservoirs.

Unit-I

Analysis of circular water tanks with various boundary conditions at base slab, variation of hoop tension, moment and deflection of wall with various H/T ratios, deep and shallow tanks. Analysis of tanks using beam on elastic foundation analogy

Unit-II

Analysis of rectangular water tanks with various boundary conditions at base slab, variation of moments with respect to height/span ratio.,

Unit-III

Design (un-cracked and cracked design) of water tank sections subjected to moment, Moment and compression, moment and tension.

Unit-IV

Earthquake Analysis of water tanks on ground and over head tanks (SDOF and MDOF model)

Unit-V

Analysis and design of jack well, approach bridge and WTP (clarifloculator, FM, aeration fountain, chemical house, flash mixer etc.) units etc. Analysis and design of ESR (container and staging)

Reference Books

1. Jaiswal, O. R., Rai, D. C., & Jain, S. K. (2007). Review of seismic codes on liquidcontaining tanks. Earthquake Spectra, 23(1), 239-260.

2. BIS IS 1893-2(2014) Criteria for Earthquake Resistant Design of Structures – Part 2: Liquid retaining tanks, Bureau of Indian Standards, New Delhi, India, (2014).

3. BIS IS 1168 (2011)Criteria for design of RCC staging for overhead water tanks, Bureau of Indian Standards, New Delhi, India, (2011)

4. Anchor, R. D. (1981). Design of liquid-retaining concrete structures. Halsted Press.
5. IS 3370(Part-I). (2009). Concrete structures for storage of liquids - code of practice.
6. IS 3370(Part-II). (2009). Concrete structures for storage of liquids - code of practice.
7. IS 3370(Part-III). (1967). Code of practice for concrete structures for the storage of liquids.
8. IS 3370(Part-IV). (1967). Code of practice for concrete structures for the storage of liquids. Design –Tables.
9. IS BIS IS 13920 (2016). Ductile design and detailing of reinforced concrete structures subjected to seismic forces – code of practice (first revision), Bureau of Indian Standards, New Delhi, India.
10. Ghali, A. (2014). Circular storage tanks and silos. CRC Press.

ANURAG UNIVERSITY

M. Tech. I Year I- Sem. (Structural Engineering)

ADVANCED FOUNDATION ENGINEERING

Professional Elective-I

Course Objective:
To determine the bearing capacity of shallow and deep foundations and to estimate settlements of structures subjected to external loads, leading to design of foundations resting on soils.

Course Outcomes: At the end of the course the students will be able to
CO 1: Explain the soil exploration methods
CO 2: Apply the conventional method of soil testing approaches
CO 3: Differentiate the settlement and consolidation of soils
CO 4: Evaluate the deep foundation techniques
CO 5: Design a reliable based foundations on collapsible soils

Unit-I

Soil Exploration: Exploration Methods; Planning the Exploration Program; Boring and Sampling; In Situ Tests: Standard & Cone Penetration Tests, Field Vane, Dilatometer, Pressure meter; Rock Sampling, Core Recovery, RQD; Geophysical Exploration; Preparation of Soil Report, Case Studies.

Unit-II

Shallow Foundations: **Bearing Capacity:-** Shear Failure; Effect of Water Table; Footings with Eccentric or Inclined Loads, Footings on Layered Soils, Slopes on finite layer with a Rigid Base at Shallow Depth, effect of compressibility of soil, on soils with strength increasing with depth, Plate Load tests, Presumptive bearing capacity.

Unit-III

Settlement: Components – Immediate, Primary and Secondary Settlements, Consolidation, Stresses and Displacements in Homogeneous, Layered and Anisotropic Soils; Bearing Pressure using SPT, CPT, Dilatometer and Pressure meter; Settlement of foundations on Sands- Schmertmann and Burland & Burbridge methods; Structure Tolerance to Settlement and Differential Settlements, Rotation, Codal Provisions.

Unit-IV

Deep Foundations: **Single Pile:** Vertically loaded piles, Static capacity- α, β and λ Methods, Dynamic formulae; Wave Equation Analyses; Point Bearing Resistance with SPT and CPT Results; Bearing Resistance of Piles on Rock; Settlement; Pile Load Test; Uplift Resistance; Laterally Loaded Piles -Ultimate Lateral Resistance; Negative Skin Friction; Batter Piles; Under Reamed Piles; Ultimate Capacity of Pile Groups in Compression, Pullout & Lateral Load; Efficiency; Settlements of Pile Groups; Interaction of Axially & Laterally Loaded Pile Groups, Codal Provisions, Analysis of foundation on soft soil.

Unit-V

Special Topics of Foundation Engineering

Foundations on Collapsible Soils: Origin and occurrence, Identification, Sampling and Testing, Preventive and Remedial measures.

Foundations on Expansive Soils: The nature, origin and occurrence, Identifying, testing and evaluating expansive soils, typical structural distress patterns and Preventive design & construction measures.

***Introduction to Reliability-Based Design**: Brief introduction of probability and statistics, LRFD for structural strength requirements, LRFD for geotechnical strength requirements, Serviceability requirements

Text books

1. Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering (2004)
2. Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012. Phi Learning (2008)

Reference books

3. Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc. (1996)
4. Poulos, H. G. & Davis, E. H. - Pile Foundation Analysis and Design john Wiley & sons inc(1980-08)
5. Tomlinson, M. J. - Foundation Design and Construction - Prentice Hall (2003).
6. Baecher, G.B. & Christian, J.T. – Reliability and Statistics in Geotechnical Engineering, Wiley Publications (2003).

ANURAG UNIVERSITY

M. Tech. I Year I- Sem. (Structural Engineering)

DESIGN OF MASONRY STRUCTURES
Professional Elective-I

Course Objectives: To enable the student to understand the fundamental Concepts of
1. Masonry materials and its mechanical properties.
2. Analysis and the behavior of structural masonry
3. Shear and flexural behavior of Reinforced and unreinforced masonry
4. Summarize construction practices, seismic behavior, specifications, for Design of masonry
5. Seismic evaluation and Retrofit of Masonry.

Course Outcomes: At the end of the course the students will be able to

CO 1: Explain the national and international perspective of masonry construction.

CO 2: Apply the basic principles to know the loads acting on masonry structures

CO 3: Analyze the masonry structures for combined bending and axial loads

CO 4: Evaluate the seismic forces on masonry structures

CO 5: Design rehabilitation and retrofitting method for masonry structures

UNIT - I
Introduction - Masonry construction - National and International perspective – Historical development, Modern masonry, Principles of masonry design, Masonry standards: IS 1905 and others. Material Properties - Masonry units: clay and concrete blocks, Mortar, grout and reinforcement, Bonding patterns, Shrinkage and differential movements.

UNIT - II
Masonry in compression: prism strength, eccentric loading, kern distance. Masonry under Lateral loads: In-plane and out-of-plane loads, Analysis of perforated shear walls, Lateral force distribution -flexible and rigid diaphragms.

UNIT - III
Behavior of Masonry - Shear and flexure - Combined bending and axial loads - Reinforced and unreinforced masonry - Cyclic loading and ductility of shear walls for seismic design – Infill masonry.

UNIT - IV
Structural design of Masonry - Working and Ultimate strength design - In-plane and out-of-plane design criteria for load-bearing and infills, connecting elements and ties - Consideration of seismic loads - Code provisions.

UNIT - V
Seismic evaluation and Retrofit of Masonry - In-situ and non-destructive tests for masonry - properties - Repair and strengthening of existing masonry -structures for seismic loads.

Textbooks

1. P. Dayaratnam and P. Sarah, “Brick and Reinforced Brick Structures”,Oxford& IBH Publishing Co, 2017.
2. R. G. Drysdale, A. H. Hamid and L. R. Baker, “Masonry Structures:Behaviour & Design”, Prentice Hall Hendry,1994.

References

3. A.W. Hendry, B.P. Sinha and S. R. Davis, “Design of MasonryStructures”, E & FN Spon, UK, 1997.
4. S. Sahlin, “Structural Masonry”, Prentice Hall, Englewood Cliffs, NJ,1971.
5. R.S. Schneider and W.L. Dickey, “Reinforced Masonry Design”,Prentice Hall, 3rd edition, 1994.

ANURAG UNIVERSITY
M. Tech. I Year I-Sem. (Structural Engineering)

STABILITY OF STRUCTURES
Professional Elective-2

Course Objectives: To impart knowledge on the elastic, inelastic buckling and torsional buckling of structures.

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify the behavior beam column joint for different loads
CO 2: Demonstrate the elastic buckling of bars and frames
CO 3: Examine the inelastic buckling of structural elements
CO 4: Evaluate the pure torsion of thin walled bars of open cross section.
CO 5: Judge the lateral buckling of simply supported beams.

UNIT – I
Beam Columns: Differential equations for beam columns- beam columns with concentrated loads – continuous lateral loads-couples- beam columns with built in ends – continuous beams with axial load- application of trigonometrically series – Effects of initial curvature on deflections – Determination of allowable stresses.

UNIT - II
Elastic Buckling of bars and frames: Elastic Buckling of straight columns – Effect of shear stress on buckling – Eccentrically and laterally loaded columns- Buckling of frames-large deflections of buckled bars-Energy methods- Buckling of bars on elastic foundations- Buckle line of bar with intermediate compressive forces - Buckling of bars with change in cross-section – Effect of shear force on critical load- built up columns.

UNIT - III
Inelastic Buckling: Buckle line of straight bar- Double modulus theory – Tangent modulus theory, Inelastic lateral Buckling. Experiments and design formulae: Experiments on columns – Critical stress diagram – Empirical formulae for design – various end conditions

UNIT - IV
Torsion Buckling: Pure torsion of thin walled bars of open cross section – Non-uniform torsion of thin walled bars of open cross section- Torsional buckling – Buckling by torsion and flexure.

UNIT – V
Lateral buckling of simply supported Beams: Beams of Rectangular cross-section subjected to pure bending. Buckling of simply supported Rectangular plates: Derivation of equation of plate subjected to constant compression in one and two directions.

Text books:

1. Theory of elastic Stability by Timshenko & Gere -McGraw Hill

References:

2. Stability of metallic structures by Blunch- McGraw Hill
3. Theory of Beam- Columns Vol. I by Chem. & Atste McGraw Hill
4. Stability Theory of Structures by Ashwini Kumar, Allied Publishers.

ANURAG UNIVERSITY

M. Tech. I Year I-Sem. (Structural Engineering)

RETROFITTING AND REHABILITATION OF STRUCTURES
Professional Elective-2

Course Objectives:

- Learn the fundamentals of maintenance and repair strategies.
- Study the quality assurance, serviceability and durability of concrete.
- Know the various materials and techniques used for repair of structures.
- Educate the different repair, strengthening, rehabilitation and retrofitting techniques.
- Instruct the various health monitoring and demolition techniques.

Course Outcomes: At the end of the course the students will be able to

CO 1: Locate the maintenance and repair strategies requirement of structures

CO 2: Demonstrate the serviceability and durability of concrete

CO 3: Differentiate the material and techniques required for repairs of structure

CO 4: Judge the repairs, rehabilitation and retrofitting techniques

CO 5: Develop the health monitoring and demolition techniques.

UNIT - I

Maintenance: Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration.

Repair Strategies: Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure.

UNIT - II

Serviceability and Durability of Concrete: Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

UNIT - III

Materials and Techniques for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Bacterial concrete, Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection.

UNIT - IV

Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

UNIT – V

Health Monitoring and Demolition Techniques: Long term health monitoring techniques, Engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.

TEXT BOOKS:

1. Concrete Technology by A. R. Santhakumar, Oxford University press
2. Defects and Deterioration in Buildings, E F & N Spon, London

REFERENCES:

1. Non-Destructive Evaluation of Concrete Structures by Bungey - Surrey University Press
2. Maintenance, Repair & Rehabilitation and Minor Works of Buildings by P. C. Varghese, PHI.
3. Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.
4. Concrete Repair and Maintenance Illustrated, RS Means Company Inc W. H. Ranso, (1981)
5. Building Failures: Diagnosis and Avoidance, EF & N Spon, London, B. A. Richardson, (1991**).**

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M. Tech. I Year I-Sem. (Structural Engineering)

HIGH RISE STRUCTURES
Professional Elective-2

Course Objective: To impart knowledge on analysis of high rise buildings.

Course Outcomes: At the end of the course the students will be able to

CO 1: Identify the design principles and estimation of wind loads on tall buildings.

CO 2: Demonstrate the estimation of earthquake loads on a tall building.

CO 3: Distinguish the special structural systems for tall buildings

CO 4: Evaluate the dynamic load effects on reinforced concrete chimneys.

CO 5: Design the transmission line towers.

UNIT- I

Introduction to Tall Buildings: Design Principles for Lateral Load resistance, ductility considerations in earthquake resistant design of concrete buildings, construction methods, choice of materials, cladding systems and their design principles, types of foundations for tall buildings.

Wind Loads on Tall Buildings: Introduction to wind, characteristics of wind, Computation of wind loads on buildings as per IS code methods, Wind Tunnel testing, Introduction to Computational Fluid Dynamics.

UNIT- II

Seismic Loads on Tall Buildings: Introduction to Earthquakes, Characteristics of Earthquake, Computation of seismic loads on tall buildings – Response Spectrum Method, Vibration Control – active control & passive control, Liquefaction effects of earthquake, Introduction to Time history Analysis and Pushover analysis.

UNIT – III

Structural systems for Tall Buildings: Necessity of special structural systems for tall buildings, Structural Systems for Steel Buildings -Braced frames, Staggered Truss System, Eccentric Bracing System, Outrigger & Belt truss system, Tube Systems; Structural Systems for Concrete Buildings - shear walls, frame tube structures, bundled tube structures; Design of shear wall as per IS code. Design of Pile Foundation.

Special Topics in Tall Buildings: Second order effects of gravity loading, Creep and shrinkage in columns, Differential shortening of columns, Floor levelling problems, Panel zone effects, P-Delta analysis

.

UNIT – IV

RCC Chimneys: Introduction, parts of an RCC chimney, design factors, stresses in RC shafts due to self weight and wind loads, stresses in horizontal reinforcement due to shear force, stresses due to temperature difference, design of RCC chimney, design of reinforcements in chimneys using charts, dynamic loads effects on RCC chimneys.

UNIT – V

Transmission Line Towers: Classification, economical spacing and design loads - IS code provisions - Calculation of wind loads and permissible stresses – Overall arrangement and design procedure - Detailed design including foundations

Textbooks

1. B. S. Taranath ,Reinforced Concrete Design of Tall Buildings, McGraw-Hill Book Company, 2010.
2. E. Simlu, Wind Effect on Structures: An Introduction to Wind Engineering, Wile& Sons, 1986.

References

3. M. Fintel, Hand Book of Concrete Engineering, Von Nostrand,2004.
4. Emilio Rosenblueth, Design of Earthquake Resistant Structures, Pentech Press Ltd., 1990.
5. W. Schuellar, High Rise Building Structures,John Wiley & Sons Inc, 1977.
6. Bryan Stafford Smith & Alex Coull,Tall Building Structures: Analysis & Design, Wiley India Pvt Ltd, 1991.
7. Lynn S. Beedle Advances in Tall Building,s, CBS Publishers and Distributors Delhi, 1996.

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M. Tech. I Year I-Sem. (Structural Engineering)

SOIL STRUCTURE INTERACTION
Professional Elective-2

Course Objectives: To enable the student to understand the

- Soil behavior and scope of its interaction with the elastic foundation
- Interaction analysis between the soil-structure
- Analysis of infinite and Winkler shapes of plates
- Solutions for settlement and load distribution behavior of piles
- Behavior of laterally loaded piles.

Course Outcomes: At the end of the course the students will be able to

CO 1: Describe the soil behavior and interaction with the elastic foundation
CO 2: Employ the beams on elastic foundation
CO 3: Examine the numerical analysis of finite plates
CO 4: Evaluate the elastic analysis of piles
CO 5: Design the laterally loaded piles

UNIT – I

Soil-Foundation Interaction: Introduction to soil - Foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil-foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.

UNIT – II

Beam on Elastic Foundation - Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

UNIT – III

Plate on Elastic Medium: Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, simple solutions.

UNIT – IV

Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distribution, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

UNIT – V

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Interaction analysis, and pile raft system, solutions through influence charts.

Text books:

1. J. A. Hemsley, “Elastic Analysis of Raft Foundations”, Thomas Telford, 1998.

2. D. F. McCarthy, “Essentials of Soil Mechanics and Foundations, basic geotechnics”, Prentice Hall, 2002.

References:

1. H. G. Poulos and E. H. Davis., “Pile Foundation Analysis and Design”, John Wiley, 1980.
2. P. S. Selvadurai, “Elastic Analysis of Soil Foundation Interaction”, Elsevier, 2015
3. H. G. Poulos, and E. H. Davis, “Pile Foundation Analysis and Design”, John Wiley, 1980.
4. R. F. Scott, “Foundation Analysis”, Prentice Hall, 1981. 7. Structure Soil Interaction - State of Art Report, Institution of structural Engineers, 1978. ACI 336

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M. Tech. I Year I- Sem. (Structural Engineering)

RESEARCH METHODOLOGY

Course Objectives:

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

Course Outcomes: At the end of the course the students will be able to

CO 1: Describe the significance of research and its methodology

CO 2: Illustrate the importance and source of literature and record of research review

CO 3: Examine the meaning and need of research design

CO 4: Appraise the data collection and its analysis

CO 5: Design the research report writing and formulate the research proposal preparation

UNIT – I

Research methodology: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Criteria of good research - Problems encountered by researchers in India - Benefits to the society in general. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.

UNIT – II

Literature survey: Importance of literature survey - Sources of information-Assessment of quality of journals and articles - Information through internet.

Literature review: Need of review - Guidelines for review - Record of research review.

UNIT – III

Research design: Meaning of research design - Need of research design - Feature of a good design - Important concepts related to research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes.

UNIT – IV

Data collection: Collection of primary data - Secondary data - Data organization - Methods of data grouping - Diagrammatic representation of data - Graphic representation of data - Sample design - Need for sampling - Some important sampling definitions - Estimation of population - Role of statistics for data analysis - Parametric vs. non parametric methods - Descriptive statistics - Measures of central tendency and dispersion - Hypothesis testing - Use of statistical softwares.

Data Analysis: Deterministic and random data - Uncertainty analysis - Tests for significance - Chi-square - Student’s t-test - Regression modeling

- Direct and interaction effects – ANOVA - F-test - Time series analysis -

Autocorrelation and autoregressive modeling.

UNIT - V

Research report writing: Format of the research report – Synopsis – Dissertation - Thesis - Its differentiation – References – Bibliography – Webliography - Technical paper writing - Journal report writing - Making presentation - Use of visual aids.
Research proposal preparation: Writing a research proposal and research report - Writing research grant proposal.

Textbooks:

1. C.R Kothari, "Research Methodology, Methods & Technique", New Age International Publishers, New Delhi, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, Chennai, 2011

References:

3. Ratan Khananabis and Suvasis Saha, "Research Methodology", Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publishing Pvt. Ltd., New Delhi, 2004.
5. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
6. G.Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.

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M. Tech. I Year I- Sem. (Structural Engineering)

CONSTRUCTION ENGINEERING LABORATORY

Course Objective:
To evaluate the properties of constituents of concrete, various building materials, concrete with variable workability, concrete with variable parameters.

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the properties of constituents of concrete.
CO 2: Illustrate the properties of various building materials.
CO 3: Experiment the variation of workability of concrete with time and grade of concrete
CO 4: Judge the influence of various parameters on strength of concrete

List of Experiments

1. Evaluation of properties of cement, fine aggregates and coarse aggregates.
2. Evaluation of properties of reinforcing steel, timber, building block and tile.
3. Variation of workability with time for different grades of concrete – experimental observations.
4. Experimental observation on influence of following parameters on strength characteristics of concrete (Some of these parameters may be considered depending up on time)
   i. Size, Shape and grade of coarse aggregate
   ii. Grading of fine aggregate
   iii. Hand Mixing / Machine Mixing
   iv. Aggregate – Cement Ratio
   v. Coarse Aggregate – Fine Aggregate Ratio
   vi. Size and Shape of Test Specimen
   vii. Admixtures

ANURAG UNIVERSITY

M. Tech. I Year I- Sem. (Structural Engineering)

VIRTUAL SMART STRUCTURES AND DYNAMICS LAB

Course Objective:

To enable the students to understand the behavior of the structures against the dynamic loads

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the behavior of structures subjected to dynamic loadings

CO 2: Understand the dynamic characteristics of structures instrumented with sensors.

CO 3: Visualize shear lag effect and Rebar Corrosion

CO 4: Draw response spectrum curve for given condition

CO 5: Measure displacements using Photogrammetry

List of Experiments

Simulation based:

1. Free Vibration of S.D.O.F System
2. Forced Vibration of S.D.O.F System
3. Impulse Response of S.D.O.F System
4. Concept of Response Spectrum
5. Vibration of M.D.O.F System
6. Behavior of Rigid Blocks
7. Torsional Response of Building
8. Continuous Systems
9. Vibration Control
10. Modes of Vibration of Simply Supported Beam Under Flexure
11. Modes of Vibration of Simply Supported Plate
12. Damage Detection and Qualitative Quantification Using Electro-Mechanical Impedance (EMI)Technique
13. Dynamics of Bandra Worli Sea Link Bridge
14. Piezoelectric Energy Harvesting and Structural Health Monitoring Using Thin Surface Bonded PZTPatches.
15. Shear Lag Effect in Electro-Mechanical Impedance (EMI) Technique
16. Rebar Corrosion Detection and Assessment Using Electro-Mechanical Impedance (EMI) Technique.
17. Vibration Characteristics of Aluminum Cantilever Beam Using Piezoelectric Sensors
18. Identification of High Frequency Axial Modes of Beam in "Free-Free" Condition Using Electro-Mechanical Impedance (EMI) Technique
19. Forced Excitation of Steel Beam Using Portable Shaker
20. *Photogrammetry for Displacement Measurement*

E-Resources:

1. http://sd-iiith.vlabs.ac.in/Introduction.html (For Experiments 1 to 9)
2. http://vssd-iitd.vlabs.ac.in/home.html (For Experiments 10 to 20)

ANURAG UNIVERSITY

M. Tech. I Year II-Sem. (Structural Engineering)

FINITE ELEMENT METHODS

Course Objectives:

To impart knowledge about various finite element techniques and development of finite element codes to solve the structural engineering problems.

Course Outcomes: At the end of the course the students will be able to

CO 1: Explain the basic concepts of FEM and the solution of 1D problems

CO 2: Choose the CST elements to solve the 2D problems

CO 3: Distinguish the shape functions required for various elements

CO 4: Evaluate the analysis procedures for the analysis of 3D problems

CO 5: Formulate the analysis procedures for 3D problems

Unit -I

Introduction: Concepts of FEM, steps involved, merits and demerits, matrix displacement method vs FEM, element definition: interpolation functions, stress-strain relationship, strain displacement relationship, stiffness matrix and load vector from the energy principles, Raleigh-Ritz method of functional approximation.

One dimensional problem: Stiffness matrix for a two-nodded and three-nodded bar elements and their shape functions, equivalent nodal force vector due to surface and body forces, analysis of 1D structures using 2-noded and 3-noded bar elements.

Unit-II

CST element – two dimensional problems: plane stress and plane strain problems, stiffness matrix of constraint strain triangle (CST) element, shape functions, equivalent nodal force vector, applications, introduction to linear strain triangle.

Unit – III

Shape functions: Shape functions for 1D elements in Cartesian coordinators of 2-noded and 3-noded elements, methods of constants, Lagrange polynomial, in natural coordinates.

Shape functions for 2D elements: rectangular elements of Lagrange family, Serendipity family, shape functions of triangular elements in area coordinator.

Introduction to shape functions of 3D element, Conditions which shape functions should satisfy.

Unit –IV

Isoparametric elements and numerical integration: Isoparametric concept, isoparametric elements for 1D analysis, isoparametric elements for 2D analysis (Serendipity Family), stiffness matrix for linear isoparametric element, equivalent nodal force vector, numerical integration, applications, convergence and compatibility requirements, Validity of isoparametric elements.

Unit -V

Two-nodded beam element stiffness matrix of a beam element from a cubic polynomial, Hermitian polynomials and their properties, equivalent nodal force vector.

Axi-symmetric analysis: bodies of revolution, axi symmetric modeling, strain displacement relationship, formulation of axi symentric solid elements.

Three dimentional FEM: Different 3D elements, strain-displacement relationship, formulation of hexahedral and isoparametric solid element.

Textbooks

1. Introduction to finite element method by P.N. Godbole, I.K.International Publishing House Pvt. Ltd., New Delhi.
2. Introduction to finite elements in engineering by T.R. chandrupatla and A.D. Belegundu, Prentice Hall
3. The finite element method, O.C. Zienkiewicz, Tata McGraw-Hill Publishing Company, New Delhi.

References

1. C.S. Krishna Murthy, Finite Element Analysis, Mc Graw Hill., 1997
2. C.S. Desai and J.F. Abel, Introduction to the Finite Method, Van Nostrand, 2002
3. David V. Hutton, Fundamentals of Finite Element Analysis, McGraw Hill Education (India) Private Limited, Delhi, 2014.
4. Daryl L, Logan, "A first course in the Finite Element Method", Third Edition, Thomson Brook, Canada Limited, 2007.
5. R. D. Cook, R.D" Concepts and Applications of Finite Element Analysis", John Wiley and sons, 1981.
6. Reddy, J. N, An Introduction to the Finite Element Method, McGraw Hill, New York, 1993.
7. Bathe, K. J, (2006). Finite Element Procedures, Prentice Hall of India, New Delhi.

ANURAG UNIVERSITY

M. Tech. I Year II-Sem. (Structural Engineering)

EARTHQUAKE RESISTANT DESIGN OF BUILDINGS

Course Objectives:
To impart the knowledge on earthquake resistant design of various structures

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the earthquake phenomenon and its causes
CO 2: Demonstrate the conceptual design of horizontal and vertical load resistant systems
CO 3: Differentiate the seismic design requirements and methods
CO 4: Evaluate the design procedures of shear walls
CO 5: Develop the capacity based design of buildins

UNIT - I
Engineering Seismology: Earthquake phenomenon cause of earthquakes-Faults- Plate tectonics- Seismic waves- Terms associated with earthquakes-Magnitude/Intensity of an earthquake-scales- Energy released-Earthquake measuring instruments-Seismoscope, Seismograph, accellerograph- Characteristics of strong ground motions-Seismic zones of India.
Introduction-Functional planning-Continuous load path-Overall form-simplicity and symmetry- elongated shapes-stiffness and strength - Seismic design requirements-regular and irregular configurations-basic assumptions.

UNIT - II
Conceptual Design of Horizontal and Vertical Load Resisting Systems - System and Members for Lateral Loads and High Rise / Tall Structures. Twisting of Buildings – Flexible Building and Rigid Building Systems. Strength and Stiffness – Ductility – Definition – Ductility Relationships – Choice of construction Materials – Unconfined Concrete & Confined Concrete – Masonry, Steel Structures. Design Earthquake Loads – Basic Load Combinations – Permissible Stresses. Seismic Methods of Analysis – Static Method – Equivalent Lateral Force Method. Dynamic Analysis – Response Spectrum Method – Modal Analysis Torsion.

UNIT - III
Introduction to Earthquake Resistant Design – Seismic Design Requirements and Methods.
RC Buildings – IS Code based Method.- Vertical Irregularities – Mass Irregularity Torsional Irregularity - Plan Configuration Problem - Design Lateral Force, Base Shear Evaluation – Lateral Distribution of Base Shear – Structural Walls Strategies and the Location of Structural Walls – Sectional Shapes – Behaviour of Unreinforced and Reinforced Masonry Walls – Behaviour of Walls Box Action and Bands – Behaviour of infill Walls - Non Structural Elements – Failure Mechanism of Nonstructural Elements – Effects of Nonstructural Elements on Structural System – Analysis – Prevention of Damage to Nonstructural Elements – Isolation of Non-Structures.

UNIT - IV

Design of Shear walls: Classification according to Behavior, Loads in Shear walls, Design of Rectangular and Flanged Shear walls, Derivation of Formula for Moment of Resistance of Rectangular Shear walls – Coupled Shear Walls.

UNIT - V

Ductility Considerations in Earthquake Resistant Design of RC Buildings: Introduction- Impact of Ductility- Requirements for Ductility- Assessment of Ductility- Factors affecting Ductility- Ductile detailing considerations as per IS 13920. Behavior of beams, columns and joints in RC buildings during earthquakes-Vulnerability of open ground storey and short columns during earthquake- Seismic Evaluation and Retrofitting.

Capacity Based Design: Introduction to Capacity Design, Capacity Design for Beams and Columns- Case studies.

Text Books:

1. Earthquake Resistant Design of structures – S. K. Duggal, Oxford University Press
2. Earthquake Resistant Design of structures – Pankaj Agarwal and Manish Shrikhande, Prentice Hall of India Pvt. Ltd.

References:

1. Seismic Design of Reinforced Concrete and Masonry Building – T. Paulay and M.J.N. Priestly, John Wiley & Sons
2. Masory and Timber structures including earthquake Resistant Design –Anand S.Arya, Nem chand & Bros
3. Earthquake –Resistant Design of Masonry Building –Miha Tomazevic, Imperial college Press.
4. Earthquake Tips – Learning Earthquake Design and Construction C.V.R.Murty

5. **Reference Codes:**
6. IS: 1893 (Part-1) -2002. “Criteria for Earthquake Resistant – Design of structures.” B.I.S., New Delhi.
7. IS:4326-1993, “ Earthquake Resistant Design and Construction of Building”, Code of Practice B.I.S., New Delhi.
8. IS:13920-1993, “ Ductile detailing of concrete structures subjected to seismic force” Guidelines, B.I.S., New Delhi.

ANURAG UNIVERSITY
M. Tech. I Year II-Sem. (Structural Engineering)

THEORY OF PLATES
Professional Elective-3

Course Objectives: To impart knowledge on the behavior of plates and to analyse the problems pertaining to beams on elastic foundation.

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the cylindrical bending and pure bending of plates.
CO 2: Interpret the deflection theory of thin rectangular plates
CO 3: Differentiate the circular plates and orthotropic plates
CO 4: Select the plates on elastic foundation.
CO 5: Write the governing equation for bending of plates

UNIT - I
Cylindrical Bending: Different kind of plates – Assumptions – Derivation of differential equation for cylindrical bending of long rectangular plates - Analysis of uniformly loaded rectangular plates with edges simply supported and fixed subjected to uniform load.
Pure Bending of Plates: Slope and curvature of slightly bent plates – Relations between moments and curvature - Particular cases of pure bending –Moment in any direction-Principal moments-Strain energy in pure bending –Energy methods like Ritz and Galerkin Methods to rectangular plates subjected to simple loadings.

UNIT - II
Small Deflection Theory of Thin Rectangular Plates: Assumptions – Derivation of governing differential equation for thin plates – Boundary conditions – simply supported plate under sinusoidal load – Navier’s solution – Application to different loading cases – Levy’s solution for various boundary conditions subjected to different loadings like uniform and hydrostatic pressure.

UNIT - III
Circular Plates: Symmetrical loading – Relations between slope, deflection, moments and curvature–Governing differential equation – Uniformly loaded plates with clamped and simply supported edges–Central hole – bending by moments and shearing forces uniformly distributed.
Orthotropic Plates: Introduction – Bending of anisotropic plates - Derivation of governing differential equation – Determination of Rigidities in various cases like R.C. slabs, corrugated sheet – Application to the theory of grid works.

UNIT - IV
Plates on Elastic Foundations: Governing differential equation – deflection of uniformly loaded simply supported rectangular plate – Navier and Levy type solutions – Large plate loaded at equidistant points by concentrated forces.

UNIT - V

Buckling of Plates: Governing equation for Bending of plate under the combined action of in-plane loading and lateral loads – Buckling of rectangular plates by compressive forces acting in one and two directions in the middle plane of plate

Finite Difference Methods: Introduction - Application to rectangular plates subjected to simple loading for various boundary conditions. Problems

Text books

1. Timoshenko Theory of Plates and Shells, McGraw Hill Book Co., New York. 2017.
2. Bhavikatti SS. Theory of plates and shells. New Age International; 2012.

References

1. P. Szilard Theory and Analysis of Plates, Prentice Hall.2014.
2. Reddy JN. Theory and analysis of elastic plates and shells. CRC press; 2006.
3. N. K. Bairagi Plate Analysis, Khanna Publishers. New Delhi.2010.

ANURAG UNIVERSITY
M. Tech. I Year II-Sem. (Structural Engineering)

BRIDGE ENGINEERING
Professional Elective-3

Course Objectives:
To impart knowledge about different types of bridges, their analysis and design for combination of different loading condition as per codal provisions.

Outcomes: At the end of the course the students will be able to
CO 1: Describe the basic concepts of bridge engineering
CO 2: Examine the design aspects of girder bridges
CO 3: Evaluate the loads and moments acting on the box colverts
CO 4: Design the prestressed concrete bridges
CO 5: Construct the sub structure of a bridge

UNIT I
Concrete Bridges: Introduction-Types of Bridges-Economic span length-Types of loading-Dead Load-live load-Impact Effect-Centrifugal force-wind loads-Lateral loads-Longitudinal forces-Seismic loads- Frictional resistance of expansion bearings-Secondary Stresses-Temperature Effect-Erection Forces and effects-Width of roadway and footway-General Design Requirements.
Solid slab Bridges: Introduction-Method of Analysis and Design.

UNIT II
Girder Bridges: Introduction-Method of Analysis and Design-Courbon's Theory, Grillage analogy

UNIT III
Box Culvert: - Single Cell Box Culvert – Design Loads, Design Moments, Shears and Thrusts.
Design of Critical sections.

UNIT IV
Pre-Stressed Concrete Bridges: Basic principles-General Design requirements-Mild steel reinforcement in prestressed concrete member-Concrete cover and spacing of pre-stressing steel-Slender beams-Composite Section-Propped-Design of Propped Composite Section-Unproped Composite section-Two-stage Prestressing-Shrinking stresses-General Design requirements for Road Bridges.

UNIT V
Sub-structure of bridges: Substructure- Beds block-Piers- Pier Dimensions- Design loads for piers-Abutments- Design loads for Abutments. Health Monitoring of Bridge structures.

Text books:

1. N. Krishna Raju Design of Bridges, Oxford & IBH
2. Johnson Victor Essentials of Bridge Engineering, Oxford & IBH

References

1. M.G. Aswani, V.N.Vazirani and M.M.Ratwani Design of Concrete Bridges.
2. E.C. Hambly Bridge Deck Behaviour.
3. V.K.Raina. Concrete Bridge Design and Practice
4. V.V. Sastry Design of Bridges, Dhanpat Rai & Co.

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M. Tech. I Year II-Sem. (Structural Engineering)

INDUSTRIAL STRUCTURES
Professional Elective-3

Course Objective

To introduce method for design of Industrial steel structures with loading and design standards

Course Outcomes: At the end of the course the students will be able to

CO 1: Identify the basic principles involved in the design of industrial buildings

CO 2: Demonstrate the use of composite material in industrial structure

CO 3: Distinguish the principle involved in the design of bunkers and silo

CO 4: Evaluate the design of pressure vessels and storage tanks

CO 5: Design the pre-engineered building structures

Unit-I

Design of Industrial building, Crane, Gantry Girder, North Light and Lattice girder structure

Unit-II

Multistory steel building (Maximum 2 bay and four storey), including composite construction

Unit-III

Design of Bunker and Silo (Rectangular or Circular), including supporting systems.

Unit-IV

Design of Pressure vessels and storage tanks (Circular) Introduction to IS 1893 Part IV

Unit-V

Design of Pre Engineered Building structures

Reference Books / Material

1. Subramanian, S. (2010). Steel structures design and practice, Oxford.
2. Reimbert, M. L., &Reimbert, A. M. (1987). Silos. Theory and practice. Vertical silos, horizontal silos (retaining walls) (No. Ed. 2). Lavoisier Publishing.
3. Johnson, R. P. (2008). Composite structures of steel and concrete: beams, slabs, columns, and frames for buildings. John Wiley & Sons.
4. Owens, G. W.& Knowles, P. R. (1992). Steel designers manual.
5. Faella, C., Piluso, V., &Rizzano, G. (1999). Structural steel semi rigid connections: theory, design, and software (Vol. 21). CRC press.

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COMPOSITE STRUCTURES

Professional Elective-3

Course Objective

The objective of this course is to familiarize the students with analysis and design of steel concrete composite structure.

Course Outcomes: At the end of the course the students will be able to

CO 1: Explain the design of steel concrete composite deck floors

CO 2: Illustrate the analysis and design of composite beams

CO 3: Distinguish the types of shear connectors in composite structures

CO 4: Judge the analysis and design of steel concrete columns

CO 5: Design the steel framed structures with concrete in filled.

Unit-I

Analysis and design of steel-concrete composite deck floors

Unit-II

Analysis and design composite beam, composite beams with solid steel beam, composite beams with steel beams with web opening

Unit-III

Types of shear connectors and its function, analysis and design of shear connection between concrete slab and beam

Unit-IV

Analysis and design steel-concrete composite column, steel section embedded in concrete, concrete in filled steel tubes

Unit-V

Analysis and design steel frame structure with concrete in-filled. Advanced topics and detailing in composite structures

Textbooks

1. Taranath, B. S. (2011). Structural analysis and design of tall buildings: Steel and composite construction. CRC press.

2. Vinson, J. R., & Sierakowski, R. L. (2006). The behavior of structures composed of composite materials (Vol. 105). Springer Science & Business Media.

References

3. Vinson, J. R., &Sierakowski, R. L. (2012). The behavior of structures composed of composite materials (Vol. 5). Springer Science & Business Media.

4. Jones, R. M. (1975). Mechanics of composite materials (Vol. 1). New York: McGrawHill.
5. Christensen, R. M. (2012). Mechanics of composite materials. Courier Corporation. 64
6. Kaw, A. K. (2005). Mechanics of composite materials. CRC press.
7. Daniel, I. M., Ishai, O., Daniel, I. M., & Daniel, I. (1994). Engineering mechanics of composite materials (Vol. 3). New York: Oxford university press.
8. Liang, Q. Q. (2014). Analysis and Design of Steel and Composite Structures. CRC Press.
9. IS 11384 (1985). Code of Practice for Composite Construction in Structural Steel and Concrete, Indian Standard Institution, New Delhi.
10. IS 3935(1966). Code of practice for composite construction, Indian Standard Institution, New Delhi.
11. Narayanan, R. (Ed.). (1988). Steel-concrete Composite Structures (Vol. 7). CRC Press.
12. Owens, G. W., & Knowles, P. R. (1992). Steel designers manual.
13. Davison, B., & Owens, G. W. (Eds.). (2011). Steel designers' manual. John Wiley & Sons.

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PRESTRESSED CONCRETE STRUCTURES
Professional Elective-4

Course Objectives

1. Learn the concept of pre-stressed concrete, methods and systems of pre-stressing, losses of pre-stress.
2. Analyse and design the sections for flexure, torsion and shear using different methods.
3. Learn the design of sections for bond and anchorage and deflections of pre-stressed concrete beams.
4. Study the analysis and design of statically indeterminate beams

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify the general principles of prestressed concrete structures
CO 2: Demonstrate the design of section for flexure, shear and deflection.
CO 3: Distinguish the transfer of pre stress in pre tensioned members.
CO 4: Evaluate the pre tensioned and pre compression members
CO 5: Design the pre stressed floor slabs

UNIT - I

General Principles of Pre stressed Concrete: Pre–tensioning and post – tensioning – Prestressing by straight, concentric, eccentric, bent and parabolic tendons – Different methods and systems of prestressing like Hoyer system, Freyssinet system, Magnel Blaton system – Lee-Mc call system. **Losses of Pre stress:** Loss of prestress in pre-tensioned and post-tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, creep of concrete, relaxation of steel, slip in anchorage, bending of member and frictional loss – Analysis of sections for flexure.

UNIT - II

Design of Section for Flexure: Allowable stresses – Elastic design of simple beams having rectangular and I-section for flexure – kern lines – cable profile and cable layout.
Design of Sections for Shear: Shear and Principal Stresses – Improving shear resistance by different prestressing techniques – horizontal, sloping and vertical prestressing – Analysis of rectangular and I–beam – Design of shear reinforcement – IS: 1343: 2012 provisions.
Deflections of Prestressed Concrete Beams : Short term deflections of uncracked members– Prediction of long-time deflections – load – deflection curve for a PSC beam – IS code requirements for max. Deflections.

UNIT – III

Transfer of Prestress in Pretensioned Members : Transmission of prestressing force by bond – Transmission length – Flexural bond stresses – IS: 1343 : 2012 provisions – Anchorage zone stresses in post tensioned members – stress distribution in End block – Analysis by approximate, Guyon and Magnel methods – Anchorage zone reinforcement.

Statically Indeterminate Structures : Advantages & disadvantages of continuous PSC beams
-Primary and secondary moments – P and C lines – Linear transformation concordant and non- concordant cable profiles – Analysis and design of two span continuous beams.

UNIT – IV

Tension Members: Introduction, Ties, Circular pre-stressing – Design of PSC pipes.
Compression Members: Introduction – Design of PSC columns.

UNIT – V

Slabs: Introduction – Types – rectangular and flat slabs – Codal provisions – Design of PSC floor slabs - one way and two way slabs, and simple flat slabs. Grid Floors: Introduction.

Text books:

1. Prestressed Concrete by N. Krishna Raju, Tata McGraw Hill Book – Co., New Delhi, sixth edition, 2018.
2. Prestressed Concrete by S. Ramamrutham, DhanpatRai & Sons, Delhi.

References:

1. Design of Prestressed Concrete Structures by T.Y. Lin and Burn, John Wiley, New York, 3rd Edition, 2010
2. Prestressed Concrete by N. Rajagopalan, Alpha Science International, second edition, 2005.
3. IS 1343 -2012 Prestressed Concrete – Code of Practice, Bureau of Indian Standards.

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FUNCTIONAL PLANNING AND BUILDING SERVICES

Professional Elective-4

Objectives:

To obtain the knowledge upon functional planning, plumbing and water supply systems, firefighting systems, waste water and solid waste disposal, communication network and maintenance of structures

Course Outcomes: At the end of the course the students will be able to

CO 1: Explain the functional planning of buildings, types of services required and their planning

CO 2: Sketch the plumbing and water supply systems required in structures

CO 3: Interpret the collection, removal, and disposal of solid waste and waste water from a structure

CO 4: Appraise the basic requirement of firefighting and transportation systems required in a structure

CO 5: Design a communication network, air conditionin and their maintenance requirement in a structure

UNIT-I

Components of urban forms and their planning, Concepts of neighborhood unit, Functional planning of buildings, Importance of building services, type of services required, planning of services, organization structures of services management, role and administrative functions of supervisors.

Space requirements and relationship for typical buildings like residential, offices hospitals etc.

UNIT-II

Plumbing and water supply system: Basics of plumbing systems, requirement of plumbing works, activity flowchart for plumbing work, Quality, checking of materials, water requirements for different types of buildings, simple method of removal of impurities, water saving practices and their potential, rainwater harvesting , type of spouts, sizes of rainwater pipes, typical detail of a water harvesting pit.

Water supply and distribution system is high-rise building, pumps and pumping mechanisms, Operation & maintenance of fittings & fixtures of water supply & sanitary. Do's & Don'ts for water pipe.

UNIT-III

Solid Waste disposal: Approaches for solid waste management, Solid wastes collection and removal from buildings, On-site processing and disposal methods, guidelines for municipal solid waste management, e-waste management

Disposal of Wastes : Sanitary land filling, composting, Vermi-compost, Incineration, Pyrolysis Treatment system, Root zone treatment system, Decentralized Wastewater Treatment Systems (DEWATS), Soil Bio technology, packaged Bio-Reactor

UNIT-IV

Firefighting: Basic requirement and various components of the firefighting system. maintenance, firefighting in high-rise buildings, commercial/industrial complexes, public buildings, checklist for fire safety. Lifts/Elevators, Escalators: Legal formalities for elevators, various types of lifts, working mechanisms of lift and escalators. Indian standard codes for planning & installations of elevator, inspection & maintenance of lifts.

UNIT V

Telecommunication network, computer network LAN, electrical network, basics of single phase & three phase electrification, precautions and safety measures, IS codes for electrical appliances & wiring operations & maintenance of network & appliances.
Air-Conditioning and Heating: Flowcharts, Centralized systems, monitoring and working of the equipment, checklist of inspection, performance tests.
Building maintenance: Scheduled and contingency maintenance planning,
M.T.S. for building maintenance, maintenance standards, Economic maintenance decisions, applications of computer in service management

Textbooks:

1. Building Technology IVOR H. Seeley, Mac Millian.
2. Building Finishes, fittings and domestic service Chudley, Longman, Scientific and Technical.

References:

1. Fred Hall Building Services & Equipment, Longman Scientific and Technical.
2. Lee Smith, Harry Slecter, Plumbing Technology, Design and installation, Delmar Publisher INC.
3. Fred Hall, Plumbing Cold water supplies, Drainage and Sanitation, Longman Scientific & Technical.
4. Roger Greeno, Building Services, Technology and Design, Longman.
5. Norbert Lechner, Heating Cooling, Lighting John Wiley & Sons.
6. Maintenance of Buildings A.C. Panchadari, New age international (P) limited Publishers.

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NONLINEAR STRUCTURAL ANALYSIS
Professional Elective-4

Course Objective

To course will provide insight into advanced concepts of analysis and design of structures to withstand earthquake forces and related seismic safety issues

Course Outcomes: At the end of the course the students will be able to

CO 1: Classify the sources of nonlinearity in a structure

CO 2: Employ the principles of computational plasticity

CO 3: Distinguish the distribution of nonlinearity models.

CO 4: Evaluate the solution strategies for nonlinear system of equations

CO 5: Formulate the nonlinear structural dynamic analysis

Unit-I

Introduction to nonlinear structural analysis; Overview, Sources of nonlinearities, types of structural analysis (1st order elastic, 1st order inelastic, 2nd order elastic, and 2nd order inelastic)

Unit-II

Principles of computational plasticity; overview, yield criterion, flow rule, hardening rule, loading/unloading criterion. Some commonly used uniaxial material models; elastic material, elastic-perfectly plastic material, bilinear steel material with kinematic and isotropic hardening, Ramberg-Osgood steel material model, Giuffre-Menegotto-Pinto model with isotropic strain hardening, Kent-ScottPark concrete material model, Visco-elastic material model, Bouc-Wen model;

Unit-III

Member section analysis; fiber section discretization; moment-curvature response; forcedeformation response; Material nonlinear beam-column element formulation; lumped plasticity models (beam with hinges formulation), distributed nonlinearity models; displacement-based nonlinear beam-column element; force-based nonlinear beam-column element. Geometrically nonlinear analysis; simplified 2nd order P-Δ analysis, co-rotational formulations of truss and beam elements.

Unit-IV

Solution strategies for nonlinear system of equations; incremental single-step methods; Euler method, second-order Runge-Kutta methods, incremental-iterative methods, load control, displacement control, work control, arc-length control;

Unit-V

Nonlinear structural dynamic analysis; semi-discrete equations, of motion, explicit time integration, implicit time integration, dissipative integration algorithms, stability and accuracy. Application to hybrid 72 simulation; overview, sub-structuring in hybrid simulation; application to modeling analytical substructures, solution of time discretized equations of motion.

Textbooks:

1. Owen, D. R. &Hinton, E. (1980)Finite Elements in Plasticity (Theory and Practice), Pineridge Press Limited, Swansea.
2. Bathe, K. J. (1987)Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, New Jersey.

References:

1. Crisfield, M. A. (1991)Non-Linear Finite Element Analysis of Solids and Structures (Vol. 1: Essentials), John Wiley & Sons, Chichester.
2. Washizu, K. (1975). Variational methods in elasticity and plasticity (Vol. 3). Oxford: Pergamon press.
3. Crisfield, M. A. (1993). Non-linear finite element analysis of solids and structures (Vol. 1). New York: Wiley.
4. James, F. D. (2010). Nonlinear analysis of thin-walled structures. Springer.
5. Denkowski, Z., Migórski, S., &Papageorgiou, N. S. (2013). An introduction to nonlinear analysis: theory. Springer Science & Business Media.
6. Li, G., & Wong, K. (2014). Theory of nonlinear structural analysis: The force analogy method for earthquake engineering. John Wiley & Sons.
7. Sathyamoorthy, M. (1997). Nonlinear analysis of structures (Vol. 8). CRC Press.

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DESIGN OF SUB STRUCTURES
Professional Elective-4

Course Objectives: To impart knowledge on geotechnical and structural design of different types of foundation appropriate to the type of soil for different structures.

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify the basic requirement of foundations.
CO 2: Employ the raft foundation for weak soils.
CO 3: Distinguish the pile foundation requirement for weak soils
CO 4: Evaluate the design of retaining walls
CO 5: Design the machine foundations

UNIT – I
Shallow Foundations: Basic requirements of foundation –Types and selection of foundations. Bearing capacity of foundations, structural design of isolated, combined, eccentric, strip, and strap footings, Detailing of reinforcement.

UNIT – II
Raft Foundations: Types of rafts, SBC of raft foundation and structural design of different raft foundations, Detailing of reinforcement.

UNIT – III
Pile Foundations: Types of piles, Load carrying capacity of single and pile groups, structural design of piles, pile caps and pile-raft foundation, Detailing of reinforcement.

UNIT – IV
Design of Retaining walls: Stability Checks and structural design of gravity, Cantilever retaining walls, Detailing of reinforcement, Design of Strut, Brace Excavation.

UNIT – V
Machine Foundations: Vibration analysis of machine foundation - Design of foundation for Reciprocating machines and Impact machines - as per l S Codes, Detailing of reinforcement.

Text books:

1. Varghese P.C. Design of RC foundations, PHI Learning Pvt. Ltd.
2. Unnikrishnana Pillai & Devadas Menon, Reinforces Concrete Design, McGraw Hill Publishing Pvt. Ltd.

Reference:

1. Bowles. J.E., “Foundation Analysis and Design”, McGraw Hill Publishing co., New York, 1986

2. Tomlinson. M.J, “Foundation Design and Construction”, Longman, Sixth Edition, New Delhi, 1995.
3. Das, B.M., Principles of Foundation Engineering, Design and Construction, Fourth Edition, PWS Publishing, 1999.
4. Narayan V. Nayak, Foundation design manual, Dhanpat Rai & Sons, 2006.
5. Prakash Shamsher and Puri Vijay K, Foundations for Machines, Analysis and Design” John Wiley and Sons, USA, 1988.
6. IS 2911: Part 1: Sec 1: 1979 Code of practice for design and construction of pile foundations: Part 1 Concrete piles, Section 1 Driven cast in-situ concrete piles.

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ENGLISH FOR PROFESSIONALS

Open Elective Course

Introduction:
The course aims at preparing the students with the tools needed for successful communication at the professional front. It is designed to improve students' academic and professional skills which the employers are currently looking for.

Objective:
To prepare the students to use the language effectively in all professional pursuits

Course Outcomes: On successful completion of this course, students will be able to
CO 1: Analyze the language use in communicative process
CO 2: Describe the process and product
CO 3: Interpret the ideas in group activities
CO 4: Apply different approaches to comprehend the written text
CO 5: Write any technical and official correspondence within the framework

UNIT-I
Essentials of Communication: Essentials of Grammar-Rudiments of Communications Skills(Listening, Speaking, Reading, and Writing)- Applied Grammar and Usage- Non-Verbal Communication
UNIT-II
Listening Skills: Art of Listening- Developing Effective Listening Skills-Process of Listening, Intensive & Extensive Listening, Podcasts, Vodcasts(ICT enabled)-Five steps to Active Listening-Effective and Ineffective Listening Skills-Listening &Note-taking

UNIT-III
Speaking Skills: Dynamics of Effective Speaking -Group Discussion-Simulated Presentations, Process & Product Descriptions- Proxemics, Paralinguistic Features

UNIT-IV
Reading Skills: The Art of Effective Reading- Basic steps to Effective Reading-Extensive and Intensive Reading -Approaches to Efficient Reading-Reading Comprehension

UNIT-V
Writing Skills: Art of Condensation-Descriptive Writing Techniques-Writing & Answering Memos, Circulars -Inter & Intra Official Communication -Writing Minutes of Meeting-Netiquette - E-mail & Blog Writing - Note-making

Textbook:
Kumar, Sanjay and Pushp Lata, Communication Skills, Second edition, Oxford University Press, 2015.

References:

1. Adair, John.The Effective Communicator. Jaico Publishing House.1995.
2. Adler, B.Ronald.Communicating at Work.(Seventh edition.) McGraw Hill.2004.
3. Aruna, Koneru. Professional Communication.McGraw Hill.2017.
4. Ibbotson,Mark.Cambridge English for Engineering Professionals. Cambridge University.2008.
5. Oxford English for Careers.Oxford University Press.

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ESSENTIAL ENGLISH AND EMPLOYABILITY SKILLS
Open Elective Course

Introduction:
The purpose of graduate education is not only to gain knowledge but also to acquire employability skills fit for the qualification. The challenge of fresh graduates does not end with merely acquiring a job but to maintain credibility and sustainability throughout their career. Hence, varied skills and competencies are the pre-requisites for professional students who emerge from colleges and are ready to take up global careers.

Objectives:
1. To enable students to develop their personality, infuse confidence and increase employability skills in any chosen career
2. To provide the students hands-on experience to cope with the demands of the world of recruiters
3. To help the students acquire the job skills essential for employment

Course Outcomes: On successful completion of this course, students will be able to
CO 1: Enhance employability skills and professional etiquette to work in the corporate world
CO 2: Develop leadership, interpersonal and decision-making skills
CO 3: Acquire productive knowledge, competent learning, and innovative thinking skills
CO 4: Analyse the importance of tackling various job interviews
CO 5: Provide insights to implement verbal and non-verbal communication competencies in workplace

UNIT-I
Six Sigma: Dabbawala from English for Employability
Personality Development: A Must for Leadership and Career Growth from Personality Development and Soft Skills
Introduction - Learning about Personality Development from 3 Cases - Personality Analysis - Freudian analysis of Personality Development - Swami Vivekananda's Concept of Personality Development - Personality Begets Leadership Qualities

UNIT-II
Yet I am not defeated! from English for Employability, Interpersonal skills from Personality Development and Soft Skills, The Personality Attribute of Taking Bold Decisions - Personality Types and Leadership Qualities - Personality Tests

UNIT-III
Patricia Narayanan: An Entrepreneur by accident, from English for Employability
Soft Skills: Demanded by Every Employer from Personality Development and Soft Skills

Introduction to Soft Skills - Lessons from the 3 Case Studies - Change in Today's Workplace - Soft Skills as a Competitive Weapon - Antiquity of Soft Skills - Classification of Soft Skills

UNIT-IV

Satya Nadella: CEO of Microsoft from English for Employability, Interview Skills from Personality Development and Soft Skills

UNIT-V

Body Language Reveals Your Inner self and Personality from Personality Development and Soft Skills

Introduction - Emotions Displayed by Body Language – Handshake -The Most Common Body Language - Eyes - A Powerful Reflection of One's Inner self - Entry to My Space - Personal Zones may vary - Body Language exhibited during different Professional Interactions.

Textbooks Prescribed:

1. Textbook 1: Purushotham, K. English for Employability. Orient Black Swan, Hyderabad.
2. Textbook 2: Mitra, K. Barun. Personality Development and Soft Skills. Oxford University Press.

References:

3. Enhancing English and Employability Skills. State Board of Technical Education and Training. Hyderabad: Orient Black swan Private Limited, 2012.
4. Rao, M. S. Soft Skills Enhancing Employability. New Delhi: I. K. Publishing House, 2010.
5. Rao, Nageshwar. Communication Skills. New Delhi: Himalaya Publishing House Pvt. Ltd, 2008.
6. Sharma, T. K. Enhancing Employability in Education. India: Patridge Publishing House. 2015.
7. Yadav, Shalini. Communication Technique. New Delhi: University Science Press, 2010.

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TECHNICAL AND BUSINESS COMMUNICATION
Open Elective Course

Introduction:
The course is intended to expose the students to learn and practice the five communication skills thinking, listening, speaking reading, and writingin English, the global language of communication. It reflects some of the approaches in English language teaching and learning currently in practice around the world.

Objective:
To help the students to develop effective communication skills in all communicative contexts for professional advancement

Course Outcomes: On successful completion of the course, students will be able to
CO 1: Communicate technical and business correspondence
CO 2: Reflect on the themes discussed
CO 3: Recognize ethical implications of technical communication
CO 4: Identify the contemporary issues in engineering from environmental and global perspectives
CO 5: Demonstrate ethical decisions in complex situations

UNIT-I
E-World & E-Communication: E-language - E-governance - E-commerce/E-business - E-banking - E-waste

UNIT-II
Business Establishment & Infrastructure Development: Power Supply - Industrial Park - Business Correspondence: Follow-up letters - Acceptance & Rejections - Persuasive letters - Resignation letters

UNIT-III
Technology and Society: Robot Soldiers - For a Snapshot of a Web - Placing an order - Proposal Writing - Patents & Rights (National & International) - Intellectual Property - Nanotechnology

UNIT-IV
Ethics in Business Communication: Ethical issues involved in Business Communication - Ethical dilemmas facing managers - Ethical Code & Communication - Standards in Daily Life - Total Quality Management - World University Ranking

UNIT-V
Management Information System: Corporate Governance - Business Process Outsourcing - Project Management Communication - Marketing Communication

Textbook:
1. Dhanavel, P. S. English and Communication Skills for Students of Science and Engineering. Orient Black Swan. 2009.

References:

1. Anderson, V. Paul. Technical Communication. Cengage. 2014.
2. Kalkar, Anjali. et.al. Business Communication. Orient Black Swan. 2010.
3. Knisely, W. Charles. and Knisely, I. Karin. Engineering Communication. Cengage. 2015.
4. Kumar, Sanjay. and Pushp Lata. Language and Communication skills for Engineers. Oxford University Press. 2018.
5. Raman, Meenakshi and Singh, Prakash. Business Communication. (Second Edition.). Oxford University Press. 2012.

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BUSINESS ANALYTICS
Audit Course

Course Objectives:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.

Course Outcomes:

CO 1: Identify the business analytics and statistical tools
CO 2: Illustrate the trendiness and regression analysis
CO 3: Examine the organization structures of business analysis
CO 4: Evaluate the forecasting techniques and risk analysis
CO 5: Formulate the decision strategies

Unit I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Unit II

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression, Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Unit IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Unit V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Textbooks:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press 2015.
2. Business Analytics by James Evans, persons Education.2010.

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INDUSTRIAL SAFETY
Audit Course

Course Objectives:
To enable the students to understand the hazards in industry and their preventive measures

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the causes of industry hazards.
CO 2: Schedule the primary and secondary functions and responsibility of maintenance department
CO 3: Differentiate the types of corrosions and their preventive measures
CO 4: Judge the fault tracing concepts
CO 5: Develop the periodic maintenance of hazards preventive measures

Unit-I
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit-II
Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV
Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components,

overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Textbooks

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

References

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

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MACHINE LEARNING
Audit Course

Prerequisites: Data Structures, Knowledge on Statistical Methods

Course Objectives:

1. This course explains machine learning techniques such as decision tree learning, Bayesian learning etc.
2. To understand computational learning theory.
3. To study the pattern comparison techniques.

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the perspectives and issues in machine learning
CO 2: Demonstrate the problems for Artificial Intelligence network
CO 3: Examine the computational learning theory and instant based learning
CO 4: Defend the pattern comparison techniques
CO 5: Develop the analytical learning

UNIT – I
Introduction - Well-posed learning problems, designing a learning system Perspectives and issues in machine learning
Concept learning and the general to specific ordering – Introduction, A concept learning task, concept learning as search, Find-S: Finding a Maximally Specific Hypothesis, Version Spaces and the Candidate Elimination algorithm, Remarks on Version Spaces and Candidate Elimination, Inductive Bias.
Decision Tree Learning – Introduction, Decision Tree Representation, Appropriate Problems for Decision Tree Learning, The Basic Decision Tree Learning Algorithm Hypothesis Space Search in Decision Tree Learning, Inductive Bias in Decision Tree Learning, Issues in Decision Tree Learning.

UNIT – II
Artificial Neural Networks Introduction, Neural Network Representation, Appropriate Problems for Neural Network Learning, Perceptions, Multilayer Networks and the Back propagation Algorithm. Discussion on the Back Propagation Algorithm, An illustrative Example: Face Recognition **Evaluation Hypotheses** – Motivation, Estimation Hypothesis Accuracy, Basics of Sampling Theory, A General Approach for Deriving Confidence Intervals, Difference in Error of Two Hypotheses, Comparing Learning Algorithms.

UNIT – III
Bayesian learning - Introduction, Bayes Theorem, Bayes Theorem and Concept Learning Maximum Likelihood and Least Squared Error Hypotheses, Maximum Likelihood Hypotheses for Predicting Probabilities, Minimum Description Length Principle, Bayes Optimal Classifier, Gibs Algorithm, Naïve Bayes Classifier, An Example: Learning to Classify Text, Bayesian Belief Networks, EM Algorithm.
Computational Learning Theory – Introduction, Probably Learning an Approximately Correct Hypothesis, Sample Complexity for Finite Hypothesis Space,

Sample Complexity for Infinite Hypothesis Spaces, The Mistake Bound Model of Learning.

Instance-Based Learning – Introduction, k-Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning.

UNIT – IV

Pattern Comparison Techniques, Temporal patterns, Dynamic Time Warping Methods, Clustering, Codebook Generation, Vector Quantization

Pattern Classification: Introduction to HMMS, Training and Testing of Discrete Hidden Markov Models and Continuous Hidden Markov Models, Viterbi Algorithm, Different Case Studies in Speech recognition and Image Processing

UNIT – V

Analytical Learning – Introduction, Learning with Perfect Domain Theories : PROLOG-EBG Remarks on Explanation-Based Learning, Explanation-Based Learning of Search Control Knowledge, Using Prior Knowledge to Alter the Search Objective, Using Prior Knowledge to Augment Search Operations.

Combining Inductive and Analytical Learning – Motivation, Inductive-Analytical Approaches to Learning, Using Prior Knowledge to Initialize the Hypothesis.

Text books:

1. Machine Learning – Tom M. Mitchell,- MGH
2. Fundamentals of Speech Recognition By Lawrence Rabiner and Biing – Hwang Juang.

Reference book:

1. Machine Learning : An Algorithmic Perspective, Stephen Marsland, Taylor & Francis

ANURAG UNIVERSITY
M. Tech. I Year II- Sem. (Structural Engineering)

COST MANAGEMENT OF ENGINEERING PROJECTS
Audit Course

Course Objectives:
To enable the students to know the cost management of engineering projects

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify the strategic cost management processes
CO 2: Schedule the pre project execution clearances and documents
CO 3: Examine the infrastructure project sites
CO 4: Appraise the cost behavior and profit planning
CO 5: Construct the quantitative techniques cost management

Unit-I
Introduction and Overview of the Strategic Cost Management Process. Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Unit-II
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documents.

Unit-III
Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Unit-IV
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.

Unit-V
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Textbooks:
1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting

References:

1. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
2. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
3. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

ANURAG UNIVERSITY

M. Tech. I Year II- Sem. (Structural Engineering)

COMPUTER ORIENTED NUMERICAL METHODS
Audit Course

Course Objectives:
To make the students to understand the computer oriented numerical methods in construction activities.

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the solutions of linear equations formulated for construction activities
CO 2: Identify the interpolation techniques
CO 3: Illustrate the finite difference and their applications
CO 4: Examine the numerical differentiation integration techniques
CO 5: Formulate the ordinary differential equations

Unit - I
Solutions of linear equations: Direct method – Cramer's rule, Guass – Elimination method- Gauss – Jordan elimination – Triangulation (LU Decomposition) method – Iterative methods Jacobi – Iteration method – Gauss – Siedel iteration, Successive over –relaxation method.
Eigen values and Eigen_vectors: Jacobi method for symmetric matrices- Given's method for symmetric matrices-Householder's method for symmetric matrices-Rutishauser method of arbitrary matrices – Power method.

UNIT - II
Interpolation: Linear Interpolation – Higher order Interpolation – Lagrange Interpolation – Interpolating polynomials using finites differences- Hermite Interpolation –piece-wise and spline Interpolation.

Unit - III
Finite Difference and their Applications: Introduction- Differentiation formulas by Interpolating parabolas – Backward and forward and central differences- Derivation of Differentiation formulae using Taylor series- Boundary conditions- Beam deflection – Solution of characteristic value problems- Richardson's extrapolation- Use of unevenly spaced pivotal points- Integration formulae by interpolating parabolas- Numerical solution to spatial differential equations – Applications to Simply Supported Beams, Columns and Rectangular Plates.

UNIT - IV
Numerical Differentiation: Difference methods based on undetermined coefficients- optimum choice of step length– Partial differentiation.
Numerical Integration: Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method- composite integration method – Double integration using Trapezoidal and Simpson's method – New Marks Method and Application to Beams – Calculation of Slopes and Deflections.

UNIT - V

Ordinary Differential Equation: Euler's method – Backward Euler method – Midpoint method – single step method, Taylor's series method- Boundary value problems.

Text books:

1. Numerical methods for scientific and engineering computations. M.K. Jain-S.R.K. Iyengar – R.K. Jain Willey Eastern Limited
2. Numerical Methods for Engineering Problems, N. Krishna Raju, KU Muthu, Mac-Millan publishers

References:

1. Introductory Numerical Methods by S.S. Shastry, PHI Learning Pvt. Ltd.
2. Applied numerical analysis by – Curtis I. Gerala- Addission Wasley – published campus.
3. Numerical methods for Engineers Stevan C. Chopra, Raymond P. Canal Mc. Graw Hill Book Company.
4. C Language and Numerical methods by C. Xavier – New age international publisher.
5. Computer based numerical analysis by Dr. M. Shanta Kumar, Khanna Book publishers, New Delhi.

ANURAG UNIVERSITY
M. Tech. I Year II- Sem. (Structural Engineering)

WASTE TO ENERGY

Audit Course

Course Objectives:
To enable the student to know the best use of waste in the preparation of energy

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the energy conversion devices
CO 2: Illustrate the manufacture of pyrolytic oils and gases
CO 3: Examine the biomass gasification
CO 4: Defend the biomass combustion techniques
CO 5: Develop the biogas plant technology

Unit-I
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit-II
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit-III
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit-IV
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit-V
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Texbooks:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

References:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

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M. Tech. I Year II-Sem. (Structural Engineering)

COMPUTER AIDED DESIGN LABORATORY

Course Objective: To impart the knowledge of functional planning and design and detailing of various structures.

Course Outcome: At the end of this course the student will be able to

CO 1: Explain the functional planning and drawing of a residential building as per building by-laws.

CO 2: Employ software for the analysis and design of structures.

CO 3: Examine the reinforcement details of various elements of a structure.

CO 4: Evaluate the various materials that are required for a structure and their cost.

CO 5: Design a structure with all structural details and estimates independently.

List of Experiments

1. Drawing the functional planning of a building by adopting all building by laws
2. Analysis and design of a single story building using any available software.
3. Drawing the reinforcement details of slab, beam, columns and foundations of the above building.
4. Drawing the reinforcement details of staircase
5. Estimation of various materials and their cost of the above building
6. Analysis, designing and detailing of water tank attached to the above building
7. Comparing the design details using Microsoft excel.
8. Analysis of multistory multibay 2D frame
9. Analysis of multistory building for wind loads
10. Analysis of multistory building for earthquake loads

ANURAG UNIVERSITY

M. Tech. I Year II-Sem. (Structural Engineering)

SEMINAR

Course Objectives:
To acquire knowledge of literature review, writing a comprehensive report and presenting a seminar.

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify appropriate topic of relevance.
CO 2: Illustrate the literature on technical articles of selected topic and develop comprehensive report
CO 3: Examine the innovations and methodologies understood from the literature
CO 4: Defend the innovative ideas and formulate the technical gaps in the research
CO 5: Write a comprehensive technical report and develop a presentation on the chosen topic

The students are instructed to choose a topic of their interest from the field of structural engineering

ANURAG UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
M. Tech. Construction Technology and Management

COURSE STRUCTURE AND SYLLABUS
R 21 Regulations

I - SEMESTER

S. No.	Course Code	Course Name	Teaching Scheme L	T	P/D	Credits
1		Construction Management	3	0	0	3
2		Construction Planning and Control	3	0	0	3
3		Construction Economics and Finance	3	0	0	3
4		**Professional Elective 1** 1. Advanced Concrete Technology 2. Quantitative Methods in Construction Management 3. Quality and Safety in Construction 4. Construction Engineering Practices 5. Formwork and Scaffolding Design	3	0	0	3
5		**Professional Elective 2** 1. Legal Issues in Construction Management 2. Functional Planning and Building Services 3. Value Engineering in Construction 4. Management Information Systems Bridge Engineering	3	0	0	3
6		Research Methodology	2	0	0	2
7		Construction Engineering Laboratory	0	0	4	2
8		Soft Computing Techniques Laboratory	0	0	4	2
Total			**17**	**0**	**8**	**21**

II - SEMESTER

S. No.	Course Code	Course Name	Teaching Scheme L	T	P/D	Credits
1		Construction Equipment Management	3	1	0	4
2		Construction Contracts and Law	3	1	0	4
3		**Professional Elective 3** 1. TQM Techniques in Construction 2. Human Resources Development for Construction 3. Green Building Technology 4. Retrofitting and Rehabilitation of Structures 5. Strategic Management in Construction	3	0	0	3
4		**Professional Elective 4** 1. Geospatial Technology 2. Disaster Management 3. Environmental Impact Assessment	3	0	0	3

		4. Geotechnical Investigations for Construction Projects 5. Precast and Composite Structures				
5		**Open Elective Courses** 1. English for Professional 2. Essential English and Employability Skills 3. Technical and Business Communication	3	0	0	3
6		**Audit Course**	3	0	0	0
7		Advanced Construction Engineering Laboratory	0	0	4	2
8		Seminar	0	0	4	2
Total			**18**	**2**	**8**	21

III - SEMESTER

S. No	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P/D	
1		Dissertation Phase – I	0	0	24	12
Total			**0**	**0**	**24**	**12**

IV - SEMESTER

S. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P/D	
1		Dissertation Phase – II	0	0	28	14
Total			**0**	**0**	**28**	**14**

ANURAG UNIVERSITY

M. TECH. Construction Technology and Management

LIST OF COURSES

S. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P/D	
Core Courses						
1		Construction Management	3	0	0	3
2		Construction Planning, Scheduling and Control	3	0	0	3
3		Construction Economics and Finance	3	0	0	3
4		Construction Equipment Management	3	1	0	4
5		Construction Contracts and Law	3	1	0	4
6		Research Methodology	2	0	0	2
Professional Elective Courses (Any Four)						
7		Advanced Concrete Technology	3	0	0	3
8		Quantitative Methods in Construction Management	3	0	0	3
9		Quality and Safety in Construction	3	0	0	3
10		Construction Engineering Practices	3	0	0	3
11		Formwork and Scaffolding Design	3	0	0	3
12		Legal Issues in Construction Management	3	0	0	3
13		Functional Planning and Building Services	3	0	0	3
14		Value Engineering in Construction	3	0	0	3
15		Management Information Systems	3	0	0	3
16		Bridge Engineering	3	0	0	3
17		TQM Techniques in Construction	3	0	0	3
18		Human Resources Development for Construction	3	0	0	3
19		Green Building Technology	3	0	0	3
20		Retrofitting And Rehabilitation of Structures	3	0	0	3
21		Strategic Management in Construction	3	0	0	3
22		Geospatial Technology	3	0	0	3
23		Disaster Management	3	0	0	3
24		Environmental Impact Assessment	3	0	0	3
25		Geotechnical Investigations for Construction Projects	3	0	0	3
26		Precast and composite structures	3	0	0	3
Audit Courses (Any One)						

27		Business Analytics	3	0	0	3
28		Industrial Safety	3	0	0	3
29		Machine Learning	3	0	0	3
30		Cost Management of Engineering Projects	3	0	0	3
31		Computer Oriented Numerical Methods	3	0	0	3
32		Waste to energy	3	0	0	3
Open Elective Courses (Any One)						
33		English for Professional	3	0	0	0
34		Essential English and Employability Skills	3	0	0	0
35		Technical and Business Communication	3	0	0	0
Laboratory Courses						
36		Construction Engineering Laboratory	0	0	4	2
37		Soft Computing Techniques Laboratory	0	0	4	2
38		Advanced Construction Engineering Laboratory	0	0	4	2
Seminar & Dissertation						
39		Seminar	0	0	4	2
40		Dissertation Phase – I	0	0	24	12
41		Dissertation Phase – II	0	0	28	14

ANURAG UNIVERSITY

M. Tech. I Year I Semester (Construction Technology Management)

CONSTRUCTION MANAGEMENT

Course Objectives:

- Understand the broad principles and concepts of construction management
- To create awareness of MIS techniques in construction industry
- Represent various works measurement standards

Course Outcomes: At the end of the course the students will be able to

CO 1: Recognize the owners perspective of a construction project

CO 2: Explain the Project Organizations - Perceptions of Owners and Contractors.

CO 3: Differentiate the design and construction processes

CO 4: Judge Labor, Material and Equipment Utilization

CO 5: Develop the cost estimates of a project

Unit I

The Owner's Perspective

Introduction - The Project Life Cycle - Major Types of Construction - Selection of Professional Services - Construction Contractors -Financing of Constructed Facilities - Legal and Regulatory Requirements - The Changing Environment of the Construction Industry - The Role of Project Managers.

Unit II

Organizing for Project Management

What is Project Management? - Trends in Modern Management -Strategic Planning and Project Programming - Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer -Constructor Sequence - Professional Construction Management - Owner - Builder Operation - Turnkey Operation - Leadership and Motivation for the Project Team - Interpersonal Behaviour in Project Organizations - Perceptions of Owners and Contractors.

Unit III

The Design and Construction Process

Design and Construction as an Integrated System - Innovation and Technological Feasibility - Innovation and Economic Feasibility - Design Methodology - Functional Design - Physical Structures - Geo- Technical Engineering Investigation - Construction Site Environment - Value Engineering- Construction Engineering - Industrialized Construction and pre - fabrication - Computer - Aided Engineering.

Unit IV

Labour, Material and Equipment Utilization

Historical Perspective - Labour Productivity - Factors Affecting Job - Site Productivity- Labour Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of

Costs in Materials Management - Construction Equipment - Choice of Equipment and Standard Production Rates - Construction Process Queues and Resource bottlenecks.

Unit V

Cost Estimation

Costs Associated with Constructed facilities - Approaches to Cost Estimation - Type of Construction Cost Estimates - Effects of Scale on Construction Cost - Unit Cost Method of Estimation - Methods for Allocation of Joint Costs - Historical Cost Data - Cost Indices - Applications of Cost Indices to Estimating - Estimate Based on Engineer's List of Quantities- Allocation of Construction Costs Over Time - Computer Aided Cost Estimation - Estimation of Operating Costs.

References

1. Chris Hendrickson and Tung Au, Project Management for Construction - Fundamental Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh, 2000.
2. CPWD Handbook on Construction Project Management.

Textbooks;

1. Tenah, K.A. (1985). "The Construction Management Process" Reston Publishing Company, Inc. Virginia, USA.
2. Roy Pilcher (1985) "Project Cost Control in Construction," Collins Professional and technical books, London.
3. Raina, C.M. "Construction Management and Practice." Tata McGraw- Hill, New Delhi, 1980.
4. Construction Planning & management By P S Gahlot & B M Dhir , New Age International Limited Publishers
5. Construction Project planning & Scheduling By Charles Patrick, Pearson, 2012
6. Construction Project Management Theory & practice --- Kumar Neeraj Jha, Pearson,2012
7. Construction management Fundamantals by Knutson, Schexnayder, Fiori, Mayo, Tata McGraw Hill, 2nd Edition, 201
8. Kim Heldman, Project management Jumpstart

ANURAG UNIVERSITY

M. Tech. I Year I Semester (Construction Technology Management)

CONSTRUCTION PLANNING, SCHEDULING AND CONTROL

Course Objectives:
The objective of the course is to gain the knowledge of planning, scheduling, and control of a construction project

.

Course Outcomes: At the end of the course the students will be able to
CO 1: Explain the project planning and scheduling techniques

CO 2: Illustrate the construction Scheduling Procedures And Techniques
CO 3: Appraise the Cost Control, Monitoring And Accounting
CO 4: Evaluate the Quality Control And Safety During Construction
CO 5: Formulate the Organization Of Project Information `

Unit I
Construction Planning: Basic Concepts in the Development of Construction Plans - Choice of Technology and Construction Method - Defining Work Tasks - Defining Precedence Relationships among Activities - Estimating Activity Durations - Estimating Resource Requirements for Work Activities - Coding Systems

Unit II
Scheduling Procedures And Techniques
Construction Schedules - Critical Path Method – Scheduling Calculations - Float - Presenting Project Schedules - Scheduling for Activity-on-Node and with Leads, Lags, and Windows - Scheduling with Resource Constraints and Precedences - Use of Advanced Scheduling Techniques - Scheduling with Uncertain Durations - Calculations for Monte Carlo Schedule Simulation - Crashing and Time/Cost Tradeoffs - Improving the Scheduling Process.

Unit III
Cost Control, Monitoring And Accounting
The Cost Control Problem - The Project Budget - Forecasting for Activity Cost Control - Financial Accounting Systems and Cost Accounts - Control of Project Cash Flows - Schedule Control - Schedule and Budget Updates - Relating Cost and Schedule Information.

Unit IV
Quality Control And Safety During Construction
Quality and Safety Concerns in Construction - Organizing for Quality and Safety - Work and Material Specifications - Total Quality Control - Quality Control by Statistical Methods - Statistical Quality Control with Sampling by Attributes - Statistical Quality Control with Sampling by Variables - Safety

Unit V

Organization And Use Of Project Information

Types of Project Information - Accuracy and Use of Information - Computerized Organization and Use of Information - Organizing Information in Databases - Relational Model of Databases - Other Conceptual Models of Databases - Centralized Database Management Systems - Databases and Applications Programs - Information Transfer and Flow.

Textbooks:

1. Chitkara, K.K. Construction Project Management: Planning, Scheduling and Control, Tata McGraw-Hill Publishing Company, New Delhi, 1998.
2. Calin M. Popescu, Chotchai Charoenngam, Project Planning, Scheduling and Control in Construction: An Encyclopedia of terms and Applications, Wiley, New York, 1995.

References:

3. Chris Hendrickson and Tung Au, Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh, 2000.
4. Willis, E. M., Scheduling Construction Projects, John Wiley & Sons, 1986.
5. Halpin, D. W., Financial and Cost Concepts for Construction Management, John Wiley & Sons, New York, 1985.
6. Moder, J.J., Phillips, C.R., and Davis, E.W., "Project Management with CPM and PERT and precedence diagramming." C.B.S. Publishers & Distributors, New Delhi, 1986.
7. Fisk, E.R. (2000) "Construction Project Administration," Prentice Hall International, London.
8. Kwakye, A.A. (1997), "Construction Project Administration", Adisson Wesley Longman, London.
9. Pilcher, R. "Project Cost Control in Construction." Collins, London, 1992
10. Brien. J.J. "CPM in Construction Management." McGraw Hill Book Company Inc., NY,1971.

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M. Tech. I Year I Semester (Construction Technology Management)

CONSTRUCTION ECONOMICS AND FINANCE

Course Objectives

To gain the knowledge about the economics and finances of a structure

Course Outcomes: At the end of the course the students will be able to

CO 1: Identify the basic economic concepts related to construction industry

CO 2: Demonstrate the investment problems in construction and their analysis

CO 3: Distinguish the construction concepts and budgeting and budgeting control system

CO 4: Judge the standard costing and variance analysis in relation to construction

CO 5: Create the program evaluation techniques and critical path methods

UNIT-I

Introduction to engineering economics, basic economic concepts related to construction industry- marginal cost, marginal revenue, opportunity cost contribution, time perspective, elementary economic analysis-material selection for a product, design selection, building material and process planning.

Interest formulae's and their applications- time value of money, present worth method, future worth method, annual equivalent method, rate of return method.

UNIT-II

Introduction to investments-types of investments problems, stages in an economic appraisal, risk and uncertainty in investments decisions, cost of capital, time values of money, cash flows, equivalence for comparison and selection, effect of rate of return, and capital ratio.

Investment analysis- capital budgeting- methods of evaluation of capital budgeting-payback period methods, rate of return method, Net present value method, interval rate of return method, profitability index method.

UNIT-III

Cost concepts, break even analysis, Budgeting and budgeting control system, classification and types of budgets ,fixed and flexible budgets, sales budget, production budget, cost of production budget, materials budget, direct labor budget, overhead cost budget, selling and distribution overhead budget.

UNIT-IV

Standard costing and variance analysis in relation to construction , direct material variance , direct labor variance , overhead variances , job , batch and contract costing-procedures, determination of economic batch, Network analysis as a basis for cost control.

UNIT-V

Working capital, working capital at project level management of cash, Receivable management, Inventory management, price level accounting (Inflation Accounting), project management network techniques- program evaluation review techniques and critical path method.

Textbooks

1. Shutt R.C. (1995), "Economics for the construction industry," Longman Scientific and Technical, England.
2. Roy Pilcher (1985) "Project Cost Control in Construction," Collins Professional and technical books, London.

References:

1. Panneerselvam, R. (2001), "Engineering Economics," Prentice Hall of India, India.
2. Humphreys, K.K., and Wellman, P. (1996) "Basic Cost Engineering," Marcel Dekker, Inc. New York.

ANURAG UNIVERSITY

M. Tech. I Year I Semester (Construction Technology Management)

ADVANCED CONCRETE TECHNOLOGY

Professional Elective-I

Course Objectives: Study the different types of admixtures, mix design, properties and applications of special concretes.

Course Outcomes: At the end of the course the students will be able to

CO 1: Explain the types of cements and identify the influence of admixtures on properties of concrete
CO 2: Interpret the methods of making durable concrete
CO 3: Distinguish the high strength and high performance concrete
CO 4: Evaluate the destructive, non-destructive testing methodology
CO 5: Develop a special concrete for the construction

UNIT – I

Cement chemistry-Portland cement and its constituent phases-High temperature chemistry-The chemistry of Portland cement manufacture-Hydration of calcium silicate phases-Hydrated aluminates, ferrite and sulphate phases- Hydration of cement.
Admixtures: Classification of admixtures - Chemical and mineral admixtures - Influence of various admixtures on properties of concrete and their applications

UNIT –II

Mix Design of Concrete as per IS 10262-2019, ACI Method and DOE Method
Durability Properties - Permeability – chemical attack – Sulphate attack – Carbonation - Quality of water – marine conditions – Thermal properties of concrete – fire resistance – methods of making durable concrete

UNIT –III

High Strength Concrete – Micro structure – Manufacturing and Properties- Design of HSC Using Erintroy Shaklok Method- Ultra High Strength Concrete. High Performance Concrete- Requirements and properties of High-Performance Concrete-Design Considerations.

UNIT –IV

Concrete - Understanding the quasi-brittle nature of concrete - Failure of concrete under low stress - Micro— cracking, crack propagation - stress concentration at openings – Destructive, semi-destructive & Non-destructive testing methodology - Rebound hammer test – Ultrasonic Pulse Velocity (UPV) Test - Penetration resistance test - Pull-out Test - Pull-off Method - Break-off test - Cover Measurement

UNIT - V

Special Concrete: Self Compacting concrete – Polymer concrete – Fiber reinforced concrete – Reactive Powder concrete – Blended Concrete-RMC-Requirements and Guidelines – Advantages and Applications. Light weight concrete. Concrete mix design: Quality Control – Quality assurance – Quality audit.

Text Books:

1. A.M. Neville Properties of Concrete , ELBS publications, Fifth edition, 2012.
2. Shetty M.S., “Concrete Technology”, S.Chand and Company Ltd. Delhi, Seventh edition, 2013.

Refernces:

1. Gambhir.M.L., “Concrete Technology”, Tata McGraw Hill, Publishing Co. Ltd NewDelhi, 2013.
2. Santhakumar .A.R.,” Concrete Technology”, Oxford University Press, NewDelhi2006.
3. Rajat Siddique Special Structural concretes, Galgotia Publications.
4. N.Krishna Raju Design of Concrete Mixes , CBS Publications, 5/e edition, 2018
5. P.K. Mehta Concrete: Micro Structure, Properties and Materials, Tata Mc-Graw Hill Publishing House Pvt. Ltd, fourth edition.

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M. Tech. I Year I Semester (Construction Technology Management)

QUANTITATIVE METHODS IN CONSTRUCTION MANAGEMENT

Professional Elective-I

Course Objectives:

- To study the classical methods like Monte-Carlo simulation methods in construction.
- To gain knowledge of formulation of optimization models using L.P.,
- D.P tools
- To understand transportation model utility in construction industry

Course Outcomes: At the end of the course the students will be able to

CO 1: Explain the phases of operation research

CO 2: Demonstrate the formulation of linear programming (LP)

CO 3: Examine the methods of solutions of transportation modes

CO 4: Evaluate the applications of dynamic programming (DP) in construction industry

CO 5: Formulate the various theories and their application to construction

UNIT-I

Introduction, phases of operations research (or), models and scope of or in construction management, concept of probability theory and statistical tools - classical methods such as Monte-Carlo and Lagrangian multiplier methods.

UNIT-II

Standard formulation of linear programming, graphical solutions of linear programming, simplex method, linear programming and their computer solutions, characteristics of linear optimization problems.

UNIT-III

Transportation problems: introduction, terminology, minimization and maximization problems – formulation of mathematical models – methods of solution of transportation models using north west corner and least cost method and vogel's approximation method. Assignment problems, formulation and solution of assignment problems.

UNIT-IV

Dynamic programming: introduction, terminology, need for dynamic programming, characteristics of dynamic programming, application of dynamic programming in construction industry - waiting line models.

UNIT-V

Decision theory, game theory, queuing theory, simulation and its applications to construction, modifications and improvements on CPM/PERT techniques.

Text Books:

1. Adrian, J. "Quantitative Methods in Construction Management." American Elsevier Publishing Co., Inc., Amsterdam, Netherlands, 1973.
2. Moder, J.J., Phillips, C.R., and Davis, E.W., "Project Management with CPM and PERT and precedence diagramming." C.B.S. Publishers & Distributors, New Delhi, 1986.

3. Stark, R.M., and Mayer, J.H. “Quantitative Construction Management.” John Wiley and Sons, NY, 1983.

References:

1. Freund,J.E.and Miller,I.R., Probability and statistics for engineers,5th edition, Prentice hall of India, New delhi,1994.
2. Goel B.S and Mittal.S.K., Operation Research, pragati Prakashan,Meerut,2000.
3. Gupta,S.C.and Kapur,V.K., Fundamentals of mathematical statistics, sultan, Chand and sons new delhi,1999.
4. Taha,H.A., Operations research: An introduction,8th edition, Prentice Hall India, New Delhi,2010

ANURAG UNIVERSITY

M. Tech. I Year I Semester (Construction Technology Management)

QUALITY AND SAFETY IN CONSTRUCTION

Professional Elective 1

Course Objectives: To study the

- Total quality management concepts
- Various safety concepts and requirements applied to construction industry.
- Various construction safety problems and safety programs.
- Various laws related to safety in construction industry
- Importance of workers compensation insurance.

Course outcomes: At the end of the course the students will be able to

CO 1: Explain the total quality management concepts

CO 2: Illustrate the safety management functions and importance of safety

CO 3: Distinguish the safety and hazards in construction projects

CO 4: Judge the safety in the use of construction equipment

CO 5: Develop the laws related to the construction industry

UNIT-I

Total quality management concepts; ISO9000; QA/QC systems and organizations, Quality Audits; Problem solving techniques; Statistical Quality Control; Quality Function Deployment; Material Quality Assurance; Specifications and Tolerances.

UNIT-II

Safety management function, Importance of safety in construction industry, Line versus staff authority, Safety responsibility and accountability in construction industry, Safety organizations, Role of various parties, duties, responsibilities of top management, site managers, supervisors etc., Role of safety officers, Responsibilities of general employees, Safety administration.

UNIT-III

Construction safety problems, Hazards in construction projects, Accident: definition, causes, cost, measurement, investigation and prevention of accidents, Legal and financial aspects of accident, Safety Program: Need,

Elements of an Effective and safety program, general safety program in construction industry.

Hazard Identifications and Control Techniques – HAZOP, FMEA, FMECA.

UNIT-IV

Safety in use of construction equipment - vehicles, cranes, hoists and lifts etc., Safety of scaffolding, ladders, working platforms etc, safety while using electrical appliances, explosives, blasting etc, fire safety, Fire safety Causes and safety of accidents on various construction sites such as buildings, dams, tunnels, bridges, roads, high rise constructions etc., safety measures for storage and handling of building materials.

Safety equipment and gear used on construction site, First aid on site.

UNIT-V

Laws related to construction industry, Laws related to the Industrial Safety, Safety Provisions in the Factory Act, Labour laws.

Measurement of Safety Performance, Safety Audit. Experience modification rating, workers insurance.

Case based reasoning, case indexing, retrieval, accident prevention and forecasting using CBR method.

Systems safety analysis, faulty tree analysis, failure modes and effects analysis in construction industry.

Textbooks:

1. Juran Frank, J.M. and Gryna, F.M. " Quality planning and Analysis ", Tata McGraw Hill, 1982.
2. John V. Grimaldi. (1996). "Safety Management." AITBS Publishers & Distributors, New Delhi, India.

References:

1. Kwakye, A.A. (1997), "Construction Project Administration", Adisson Wesley Longman, London.
2. Jimmy W.Hinze, "Construction Safety ", Prentice Hall Inc., 1997.
3. Richard J. Coble, Jimmie Hinze and Theo C. Haupt, "Construction Safety and Health Management ", Prentice Hall Inc., 2001. Internal continuous assessment: 100 marks Internal continuous assessment is in the form of periodical tests, assignm
4. James, J.O Brien, "Construction Inspection Handbook - Quality Assurance and Quality Control ", Van Nostrand, New York, 1989. 14
5. Kwaku A., Tenah and Jose M.Guevera, "Fundamental of Construction Management and Organization ", Prentice Hall of India, 1995.
6. Hutchins. G., "ISO 9000 ", Viva Books, New Delhi, 1993.
7. Hand book on Construction Safety Practices, SP:70, BIS,2001.
8. Safety Management in Construction Industry- A manual for project managers, NICMAR, Mumbai

ANURAG UNIVERSITY

M. Tech. I Year I Semester (Construction Technology Management)

CONSTRUCTION ENGINEERING PRACTICES

Professional Elective I

Course Objectives:

To gain the knowledge about the various construction engineering practices

Course outcomes: At the end of the course the students will be able to

CO 1: Describe the uses of reinforced, prestressed and prefabricated structures
CO 2: Interpret the production of ready mix concrete
CO 3: Distinguish the modular construction practices
CO 4: Appraise the modular coordination
CO 5: Develop the modular construction implementation procedures

UNIT-I

Reinforced and prestressed concrete construction, prefabricated structures.

UNIT-II

Production of ready mixed concrete-productivity analysis-Economics of formwork-Design of farmwork and their reusability.

UNIT-III

Modular construction practices-fibonacci series, its handling and other reliable proportioning concepts.

UNIT-IV

Modular coordination-standardization-system building-advantages.

UNIT-V

Lamination and advantages of modular construction-concepts implementation procedures.

Text Books:

1. Allen E, Iano,J, Fundamentals of Building Construction Material and Method, john wiely and sons,2011.
2. Cameron K.and res.ronald C.Smith, Principals and Practices of Commercial Construction,8^{th} edition, prentice hall,2009.

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M. Tech. I Year I Semester (Construction Technology Management)

FORMWORK AND SCAFFOLDING DESIGN

Professional Elective 1

Course objectives:

- To study and understand the overall and detailed planning of formwork.
- To understand the Design and erection of forms for various elements such as slabs, beams, columns, walls.
- To know the latest methods of form construction.

Course outcomes: At the end of the course the students will be able to

CO 1: Classify the form work and false work systems

CO 2: Interpret the loadings and moments on formwork

CO 3: Differentiate the types of formwork for beam, decking and column

CO 4: Judge the effect of foundation and soil on false work design

CO 5: Develop the special forms

UNIT-I

Introduction: Formwork and false work - Temporary work systems, construction planning and site constraints, Materials and construction of the common formwork and false work systems, Special and proprietary forms.

UNIT-II

Formwork – Design: Concrete pressure on forms, Design of timber and steel forms, Loading and moment of formwork.

UNIT-III

Design of Decks and False works: Types of beam, decking and column formwork, Design of decking, Design of formwork for walls, False work design, Effects of wind load

UNIT-IV

Foundation and soil on false work design; Design of formwork for shear wall

UNIT-V

Special forms: The use and applications of special forms; Sequence of construction; Safety use of formwork and false work. Timber Fasteners – nails, screws, bolts

Textbooks:

1. Austin, C.K., Formwork for Concrete, Cleaver, Hume Press Ltd., London, 1996.
2. Michael P. Hurst, Construction Press, London and NewYork, 2003.

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M. Tech. I Year I Semester (Construction Technology Management)

LEGAL ISSUES IN CONSTRUCTION MANAGEMENT

Professional Elective II

Course Objectives: To study the

- Various types of construction contracts and their legal aspects and provisions
- Tenders, arbitration, legal requirements, labor and human rights regulations

Course Outcomes: At the end of the course the students will be able to

CO 1: Recognize the construction laws and identifying the principals involved in various contracts

CO 2: Choose the construction tendering process

CO 3: Differentiate the duties and responsibilities of project manager, owner, engineer and contractors

CO 4: Judge the disputes liabilities in construction

CO 5: Develop a dispute resolution in construction

UNIT-I

Introduction to Construction Law: Need for legal issues in Construction in the Indian Judicial System – Context of Construction Industry, Principles of a Contract, Indian Contract Act 1872 – Provisions for Construction Industry, Essentials of a Valid Contract, Types of Contracts, Alternate Contract Methods, Concept of Completion of a Contract, IT Law 2000 and its Influence on construction Contracts

UNIT-II

Construction Tendering Process: Introduction to Construction Process, Need for tendering, process of Tendering in Construction, Importance of Specifications and Estimates in Construction, Concept of completion of the contract, Sub-Contracts and requirements, Tendering Models and Strategies, Prequalification of Bidders, Documents forming a BID and a Contract, Agreements and Bonds in Tendering Process

UNIT-III

Construction Administration: Duties and Responsibilities – Project Manager, Owner, Engineers and Contractors, Important Site Documents, Process of Building Permissions, Provision for Scheduling delays and accelerations, Environmental Provisions for Construction Contracts.

UNIT-IV

Disputes and Liabilities in Construction: Major sources of disputes in construction, Delays – Types, Claims and solutions, Labor Laws in India, Worker Compensation and Insurance laws, Construction Liabilities and Litigations, Disputes in Land Development,

UNIT-V

Dispute Resolution in Construction: Dispute Resolution in Construction, Judicial Process in Dispute Resolution, Alternate Dispute resolution methods, Arbitration and Conciliation Act 1996, Importance of Arbitration in Construction, Arbitration Process, Arbitration Clause in Contracts

Textbooks:

1. Indian Contract Act 1892
2. Indian Arbitration and Conciliation Act,1996

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M. Tech. I Year I Semester (Construction Technology Management)

FUNCTIONAL PLANNING AND BUILDING SERVICES

Professional Elective-II

Objectives:

To obtain the knowledge upon functional planning, plumbing and water supply systems, firefighting systems, waste water and solid waste disposal, communication network and maintenance of structures

Course Outcomes: At the end of the course the students will be able to

CO 1: Explain the functional planning of buildings, types of services required and their planning

CO 2: Sketch the plumbing and water supply systems required in structures

CO 3: Interpret the collection, removal, and disposal of solid waste and waste water from a structure

CO 4: Appraise the basic requirement of firefighting and transportation systems required in a structure

CO 5: Design a communication network, air conditionin and their maintenance requirement in a structure

UNIT-I

Components of urban forms and their planning, Concepts of neighborhood unit, Functional planning of buildings, Importance of building services, type of services required, planning of services, organization structures of services management, role and administrative functions of supervisors.

Space requirements and relationship for typical buildings like residential, offices hospitals etc.

UNIT-II

Plumbing and water supply system: Basics of plumbing systems, requirement of plumbing works, activity flowchart for plumbing work, Quality, checking of materials, water requirements for different types of buildings, simple method of removal of impurities, water saving practices and their potential, rainwater harvesting , type of spouts, sizes of rainwater pipes, typical detail of a water harvesting pit.

Water supply and distribution system is high-rise building, pumps and pumping mechanisms, Operation & maintenance of fittings & fixtures of water supply & sanitary. Do’s & Don’ts for water pipe.

UNIT-III

Solid Waste disposal : Approaches for solid waste management, Solid wastes collection and removal from buildings, On-site processing and disposal methods, guidelines for municipal solid waste management, e-waste management

Disposal of Wastes : Sanitary land filling, composting, Vermi-compost, Incineration, Pyrolysis Treatment system, Root zone treatment system, Decentralized Wastewater Treatment Systems (DEWATS), Soil Bio technology, packaged Bio-Reactor

UNIT-IV

Firefighting: Basic requirement and various components of the firefighting system. maintenance, firefighting in high-rise buildings, commercial/industrial complexes, public buildings, checklist for fire safety. Lifts/Elevators, Escalators: Legal formalities for elevators, various types of lifts, working mechanisms of lift and escalators. Indian standard codes for planning & installations of elevator, inspection & maintenance of lifts.

UNIT V

Telecommunication network, computer network LAN, electrical network, basics of single phase & three phase electrification, precautions and safety measures, IS codes for electrical appliances & wiring operations & maintenance of network & appliances.

Air-Conditioning and Heating: Flowcharts, Centralized systems, monitoring and working of the equipment, checklist of inspection, performance tests.

Building maintenance: Scheduled and contingency maintenance planning,

M.T.S. for building maintenance, maintenance standards, Economic maintenance decisions, applications of computer in service management

Textbooks:

1. Building Technology IVOR H. Seeley, Mac Millian.
2. Building Finishes, fittings and domestic service Chudley, Longman, Scientific and Technical.

References

1. Fred Hall Building Services & Equipment, Longman Scientific and Technical.
2. Lee Smith, Harry Slecter, Plumbing Technology, Design and installation, Delmar Publisher INC.
3. Fred Hall, Plumbing Cold water supplies, Drainage and Sanitation, Longman Scientific & Technical.
4. Roger Greeno, Building Services, Technology and Design, Longman.
5. Norbert Lechner, Heating Cooling, Lighting John Wiley & Sons.
6. Maintenance of Buildings A.C. Panchadari, New age international (P) limited Publishers.

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M. Tech. I Year I Semester (Construction Technology Management)

VALUE ENGINEERING IN CONSTRUCTION

Professional Elective-II

Course Objectives:

- Define Value engineering and its objectives
- Estimation of project budget using capitalized income approach
- Analyze a building using LCC methodology

Course Outcomes: At the end of the course the students will be able to

CO 1: Recognizing the value engineering techniques and its methodology
CO 2: Interpret the project budget and the need for the cost control
CO 3: Differentiate the life cycle cost and building costs
CO 4: Appraise the value engineering and total project management
CO 5: Develop the concepts of Delphi techniques and rules for brainstorming

UNIT - I

Introduction to value engineering (VE), definition, objectives of value engineering, reasons for unnecessary costs, VE techniques and methodology, interface with the other programs.

UNIT - II

Elements of the project budget, need for cost control, meaning of capitalization, capitalization process, and capitalized income approach to construction project budgeting.

UNIT - III

Life cycle cost (LCC) and building costs, LCC technology and examples, LCC methodology, LCC formats and analysis and weighted evaluation – application of LCC to buildings.

UNIT - IV

Value engineering and total project management, level of effort, team selection, value engineering job plan, and work plan phases.

UNIT - V

Classifying function, defining function, project level function system technique (fast) diagram, creativity and fixation, interpersonal skills, generation of ideas, brainstorming, rules for brainstorming, Delphi technique, application of Delphi technique to civil engineering projects.

Textbooks:

1. Tenah, K.A. (1985). "The Construction Management Process", Reston Publishing Company, Inc. Virginia
2. Dell'Isola, Alphonse (1997). "Value Engineering: Practical Applications." R.S. Means Company, Inc: Kingston, MA.
3. Oberiender, G. D. (1993). "Project Management for Engineering and Construction". *McGraw-Hill, Inc.*: New York.

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M. Tech. I Year I Semester (Construction Technology Management)

MANAGEMENT INFORMATION SYSTEMS

Professional Elective-II

Course objectives:

- To study the concepts of information systems and their applications, system development and information systems, implementation and control, and system audit.
- Analyze the business issues, processes, and techniques associated with management information systems

Course outcomes: At the end of the course the students will be able to

CO 1: Describe the importance of management information systems.

CO 2: Demonstrate the management and decision making in construction industry.

CO 3: Examine strategic information system related to construction industry

CO 4: Appraise the role of IT in construction industries

CO 5: Develop file structures and processing methods in construction organization.

UNIT-1

Importance of management information systems (MIS), logical foundation of MIS, manger's view of information systems, functions of management, managerial role, activities of a construction organization.

UNIT-II

Management and decision making in construction industry, classification of information systems, and impact of construction work on management information systems.

UNIT-III

Strategic uses of information technology, inter organizational systems, strategic information systems related to construction industry.

UNIT-IV

Information technology, role of information technology in construction industry, impact of information technology on the individuals, impact on the construction organization, and process of reengineering work.

UNIT-V

File structures and processing methods in construction organizations, data base concepts and data base management systems.

Textbooks:

1. Robert Schultheis, Mary Sumner. (1999). "Management Information Systems-The Manager's View." Tata McGraw Hill Edition, New Delhi.
2. Kwakye, A.A. (1997), "Construction Project Administration", Adisson Wesley Longman, London.

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M. Tech. I Year I Semester (Construction Technology Management)

BRIDGE ENGINEERING

Professional Elective-II

Course Objectives:

To impart knowledge about different types of bridges, their analysis and design for combination of different loading condition as per codal provisions.

Outcomes: At the end of the course the students will be able to

CO 1: Describe the basic concepts of bridge engineering

CO 2: Examine the design aspects of girder bridges

CO 3: Evaluate the loads and moments acting on the box colverts

CO 4: Design the prestressed concrete bridges

CO 5: Construct the sub structure of a bridge

UNIT I

Concrete Bridges: Introduction-Types of Bridges-Economic span length-Types of loading-Dead Load-live load-Impact Effect-Centrifugal force-wind loads-Lateral loads-Longitudinal forces-Seismic loads- Frictional resistance of expansion bearings-Secondary Stresses-Temperature Effect-Erection Forces and effects-Width of roadway and footway-General Design Requirements.

Solid slab Bridges: Introduction-Method of Analysis and Design.

UNIT II

Girder Bridges: Introduction-Method of Analysis and Design-Courbon's Theory, Grillage analogy

UNIT III

Box Culvert: - Single Cell Box Culvert – Design Loads, Design Moments, Shears and Thrusts.

Design of Critical sections.

UNIT IV

Pre-Stressed Concrete Bridges: Basic principles-General Design requirements-Mild steel reinforcement in prestressed concrete member-Concrete cover and spacing of pre-stressing steel-Slender beams-Composite Section-Propped-Design of Propped Composite Section-Unproped Composite section-Two-stage Prestressing-Shrinking stresses-General Design requirements for Road Bridges.

UNIT V

Sub-structure of bridges: Substructure- Beds block-Piers- Pier Dimensions- Design loads for piers-Abutments- Design loads for Abutments. Health Monitoring of Bridge structures.

TEXT BOOKS:

1. N. Krishna Raju Design of Bridges, Oxford & IBH
2. Johnson Victor Essentials of Bridge Engineering, Oxford & IBH

REFERENCES

1. M.G. Aswani, V.N.Vazirani and M.M.Ratwani Design of Concrete Bridges.
2. E.C. Hambly Bridge Deck Behaviour.
3. V.K.Raina. Concrete Bridge Design and Practice
4. V.V. Sastry Design of Bridges, Dhanpat Rai & Co.

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M. Tech. I Year I Semester (Construction Technology Management)

RESEARCH METHODOLOGY

Course Objectives:

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the significance of research and its methodology
CO 2: Illustrate the importance and source of literature and record of research review
CO 3: Examine the meaning and need of research design
CO 4: Appraise the data collection and its analysis
CO 5: Design the research report writing and formulate the research proposal preparation

UNIT – I

Research methodology: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Criteria of good research - Problems encountered by researchers in India - Benefits to the society in general. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.

UNIT – II

Literature survey: Importance of literature survey - Sources of information-Assessment of quality of journals and articles - Information through internet.
Literature review: Need of review - Guidelines for review - Record of research review.

UNIT – III

Research design: Meaning of research design - Need of research design - Feature of a good design - Important concepts related to research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes.

UNIT – IV

Data collection: Collection of primary data - Secondary data - Data organization - Methods of data grouping - Diagrammatic representation of data - Graphic representation of data - Sample design - Need for sampling - Some important sampling definitions - Estimation of population - Role of statistics for data analysis - Parametric vs. non parametric methods - Descriptive statistics - Measures of central tendency and dispersion - Hypothesis testing - Use of statistical softwares.
Data Analysis: Deterministic and random data - Uncertainty analysis - Tests for significance - Chi-square - Student’s t-test - Regression modeling

- Direct and interaction effects – ANOVA - F-test - Time series analysis - Autocorrelation and autoregressive modeling.

UNIT - V

Research report writing: Format of the research report – Synopsis – Dissertation - Thesis - Its differentiation – References – Bibliography – Webliography - Technical paper writing - Journal report writing - Making presentation - Use of visual aids.

Research proposal preparation: Writing a research proposal and research report - Writing research grant proposal.

Textbooks:

1. C.R Kothari, "Research Methodology, Methods & Technique", New Age International Publishers, New Delhi, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, Chennai, 2011

References:

1. Ratan Khananabis and Suvasis Saha, "Research Methodology", Universities Press, Hyderabad, 2015.
2. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publishing Pvt. Ltd., New Delhi, 2004.
3. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
4. G.Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.

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M. Tech. I Year I Semester (Construction Technology Management)

CONSTRUCTION ENGINEERING LABORATORY

Course Objective:
To evaluate the properties of constituents of concrete, various building materials, concrete with variable workability, concrete with variable parameters.

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the properties of constituents of concrete.
CO 2: Illustrate the properties of various building materials.
CO 3: Experiment the variation of workability of concrete with time and grade of concrete
CO 4: Judge the influence of various parameters on strength of concrete

List of Experiments

5. Evaluation of properties of cement, fine aggregates and coarse aggregates.
6. Evaluation of properties of reinforcing steel, timber, building block and tile.
7. Variation of workability with time for different grades of concrete – experimental observations.
8. Experimental observation on influence of following parameters on strength characteristics of concrete (Some of these parameters may be considered depending up on time)
   viii. Size, Shape and grade of coarse aggregate
   ix. Grading of fine aggregate
   x. Hand Mixing / Machine Mixing
   xi. Aggregate – Cement Ratio
   xii. Coarse Aggregate – Fine Aggregate Ratio
   xiii. Size and Shape of Test Specimen
   xiv. Admixtures

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M. Tech. I Year I Semester (Construction Technology Management)

SOFT COMPUTING TECHNIQUES LABORATORY

Objective:
To train the students to develop the knowledge on soft computing techniques in construction technology and management (CTM)

Outcomes: Student shall be able to
CO 1: Describe Capital Budgeting of a Construction project in excel sheet.
CO 2: Illustrate time value of money formulae such as IRR, CRF, PV,FV in the excel sheet.
CO 3: Examine construction programme for town ship, road project, bridge project etc. with using Prima Vera Software.
CO 4: Judge spreadsheet applications for calculation of present worth, future worth, IRR, CRF etc.
Design project management software.

List of Experiments

1. Quantity takeoff, Preparation and delivery of the bid or proposal of an engineering construction project.
2. Design of a simple equipment information system for a construction project.
3. Scheduling of a small construction project using Primavera scheduling systems including reports and tracking.
4. Scheduling of a small construction project using tools like MS project scheduling systems including reports and tracking.

REFERRENCE:

1. Project Management using Primavera, Eastwood Harris Publications.
2. M.S. Project Microsoft Press.

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M. Tech. I Year II Semester (Construction Technology Management)

CONSTRUCTION EQUIPMENTMANAGEMENT

Course Objectives:

- Importance of prefabrication in construction
- Advantages of modular coordination in prefabrication
- Application of different equipment in construction industry

Course Outcomes: At the end of the course the students will be able to
CO 1: Explain the equipment management in projects
CO 2: Demonstrate the fundamentals of earth work operations
CO 3: Distinguish the equipment required for various other construction works
CO 4: Judge the materials handling equipment
CO 5: Develop the selection criteria of equipment for different works

Unit I
Identification
Planning – Equipment Management in Projects – Maintenance Management – Replacement – Cost control of Equipment – Depreciation Analysis – Safety Management.

Unit II
Equipment for Earthwork
Fundamentals of Earth work operations – Earth moving operations – Types of Earth work equipment – Tractors, Motor Graders, Scrapers, Front end Waders, Earth Movers

Unit III
Other Construction Equipment
Equipment for Dredging, Trenching, Tunneling, Drilling, Blasting – Equipment for Compaction – Erection equipment – Types of pumps used in construction – Equipment for Dewatering and Grouting – Foundation and Pile Driving Equipment.

Unit IV
Materials Handling Equipment
Forklifts and related equipment – Portable material Bins – Conveyors – Hauling Equipment.
Equipment for Production of Aggregate and Concreting
Crushers – Feeders – Screening Equipment – Handling Equipment – Batching and Mixing Equipment – Hauling, Pouring and pumping Equipment – Transporters.

Unit V
Equipment Management
Selection criteria of equipment for different works, Economics behind equipment management, Purchasing equipment vs hiring equipment, process of procuring equipment for works.

Textbooks:

1. Peurify, R.L.(1996). “Construction, Planning, Equipment and Methods." McGraw-Hill Book Company, Inc, NY
2. Mahesh Varma (1997) “Construction Equipment and its planning & applications." Metropolitan Book Co (P) Ltd, New Delhi, India.
3. U.K. Srivastava (1999). "Construction Planning and Management." Galgotia Publications Pvt., ltd, New Delhi, India

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M. Tech. I Year II Semester (Construction Technology Management)

CONSTRUCTION CONTRACTS AND LAW

Course Objectives:
To obtain the knowledge about contract management in construction

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify the concepts of construction contracts
CO 2: Interpret the standard forms of contracts
CO 3: Distinguish the conditions of ministry of statistics and program implementation
CO 4: Evaluate construction claims and dispute resolution
CO 5: Develop the Indian arbitration and conciliation act

Unit I
Construction Contracts:
a. Indian Contract Act (1872) :a)Definition of the contract as per the ACT. Valid, Voidable, Void contracts, Objectives of the act. (From model 5)
b. Clauses 1 to 75- Contract formation, contract performance, valid excuses for non-performance, Breach of contract, effects of breach- understanding the clauses and applying them to situations/scenarios on construction projects. Importance of the Workmen‘s Compensation Act on construction projects.

Unit II
Contract Formation
a. Standard forms of contracts, Need for tendering, process of Tendering in Construction, Importance of Specifications and Estimates in Construction, Concept of completion of the contract, Sub-Contracts and requirements, Tendering Models and Strategies, Prequalification of Bidders, Documents forming a BID and a Contract, Agreements and Bonds in Tendering Process
b. Contract formation, conditions of contracts, contracts with various stakeholders on a major construction projects, contract pricing by the client, project management consultants and the contractor, contract performance, contract correspondence and contract closure.

Unit III
Contract Conditions
a. General condition and Particular conditions,
b. Conditions of Ministry of Statistics and Program Implementation- Government Of India. Model forms of contract.

FIDIC (International Federation of Consulting Engineers Contracts)
ICE conditions-Introduction, FIDIC conditions- evolution of FIDIC document, types based on whether design is of employer or contractor, Design & Build contract, EPC contract, short forms of contract- Colour Code. Various conditions of Red Book.

Unit IV
Construction Claims and Dispute Resolution
a. Construction Claims : Extra items and causes of claims. Types of construction claims, documentation. settlement of claims.

b. Dispute Resolution:Causes of disputes and importance of role of various stakeholders in prevention of disputes, Alternate Dispute Resolution methods-mediation, conciliation, arbitration and Dispute Resolution Boards.

Unit V

Conciliation & Arbitration: Indian Arbitration And Conciliation Act 1996 Difference between 1940 Act and 1996 Act. Extent of application of 1996 Act. Objectives, general provisions. Composition of the arbitral tribunal, jurisdiction of arbitral tribunal, duties, power of arbitrators. Conciliation: Conciliation and its provisions in the Act, Conduct of conciliation and arbitral proceedings, grounds for challenge. Arbitral award and its enforcement. Procedure of appeal against the awards.

Reference Books:

1. Civil Engineering Contracts and Estimates - B. S. Patil – Universities Press- 2006 Edition, reprinted in 2009.
2. The Indian Contract Act (9 of 1872), 1872- Bare Act- 2006 edition, Professional Book Publishers.
3. The Arbitration and Conciliation Act,(1996), 1996 (26 of 1996)- 2006 Edition, Professional Book Publisher.
4. Law of contract Part I and Part II, Dr. R.K. Bangia- 2005 Edition, Allahabad Law Agency.
5. Arbitration, Conciliation and Alternative Dispute Resolution Systems- Dr. S.R. Myneni-2004 Edition, reprinted in 2005- Asia Law House Publishers.

Text books:

1. Gajaria G.T., laws relating to building and engineering contracts in India, M.M Tripathi private Ltd., Bombay, 1982.
2. Jimmie Hinze, construction contracts, 2nd Edition, McGraw hill, 2001.
3. Joseph T. Bockrath, contracts and the legal environment for engineers and architects, 6th Edition, McGraw Hill, 2000.

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M. Tech. I Year II Semester (Construction Technology Management)

TQM TECHNIQUES IN CONSTRUCTION

Professional Elective-III

Course Objectives:

- To familiarize with quality management in construction Industry
- To familiarize with clauses for quality management in construction Industry
- To understand the leadership in construction Industry

Course Outcomes: At the end of the course the students will be able to

CO 1: Identify the approaches to maintain quality in construction Industry

CO 2: Illustrate the clauses of ISO 9000 and third party assessment for construction works.

CO 3: Employ the approaches for team work in construction Industry

CO 4: Judge the lean production and management

CO 5: Develop the total Quality management in constructions

UNIT-1

Quality management in construction industry, new approach to quality management, and road to quality management.

UNIT-II

Formal QA, quality assurance, ISO 9000, clauses of ISO 9000, third party assessment for construction works.

UNIT-III

Leadership and total quality management, tools for total quality management, teamwork for total quality management, stages in team development, and role within a team.

UNIT-IV

Learning organization, lean production and management applied to construction industry.

UNIT-V

Quality management in the construction industry, research objectives, senior management and total quality management, cultural change in construction.

Textbooks:

1. Steven McCabe. (1998). "Quality Improvement Techniques in Construction." LONGMAN.
2. Kwakye, A.A. (1997), "Construction Project Administration", Adisson Wesley Longman, London.

ANURAG UNIVERSITY

M. Tech. I Year II Semester (Construction Technology Management)

HUMAN RESOURSES DEVELOPMENT FOR CONSTRUCTION

Professional Elective-III

Course objectives:

- To study the management and control of human resources in construction industry.
- To understand the concepts of organization and management theory.

Course outcomes: At the end of the course the students will be able to

CO 1: Recognize the maintenance and development of human resources in construction industry

CO 2: Solve the challenges of managing people in construction

CO 3: Demonstrate the strategic and operational HMR approaches

CO 4: Evaluate the employee relations and empowerment within HMR

CO 5: Develop the trade unions and management relations

UNIT-I

The Human resource Management an Introduction:- Human resource, Nature and scope of HRM, The human resource in the environment, Human resource activities, Diversity of work and Strategies- Human resource hiring:-Job analysis, selection, recruitment, orientation, placement, socialization-

Maintenance and development of the Human Resource: Work motivation and performance, Employee welfare, Compensation, Welfare schemes, Career enlargement and enrichment, Leadership and Effective communication.

UNIT-II

Organization and management theory: Challenges of managing people in construction, Contemporary management Theory, Production efficiency: the Classical Approach, Human Behavior theory, Manager's attitude towards people in construction, Expectations of the employment relationship.

UNIT-III

Strategic HRM approaches and operational HRM approaches: Models of HRM, Employee resourcing, Recruitment & Selection, Case Study Discussion, Training & Development, Appraisal Systems, Reward management, Case Study Discussion, Mentoring, Career in Construction Management.

UNIT-IV

Employee relations and empowerment: Employees relations, The changing role of trade unions, The effect of unions, Collective bargaining, Case Study Discussion, The evolution of empowerment within HRM.

UNIT-V

Work for Analysis:-Trade Unions and Management relationships, Ethical Issues, Employee problems, Industrial Counseling.

Employee empowerment- salient features- diversity and worklife balance. Employee welfare - strategic Human resource development - employment legislation -legal aspects.

Textbooks:

1. Langfor D.A. Human Resource management in construction, Longman, 1995.
2. Martin Loosemore, Andrew Dainty, Helen Lingard, Human Resource Management in construction projects: strategic and operational approaches, Taylor and Francis, 2010.

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M. Tech. I Year II Semester (Construction Technology Management)

GREEN BUILDING TECHNOLOGY

Professional Elective-III

Objectives:

- Exposure to the green building technologies and their significance.
- Understand the judicial use of energy and its management.
- Educate about the Sun-earth relationship and its effect on climate.
- Enhance awareness of end-use energy requirements in the society.
- Develop suitable technologies for energy management.

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the fundamentals of energy use and energy processes in building.

CO 2: Illustrate the indore environmental requirement and its management.

CO 3: Analyze the sun-earth relationship vis-a-vis its effect on climate.

CO 4: Evaluate the end-use energy requirements.

CO 5: Formulate the audit procedures of energy.

UNIT I

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT II

Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

UNIT III

Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT IV

End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer

UNIT V

Energy management options - Energy audit and energy targeting - Technological options for energy management

Textbooks:

1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.

References:

3. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
4. Bryant Edwards (2005): Natural Hazards, Cambridge University Press,U.K.

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M. Tech. I Year II Semester (Construction Technology Management)

RETROFITTING AND REHABILITATION OF STRUCTURES

Professional Elective-III

Course Objectives:

- Learn the fundamentals of maintenance and repair strategies.
- Study the quality assurance, serviceability and durability of concrete.
- Know the various materials and techniques used for repair of structures.
- Educate the different repair, strengthening, rehabilitation and retrofitting techniques.
- Instruct the various health monitoring and demolition techniques.

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the fundamentals of maintenance and repair strategies.

CO 2: Interpret the serviceability and durability aspects of concrete.

CO 3: Examine the materials and techniques used for repair of structures.

CO 4: Appraise the appropriate repair, rehabilitation and retrofitting technique required for a structure.

CO 5: Develop an appropriate health monitoring and demolition techniques.

UNIT - I

Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration.

Repair Strategies: Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure

UNIT - II

Serviceability and Durability of concrete: Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

UNIT - III

Materials and Techniques for repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fiber reinforced concrete. Bacterial concrete, Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection

UNIT - IV

Repairs, Rehabilitation and Retrofitting of structures: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, long term health monitoring techniques. Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

UNIT – V

Demolition Techniques& Health Monitoring of structures: Engineered demolition techniques for Dilapidated structures Use of Sensors – Building Instrumentation

Textbooks:

1. Concrete Technology by A.R. Santakumar, Oxford University press
2. Defects and Deterioration in Buildingts, E F & N Spon, London

References:

3. Non-Destructive Evaluation of Concrete Structures by Bungey - Surrey University
4. Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.
5. Concrete Repair and Maintenance Illustrated, RS Means Company Inc
6. W. H. Ranso, (1981) ‘Building Failures : Diagnosis and Avoidance, EF & N Spon, London, B.
7. Mehta, P.K and Montevic. P.J., Concrete- Microstructure, Properties and Materials, ICI, 1997.,
8. 8Jackson, N., Civil Engineering Materials, ELBS, 1983.

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M. Tech. I Year II Semester (Construction Technology Management)

STRATEGIC MANAGEMENT IN CONSTRUCTION

Professional Elective-III

Course Objectives:

To enable the students to know the strategic management concepts and design the events effectively in the construction industry

Course Outcomes: At the end of the course the students will be able to

CO 1: Identify the strategic management concepts and its significance in construction

CO 2: Employ the strategic management approaches

CO 3: Examine the external and internal environment analysis

CO 4: Judge the financial strategies

CO 5: Design the corporate strategic events and social responsibilities

Unit-I

Introduction, strategic management concepts, necessity and significance of strategic management

Unit-II

Different approaches of Strategy Formation and Implementation-procedures- problems encountered.

Unit-III

External and Internal Environment Analysis

Unit-IV

Financial Strategies-budget allocation for different tasks -Decision and Analytical Tools

Unit-V

Corporate Strategic Events, Leadership and Decision-making, Corporate Social Responsibility

Text Books:

1. David Langford, Steven Male, Strategic Management in Construction, 2nd Edition, John Wiley and Sons, 2008.
2. Richard Fellows, Construction Management in Practice, 2nd Edition, Blackwell Science, 2001.

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GEOSPATIAL TECHNOLOGY

Professional Elective-IV

Course Objectives:

- Discuss the various spatial and non-spatial data types, and data base management techniques
- Develop the concepts and professional skills in utility of geospatial techniques
- Improve the working knowledge of geospatial techniques in field problems

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the fundamentals of geographical information systems(GIS)

CO 2: Demonstrate the geospatial technology relating to the data acquiring, processing and geographic locations

CO 3: Choose the data modeling and organize the data for analysis

CO 4: Evaluate the applications of GIS

CO 5: Develop the general background of remote sensing technology

UNIT–I

Introduction - Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems.

Projections and Coordinate Systems - Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

UNIT–II

Data Acquisition and Data Management - data types, spatial, non-spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty.

Data Processing - Geometric errors and corrections, types of systematic and non-systematic errors, radiometric errors and corrections, internal and external errors.

UNIT–III

Data Modeling - Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.

GIS Analysis and Functions - Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non-spatial data.

UNIT–IV

Applications of GIS - Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

UNIT–V

Introduction to Remote Sensing - General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

Textbooks:

1. Burrough, P. A., and McDonnell R. A. (1998). *Principles of Geographical Information Systems.* Oxford University Press, New York, Pp.333.
2. Choudhury S., Chakrabarti, D., and Choudhury S. (2009). *An Introduction to Geographic Information Technology.* I.K. International Publishing House (P) Ltd, New Delhi, Pp.276.

References:

3. Kang-tsung Chang. (2006). *Introduction to Geographical information Systems.* Tata McGraw-Hill Publishing Company Ltd., Third Edition, New Delhi, Pp.432.
4. Lilysand T.M., and Kiefer R.W. (2002). *Remote Sensing and Image Interpretation*. John Wiley and Sons, Fourth Edition, New York, Pp.724.
5. Sabins F.F. Jr. (1978). *Remote Sensing Principles and Interpretations.*

W.H. Freeman and Company, San Francisco, Pp. 426.

6. Tor Bernhardsen. (2002). *Geographical Information System.* Wiley India (P) Ltd., Third Edition, New Delhi, Pp. 428.
7. Hoffman-Wellenhof, B, et al. (1997). *GPS Theory and Practice.* Fourth Edition, Springer Wein, New York.

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DISASTER MANAGEMENT

Professional Elective-IV

Course Objectives:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country.
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the fundamentals of disasters and its impacts.

CO 2: Demonstrate the cyclones, local storms and floods.

CO 3: Choose the approaches to disaster risk reduction.

CO 4: Evaluate the inter-relationship between disasters and development.

CO 5: Design the disaster risk management in India and case studies on reducing disaster risks.

UNIT-I

Introduction to Disasters: Concepts and definitions of Disaster, Hazard, Vulnerability, Resilience, Risks. Natural and Manmade disasters, impact of drought, review of past disasters and drought in India, its classification and characteristics. Classification of drought, causes, Impacts (including social, economic. political, environmental, health, psychosocial, etc.)

UNIT-II

Disaster: Classifications, Causes, Impacts including social, economic, political, environmental, health, psychosocial etc.

Differential Impacts - in terms of caste, class, gender, age, location, disability Global trends in disasters, urban disasters, pandemics, complex emergencies, climate change.

Cyclones and Floods: Tropical cyclones & Local storms, Destruction b y tropical cyclones and local storms, Cumulative atmospheric hazards/ disasters, Cold waves, Heat waves, Causes of floods, Rood hazards in India.

UNIT-III

Approaches to Disaster Risk Reduction: Disaster cycle - its analysis, Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural-nonstructural sources, roles and responsibilities of community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), states, Centre, and other stake-holders.

UNIT-IV

Inter-relationship between Disasters and Development: Factors affecting Vulnerabilities, differential impacts, impact of development projects such as darns, embankments, changes in Land-use etc. Climate Change Adaptation, Relevance of indigenous knowledge, appropriate technology and local resources

UNIT-V

Disaster Risk Management in India: Hazard and Vulnerability profile of India Components of Disaster Relief: Water, Food, Sanitation, Shelter, and Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, OM Act and Policy, other related policies, plans, programmes and legislation)

Field Work and Case Studies: The field work is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived creatively based on the geographic location and hazard profile of the region where the college is located.

Textbooks:

1. Sharma, V. K. (1999), "Disaster Management", National Centre for Disaster Management, IIPE, Delhi.
2. Anil, K. Gupta and Sreeja, S. Nair (2011), "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi.

References:

3. Nick (1991), "Disaster Management: A Disaster Manager's Handbook", Asian Development Bank, Manila Philippines.
4. Kapur, et al. (2005), "Disasters in India: Studies of Grim Reality", Rawat Publishers, Jaipur.
5. Pelling Mark (2003), "The Vulnerability of Cities: Natural Disaster and Social Resilience", Earthscan Publishers, London.

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M. Tech. I Year II Semester (Construction Technology Management)

ENVIRONMENTAL IMPACT ASSESSMENT

Professional Elective-IV

Course Objectives:

- Introduction of EIA concepts and methodologies.
- Importance of data collection of EIA assessment.
- Preparation of EIA reports and discussion about various environmental impact Laws pertaining to India.

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the basic concepts and principals of EIA

CO 2: Choose the better EIA methodologies

CO 3: Write the environment impact statement

CO 4: Defend the environment legislation and regulations

CO 5: Design an efficient municipal solid waste management system

UNIT I

Environmental Impact Assessment: Definition, basic concepts and principles of EIA. Regulatory frame work in India. Environmental inventory, base line studies, over view of EIA studies.

UNIT II

Assessment and Methodologies: Physical, biological assessment, Socio economic and cultural environmental assessment, EIA methodologies– Adhoc, matrix, checklist approaches. Economic evaluation of impacts-cot benefits of EIA, Public participation in environmental decision making. Procedures for reviewing EIA analysis and statement

UNIT III

Environmental Assessment: Introduction, process, Basic steps involved, Description of environmental setting – Base line data collection, possible impacts due to water resources projects. Impact prediction and assessment
– methods of impact assessment, Matrix and check list method, Selection of proposed action. Preparation of environmental impact statement.

UNIT IV

Environmental Legislation and Regulations: Rationale, concerns, legislative data systems, safe drinking water act, clean water act, clean air act, noise control act, resource conservation and recovery act, comprehensive environmental response, compensation and liability act.

UNIT V

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/recycle, energy recovery, treatment and disposal).

Textbooks:

1. Canter, L.W. (1996), 'Environmental Impact Assessment', McGraw- Hill Book Company, New York.
2. Corbitt Robert A. (1999), Standard Hand Book of Environmental Engineering' McGraw-Hill Book Company, New York.

References:

3. Marriott, 'Environmental Impact Assessment: A Practical Guide', McGraw-Hill Book Company, New York.
4. Sabins F.F. Jr.(1978), 'Remote Sensing Principles and Interpretations'
5. W.H. Freeman and Company, San Francisco Jensen John R. (1986), 'Introductory Digital Image Processing', Prentice-Hall of India New York

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GEOTECHNICAL INVESTIGATIONS FOR CONSTRUCTION PROJECTS

Professional Elective-IV

Course Objectives:

To obtain the knowledge upon the geotechnical investigation method for construction projects

Course Outcomes: At the end of the course the students will be able to

CO 1: Identify the methods of site investigation

CO 2: Employ the sampling techniques and safety measures

CO 3: Examine the geotechnical processes

CO 4: Select the in-site stabilization techniques with additives

CO 5: Develop a geotechnical engineering case histories

UNIT-I

Site Investigations: Planning of investigation programs, Information required for planning different stages of investigations. Geophysical methods, **Methods of site investigations:** Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. **Field tests:** In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, plate load test.

UNIT-II

Sampling techniques, Sampling disturbances, storage, labeling and transportation of samples, sampler design, influence on properties.

Geotechnical specification and proposal and report writing, boring log preparation, Safety measures, and Geotechnical risks

UNIT-III

Geotechnical Processes: Field compaction, field compaction techniques- static, vibratory, impact, Earth moving machinery, Compaction control in field.

UNIT-IV

In-situ stabilization with additives: Lime, fly ash, cement and other chemicals and bitumen.

Deep Stabilization: sand column, stone column, sand drains, prefabricated drains, electro-osmosis, lime column. soil-lime column.

Grouting: permeation, compaction and jet. Vibro-floatation, dynamic compaction, thermal, freezing. Dewatering systems

UNIT-V

Geotechnical Engineering Case Histories: Earthen dam and reservoir, Industrial Structures, Ground Liquefaction, opencast coal mining, landslides, failure of geotechnical structures under critical natural hazards, debris flow, forensic geotechnical investigation.

Textbooks:

1. Raj Purushothama, Ground Improvement Techniques , Laxmi Publications
2. S. K. Saxena, S. A. Gill and R. G. Lukas **,** Subsurface Exploration and Soil Sampling , American Society of Civil Engineers

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PRECAST AND COMPOSITE STRUCTURES

Professional Elective-IV

Course Outcomes:

To gain the knowledge upon the precast and composite structures

Course Outcomes: At the end of the course the students will be able to

CO 1: Describe the history of precast concrete and concepts of prefabrication methods
CO 2: Demonstrate the selection, casting and erection of modular elements
CO 3: Apply the prefabrication systems for various structures
CO 4: Appraise the analysis and design of prestressed elements
CO 5: Design the prestressed concrete solid flat slabs, bridges and box grinders

UNIT-I

History of Precast Concrete, Materials, Typical framing, Standard components, Scope and concept of prefabrication and methods, Principles & Design considerations,

UNIT-II

Modular coordination of elements, Selection, casting and erection

UNIT-III

Prefabrication system for buildings, Walls floors, precast shells, prefabrication and housing, limit state of stability and collapse, prefabrication of bridges

UNIT-IV

Need for Prestressing, Prestressing Methods, Analysis and Design, of elements, Composite construction, Reinforced and Prestressed Wall, Slab, Beam, Column Masonry elements. Precast sandwich Panels

UNIT-V

Prestressed concrete solid flat slabs, Hollow core slab/panels, Prestressed concrete Double “T”,Bridge, Precast segmental Box Girders, Specifications and Seismic considerations.

Textbooks:

1. P.R Knowels, Composite steel and concrete Construction, Butterworth, London. 1971.
2. R.P.Johnson & R.J.buckby, Composite Structures of steel and concrete Granada Publishing LTd. 1979.

References:

1. A.M.Hass, Precast Concrete Design and Application Applied Science Publishers London 1983.
2. Plan Cast Precast and Prestressed concrete(A Design Guide) Devid A.Sheppard & William R. Phillps Mcgraw Hill Publication Co. 1989.

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ENGLISH FOR PROFESSIONALS

Open Elective Course

Introduction:
The course aims at preparing the students with the tools needed for successful communication at the professional front. It is designed to improve students' academic and professional skills which the employers are currently looking for.

Objective:
To prepare the students to use the language effectively in all professional pursuits

Course Outcomes: On successful completion of this course, students will be able to
CO 1: Analyze the language use in communicative process
CO 2: Describe the process and product
CO 3: Interpret the ideas in group activities
CO 4: Apply different approaches to comprehend the written text
CO 5: Write any technical and official correspondence within the framework

UNIT-I
Essentials of Communication: Essentials of Grammar-Rudiments of Communications Skills(Listening, Speaking, Reading, and Writing)- Applied Grammar and Usage- Non-Verbal Communication

UNIT-II
Listening Skills: Art of Listening- Developing Effective Listening Skills-Process of Listening, Intensive & Extensive Listening, Podcasts, Vodcasts(ICT enabled)-Five steps to Active Listening-Effective and Ineffective Listening Skills-Listening &Note-taking

UNIT-III
Speaking Skills: Dynamics of Effective Speaking -Group Discussion-Simulated Presentations, Process & Product Descriptions- Proxemics, Paralinguistic Features

UNIT-IV
Reading Skills: The Art of Effective Reading- Basic steps to Effective Reading-Extensive and Intensive Reading -Approaches to Efficient Reading-Reading Comprehension

UNIT-V
Writing Skills: Art of Condensation-Descriptive Writing Techniques-Writing & Answering Memos, Circulars -Inter & Intra Official Communication -Writing Minutes of Meeting-Netiquette - E-mail & Blog Writing - Note-making

Textbook:

1. Kumar, Sanjay and Pushp Lata, Communication Skills, Second edition, Oxford University Press, 2015.

References:

1. Adair, John.The Effective Communicator. Jaico Publishing House.1995.
2. Adler, B.Ronald.Communicating at Work.(Seventh edition.) McGraw Hill.2004.
3. Aruna, Koneru. Professional Communication.McGraw Hill.2017.
4. Ibbotson,Mark.Cambridge English for Engineering Professionals. Cambridge University.2008.
5. Oxford English for Careers.Oxford University Press.

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ESSENTIAL ENGLISH AND EMPLOYABILITY SKILLS
Open Elective Course

Introduction:
The purpose of graduate education is not only to gain knowledge but also to acquire employability skills fit for the qualification. The challenge of fresh graduates does not end with merely acquiring a job but to maintain credibility and sustainability throughout their career. Hence, varied skills and competencies are the pre-requisites for professional students who emerge from colleges and are ready to take up global careers.

Objectives:
4. To enable students to develop their personality, infuse confidence and increase employability skills in any chosen career
5. To provide the students hands-on experience to cope with the demands of the world of recruiters
6. To help the students acquire the job skills essential for employment

Course Outcomes: On successful completion of this course, students will be able to
CO 1: Enhance employability skills and professional etiquette to work in the corporate world
CO 2: Develop leadership, interpersonal and decision-making skills
CO 3: Acquire productive knowledge, competent learning, and innovative thinking skills
CO 4: Analyse the importance of tackling various job interviews
CO 5: Provide insights to implement verbal and non-verbal communication competencies in workplace

UNIT-I
Six Sigma: Dabbawala from English for Employability
Personality Development: A Must for Leadership and Career Growth from Personality Development and Soft Skills
Introduction - Learning about Personality Development from 3 Cases - Personality Analysis - Freudian analysis of Personality Development - Swami Vivekananda’s Concept of Personality Development - Personality Begets Leadership Qualities

UNIT-II
Yet I am not defeated! from English for Employability, Interpersonal skills from Personality Development and Soft Skills, The Personality Attribute of Taking Bold Decisions - Personality Types and Leadership Qualities - Personality Tests

UNIT-III
Patricia Narayanan: An Entrepreneur by accident, from English for Employability

Soft Skills: Demanded by Every Employer from Personality Development and Soft Skills

Introduction to Soft Skills - Lessons from the 3 Case Studies - Change in Today's Workplace - Soft Skills as a Competitive Weapon - Antiquity of Soft Skills - Classification of Soft Skills

UNIT-IV

Satya Nadella: CEO of Microsoft from English for Employability, Interview Skills from Personality Development and Soft Skills

UNIT-V

Body Language Reveals Your Inner self and Personality from Personality Development and Soft Skills

Introduction - Emotions Displayed by Body Language – Handshake -The Most Common Body Language - Eyes - A Powerful Reflection of One's Inner self - Entry to My Space - Personal Zones may vary - Body Language exhibited during different Professional Interactions.

Textbooks Prescribed:

1. Textbook 1: Purushotham, K. English for Employability. Orient Black Swan, Hyderabad.
2. Textbook 2: Mitra, K. Barun. Personality Development and Soft Skills. Oxford University Press.

References:

1. Enhancing English and Employability Skills. State Board of Technical Education and Training. Hyderabad: Orient Black swan Private Limited, 2012.
2. Rao, M. S. Soft Skills Enhancing Employability. New Delhi: I. K. Publishing House, 2010.
3. Rao, Nageshwar. Communication Skills. New Delhi: Himalaya Publishing House Pvt. Ltd, 2008.
4. Sharma, T. K. Enhancing Employability in Education. India: Patridge Publishing House. 2015.
5. Yadav, Shalini. Communication Technique. New Delhi: University Science Press, 2010.

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TECHNICAL AND BUSINESS COMMUNICATION
Open Elective Course

Introduction:

The course is intended to expose the students to learn and practice the five communication skills thinking, listening, speaking reading, and writingin English, the global language of communication. It reflects some of the approaches in English language teaching and learning currently in practice around the world.

Objective:

To help the students to develop effective communication skills in all communicative contexts for professional advancement

Course Outcomes: On successful completion of the course, students will be able to

CO 1: Communicate technical and business correspondence

CO 2: Reflect on the themes discussed

CO 3: Recognize ethical implications of technical communication in professional contexts

CO 4: Identify the contemporary issues in engineering from environmental and global perspectives

CO 5: Demonstrate ethical decisions in complex situations

UNIT-I

E-World & E-Communication:

E-language - E-governance - E-commerce/E-business - E-banking - E-waste

UNIT-II

Business Establishment & Infrastructure Development:

Power Supply - Industrial Park - Business Correspondence: Follow-up letters - Acceptance & Rejections - Persuasive letters - Resignation letters

UNIT-III

Technology and Society:

Robot Soldiers - For a Snapshot of a Web - Placing an order - Proposal Writing - Patents & Rights (National & International) - Intellectual Property - Nanotechnology

UNIT-IV

Ethics in Business Communication:

Ethical issues involved in Business Communication - Ethical dilemmas facing managers - Ethical Code & Communication - Standards in Daily Life - Total Quality Management - World University Ranking

UNIT-V

Management Information System:

Corporate Governance - Business Process Outsourcing - Project Management Communication - Marketing Communication

Textbook:

1. Dhanavel, P. S. English and Communication Skills for Students of Science and Engineering. Orient Black Swan. 2009.

References:

1. Anderson, V. Paul. Technical Communication. Cengage. 2014.
2. Kalkar, Anjali. et.al. Business Communication. Orient Black Swan. 2010.
3. Knisely, W. Charles. and Knisely, I. Karin. Engineering Communication. Cengage. 2015.
4. Kumar, Sanjay. and Pushp Lata. Language and Communication skills for Engineers. Oxford University Press. 2018.
5. Raman, Meenakshi and Singh, Prakash. Business Communication. (Second Edition.). Oxford University Press. 2012.

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BUSINESS ANALYTICS
Audit Course

Course Objectives:

5. Understand the role of business analytics within an organization.
6. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
7. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
8. To become familiar with processes needed to develop, report, and analyze business data.

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify the business analytics and statistical tools
CO 2: Illustrate the trendiness and regression analysis
CO 3: Examine the organization structures of business analysis
CO 4: Evaluate the forecasting techniques and risk analysis
CO 5: Formulate the decision strategies

Unit I
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Unit II
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression.
Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit III
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Unit IV
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Unit V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Textbooks:

3. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press 2015.
4. Business Analytics by James Evans, persons Education.2010.

ANURAG UNIVERSITY
M. Tech. (Construction Technology Management)

INDUSTRIAL SAFETY
Audit Course

Course Objectives:
To enable the students to understand the hazards in industry and their preventive measures

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the causes of industry hazards.
CO 2: Schedule the primary and secondary functions and responsibility of maintenance department
CO 3: Differentiate the types of corrosions and their preventive measures
CO 4: Judge the fault tracing concepts
CO 5: Develop the periodic maintenance of hazards preventive measures

Unit-I
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit-II
Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV
Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TEXTBOOKS

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

REFERENCES

3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

ANURAG UNIVERSITY
M. Tech. (Construction Technology Management)

MACHINE LEARNING
Audit Course

Prerequisites: Data Structures, Knowledge on Statistical Methods

Course Objectives:

4. This course explains machine learning techniques such as decision tree learning, Bayesian learning etc.
5. To understand computational learning theory.
6. To study the pattern comparison techniques.

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the perspectives and issues in machine learning
CO 2: Demonstrate the problems for Artificial Intelligence network
CO 3: Examine the computational learning theory and instant based learning
CO 4: Defend the pattern comparison techniques
CO 5: Develop the analytical learning

UNIT – I
Introduction - Well-posed learning problems, designing a learning system Perspectives and issues in machine learning
Concept learning and the general to specific ordering – Introduction, A concept learning task, concept learning as search, Find-S: Finding a Maximally Specific Hypothesis, Version Spaces and the Candidate Elimination algorithm, Remarks on Version Spaces and Candidate Elimination, Inductive Bias.
Decision Tree Learning – Introduction, Decision Tree Representation, Appropriate Problems for Decision Tree Learning, The Basic Decision Tree Learning Algorithm Hypothesis Space Search in Decision Tree Learning, Inductive Bias in Decision Tree Learning, Issues in Decision Tree Learning.

UNIT – II
Artificial Neural Networks Introduction, Neural Network Representation, Appropriate Problems for Neural Network Learning, Perceptions, Multilayer Networks and the Back propagation Algorithm. Discussion on the Back Propagation Algorithm, An illustrative Example: Face Recognition **Evaluation Hypotheses** – Motivation, Estimation Hypothesis Accuracy, Basics of Sampling Theory, A General Approach for Deriving Confidence Intervals, Difference in Error of Two Hypotheses, Comparing Learning Algorithms.

UNIT – III
Bayesian learning - Introduction, Bayes Theorem, Bayes Theorem and Concept Learning Maximum Likelihood and Least Squared Error Hypotheses, Maximum Likelihood Hypotheses for Predicting Probabilities, Minimum Description Length Principle, Bayes Optimal Classifier, Gibs Algorithm, Naïve Bayes Classifier, An Example: Learning to Classify Text, Bayesian Belief Networks, EM Algorithm.
Computational Learning Theory – Introduction, Probably Learning an Approximately Correct Hypothesis, Sample Complexity for Finite Hypothesis Space,

Sample Complexity for Infinite Hypothesis Spaces, The Mistake Bound Model of Learning.

Instance-Based Learning – Introduction, k-Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning.

UNIT – IV

Pattern Comparison Techniques, Temporal patterns, Dynamic Time Warping Methods, Clustering, Codebook Generation, Vector Quantization

Pattern Classification: Introduction to HMMS, Training and Testing of Discrete Hidden Markov Models and Continuous Hidden Markov Models, Viterbi Algorithm, Different Case Studies in Speech recognition and Image Processing

UNIT – V

Analytical Learning – Introduction, Learning with Perfect Domain Theories : PROLOG-EBG Remarks on Explanation-Based Learning, Explanation-Based Learning of Search Control Knowledge, Using Prior Knowledge to Alter the Search Objective, Using Prior Knowledge to Augment Search Operations.

Combining Inductive and Analytical Learning – Motivation, Inductive-Analytical Approaches to Learning, Using Prior Knowledge to Initialize the Hypothesis.

TEXT BOOKS:

3. Machine Learning – Tom M. Mitchell,- MGH
4. Fundamentals of Speech Recognition By Lawrence Rabiner and Biing – Hwang Juang.

REFERENCE BOOK:

1. Machine Learning : An Algorithmic Perspective, Stephen Marsland, Taylor & Francis

ANURAG UNIVERSITY
M.Tech. (Construction Technology Management)

COST MANAGEMENT OF ENGINEERING PROJECTS
Audit Course

Course Objectives:
To enable the students to know the cost management of engineering projects

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify the strategic cost management processes
CO 2: Schedule the pre project execution clearances and documents
CO 3: Examine the infrastructure project sites
CO 4: Appraise the cost behavior and profit planning
CO 5: Construct the quantitative techniques cost management

Unit-I
Introduction and Overview of the Strategic Cost Management Process. Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Unit-II
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documents.

Unit-III
Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Unit-IV
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.

Unit-V
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

TEXTBOOKS:
1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting

REFERENCES:

3.Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

ANURAG UNIVERSITY
M. Tech. (Construction Technology Management)

COMPUTER ORIENTED NUMERICAL METHODS
Audit Course

Course Objectives:
To make the students to understand the computer oriented numerical methods in construction activities.

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the solutions of linear equations formulated for construction activities
CO 2: Identify the interpolation techniques
CO 3: Illustrate the finite difference and their applications
CO 4: Examine the numerical differentiation integration techniques
CO 5: Formulate the ordinary differential equations

Unit - I
Solutions of linear equations: Direct method – Cramer's rule, Guass – Elimination method- Gauss – Jordan elimination – Triangulation (LU Decomposition) method – Iterative methods Jacobi – Iteration method – Gauss – Siedel iteration, Successive over –relaxation method.
Eigen values and Eigen vectors: Jacobi method for symmetric matrices- Given's method for symmetric matrices-Householder's method for symmetric matrices-Rutishauser method of arbitrary matrices – Power method.

UNIT - II
Interpolation: Linear Interpolation – Higher order Interpolation – Lagrange Interpolation – Interpolating polynomials using finites differences- Hermite Interpolation –piece-wise and spline Interpolation.

Unit - III
Finite Difference and their Applications: Introduction- Differentiation formulas by Interpolating parabolas – Backward and forward and central differences- Derivation of Differentiation formulae using Taylor series- Boundary conditions- Beam deflection – Solution of characteristic value problems- Richardson's extrapolation- Use of unevenly spaced pivotal points- Integration formulae by interpolating parabolas- Numerical solution to spatial differential equations – Applications to Simply Supported Beams, Columns and Rectangular Plates.

UNIT - IV
Numerical Differentiation: Difference methods based on undetermined coefficients- optimum choice of step length– Partial differentiation.
Numerical Integration: Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method- composite integration method – Double integration using Trapezoidal and Simpson's method – New Marks Method and Application to Beams – Calculation of Slopes and Deflections.

UNIT - V

Ordinary Differential Equation: Euler's method – Backward Euler method – Midpoint method – single step method, Taylor's series method- Boundary value problems.

TEXT BOOKS:

1. Numerical methods for scientific and engineering computations. M.K. Jain-S.R.K. Iyengar – R.K. Jain Willey Eastern Limited
2. Numerical Methods for Engineering Problems, N. Krishna Raju, KU Muthu, Mac-Millan publishers

REFERENCES:

1. Introductory Numerical Methods by S.S. Shastry, PHI Learning Pvt. Ltd.
2. Applied numerical analysis by – Curtis I. Gerala- Addission Wasley – published campus.
3. Numerical methods for Engineers Stevan C. Chopra, Raymond P. Canal Mc. Graw Hill Book Company.
4. C Language and Numerical methods by C. Xavier – New age international publisher.
5. Computer based numerical analysis by Dr. M. Shanta Kumar, Khanna Book publishers, New Delhi.

ANURAG UNIVERSITY
M. Tech. (Construction Technology Management)
WASTE TO ENERGY
Audit Course

Course Objectives:
To enable the student to know the best use of waste in the preparation of energy

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the energy conversion devices
CO 2: Illustrate the manufacture of pyrolytic oils and gases
CO 3: Examine the biomass gasification
CO 4: Defend the biomass combustion techniques
CO 5: Develop the biogas plant technology

Unit-I
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit-II
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit-III: Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit-IV
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit-V
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

TEXBOOKS:
1.Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2.Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

REFERENCES:
1.Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

2.Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

ANURAG UNIVERSITY

M. Tech. I Year II Semester (Construction Technology Management)

ADVANCED CONSTRUCTION ENGINEERING LABORARY

Course Objectives: To study the

- To describe the Concrete mix design using various codes and evaluate the properties of concrete.
- To demonstrate the Properties of concrete and correlate them with the non- destructive testing results.
- To examine the Effect of different parameters on non-destructive testing results.
- To evaluate the Crack propagation in a beam under single-point - two- point loading.

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the concrete mixes using various codes and assess the properties of concrete.
CO 2: Demonstrate the properties of concrete with the non-destructive testing results.
CO 3: Examine the effect of different parameters on non-destructive testing results.
CO 4: Evaluate the crack propagation and crack patterns in a beam.

List of Experiments

1. Concrete mix design by BIS, ACI and BS method – proportioning, batching, mixing, moulding of specimens for compression, modulus of elasticity and modulus of rupture – testing of specimens as per relevant codes of practice (comparative study).
2. Development of correlation between Non-Destructive and Destructive tests using Rebound Hammer & UPV instruments.
3. Influence of following parameters on NDT readings – experimental observations.
   a. Aggregate Cement Ratio
   b. Cement Ratio
   c. Excess / Deficient Cement
   d. Excess / Deficient Water
   e. Aggregate type.
   (Some of the above parameters may be considered depending upon time)
4. Strain and deflection measurement for a structural member under single point / two point loading – crack propagation observation. Measurement and plotting.

M. Tech. I Year II Semester (Construction Technology Management)

SEMINAR

Course Objectives:
To acquire knowledge of literature review, writing a comprehensive report and presenting a seminar.

Course Outcomes: At the end of the course the students will be able to
CO 1: Identify appropriate topic of relevance.
CO 2: Illustrate the literature on technical articles of selected topic and develop comprehensive report
CO 3: Examine the innovations and methodologies understood from the literature
CO 4: Defend the innovative ideas and formulate the technical gaps in the research
CO 5: Write a comprehensive technical report and develop a presentation on the chosen topic

The students are instructed to choose a topic of their interest from the field of construction technology and management.

ANURAG UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
B. Tech. Civil Engineering with Honors in 'Smart City Planning and Development'

COURSES STRUCTURE

S. No.	Course Title	Offered in Semester	Teaching scheme			Credits
			L	T	P/D	
1	Green Building Technology	III	3	0	0	3
2	Infrastructure Planning	IV	3	0	0	3
3	Smart Transportation Systems	V	3	0	0	3
4	Integrated Waste Management for Smart City	VI	3	0	0	3
5	Project	VII	0	0	12	6
Total						**18**

Note:
1. The above courses shall be offered by the department of civil engineering starting from II year I semester.
2. The students are also allowed to do one or two 'on line courses' in place of any of the above courses, in the relevant area with the prior permission of the department 'Board of Studies', for which a course coordinator will be allocated from the department.
3. One has to obtain a minimum of 18 additional credits for the award of B. Tech. Civil Engineering with **'Honors'** in 'Smart City Planning and Development'

GREEN BUILDING TECHNOLOGY

Objectives:

- Exposure to the green building technologies and their significance.
- Understand the judicial use of energy and its management.
- Educate about the Sun-earth relationship and its effect on climate.
- Enhance awareness of end-use energy requirements in the society.
- Develop suitable technologies for energy management.

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the fundamentals of energy use and energy processes in building.

CO 2: Illustrate the indore environmental requirement and its management.

CO 3: Analyze the sun-earth relationship vis-a-vis its effect on climate.

CO 4: Evaluate the end-use energy requirements.

CO 5: Formulate the audit procedures of energy.

UNIT I

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT II

Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

UNIT III

Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT IV

End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer

UNIT V

Energy management options - Energy audit and energy targeting - Technological options for energy management

Textbooks

1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.

References

1. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
2. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

ANURAG UNIVERSITY

INFRASTRUCTURE PLANNING

Course Objectives:
The objective of the course is to impart the knowledge on infrastructure planning and development

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the planning and appraisal of major infrastructure projects

CO 2: Employ the municipal infrastructure systems
CO 3: Distinguish the financial and economic analysis of various projects

CO 4: Judge the environmental and social impact asssessment
CO 5: Develop the special planning issues for developing countries

Unit I
Introduction, definitions of "Public Works" and "Infrastructure", Examples of Infrastructure Projects, Categories of Public Infrastructure Projects, Relationships between Infrastructure and Development, Planning Contexts, Perspectives, and Objectives,
Planning and Appraisal of Major Infrastructure Projects: Sequence of Studies for a Single Major Infrastructure Project
Screening Projects and Master Planning: Needs, Problems, and Opportunities in Planning Studies

Unit II
Municipal Infrastructure Systems: Performance and Prioritization: Prioritization of Projects for Maintenance, Rehabilitation, and Replacement of Local Infrastructure Systems: Urban Institute Studies
Comparisons of Infrastructure Alternatives: Methods for Comparing and Prioritizing Infrastructure Alternatives, Formulas Involving Discount Rate and Use of Spreadsheets, Solutions of Problems Involving Comparisons of Public Works Alternatives, Using Interest Formulas and Spreadsheets

Unit III
Planning Aids: Basic Data for Planning, Classification of Data, Aerial Photos, Remote Sensing, GPS, and Satellites, Forecasting Models for Infrastructure Planning
Financial Analyses: Types of Financial Analyses, General Principles, Financial Analyses for a Municipal Water Supply Project, Project with Different Sponsorships
Economic Analyses: General Concepts of Economic Analysis for Public Works, Applications, Scope of Evaluations and Costs and Benefits, Format for Benefit-Cost Calculations, Example of Benefit-Cost Analysis of Municipal Water Supply, Transportation Projects

Unit IV
Environmental and Social Impact Assessment: Concepts, Requirements, and Procedures, The Ecological and Human Environments: Categories, Attributes, and Parameters, Identification of Environmental and Social Impacts over Project Area and over Project Cycle, Special Considerations Involving Land and Water Interrelationships, Energy Consumption, and Air Pollution, Concepts of Human Environment, Human Well-Being, Social Well-Being, Social Welfare, and Quality of Life, Public Involvement
Sustainability: Conservation and environmental movement, global warming concerns

Unit V

Special Planning Issues for Developing Countries: Planning Concepts and Methodologies, Important Principles for Project Designs in Developing Countries

Construction and Professional Services: Project Delivery Methods, Project Development Process (PDP), Constructability Review Process (CRP) and Value Engineering (VE)

Planning for Uncertainty and Risk: Uncertainty, Sensitivity and Risk: Recapitulation of Concepts and Case Studies

Operations Research Methods for Planning and Analysis: Nature and Applicability of Mathematical Models, Mathematical Programming Models, Artificial Intelligence Systems, Decision Theory, Utility Theory,

Textbooks

1. Goodman, Alvin S. and Hastak, Makarand. **'Infrastructure Planning Handbook: Planning, Engineering, and Economics',** US: McGraw-Hill Education, 2015
2. J. Parkin and D. Sharma, *Infrastructure Planning*, Thomas Telford, London, 1999.

SMART TRANSPORTATION SYSTEMS

Course objectives:
To impart the knowledge of user services, architecture, control of intelligent transportation systems (ITS) and to know the rapid transit by metro systems.

Course outcomes: On completion of the course, the students will be able to:
CO 1: Understand the importance of telecommunications in the ITS system.
CO 2: Demonstrate the ITS user services and functional areas
CO 3: Differentiate the ITS architecture and planning
CO 4: Evaluate the intelligent signalling system
CO 5: Design the rapid transit by metro systems

Unit I
Overview of Intelligent Transportation Systems: Definition of ITS, Identification of ITS objectives, Historical background, Benefits of ITS; ITS data collection techniques - Detectors, RFID, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), Video Data Collection; Vehicle – Roadside communication – Vehicle Positioning System; Telecommunications in ITS - Importance of telecommunications in the ITS system.

Unit II
ITS user services and functional areas: ITS user services – Traffic management, Public transportation management, Electronic payment, Commercial vehicle operations, Emergency management, Advanced vehicle control and safety systems, Information management, Maintenance and construction management; Automated highway systems; Functional areas - Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS).

Unit III
ITS architecture and planning: Necessity and requirement of ITS architecture, National ITS architecture; ITS planning – Transportation planning and ITS, Planning and ITS architecture, Planning for ITS, Integrating ITS into transportation planning.

Unit IV
Intelligent Train Control System: Train operation, Protection and track supervision, Absolute block system, Automatic block system, Advance interlocking and accident prevention, Intelligent track maintenance – Track geometry, Rail profile, Track video surveillance, Intelligent signalling system.

Unit V
Metro systems: Concept of rapid transit and metro Systems; Need and benefits of metros; Routing studies; Basic planning and financials; Status of metro systems in India; Overview and construction methods for: Elevated and underground stations; Viaduct spans and bridges; Underground tunnels; Depots; Commercial and Service buildings; Basics of construction planning & management; Signalling systems; Automatic fare collection; Tunnel ventilation systems; Air conditioning for stations and buildings; Fire control systems; Lifts and escalators.

Text Books:

1. Chowdhury, M. A., and Sadek, A. Fundamentals of Intelligent Transportation Systems Planning. Artech House, 2003.
2. Sarkar P. K., and Jain, A. K. Intelligent Transport Systems. PHI Learning Publications, 2018.
3. Garbutt, P. E. World Metro Systems. Capital Transport Publishing; 2nd edition, 1997.

Reference Books:

1. Sussman, J. M. Perspective on ITS. Artech House Publishers, 2005.
2. Kadiyali, L. R. Traffic Engineering and transportation Planning, 8th edition, Khanna Publishers, New Delhi, 2005
3. Chandra, S., and Agarwal, M. M. Railway Engineering. Oxford University Press, 2007.
4. Rai, B. U. Handbook of Research on Emerging Innovations in Rail Transportation Engineering. IGI global publisher of timely knowledge, 2016.
5. Pyrgidis, C. N. Railway Transportation Systems Design, Construction and Operation. CRC Press, 2019.

NPTEL

1. https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_48.pdf
2. https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_49.pdf

INTEGRATED WASTE MANAGEMENT FOR SMARTCITY

Course Objectives:
To understand the need for waste management systems for a smart city, various approaches available, different technologies, role of IT and current scenario in waste management practices.

Course Outcomes: At the end of the course the students will:
CO 1: Explain the sustainable of city and its importance.
CO 2: Demonstrate the various approaches for smart city waste management.
CO 3: Implement the right technologies for waste management.
CO 4: Judge the appropriate IT tools for efficient management for waste.
CO 5: Estimate the waste management practices in India.

Unit I
Introduction: City as an Organism, History of Waste Management, Smart Sustainable City and Its Attributes, Technological Advancement and Waste Generation, Impact of Urbanization on Natural Resources, Importance of Decentralization in Waste Management, Smart Cities as Safe Cities, Carrying Capacity of Cities, Environmentally Sustainable Cities, Waste Management in Environmental Planning, Environmental Infrastructure, Waste Management and High Quality of Life

Unit II
Environmental Approaches: Principles of Waste Management, Reduction in Carbon Emissions, Environmental Ethics, Green Economics and Benefits, 5 R Approaches in Resource Conservation, Emission Reductions, Wealth from Wastes, Green Belt Development, Concept of Sustainability and Waste Reduction; Ideal Practices in Waste Management, Criteria for Site Selection, Zero Waste Technologies and Resource Recovery, Importance of EIA Practices, Green Buildings and Practices, Role of Urban Local Bodies, Urban Finance for Waste Treatment, Waste Management in developed countries; case studies.

Unit III
Technologies involved in solid waste management: Incineration of Wastes, Energy Simulation (Waste to Energy), Automated Landfill Management, Integrated Asset Management Solutions, Process Automation, Bio methanation, Energy Production, Composting, Sludge Generation and its Reuse, Landfill, Pyrolysis, Leachate Characteristics, and its Treatment.
Wastewater Management: Micro staining, Coagulation and Flocculation, Filtration, Ultra Filtration, Nano-Filtration, Ion exchange, Zero Discharge, Reverse Osmosis, Biological Treatment.
Air Emission Control: Ambient Air Quality Monitoring, Advanced Particle Control Systems, Electrolysis, Gas and Vapour Control Systems, Catalytic Converters.

Unit IV
Role of IT: Information Technology and Infrastructure, Onsite and Offsite Environmental Monitoring System, Application of GIS Technology, Automated Waste Collection and Transportation, Online Platforms, Use of Electronic/Radio Frequency Tags, Crowdsourcing, GPS Devices and Sensors, Sensor-

Based Sorting, Pollution Sensors, Internet of Things, Smart Pneumatic Waste Conveyance System, Water Quality Meters, Use of Ultrasonic Sensors and GSM Technology, Intelligent Management of Water and Sewer System.

Unit V

Current Practices: Green Chemistry and Applications for Waste Treatment, Analysis of Environmental Pollutants, Hazardous Waste Management, Electronic Waste Management, Carbon Footprint, Water Footprint, Plastic Waste Degradation, Lifecycle of Product, Nanotechnology in Waste Management, Innovative, Eco-friendly and Low-Cost Technologies in Waste Management, RS and GIS Technology, Fuel Cell Implementation in Waste Management.

Indian Scenario: The mission of India and Plans for Smart Cities, Urban Environmental Planning and Management, National Environmental Policy, Environmental Laws in India, Current Practices in Top Ten Cities of India

Textbooks:

1. William A Worrell and P. Aarne Veslind. Solid Waste Engineering, 2nd Edition (SI Edition) Cengage Learning, 2012 (ISBN-13: 978-1-4390-6217-3)
2. David E. Newton. Waste Management: A Reference Handbook (Contemporary World Issues) Annotated Edition, 2020. (ISBN-13: 978-1440872822)
3. Ram Naresh Bharagava & Pankaj Chowdhary, Emerging and Eco-Friendly Approaches for Waste Management, Ist Edition, 2019. (ISBN-13: 978-9811086687)

References:

1. Ashok K. Rathoure. Zero Waste Management Practices for Environmental Sustainability, Ist Edition, 2020 (ISBN 9780367180393)
2. Dave Whittaker, Integrated Waste Management: A Sustainable Approach, 2018. (ISBN-13: 978-1632399571)
3. Mark J. Hammer Sr. (2013): Water and Wastewater Technology: Pearson New International Edition Pearson; 7th
4. Martin B. B. Hocking (2006): Handbook of Chemical Technology and Pollution Control. 3rd Edition Academic Press
5. ACT Waste Management Strategy towards a Sustainable Canberra (2011–2025) Reducing Waste and Recovering Resources to Achieve a Sustainable, Carbon-Neutral Canberra.

NPTEL

- NPTEL Course by Prof. Brajesh Kumar Dubey. Integrated Waste Management for a Smart City.

PROJECT

The students are expect to take up a project in the field of smart city planning and development to implement an innovative idea under the guidance of a supervisor from the department of civil engineering and submit it at the end of IV year I-semester for the valuation.

ANURAG UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
B. Tech. Minor Degree in 'Smart City Planning'
COURSES STRUCTURE

S. No.	Course Title	Offered in Semester	Teaching scheme			Credits
			L	T	P/D	
1	Green Building Technology	III	3	0	0	3
2	Infrastructure Planning	IV	3	0	0	3
3	Smart Transportation Systems	V	3	0	0	3
4	Integrated Waste Management for Smart City	VI	3	0	0	3
5	Geospatial Technology	VII	3	0	0	3
6	Environmental Engineering Laboratory	VI	0	0	3	1.5
7	Geospatial Technology Laboratory	VII	0	0	3	1.5
Total						**18**

Note:

3. The above courses shall be offered by the department of civil engineering starting from II year I semester.
4. The students are also allowed to do one or two 'on line courses' in place of any of the above courses, in the relevant area with the prior permission of the department 'Board of Studies', for which a course coordinator will be allocated from the department.
5. One has to obtain a minimum of 18 additional credits for the award of B. Tech. Civil Engineering with **'Honors'** in 'Smart City Planning and Devlopment'

GREEN BUILDING TECHNOLOGY

Objectives:

- Exposure to the green building technologies and their significance.
- Understand the judicial use of energy and its management.
- Educate about the Sun-earth relationship and its effect on climate.
- Enhance awareness of end-use energy requirements in the society.
- Develop suitable technologies for energy management.

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the fundamentals of energy use and energy processes in building.

CO 2: Illustrate the indore environmental requirement and its management.

CO 3: Analyze the sun-earth relationship vis-a-vis its effect on climate.

CO 4: Evaluate the end-use energy requirements.

CO 5: Formulate the audit procedures of energy.

UNIT I

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT II

Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

UNIT III

Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT IV

End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer

UNIT V

Energy management options - Energy audit and energy targeting - Technological options for energy management

Textbooks

1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.

References

1. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
2. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

ANURAG UNIVERSITY

INFRASTRUCTURE PLANNING

Course Objectives:
The objective of the course is to impart the knowledge on infrastructure planning and development

Course Outcomes: At the end of the course the students will be able to
CO 1: Describe the planning and appraisal of major infrastructure projects

CO 2: Employ the municipal infrastructure systems
CO 3: Distinguish the financial and economic analysis of various projects

CO 4: Judge the environmental and social impact asssessment
CO 5: Develop the special planning issues for developing countries

Unit I
Introduction, definitions of “Public Works” and “Infrastructure”, Examples of Infrastructure Projects, Categories of Public Infrastructure Projects, Relationships between Infrastructure and Development, Planning Contexts, Perspectives, and Objectives,
Planning and Appraisal of Major Infrastructure Projects: Sequence of Studies for a Single Major Infrastructure Project
Screening Projects and Master Planning: Needs, Problems, and Opportunities in Planning Studies

Unit II
Municipal Infrastructure Systems: Performance and Prioritization: Prioritization of Projects for Maintenance, Rehabilitation, and Replacement of Local Infrastructure Systems: Urban Institute Studies
Comparisons of Infrastructure Alternatives: Methods for Comparing and Prioritizing Infrastructure Alternatives, Formulas Involving Discount Rate and Use of Spreadsheets, Solutions of Problems Involving Comparisons of Public Works Alternatives, Using Interest Formulas and Spreadsheets

Unit III
Planning Aids: Basic Data for Planning, Classification of Data, Aerial Photos, Remote Sensing, GPS, and Satellites, Forecasting Models for Infrastructure Planning
Financial Analyses: Types of Financial Analyses, General Principles, Financial Analyses for a Municipal Water Supply Project, Project with Different Sponsorships
Economic Analyses: General Concepts of Economic Analysis for Public Works, Applications, Scope of Evaluations and Costs and Benefits, Format for Benefit-Cost Calculations, Example of Benefit-Cost Analysis of Municipal Water Supply, Transportation Projects

Unit IV

Environmental and Social Impact Assessment: Concepts, Requirements, and Procedures, The Ecological and Human Environments: Categories, Attributes, and Parameters, Identification of Environmental and Social Impacts over Project Area and over Project Cycle, Special Considerations Involving Land and Water Interrelationships, Energy Consumption, and Air Pollution, Concepts of Human Environment, Human Well-Being, Social Well-Being, Social Welfare, and Quality of Life, Public Involvement

Sustainability: Conservation and environmental movement, global warming concerns

Unit V

Special Planning Issues for Developing Countries: Planning Concepts and Methodologies, Important Principles for Project Designs in Developing Countries

Construction and Professional Services: Project Delivery Methods, Project Development Process (PDP), Constructability Review Process (CRP) and Value Engineering (VE)

Planning for Uncertainty and Risk: Uncertainty, Sensitivity and Risk: Recapitulation of Concepts and Case Studies

Operations Research Methods for Planning and Analysis: Nature and Applicability of Mathematical Models, Mathematical Programming Models, Artificial Intelligence Systems, Decision Theory, Utility Theory,

Textbooks

1. Goodman, Alvin S. and Hastak, Makarand. **'Infrastructure Planning Handbook: Planning, Engineering, and Economics',** US: McGraw-Hill Education, 2015
2. J. Parkin and D. Sharma, *Infrastructure Planning*, Thomas Telford, London, 1999.

ANURAG UNIVERSITY

SMART TRANSPORTATION SYSTEMS

Course objectives:
To impart the knowledge of user services, architecture, control of intelligent transportation systems (ITS) and to know the rapid transit by metro systems.

Course outcomes: On completion of the course, the students will be able to:
CO 1: Understand the importance of telecommunications in the ITS system.
CO 2: Demonstrate the ITS user services and functional areas
CO 3: Differentiate the ITS architecture and planning
CO 4: Evaluate the intelligent signalling system
CO 5: Design the rapid transit by metro systems

Unit I
Overview of Intelligent Transportation Systems: Definition of ITS, Identification of ITS objectives, Historical background, Benefits of ITS; ITS data collection techniques - Detectors, RFID, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), Video Data Collection; Vehicle – Roadside communication – Vehicle Positioning System; Telecommunications in ITS - Importance of telecommunications in the ITS system.

Unit II
ITS user services and functional areas: ITS user services – Traffic management, Public transportation management, Electronic payment, Commercial vehicle operations, Emergency management, Advanced vehicle control and safety systems, Information management, Maintenance and construction management; Automated highway systems; Functional areas - Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS).

Unit III
ITS architecture and planning: Necessity and requirement of ITS architecture, National ITS architecture; ITS planning – Transportation planning and ITS, Planning and ITS architecture, Planning for ITS, Integrating ITS into transportation planning.

Unit IV
Intelligent Train Control System: Train operation, Protection and track supervision, Absolute block system, Automatic block system, Advance interlocking and accident prevention, Intelligent track maintenance – Track geometry, Rail profile, Track video surveillance, Intelligent signalling system.

Unit V
Metro systems: Concept of rapid transit and metro Systems; Need and benefits of metros; Routing studies; Basic planning and financials; Status of metro systems in India; Overview and construction methods for: Elevated and underground stations; Viaduct spans and bridges; Underground tunnels; Depots; Commercial and Service buildings; Basics of construction planning & management; Signalling systems; Automatic fare collection; Tunnel ventilation systems; Air conditioning for stations and buildings; Fire control systems; Lifts and escalators.

Textbooks

1. Chowdhury, M. A., and Sadek, A. Fundamentals of Intelligent Transportation Systems Planning. Artech House, 2003.
2. Sarkar P. K., and Jain, A. K. Intelligent Transport Systems. PHI Learning Publications, 2018.
3. Garbutt, P. E. World Metro Systems. Capital Transport Publishing; 2nd edition, 1997.

Reference

1. Sussman, J. M. Perspective on ITS. Artech House Publishers, 2005.
2. Kadiyali, L. R. Traffic Engineering and transportation Planning, 8th edition, Khanna Publishers, New Delhi, 2005
3. Chandra, S., and Agarwal, M. M. Railway Engineering. Oxford University Press, 2007.
4. Rai, B. U. Handbook of Research on Emerging Innovations in Rail Transportation Engineering. IGI global publisher of timely knowledge, 2016.
5. Pyrgidis, C. N. Railway Transportation Systems Design, Construction and Operation. CRC Press, 2019.

NPTEL

1. https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_48.pdf
2. https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_49.pdf

ANURAG UNIVERSITY

INTEGRATED WASTE MANAGEMENT FOR SMARTCITY

Course Objectives:
To understand the need for waste management systems for a smart city, various approaches available, different technologies, role of IT and current scenario in waste management practices.

Course Outcomes: At the end of the course the students will:
CO 1: Explain the sustainable of city and its importance.
CO 2: Demonstrate the various approaches for smart city waste management.
CO 3: Implement the right technologies for waste management.
CO 4: Judge the appropriate IT tools for efficient management for waste.
CO 5: Estimate the waste management practices in India.

Unit I
Introduction: City as an Organism, History of Waste Management, Smart Sustainable City and Its Attributes, Technological Advancement and Waste Generation, Impact of Urbanization on Natural Resources, Importance of Decentralization in Waste Management, Smart Cities as Safe Cities, Carrying Capacity of Cities, Environmentally Sustainable Cities, Waste Management in Environmental Planning, Environmental Infrastructure, Waste Management and High Quality of Life

Unit II
Environmental Approaches: Principles of Waste Management, Reduction in Carbon Emissions, Environmental Ethics, Green Economics and Benefits, 5 R Approaches in Resource Conservation, Emission Reductions, Wealth from Wastes, Green Belt Development, Concept of Sustainability and Waste Reduction; Ideal Practices in Waste Management, Criteria for Site Selection, Zero Waste Technologies and Resource Recovery, Importance of EIA Practices, Green Buildings and Practices, Role of Urban Local Bodies, Urban Finance for Waste Treatment, Waste Management in developed countries; case studies.

Unit III
Technologies involved in solid waste management: Incineration of Wastes, Energy Simulation (Waste to Energy), Automated Landfill Management, Integrated Asset Management Solutions, Process Automation, Bio methanation, Energy Production, Composting, Sludge Generation and its Reuse, Landfill, Pyrolysis, Leachate Characteristics, and its Treatment.
Wastewater Management: Micro staining, Coagulation and Flocculation, Filtration, Ultra Filtration, Nano-Filtration, Ion exchange, Zero Discharge, Reverse Osmosis, Biological Treatment.
Air Emission Control: Ambient Air Quality Monitoring, Advanced Particle Control Systems, Electrolysis, Gas and Vapour Control Systems, Catalytic Converters.

Unit IV
Role of IT: Information Technology and Infrastructure, Onsite and Offsite Environmental Monitoring System, Application of GIS Technology, Automated Waste Collection and Transportation, Online Platforms, Use of Electronic/Radio Frequency Tags, Crowdsourcing, GPS Devices and Sensors, Sensor-Based Sorting, Pollution Sensors, Internet of Things, Smart Pneumatic Waste Conveyance System, Water Quality Meters, Use of Ultrasonic Sensors and GSM Technology, Intelligent Management of Water and Sewer System.

Unit V

Current Practices: Green Chemistry and Applications for Waste Treatment, Analysis of Environmental Pollutants, Hazardous Waste Management, Electronic Waste Management, Carbon Footprint, Water Footprint, Plastic Waste Degradation, Lifecycle of Product, Nanotechnology in Waste Management, Innovative, Eco-friendly and Low-Cost Technologies in Waste Management, RS and GIS Technology, Fuel Cell Implementation in Waste Management.
Indian Scenario: The mission of India and Plans for Smart Cities, Urban Environmental Planning and Management, National Environmental Policy, Environmental Laws in India, Current Practices in Top Ten Cities of India

Textbooks:

1. William A Worrell and P. Aarne Veslind. Solid Waste Engineering, 2nd Edition (SI Edition) Cengage Learning, 2012 (ISBN-13: 978-1-4390-6217-3)
2. David E. Newton. Waste Management: A Reference Handbook (Contemporary World Issues) Annotated Edition, 2020. (ISBN-13: 978-1440872822)
3. Ram Naresh Bharagava & Pankaj Chowdhary, Emerging and Eco-Friendly Approaches for Waste Management, Ist Edition, 2019. (ISBN-13: 978-9811086687)

References:

1. Ashok K. Rathoure. Zero Waste Management Practices for Environmental Sustainability, Ist Edition, 2020 (ISBN 9780367180393)
2. Dave Whittaker, Integrated Waste Management: A Sustainable Approach, 2018. (ISBN-13: 978-1632399571)
3. Mark J. Hammer Sr. (2013): Water and Wastewater Technology: Pearson New International Edition Pearson; 7th
4. Martin B. B. Hocking (2006): Handbook of Chemical Technology and Pollution Control. 3rd Edition Academic Press
5. ACT Waste Management Strategy towards a Sustainable Canberra (2011–2025) Reducing Waste and Recovering Resources to Achieve a Sustainable, Carbon-Neutral Canberra.

NPTEL
- NPTEL Course by Prof. Brajesh Kumar Dubey. Integrated Waste Management for a Smart City.

GEOSPATIAL TECHNOLOGY

Course Objectives:

- Discuss the various spatial and non-spatial data types, and data base management techniques
- Develop the concepts and professional skills in utility of geospatial techniques
- Improve the working knowledge of geospatial techniques in field problems

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the fundamentals of geographical information systems (GIS)

CO 2: Demonstrate the geospatial technology relating to the data acquisition

CO 3: Choose the data modeling and organize the data for analysis

CO 4: Evaluate the applications of GIS

CO 5: Develop the general background of remote sensing technology

UNIT–I

Introduction: Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems.

Projections and Coordinate Systems - Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

UNIT–II

Data Acquisition and Data Management: data types, spatial, non-spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty.

Data Processing: Geometric errors and corrections, types of systematic and non-systematic errors, radiometric errors and corrections, internal and external errors.

UNIT–III

Data Modeling: Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.

GIS Analysis and Functions: Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non-spatial data.

UNIT–IV

Applications of GIS: Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

UNIT–V

Introduction to Remote Sensing : General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

Textbooks

1. Burrough, P. A., and McDonnell R. A. (1998). Principles of Geographical Information Systems. Oxford University Press, New York, Pp.333.
2. Choudhury S., Chakrabarti, D., and Choudhury S. (2009). An Introduction to Geographic Information Technology. I.K. International Publishing House (P) Ltd, New Delhi, Pp.276.

References

1. Kang-tsung Chang. (2006). Introduction to Geographical information Systems. Tata McGraw-Hill Publishing Company Ltd., Third Edition, New Delhi, Pp.432.
2. Lilysand T.M., and Kiefer R.W. (2002). Remote Sensing and Image Interpretation. John Wiley and Sons, Fourth Edition, New York, Pp.724.
3. Sabins F.F. Jr. (1978). Remote Sensing Principles and Interpretations.
4. W.H. Freeman and Company, San Francisco, Pp. 426.
5. Tor Bernhardsen. (2002). Geographical Information System. Wiley India (P) Ltd., Third Edition, New Delhi, Pp. 428.
6. Hoffman-Wellenhof, B, et al. (1997). GPS Theory and Practice. Fourth Edition, Springer Wein, New York.

ENVIRONMENTAL ENGINEERING LABORATORY

Course Objectives

To impart the knowledge of experimental investigations and limitations of chemical and biological composition of palatable and waste water produced in a smart city

Course Outcomes: At the end of the course the students will be able to

CO 1: Understand the various tests required to be conducted on palatable and waste water.

CO 2: Illustrate the experimental procedures of various tests

CO 3: Examine the limitations of chemical and biological composition

CO 4: Judge the efficient technology to conduct the tests

CO 5: Estimate the optimum chemical composition required

List of Experiments

1. Determination of pH and turbidity
2. Determination of conductivity and total dissolved solids (Organic and Inorganic)
3. Determination of alkalinity/acidity
4. Determination of chlorides
5. Determination of iron
6. Determination of dissolved oxygen
7. Determination of nitrates
8. Determination of optimum dose of coagulant
9. Determination of chlorine demand
10. Determination of total phosphorous
11. Determination of B. O. D.
12. Determination of C. O. D.
13. Determination of optimum coagulant dose
14. Determination of chlorine demand
15. Presumptive coliform test

Note: Minimum of 10 experiments are to be conducted from the above list.

GEOSPATIAL TECHNOLOGYLABORATORY

Course Objectives

- To provide the knowledge of Remote sensing and GIS and its applications in civil engineering
- To illustrate basic GIS-terms which are connected to data processing by means of exercises;
- To understand the potential of GIS use in analysis and design processes.

Course Outcomes: At the end of the course the students will be able to
CO 1: Understand the basic GIS concepts in a simulated environment
CO 2: Interpret the data capture, data processing and data presentation
CO 3: Differentiate processing techniques for remote sensing images
CO 4: Evaluate the possibilities and limitations of GIS-software
CO 5: Formulate spatial problem using GIS and Remote Sensing software

List of Experiments

1. Introduction to Geographical Information systems and its components.
2. Creation of point, line and polygon by using Arc Map.
3. Geometric corrections of a Top sheet.
4. Geometric correction of a satellite Image.
5. Generation of thematic maps by using top sheet.
5. Creation of vector layers and operations.
6. Creation of Raster layers and operations.
7. Database generation and its applications using Arc Catalog.
8. Classification of satellite image using supervised method.
9. Classification of satellite image using unsupervised method.
10. Application of digital image processing tools on satellite image.

Computer Science and Engineering

Department of Computer Science and Engineering

Minutes of the Third Board of Studies (BoS) Meeting

The e-Minutes of the third Board of Studies (BoS) Meeting of the Department of Computer Science and Engineering (CSE), Anurag University was circulated on 1-May- 2021, to all BoS members for the e-approval of the course structure and syllabus of the new PG course M.Tech (Data Science) to be started from the academic year 2021. Due to the ongoing pandemic of Covid-19 Second wave, the meeting was conducted by e- circulation.

The Chairperson, BoS, has communicated the agenda of the third e-BoS meeting and the course structure and syllabus of M.Tech (Data Science) well in advance to all the members of BoS.

Agenda of the third e-BoS meeting to approve the course structure and syllabus of M.Tech (Data Science)

Item No. 1: Course structure and syllabus of M.Tech (Data Science) of AU-R20

Resolution: The BoS members have given e-approval for the Course structure and syllabus of M.Tech (Data Science), and few modifications are suggested by few members and incorporated.

Item No.2: In case of amendments/changes in the course structure or syllabi, the Board has suggested Chairperson:

Resolution: a) In any case, if there are significant changes or amendments either in course structure or syllabus, the BOS meeting shall be called for its approval.

b) In any case, if there are minor changes or amendments either in course structure or syllabus, they will be communicated to all BOS members through e-mail for e- approval.

Item No.3: The Board has empowered the Chairperson, BoS, to

a) Incorporate New Elective courses (Professional and Open) as per the need

b) Design the syllabus by discussing in the department for the new courses for which the syllabus is not yet designed.

c) Modify or change syllabus as per item no.3.

d) Finalize the list of examiners for the external examinations/ project seminars/ Project Work.

The following members have responded to the meeting and given e-approval .

S.No	Name	Designation	Designation in BoS
1	Dr. R.B.V. Subramanyam	Professor, Dept. of CSE, and Chief Investigator, Electronics & ICT Academy (Set up by MeitY, Govt. of India), NIT, Warangal	External Member
2	Dr. Rajiv Wankar	Professor, Dept. of CSE, University of Hyderabad	External Member
3	Mr. Richard King	Regional Head, Academic Interface program, TCS, Hyderabad	External Member
4	Dr. G. Vishnu Murthy	Professor & Head Dept. of CSE, Dean-Engineering, AU	Internal Member
5	Ms. Sravanthi Satyavarapu	Asst. Manager, Tech. Mahindra, Alumni, Hyderabad	External Member
6	Dr. Sandeep Singh Rawat	Assoc. Professor Dept. of CSE, AU, Hyderabad	Internal Member
7	Dr.M. Sridevi	Assoc. Professor Dept. of CSE, AU, Hyderabad	Internal Member
8	Mrs. V. Jyothi	Asst. Professor Dept. of CSE, AU, Hyderabad	Internal Member
9	Dr. V. Vijaya Kumar	Professor- Dean- Research & Development, AU, Hyderabad	Chairperson - CSE

Sd/

Chairperson Board of Studies Department of Computer Science and Engineering Anurag University, Hyderabad

Third BOS-MoM (e-approval)-CSE-AU.

ANURAG UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

TWO YEARS COURSE STRUCTURE - M.Tech (DS)

M.TECH (DS) I YEAR I SEM (1st Semester) **[6T+ 2L+1 Audit Course]**

Sno	Category	Course title	L	T	P	Credits
1	PCC-I	Machine Learning	3	0	0	3
2	PCC-II	Python Programming	3	0	0	3
	PCC-III	Statistical Foundations for Data Science	3	1	0	4
3	PEC-I	1. Information Retrieval Systems 2. Object Oriented Programming (Java) 3. Digital Image Processing 4. Cloud Computing 5. Information Security	3	0	0	3
4	PEC-II	1. Artificial Intelligence 2. Advanced Database Management Systems 3. Natural Language Processing 4. Introduction to Internet of Things	3	0	0	3
6	PCC-III	Research Methodology	2	0	0	2
7	PCC I-Lab	Machine Learning Lab	0	0	**3**	**1.5**
8	PCC-II-Lab	Python Programming Lab	0	0	**3**	**1.5**
9		Audit Course 1	2	0	0	0
		Total	**19**	**1**	**6**	**21**

M.Tech (DS) I YEAR II SEM (2nd Semester) [5T+ 1L+ 1 seminar]

Sno	Category	Course title	L	T	P	Credits
1	PCC-IV	Big Data Analytics	3	1	0	4
2	PCC-V	Data Wrangling & Visualization	3	1	0	4
3	PEC-III	1. Sentiment Analysis 2. Text Mining 3. Block Chain Technology 4. Recommender Systems	3	0	0	3
4	PEC-IV	1. Semantic Web 2. Predictive Analytics with R 3. Data Storage Technologies 4. Deep Learning	3	0	0	3
5	OE-1	1. English for Professionals 2. Entrepreneurship Development 3. Technical and Business Communication Skills 4. Project Management	3	0	0	3
6	PCC-V Lab	Data Wrangling and Visualization Lab	0	0	4	2
7	Seminar	Seminar-I	0	0	4	2
		Total	**15**	**2**	**8**	**21**

M.Tech (DS) II YEAR I SEM Major Project Phase I

Sno	Category	Course title	L	T	P	credits
1		Project Review I / Dissertation	0	0	24	12
		Total	**0**	**0**	**20**	**12**

M.Tech (DS) II YEAR II SEM Major Project Phase II

Sno	Category	Course title	L	T	P	Credits
1		Project Review II / Dissertation	0	0	28	14
		Total	**0**	**0**	**28**	**14**

ANURAG UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

M.Tech (DS)

I Year M.Tech (DS) I Sem	**L**	**T / P / D**	**C**
	3	**0**	**3**

MACHINE LEARNING

(PCC-I)

Course Objectives: The main objective of this course is to teach the principles and foundations of machine learning algorithms

Course Outcomes:

At the end of the course the student will be able to understand

1. Basics of Machine Learning and its limitations
2. Machine Learning Algorithms: supervised, unsupervised, bio-inspired
3. Probabilistic Modeling and Association Rule Mining

Unit-I

Introduction: What does it mean to learn, Some canonical Learning Problems, The Decision Tree Model of Learning, Formalizing the Learning Problem [Reference 1], ID3 Algorithm [[Reference 2]

Limits of Learning: Data Generating Distributions, Inductive Bias, Not Everything is learnable, Underfitting and Overfitting, Separation of training and test Data, Models, parameters and Hyperparameters, Real World Applications of Machine Learning [Reference 1]

Geometry and Nearest Neighbours: From Data to Feature Vectors, k-Nearest Neighbours, Decision Boundaries, k-means Clustering, High Dimensions [Reference 1]

Unit-II

The Perceptron: Bio-inspired Learning, The Perceptron Algorithm, Geometric Interpretation, Interpreting Perceptron Weights, Perceptron Convergence and Linear Separability, Improved Generalization, Limitations of the Perceptron [Reference 1]

Practical Issues: Importance of Good Features, Irrelevant and Redundant Features, Feature Pruning and Normalization, Combinatorial Feature Explosion, Evaluating Model Performance, Cross Validation, Hypothesis Testing and Statistical Significance, Debugging Learning Algorithms, Bias Variance trade off [Reference 1]

Unit-III

Linear Models: The Optimization Framework for Linear Models, Convex Surrogate Loss Functions, Weight Regularization, Optimization and Gradient Descent, Support Vector Machines [Reference 1]

Probabilistic Modeling: Classification by Density Estimation, Statistical Estimation, Naïve Bayes Models, Prediction [Reference 1]

Unit-IV

Neural Networks: Bio-inspired Multi-Layer Networks, The Back-propagation Algorithm, Initialization and Convergence of Neural Networks, Beyond two layers, Breadth vs Depth, Basis Functions [Reference 1]

Unit-V

Unsupervised Learning: Clustering Introduction, Similarity and Distance Measures, Agglomerative Algorithms, Divisive Clustering, Bi Clustering, Principal Component Analysis, Factor Analysis, Outlier Detection, Neural network Models(unsupervised).

TEXT BOOKS:

1. A Course in Machine Learning (CIML). Hal Daume III, 2017 (freely available online) http://ciml.info/

REFERENCE BOOKS:

1. Hands on Machine Learning with SciKit-Learn, Keras and Tensor Flow. AurélienGéron. O’Reily, 2019
2. Machine Learning with Python Cookbook. Chris Albo, O’Reily, 2018
3. Introduction to Machine Learning with Python: A guide. Andreas C Miller, Sarah Guido. O’Reily, 2017

ANURAG UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

M.Tech (DS)

I Year M.Tech (DS) I Sem	**L**	**T / P / D**	**C**
	3	**0**	**3**

PYTHON PROGRAMMING

(PCC-II)

Course Objectives

1. Use Python interactively, execute a Python script at the shell prompt, use Python types, expressions, and None, use string literals and string type, use Python statements (if...elif..else, for, pass, continue, . . .)
2. Understand the difference between expressions and Statements.
3. Utilize high-level data types such as lists and dictionaries, understand the difference between mutable and immutable types.
4. write a simple class and access methods and attributes,
5. import and utilize a module, read from and write to a text file.

Course Outcomes

1. Build programs using primitive data types and user defined functions.
2. Write applications that include string built-in functions, modules and packages along with respective exceptional handling mechanism.
3. Writes applications using OO features of Python
4. Develops web-based applications to deal with data communication between client and server modules and also process data that is stored in possible databases.
5. Hands on exposure on SciPy/Tkinter/ Plotpy modules

Unit -I:

Introduction to Python: History, Features, setting up path, Working with Python Basic Syntax

Variable and Data Types, Operator. Conditional Statements (If, If- else, Nested if-else) Looping (for, While Nested loops) Control Statements (Break, Continue, Pass)

Functions: Defining a function, Calling a function, Types of functions, Function Arguments

Anonymous functions, Global and local variables

Unit-II:

String Manipulation: Accessing Strings, Basic Operations, String slices, Function and Methods

Lists: Accessing list, Operations, Working with lists Function and Methods

Tuple: Accessing tuples, Operations, Working.

Dictionaries: Accessing values in dictionaries, Working with dictionaries, Properties Functions and Methods.

Unit-III:

Modules: Importing module, Math module, Random module, Packages, Composition

Input-Output: Printing on screen, reading data from keyboard, Opening and closing file

Regular expressions: Match function, Search function, Matching VS Searching, Modifiers

Patterns.

Unit-IV:

Advance Python- OOPs concept: Class and object, Attributes, Inheritance, Overloading

Overriding, Data hiding

Exception Handling: Exception, Exception Handling, Except clause, Try, finally clause User Defined Exceptions

Unit -V:

CGI : Introduction , Architecture ,CGI environment variable, GET and POST methods

Cookies, File upload.

Python for Database: Introduction, Connections, Executing queries, Transactions Handling error Working with NumPy/ PlotPy/ SciPy/GUI Programming, Introduction, Tkinter programming, Tkinter widgets

TEXT BOOKS:

1. Think Python: How to Think Like a Computer Scientist Allen B. Downey, O'Relly publications.
2. Learning with Python by Jeffrey Elkner, Chris Meyers Allen Downey , Dreamtech Press.

REFERENCE BOOKS:

1. Introduction to Computation and Programming using Python, Revised and Expanded Edition,John V. Guttag, The MIT Press.

2. Programming Python,Fourth Edition by Mark Lutz, O'Relly
3. Python Programming using problem solving approach, Reema Thareja, Oxford Higher Education.

ANURAG UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

M.Tech(DS)

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STATISTICAL FOUNDATIONS FOR DATA SCIENCE

(PCC-III)

Course Objectives:

1. To understand the concepts of probability, notion of random variable, importance of expectations and moments.
2. In the discrete case, study the binomial and the Poisson random variables and the Normal random variable for the continuous case predominantly describe important probability distributions. Important statistical properties for these random variables provide very good insight and are essential for industrial applications.
3. To understand the importance of estimation, various methods of estimation and estimation through regression.
4. To understand the principles and various steps involved in designing and analyzing the experiments.
5. To get the knowledge on time series data and its analysis.

Course Outcomes:

The student will able to:

1. Learn the basis of probability, random variable and expectation. Also able to differentiate among many random variables involved in the probability models.
2. Identify distribution in certain realistic situation and find their characteristics.
3. Learn to estimate unknown parameter using various methods of estimation and also estimation using regression.
4. Design their experiment with the basic norms and test their design efficiency.
5. Analyze the time series data and calculate the trend and seasonal components.

Unit I:

Probability spaces, conditional probability, independence; Random variables, distribution functions, probability mass and density functions, functions of random variables, Distribution function and its properties. Bivariate distribution, joint, marginal and conditional distributions. Independence of random variables. Mathematical expectations, moments, conditional expectations, independence, covariance.

Unit-II:

Moment generating functions, characteristic function. Statement and applications of weak law of large numbers and central limit theorem. Standard univariate discrete distributions-Binomial, Poisson and Geometric and continuous distributions-Normal, Exponential, Cauchy along with their properties and real life applications.

Unit-III:

Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood, Introduction to multivariate statistical models: regression and classification problems, principal components analysis.

Unit IV:

ANOVA: Introduction to ANOVA one way and two way classification, Designs of Experiments-Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD). Factorial experiments- 2^2 and 2^3 designs.

Unit V:

Time series: Utility of Time Series, Components, Real life Applications, Measurement of Trend through Method of Least Squares, Moving averages, and Graphical methods, Measurement of seasonal variations-Simple Average method, Ratio to Trend method, Ratio to Moving average method and Link relative method.

TEXT BOOKS:

1. R. V. Hogg, J. W. McKean and A. Craig, Introduction to Mathematical Statistics, 6th Ed., Pearson Education India.
2. Fundamentals of Applied Statistics by S.C Gupta and V.K Kapoor Sultan Chand & Sons.

REFERENCES:

1. Probability and Statistics for Engineers and Scientists by Sheldon M. Ross, Academic Press.
2. Miller and John E. Freund, Probability & Statistics for Engineers, Prentice Hall of India.
3. Montgomery: Design and Analysis of Experiments, Wiley

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INFORMATION RETRIEVAL SYSTEMS

(PEC-I)

Course Objectives:

1. To introduce the fundamental issues of information retrieval with theoretical foundations.

Course Outcomes: At the end of the course the student will be able to understand

1. indexing and querying in information retrieval systems
2. the different models for information retrieval
3. text classification and clustering
4. web searching

Unit-I

Boolean retrieval: An example information, Building an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval.

The term vocabulary and postings lists: Document delineation and character sequence decoding, Determining the vocabulary of terms, Faster postings list intersection via skip pointers, Positional postings and phrase queries.

Dictionaries and tolerant retrieval: Search structures for dictionaries, Wildcard queries, Spelling correction. Index construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Other types of indexes.

Unit-II

Index compression: Statistical properties of terms in information retrieval, Dictionary compression, Postings file compression.

Scoring, term weighting and the vector space model: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, Variant tf-idf functions.

Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction.

Evaluation in information retrieval: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance.

Unit-III

Relevance feedback and query expansion: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation.

XML retrieval: Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. data-centric XML retrieval.

Probabilistic information retrieval: Basic probability theory, The Probability Ranking Principle, The Binary Independence Model.

Language models for information retrieval: Language models, The query likelihood model.

Unit-IV

Text classification and Naive Bayes: The text classification problem, Naive Bayes text classification, The Bernoulli model, Properties of Naive Bayes, Feature selection.

Vector space classification: Document representations and measures of relatedness in vector spaces, Rocchio classification, k nearest neighbour, Linear versus nonlinear classifiers.

Flat clustering: Clustering in information retrieval, Problem statement, Evaluation of clustering, k-means.

Hierarchical clustering: Hierarchical agglomerative clustering, Single-link and complete-link clustering, Group-average agglomerative clustering, Centroid clustering, Divisive clustering.

Unit-V

Matrix decompositions and latent semantic indexing: Linear algebra review, Term-document matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing.

Web search basics: Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling.

Web crawling and indexes: Overview, Crawling, Distributing indexes, Connectivity servers.

Link analysis: The Web as a graph, PageRank, Hubs and Authorities.

TEXT BOOK:

2. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, *An Introduction to Information Retrieval*, Cambridge University Press, Cambridge, England, 2008

REFERENCE BOOKS:

1. David A. Grossman, Ophir Frieder, *Information Retrieval – Algorithms and Heuristics*, Springer, 2nd Edition (Distributed by Universities Press), 2004.
2. Gerald J Kowalski, Mark T Maybury. *Information Storage and Retrieval Systems,* Springer, 2000
3. Soumen Chakrabarti, *Mining the Web : Discovering Knowledge from Hypertext Data*, Morgan-Kaufmann Publishers, 2002

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M.Tech (DS)

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OBJECT ORIENTED PROGRAMMING (JAVA)

(PEC-I)

Prerequisites: Object Oriented Programming

Course Objectives:

1. Understand the concept of OOP and learn the basic syntax and semantics of the Java language and programming environment
2. Be familiar with the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
3. Understand Exceptional handling and multithreading concepts
4. Be familiar with GUI applications.

Course Outcomes:

At the end of the course the students will be able to:

1. Understand the Object Oriented Programming concepts
2. Design programs using package and interfaces.
3. Apply the concepts of Exceptions and multithreading.
4. Develop GUI applications and AWT using Frames .
5. Design the programs using Applet and JDBC Concepts.

UNIT -I

Java Basics: History of Java, Java buzzwords, data types, variables, scope and life time of variables, arrays, operators, expressions, control statements, type conversion and costing, simple java program, concepts of classes, objects, constructors, methods, access control, this keyword, static keyword, garbage collection, overloading methods and constructors, parameter passing, recursion, nested and inner classes, Strings.

UNIT- II

Inheritance –Introduction, forms of inheritance- specialization, specification, construction, extension, limitation, combination, Member access rules, super uses, using final with inheritance

Polymorphism- method overriding, abstract classes, Object class Packages and Interfaces : Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, differences between classes and interfaces, File, Byte Streams, Character Streams.

UNIT- III

Exception handling - Concepts of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes. Package java.util- The Collection Interface, list interface, Queue interface, The Collection class: LinkedListClass, HashSetClass. TreeSetClass, StringTokenizer, Date, Random, Scanner.

Multi threading: Differences between multi threading and multitasking, thread life cycle, creating threads, thread priorities, synchronizing threads, inter thread communication.

UNIT- IV

Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes.

AWT: class hierarchy, component, container, panel, window, frame, graphics class, Layout Manager – layout manager types – boarder, grid, flow, card and grib bag.

UNIT- V

AWT controls: Labels, button, scrollbars, text components, check box, check box groups, choices, menu bar.

Applets – Concepts of Applets, differences between applets and applications, life cycle of an applet, create applets, passing parameters to applets.

JDBC Connectivity: JDBC Type 1 to 4 Drivers, connection establishment, QueryExecution.

TEXT BOOKS:

1. Java- The Complete Reference, Seventh Edition, Herbert Schildt, Tata McGraw Hill, Year of Publication:2017
2. Database Programming with JDBC&JAVA, Second Edition,GeorgeReese, O'ReillyMedia, Year of Publication:2009

REFERENCE BOOKS:

1. Understanding OOP with Java, updated edition, T. Budd, Pearson Education.
2. Thinking in Java Fourth Edition, Bruce Eckel
3. Introduction to Java programming, Y. Daniel Liang, Pearson Education

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DIGITAL IMAGE PROCESSING

(PEC-I)

Prerequisites: Mathematics

Course Objectives:

4. Comprehend fundamental aspects of digital image processing
5. Understand the image noise models and enhancement methods
6. Evaluate the image segmentation methodologies
7. Understand the colour image processing techniques
8. Understand image morphological operations

Course Outcomes:

At the end of the course the students will be able to:

6. Understand the fundamental concepts of digital image processing system.
7. Analyze the image noise models and enhancement techniques.
8. Comprehend the different image segmentation and restoration methodologies.
9. Analyze the concepts of colour image processing.
10. Apply morphological operations on binary images.

UNIT-I:

Introduction: Definition, Pixel, Digital image representation, Types of images, Fundamental steps in image processing, image processing applications. Digital image processing operations – Basic relationships and distance metrics, Classification of image processing operations- Arithmetic operations, Logical operations.

UNIT – II:

Image Enhancement and Restoration – Image quality and Need for image enhancement, image enhancement point operations, Histogram based techniques.

Categories of Image Degradations- Image Restoration in the presence of noise only- Mean filters, order statistics filters.

UNIT-III:

Image Segmentation: Introduction, classification of image segmentation algorithms, detection of discontinuities, edge detection- stages in edge detection, types of edge detectors, First-order edge detection operators, second-order derivatives filters, edge operator performance, edge linking algorithms, principle of thresholding.

UNIT –IV:

Colour image processing: introduction, devices of colour imaging, colour image storage and processing, colour models-RGB Colour Model, HSI Colour Models, HSV Colour Model, Colour Quantization, Image filters for colour images.

UNIT –V:

Image Morphology: Need for morphological processing Morphological operators: Erosion, Dilation, Opening & Closing, Hit-or-Miss transform, Basic morphological algorithms, Gray-scale morphology

TEXT BOOKS:

1. S. Sridhar, Digital Image Processing, Oxford University Press, 2nd edition 2016.
2. D. Forsyth and J. Ponce, Computer Vision: A Modern Approach, Prentice Hall, 2nd Edition, 2015.
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.
4. Gonzalez R.C., Woods R.E, Digital image processing, Pearson, Prentice-Hall of India Pvt.Ltd. New Delhi, 3rd Edition, 2018
5. Jan Erik Solem, Programming Computer Vision with Python, O'Reilly ,1st Edition, 2012

REFERENCES:

4. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine Vision, 4th Edition, Cengage Learning, 2013
5. Fundamentals of Digital Image Processing, by Anil K. Jain, Prentice- Hall of India Pvt. Ltd, New Delhi, 2002
6. Prince, Simon JD. Computer Vision: Models, Learning and Inference, Cambridge University Press, 1st Edition, 2012.

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CLOUD COMPUTING

(PEC-I)

Prerequisites: Computer organization and computer networks.

Course Objectives:

4. To understand the concepts of virtualization and its benefits
5. To impart fundamental concepts in the area of cloud computing.
6. To impart knowledge in applications of cloud computing.
7. To understand various services in cloud applications
8. To know the architecture of disaster recovery and security of cloud

Course Outcomes:

At the end of the course the students will be able to:

6. Compare and contrast various cloud architectures. (L4)
7. Learn & Implement Virtualization .(L3)
8. Analyze and design storage mechanisms. (L4)
9. Apply security mechanism for the Cloud. (L3)
10. Discuss Disaster recovery in Cloud .(L5)

Unit I:

Introduction to Virtualization: Objectives of virtualization, history of virtualization, benefits of virtualized technology, the virtual service desk, what can be virtualized, related forms of computing, cloud computing, software as a service – SaaS, grid computing, utility computing, virtualization processes.

Virtualization Technologies-I: Ubuntu (server edition),Altiris, Windows server, Software virtualization, VMware, Intel virtualization, Red Hat virtualization, Soft grid application, Linux virtualization, Desktop virtualization, Hardware virtualization, Resource virtualization, Processor virtualization, Application virtualization.

Unit II:

Virtualization Technologies-II: Storage virtualization, Virtualization density, Para-virtualization, OS virtualization, Virtualization software, Data Storage virtualization, Intel virtualization technology, Thinstall virtualization suite, Net framework virtualization, Windows virtualization on Fedora, Storage virtualization technologies, Virtualization level, Security monitoring and virtualization, Oracle virtualization.

Unit III:

Virtualization and Storage Management: The heart of cloud computing-virtualization, defining virtualization, why virtualize, what can be virtualized, where does virtualization happen, how does virtualization happen, on the road to storage virtualization, improving availability using virtualization, improving performance through virtualization, improving capacity through virtualization, business value for virtualization.

Unit IV:

Introduction to Cloud Computing: Cloud Introduction and overview- Components, Infrastructure and Services, Why Use Cloud Computing, Benefits and Limitations, Cloud Application Architectures, Cloud Infrastructure Models, Cloud Computing Technology- Hardware & Software Infrastructure

Cloud Computing Architecture: Requirements, Introduction to Cloud Computing Architecture, various kinds of Cloud Computing Architecture, Grid Computing, Transactional Computing, On Demand Computing, and Distributed Computing.

Unit V:

Security: Security issues in Cloud Computing - Data Security, Network Security, and Host Security

Disaster Recovery: Disaster Recovery Planning, Disasters in the Cloud, Disaster Management.

Scaling a Cloud Infrastructure- Capacity Planning, Cloud Scale.

Case Studies: Amazon S3, Google APP Engine, IBM Clouds, Oracle OBIEE

TEXT BOOKS:

7. Ivanka Menken, Gerard Blokdijk ,Cloud Computing Virtualization Specialist Complete Certification Kit - Study Guide Book, 2009.
3. George Reese, Cloud Application Architectures Building Applications and Infrastructure in the Cloud, O'Reilly Media Press, 2009.

REFERENCE BOOKS:

4. Anthony T. Velte, Tobe J. Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Publication Person Education, 2009
5. Tom Clark, Storage Virtualization: Technologies for Simplifying Data Storage and Management, Addison-Wesley, 2005
6. Curtis Brian J.S. Chee, Cloud Computing Technologies and Strategies of the Ubiquitous Datacenter, 2010

WEB RESOURCE:

2. https://bibliotech2803.files.wordpress.com/2018/04/cloud-application-architectures-oreilly-media.pdf

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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

M.Tech (DS)

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INFORMATION SECURITY

(PEC-I)

Course Objectives

1. Describe the basic concepts of risk management.
2. Compare and analyze encryption Algorithms
3. Summarize Authentication Functions using MAC and Hash
4. Analyze security importance of various web Applications
5. Categorize various types of Intruders and Viruses

Course Outcomes

6. Identify and explain the basic concepts of risk management.
7. Compare various encryption Algorithms.
8. Summarize authentication functions using MAC and Hash
9. Outline security importance of various web applications.
10. Categorize various types of intruders and viruses.

Unit I:

Information Security: Key Information Security Concepts; *Overview of Risk Management:* Know Yourself; Know the Enemy, Risk Identification, Risk Assessment, Risk Control Strategies; *Contingency Planning and Its Components:* Business Impact Analysis, Incident Response Plan, Disaster Recovery Plan, and Business Continuity Plan.

Planning for Organizational Readiness: Beginning the Contingency Planning Process, Elements Required to Begin Contingency Planning, Contingency Planning Policy, Business Impact Analysis, BIA Data Collection, Budgeting for Contingency Operations.

Unit II:

Cryptography: Concepts and Techniques, symmetric and asymmetric key cryptography, steganography, Symmetric key Ciphers: DES structure, DES Analysis, Security of DES, variants of DES, Block cipher modes of operation , AES structure, Analysis of AES , Key distribution Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Analysis of RSA, Diffie-Hellman Key exchange.

Unit III:

Message Authentication and Hash Functions: Authentication requirements and functions, MAC and Hash Functions, MAC Algorithms: Secure Hash Algorithm, Whirlpool, HMAC, Digital signatures, X.509, Kerberos.

Unit IV

Security at layers (Network, Transport, Application): IPSec, Secure Socket Layer(SSL), Transport Layer Security(TLS), Secure Electronic Transaction(SET), Pretty Good Privacy(PGP), S/MIME.

Unit V

Intrusion Detection and Prevention

Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider,

Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware

software, Network based Intrusion detection Systems, Network based Intrusion

Prevention Systems, Host based Intrusion prevention Systems, Security Information

Management, Network Session Analysis, System Integrity Validation.

Overview of Firewalls- Types of Firewalls, User Management and VPN Security.

TEXT BOOKS:

1. Principles of Incident Response and Disaster Recovery, Whitman & Mattord, Course Technology ISBN: 141883663X.
2. William Stallings, Cryptography and Network Security, Pearson Education,4th Edition

REFERENCE BOOKS:

1. C K Shyamala, N Harini, Dr T R Padmanabhan, Cryptography and Network Security : Wiley India, 1st Edition.
2. Bernard Menezes, Network Security and Cryptography: CENGAGE Learning
3. AtulKahate, Cryptography and Network Security: McGraw Hill, 2nd Edition

REFERENCE LINKS:

1. http://www.cs.iit.edu/~cs549/cs549s07/lectures.htm
2. http://williamstallings.com/Extras/Security-Notes/
3. http://williamstallings.com/NetworkSecurity/styled/

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M.Tech (DS)

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ARTIFICIAL INTELLIGENCE

(PEC-II)

Pre-requisite: Programming Knowledge, Computer Organization

Course Objectives:

1. The main objective of this course is to introduce the basic concepts of artificial intelligence, its foundations
2. To analyze various search strategies in intelligent systems
3. To apply search algorithms in games
4. To learn various representations of logic and knowledge
5. To understand production systems and its components

Course Outcomes:

1. At the end of this course, students will be able to:
2. Understand Strong AI and Weak AI and identify problems applicable to AI
3. Compare and contrast various uninformed and informed search algorithms to find an optimal solution for a given problem
4. Apply appropriate search algorithms for winning games
5. Learn various representations applicable to logic and knowledge useful in reasoning
6. Learn to apply appropriate inference methods in production or expert systems

Unit I: Overview of Artificial Intelligence: Introduction. The Turing Test, Strong AI versus Weak AI, Heuristics, Identifying Problems Suitable for AI, Applications and Methods, Early History of AI, Recent History of AI to the Present, AI In the New Millennium

Unit II : Uninformed Search: Introduction: Search in Intelligent Systems, State-Space Graphs, Generate-and-Test Paradigm, Blind Search Algorithms, Implementing and Comparing Blind Search Algorithms **Informed Search:** Introduction, Heuristics, Informed Search Algorithms – Finding Any Solution, The Best-First Search, The Beam Search, Additional Metrics for Search Algorithms, Informed Search – Finding An Optimal Solution,

Unit III: Search Using Games: Introduction, Game Trees and Minimax Evaluation, Minimax With Alpha-Beta Pruning, Variations and Improvements To Minimax, Games of Chance and the Expectiminimax Algorithm

Unit IV: Logic in Artificial Intelligence: Introduction, Logic and Representation, PropositionalLogic, Predicate Logic – Introduction, Several Other Logics, Uncertainty and Probability **Knowledge Representation:** Introduction, Graphical Sketches and the Human Window, Graphsand the Bridges of Königsberg Problem, Search Trees, Representational Choices, ProductionSystems, Object Orientation, Frames, Semantic Networks

Unit V: Production Systems: Introduction, Background, Production Systems and Inference Methods, Production Systems and Cellular Automata, Stochastic Processes and Markov Chains, Basic Features and Examples of Expert Systems

TEXT BOOKS:

1. Stephen Lucci, Danny Kopec. Artificial Intelligence in the 21st Century. A Living Introduction. Mercury Learning and Information. 2nd Edition. 2016

REFERENCE BOOKS:

1. Russell, Norvig: Artificial Intelligence, A Modern Approach, Pearson Education, Second Edition. 2004
2. Rich, Knight, Nair: Artificial Intelligence, Tata McGraw Hill, Third Edition 2009
3. Saroj Kaushik. Artificial Intelligence. Cengage Learning. 2011

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ADVANCED DATABASE MANGEMENT SYSTEMS

(PEC-II)

Prerequisites: DBMS

Course Objectives:

1. To provide a sound introduction to Database management systems, databases and its applications and familiarize the student to give a good formal foundation on the relational model of data
2. To Introduce SQL for storing and retrieving databases
3. To give an introduction to systematic database design approaches concepts of transactions and transaction processing and the issues, techniques related to concurrency and recovery manager.
4. To Explore the File organizations, indexing and hashing mechanisms
5. To Explain the concepts of Distributed Database Management System

Course Outcomes:

1. Model Entity-Relationship diagrams for enterprise level databases (L3)
2. Formulate optimized Queries using SQL and Relational Formal Query Languages (L3)
3. Apply Various Normal forms for schema refinement and Differentiate serial and concurrent transaction and various concurrency control protocols algorithms (L4)
4. Use of suitable File organization, Indices and Hashing mechanisms for effective storage and retrieval of Data (L3)
5. Identify the features and advantages of Distributed Databases over centralized databases

UNIT I:

Introduction to Database System Concepts: Database-System Applications, Purpose of Database Systems, View of Data, Database Language, Database Design, Database Architecture, Database Users and Administrators.

Introduction to the Relation Models and Database Design using ER Model: Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Languages, Relational Operations Overview of the Design Process, The Entity-Relationship Model, Constraints, Entity-Relationship Diagrams- Unary, Binary, ternary, Aggregation.

UNIT II:

Introduction to SQL : Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Aggregate Functions, Nested Sub queries.

Formal Relational Query Languages & Query Optimization: The Relational Algebra, Tuple Relational Calculus. Algorithm for Executing Query Operations: Select operation, Join operation, Project and set operation, Aggregate operations, Outer join, Heuristics in Query Optimization, Semantic Query Optimization.

UNIT III:

Relational Database Design: Features of Good Relational Designs, Atomic Domains and First Normal Form, Functional Dependencies, Closure set of Functional dependencies, Procedure for Computing F^{+}, Boyce Codd Normal form, BCNF Decomposition Algorithm, Third Normal Form, Third Normal Form Decomposition Algorithm

Transactions & Concurrency Control: Transaction Concept, a Simple Transaction Model, Storage Structure, Transaction Atomicity and Durability, Serializability. Lock-Based Protocols, Deadlock Handling, Multiple Granularity, Timestamp-Based Protocols.

UNIT IV:

File Organization: Fixed and variable length records, Sequential file organization, Data Dictionary, Buffer manager.

Indexing and Hashing: Basic Concepts, Ordered Indices, B+-Tree Index Files, B+-Tree Extensions, Multiple-Key Access, Static Hashing, Extendible Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices.

UNIT V:

Distributed Database, Introduction of DDB, DDBMS architectures, Homogeneous and Heterogeneous databases, Distributed data storage, Advantages of Data Distribution, Disadvantages of Data Distribution Distributed transactions, Commit protocols, Availability, Concurrency control & recovery in distributed databases, Directory systems, Data Replication, Data Fragmentation. Distributed database transparency features, distribution transparency.

TEXT BOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, Sixth Edition, Tata McGraw-Hill 2006.

REFERENCE BOOKS:

1. Raghu Rama Kirshna, Johannes Gchrke, Database Management System, Third Edition, TATA MC Graw Hill, 2003.
2. C J Date, AKannan, S Swamynathan, An Introduction to Database Systems, eigth Edition Pearson 2006
3. Tamer Ozsu.Patrick Valdureiz , Principles of Distributed Database Systems , Third Edition,Springer

4. P Raja Sekhar Reddy, A MallikarjunaReddy ,Foundations of Database Management Systems ,Lambert Academic Publishing, 2020 (e-Book) (https://www.pdfdrive.com/fundamentals-of-database-systems-pdf-e51477130.html)

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NATURAL LANGUAGE PROCESSING

(PEC-II)

Prerequisites: Artificial Intelligence, Machine Learning, Python Programming

Course Objectives:

1. To learn the fundamentals of Natural Language Processing
2. To understand the use of CFG and PCFG in NLP
3. To understand the role of semantics of sentences and pragmatics
4. To apply the NLP techniques to IR applications

Course outcomes:

1. To model the language using N-grams.
2. To implement a shallow processing models to tackle morphology/syntax of a language.
3. To Examine Syntagmatic and Paradigmatic relations be used for processing the real-time applications.
4. To apply the algorithms for Discourse Analysis.

UNIT I:

Introduction : Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Text Normalization, Minimum Edit Distance, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors

UNIT II:

Word Level Analysis : Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

UNIT III:

Syntactic Analysis: Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures.

UNIT IV:

Semantics And Pragmatics : Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

UNIT V:

Discourse Analysis And Lexical Resources: Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).

TEXT BOOKS:

1. Daniel Jurafsky, James H. Martin ,"Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", Pearson Publication, 2014.
2. Deepti Chopra, Nisheeth Joshi, Iti Mathur "Mastering Natural Language Processing with Python" First Edition, Packt Publishing, 2016

REFERENCE BOOKS:

1. James Allen, "Natural Language Understanding", 2nd Edition, Benjamin, Cummings publishing company, 1995.
2. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python" , First Edition, OReilly Media, 2009
3. Rajesh Arumugam, Rajalingappaa Shanmugamani, "Hands-On Natural Language Processing with Python" , Packt Publishing Ltd., 2018
4. http://www.pdfdrive.com/natural-language-processing-with-python-e1251452.html
5. https://learning.oreilly.com/library/view/hands-on-natural-language/9781789139495

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INTRODUCTION TO INTERNET OF THINGS

(PEC-II)

Pre-requisites: Computer Networks, Python Programming

Course Objectives:

1. Describe IoT and its working
2. Understand IoT Applications
3. Develop an IoT Application using Raspberry Pi Board
4. Design an IoT Application using Arduino Board
5. Understand different areas of robotics

Course Outcomes:

At the end of the course student will be able to:

6. Summarize the concepts of Internet of Things (L2)
7. Interpret Domain specific Internet of Things Applications (L2)
8. Develop programs for interfacing using Raspberry Pi (L6)
9. Design basic IoT applications using Arduino (L6)
10. Recite the fundamentals of Robotics (L1)

UNIT - I

Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs.

UNIT – II

Domain specific applications of IoT: Home automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and lifestyle.

UNIT - III

IoT Physical Devices and Endpoints: Introduction to Raspberry Pi-Interfaces (serial, SPI, I2C), Programming Raspberry PI with Python- Controlling LED with Raspberry PI, interfacing an LED and Switch with Raspberry PI and Interfacing a light sensor (LDR) with Raspberry PI.

UNIT - IV

Programming Arduino: Introduction, Arduino Boards, Programming-variables, if, loops, functions, digital inputs and outputs, the serial monitor, arrays and strings, analog inputs and outputs, using libraries, Arduino data types and commands. Programming Arduino Uno with Arduino- Controlling LED with Arduino, interfacing an LED and Switch with Arduino and Interfacing a light sensor (LDR) with Arduino.

UNIT - V

Introduction to Robotics: Classification, Advantages and Disadvantages, Components, Robot Joints, Robot Coordinates, Characteristics, Applications. Robotics Kinematics-Matrix representations. Actuators-Characteristics, Types of Actuators. Sensors-characteristics, types of sensors. (10 hours) Academic Project Work Submission using the Above Concepts.

TEXT BOOKS:

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things - A Hands-on Approach, Universities Press, 2015.
2. Simon Monk, Programming Arduino Next Steps: Going Further with Sketches, Second Edition, 2019.
3. Saeed B. Niku, Introduction to Robotics Analysis, Application, Pearson Education Asia, 2001.

REFERENCE BOOKS:

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).
2. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O’Reilly (SPD), 2014.

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RESEARCH METHODOLOGY

(PCC-II)

Course Objectives: The objectives of this course are to:

1. Understand the research problem
2. Know the process of literature survey, plagiarism check and ethical means of doing research
3. Get the knowledge about technical report writing
4. Create the awareness about the intellectual property rights
5. Know about the patent procedures

Course Outcomes: At the end of this course, students will be able to**:**

1. Formulate the research problem
2. Analyze research related information by following research ethics
3. Convert a technical paper into a research proposal by incorporating new ideas or concepts
4. Develop patent from the obtained research outcome
5. Protect the research output for further development in the area chosen though ipr

Unit I: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit II: Effective literature studies approaches, analysis Plagiarism, Research ethics

Unit III: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit IV: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

Unit V: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

REFERENCE BOOKS:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007
3. Mayall , "Industrial Design", McGraw Hill, 1992
4. Niebel , "Product Design", McGraw Hill, 1974
5. Asimov, "Introduction to Design", Prentice Hall, 1962
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016

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MACHINE LEARNING LAB

(PCC-I LAB)

Objective:

The main objective of this laboratory is to put into practice the various machine learning algorithms for data analysis using Python and Weka.

ML Toolkits

Students are expected to learn

1. Scikit-learn(https://scikit-learn.org/) an open source machine learning Python library that supports supervised and unsupervised learning. It also provides various tools for model fitting, data preprocessing, model selection and evaluation, and many other utilities.
2. Weka (http://www.cs.waikato.ac.nz/ml/weka/)is another widely used ML toolkit.

Datasets

1. The sklearn.datasets package embeds small toy datasets. It includes utilities to load these datasets. It also includes methods to load and fetch popular reference datasets and features some artificial data generators. Students are expected to study and make use of these datasets
2. Weka also has provides various data sets.

References:

1. scikit-learn user guide.https://scikit-learn.org/stable//_downloads/scikit-learn-docs.pdf
2. Ian Witten, Eibe Frank, and Mark Hall, Chris Pal. DATA MINING: Practical Machine Learning Tools and Techniques, 4th Edition. Morgan Kaufmann.

Exercises

Week 1:

Write a Python program using Scikit-learn to split the iris dataset into 70% train data and 30% test data. Out of total 150 records, the training set will contain 120 records and the test set contains 30 of those records. Print both datasets

Week 2:

Write Python program to use sklearn'sDecisionTreeClassifier to build a decision tree for the sklearn's datasets. Implement functions to find the importance of a split (entropy, information gain, gini measure)

Week 3:

Write a Python program to implement your own version of the K-means algorithm. Then apply it to different datasets and evaluate the performance.

Week 4:

Design a perceptron classifier to classify handwritten numerical digits (0-9). Implement using scikit or Weka.

Week 5:

Write a Python program to classify text as spam or not spam using the Naïve Bayes Classifier

Week 6:

Use WEKA and experiment with the following classifiers: Association Rule Mining (Apriori), Agglomerative and Divisive Clustering.

Week 7:

Comparative Study of K-Means and MiniBatch Kmeans Clustering Algorithms.

Week 8:

Model Section with Principal component analysis.

Week 9-16:

Study projects on Machine Learning Algorithms. Decide groups (3 members). Submission of abstract, introduction, related work and progress review, Final report and final presentations.

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PYTHON PROGRAMMING LAB

(PCC -II LAB)

Week-1:

Installation and Environment set up of Python & Programs on Data types, Operators

Week-2:

Programs on Standard I/O, String, Files, List, Tuple

Week-3:

Programs on Dictionaries

Week-4:

Programs on Control Statement

Week-5:

Programs on Functions

Week-6:

Programs on Strings and string operations

Week-7:

Programs on Regular Expressions.

Week-8:

Programs on Inheritance and overloading

Programs **Week-9:**

on Exception Handling

Week-10:

Programs on Python Additional Concepts: Email and Web Programming

Week-11:

Programs on Python Libraries

Week-12:

Implementation of different application based on python programming.

Week-13:

Demonstration of Date and Time Packages

Week-14: Overview

Week-15: Overview

TEXT BOOKS:

1. Beginning Python: using python 2.6 and Python 3.1, by James Payne, wiley Publication
2. Learning Python, 5th edition, O'reilly Publication

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BIG DATA ANALYTICS

(PCC-IV)

Prerequisites: Database management system, Java and Linux

Course Objectives:

1. To understand about Big Data and Analytics.
2. To learn the tools for Big Data Analytics.
3. To Understand Hadoop Fundamentals
4. To Understand the MapReduce and Hbase.
5. To learn Social and Mobile Analytics.

Course Outcomes:

After the completion of course students will be able to:

1. Identify need of Big Data and Analytics
2. Identify various Data Analytics Tools
3. Analyze components of HDFS
4. Apply several data intensive tasks using Map-Reduce paradigm
5. Demonstrate the applications of Social and Mobile Analytics

UNIT – I

Big Data Analytics: What is big data, Evolution of Big Data; Structuring Big Data; Characteristics of Big Data; What is Big Data Analytics, What Big Data Analytics Isn't, Why this sudden Hype Around Big Data Analytics, Greatest Challenges that Prevent Business from Capitalizing Big Data; Top Challenges Facing Big Data; Why Big Data Analytics Important; Data Science; Data Scientist; Terminologies used in Big Data Environments; Basically Available Soft State Eventual Consistency (BASE);

UNIT – II

Understanding Analytics and Big Data: Comparing Reporting and Analysis, Types of Analytics; Developing an Analytic Team; Understanding Text Analytics;

Analytical Approach and Tools to Analyze Data: Analytical Approaches; Introducing Popular Analytical Tools; Comparing Various Analytical Tools.

UNIT - III

Big Data Technology Landscape and Hadoop: Hadoop; RDBMS versus Hadoop; History of Hadoop; Hadoop Overview; Hadoop Distributors, Processing of Data with Hadoop;

Storing Data in Hadoop: Introduction of HDFS, Architecture, HDFS (Hadoop Distributed File System), HDFS Daemons, read, write, Replica, HDFS Files, File system types, commands, org.apache.hadoop.io package, HDFS High Availability.

UNIT – IV

Understanding MapReduce Fundamentals and HBase: The MapReduce Framework; Techniques to Optimize MapReduce Jobs; Uses of MapReduce; Role of HBase in Big Data Processing;

Introducing HBase: Architecture, Storing Big Data with HBase, Interacting with the Hadoop Ecosystem; HBase in Operations Programming with HBase; Combining HBase and HDFS;

UNIT - V

Social Media Analytics and Text Mining: Introducing Social Media; Key elements of Social Media; Text mining; Understanding Text Mining Process; Sentiment Analysis, Performing Social Media Analytics and Opinion Mining on Tweets;

Mobile Analytics: Introducing Mobile Analytics; Define Mobile Analytics; Mobile Analytics and Web Analytics; Types of Results from Mobile Analytics; Types of Applications for Mobile Analytics; Introducing Mobile Analytics Tools;

TEXT BOOKS:

1. BIG DATA and ANALYTICS, Seema Acharya, Subhasinin Chellappan, Wiley publications.
2. BIG DATA, Black Book TM, DreamTech Press, 2015 Edition.
3. BUSINESS ANALYTICS 5e, BY Albright |Winston

REFERENCE BOOKS:

1. Rajiv Sabherwal, Irma Becerra- Fernandez,” Business Intelligence –Practice, Technologies and Management”, John Wiley 2011.
2. Lariss T. Moss,ShakuAtre, “ Business Intelligence Roadmap”, Addison-Wesley It Service.

3. Yuli Vasiliev, “Oracle Business Intelligence: The Condensed Guide to Analysis and Reporting”, SPD Shroff, 2012.

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DATA WRANGLING & VISUALIZATION

(PCC-V)

Course Objectives:

11. To introduce the basic concepts of data wrangling using Python
12. To obtain the input data from a variety of sources
13. To extract the data and convert it into representations suitable for data analytics
14. To visualize the data

Course Outcomes: At the end of this course, students will be able to:

1. Use the pandas library
2. Load, store data in different file formats
3. Clean and prepare the data
4. Plot and Visualize data
5. Do data aggregation

UNIT-I

Getting started with pandas: Introduction to pandas Data Structures, Series, Data Frame, Index Objects. Data Loading, Storage, and File Formats: Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data to Text Format, Working with Delimited Formats, JSON Data

UNIT-II

Data Loading, Storage, and File Formats: XML and HTML: Web Scraping, Binary Data Formats: Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Web APIs, Interacting with Databases

UNIT-III

Data Cleaning and Preparation: Handling Missing Data, Filtering Out Missing Data, Filling In Missing Data, Data Transformation, Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers, String Manipulation, String Object Methods, Regular Expressions

UNIT-IV

Plotting and Visualization: A Brief matplotlib API Primer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot, Saving Plots to File, matplotlib Configuration, Plotting with pandas and seaborn, Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots, Facet Grids and Categorical Data, Other Python Visualization Tools, Conclusion

UNIT-V

Data Aggregation and Group Operations: GroupBy Mechanics, Iterating Over Groups, Selecting a Column or Subset of Columns, Grouping with Dicts and Series, Grouping with Functions, Grouping by Index Levels, Data Aggregation, Column-Wise and Multiple Function Application, Returning Aggregated Data Without Row Indexes, Pivot Tables and Cross-Tabulation

TEXT BOOKS:

5. Wes McKinney. Python for Data Analysis: Data Wrangling with pandas, NumPy and IPython. O'Reilly, 2017, 2nd Edition

6. Jacqueline Kazil and Katharine Jarmul. Data Wrangling with Python. O'Reilly, 2016

REFERENCE BOOKS:

9. Data Science Essentials in Python: Collect, Organize, Explore, Predict, Value. Dmitry Zinoriev, The Pragmatic Programmers LLC, 2016

10. TyeRattenbury, Joseph M. Hellerstein, Jeffrey Heer, Sean Kandel, and Connor Carreras. Principles of Data Wrangling: Practical Techniques for Data Preparation. O'Reilly, 2017

11. Python Data Analytics – Data Analysis and Science using Pandas, matplotlib and the Python Programming Language. Fabio Nelli, Apress, 2015

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SENTIMENT ANALYSIS

(PEC-III)

Pre-requisites: Data mining, Natural Language Processing

Course Objectives:

1. To learn the fundamentals of Sentiment analysis and Opinion Mining
2. To understand the use of Sentiment analysis.
3. To understand the role of Sentiment analysis and Opinion Mining
4. To apply the Sentiment analysis in applications

Course Outcomes:

1. To apply the Sentiment analysis for **Document** level analysis (L3)
2. To model the Sentiment analysis (L3)
3. To implement a shallow processing models to tackle morphology/syntax of a language (L3)
4. To Examine Syntagmatic and Paradigmatic relations be used for processing the real-time applications (L4)
5. To apply the algorithms for Sentiment Analysis (L3)

Unit I

Introduction: What is Sentiment analysis, Types of Sentiment Analysis, Why Is Sentiment Analysis Important, Many Facets of Sentiment Analysis, Affective Computing and Sentiment Analysis Sentiment Analysis Applications, Different Levels of Analysis, Sentiment Lexicon and Its Issues, Natural Language Processing Issues, Opinion Spam Detection.

The Problem of Sentiment Analysis: Opinion Definition, Sentiment Analysis Tasks, Opinion Summarization, Opinion Summarization, Opinion Summarization.

Unit II

Document Sentiment Classification: Sentiment Classification Using Supervised Learning, Sentiment Classification Using Unsupervised Learning, Sentiment Rating Prediction Cross-Domain Sentiment Classification, Cross-Language Sentiment Classification.

Sentence Subjectivity and Sentiment Classification: Subjectivity Classification, Sentence Sentiment Classification,4.3 Dealing with Conditional Sentences, Dealing with Sarcastic Sentences, Cross-language Subjectivity and Sentiment Classification, Using Discourse Information for Sentiment Classification.

Unit III:

Aspect-based Sentiment Analysis: Aspect Sentiment Classification, Basic Rules of Opinions and Compositional Semantics. Aspect Extraction, Identifying Resource Usage Aspect, Simutaneous Opinion Lexicon Expansion and Aspect Extraction, Grouping Aspects into Categories, Entity, Opinion Holder and Time Extraction, Coreference Resolution and Word Sense Disambiguation.

Unit IV: Sentiment Lexicon Generation: Dictionary-based Approach, Corpus-based Approach

Desirable and Undesirable Facts.

Opinion Summarization: Aspect-based Opinion Summarization, Improvements to Aspect-based Opinion Summarization, Contrastive View Summarization, Traditional Summarization, Analysis of Comparative Opinions.

Unit V: Opinion Search and Retrieval: Web Search vs. Opinion Search, Existing Opinion Retrieval Techniques.

Opinion Spam Detection: Types of Spam and Spamming, Harmful Fake Reviews, Individual and Group Spamming, Types of Data, Features and Detection, Supervised Spam Detection, Unsupervised pam Detection, Spam Detection based on Atypical Behaviours, Spam Detection Using Review Graph, Group Spam Detection.

TEXT BOOKS:

1. Bing Liu. *Sentiment Analysis and Opinion Mining*, Morgan & Claypool Publishers, May 2012.
2. Eric Cambria, Dipankar Das, Sivaji Bandyopadhyay, Antonia feraco. A Practical guide to Sentiment Analysis

REFERENCE BOOKS:

1. Liu, Bing. Sentiment Analysis: Mining Opinions, Sentiments, And Emotions, Cambridge University Press.
2. Basant Agarwal, Richi Nayak, Namita Mittal, Srikanth Patnaik Deep Learning-Based Approaches for Sentiment Analysis (Algorithms for Intelligent Systems), 1st ed. 2020 Edition

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TEXT MINING

(PEC-III)

Course Objectives:

1. To understand the basic issues and types of text mining.
2. To appreciate the different aspects of text categorization and clustering.
3. To understand the role played by text mining in Information retrieval and extraction.
4. To appreciate the use of probabilistic models for text mining.
5. To appreciate the current trends in text mining.

Course Outcomes:

Upon Completion of the course, the students will be able to:

1. Identify the different features that can be mined from text and web documents.
2. Use available open-source classification and clustering tools on some standard text data sets.
3. Modify existing classification/clustering algorithms in terms of functionality or features used.
4. Design a system that uses text mining to improve the functions of an existing open-source search engine.
5. Implement a text mining system that can be used for an application of your choice.

UNIT I: INTRODUCTION

Overview of text mining- Definition- General Architecture– Algorithms– Core Operations – Pre-processing – Types of Problems- basics of document classification- information retrieval- clustering and organizing documents- information extraction- prediction and evaluation-Textual information to numerical vectors - Collecting documents- document standardization- tokenization- lemmatization vector generation for prediction- sentence boundary determination -evaluation performance.

UNIT II: TEXT CATEGORIZATION AND CLUSTERING

Text Categorization – Definition – Document Representation –Feature Selection - Decision Tree Classifiers - Rule-based Classifiers - Probabilistic and Naive Bayes Classifiers - Linear Classifiers- Classification of Linked and Web Data - Meta-Algorithms– Clustering –Definition- Vector Space Models - Distance-based Algorithms- Word and Phrase-based Clustering -Semi-Supervised Clustering - Transfer Learning.

UNIT III: TEXT MINING FOR INFORMATION RETRIEVAL AND INFORMATION EXTRACTION

Information retrieval and text mining- keyword search- nearest-neighbor methods- similarity- web based document search- matching- inverted lists- evaluation. Information extraction- Architecture -Co-reference - Named Entity and Relation Extraction- Template filling and database construction –Applications. Inductive - Unsupervised Algorithms for Information Extraction. Text Summarization Techniques - Topic Representation - Influence of Context - Indicator Representations – Pattern Extraction - Apriori Algorithm – FP Tree algorithm.

UNIT IV: PROBABILISTIC MODELS

Probabilistic Models for Text Mining -Mixture Models - Stochastic Processes in Bayesian

Nonparametric Models - Graphical Models - Relationship Between Clustering, Dimension Reduction and Topic Modeling - Latent Semantic Indexing - Probabilistic Latent Semantic Indexing -Latent Dirichlet Allocation- Interpretation and Evaluation - Probabilistic Document Clustering and Topic Models - Probabilistic Models for Information Extraction - Hidden Markov Models - Stochastic Context- Free Grammars - Maximal Entropy Modeling - Maximal Entropy Markov Models -Conditional Random Fields.

UNIT V: RECENT TRENDS

Visualization Approaches - Architectural Considerations - Visualization Techniques in Link Analysis - Example- Mining Text Streams - Text Mining in Multimedia - Text Analytics in social media – Opinion Mining and Sentiment Analysis - Document Sentiment Classification - Opinion Lexicon Expansion -Aspect-Based Sentiment Analysis - Opinion Spam Detection – Text Mining Applications and Case studies.

TEXT BOOKS:

1. Sholom Weiss, Nitin Indurkhya, Tong Zhang, Fred Damerau “The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data”, Springer, paperback 2010

REFERENCES:

1. Ronen Feldman, James Sanger -“The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data”-Cambridge University press, 2006.
2. Charu C. Aggarwal, ChengXiang Zhai**,** Mining Text Data, Springer; 2012

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BLOCK CHAIN TECHNOLOGY

(PEC-III)

Prerequisites: Basic Knowledge of Computer Security and Data Structures

Course Objectives:

1. Identify different components and types of Blockchain.
2. Apply Ethereum tool for application development
3. Interpret various components of DApps and multichain
4. Summarize the architecture of Hyperledger Fabric
5. Analyse the impact of Blockchain in business

Course Outcomes:

6. Summarize types and applications of Blockchain
7. Illustrate the design and deployment of smart contract through Ethereum
8. Apply DApps through Truffle IDE
9. Apply Hyper Ledger Fabric model in different Networks
10. Categorize different Business Applications of Blockchain

UNIT I:

What is Blockchain: Definition, history, Digital Money to Distributed Ledgers

Why Blockchain: Properties of Blockchain, Requirements for consensus protocols, Proof of Work (PoW), Proof of Stake (PoS), Zero Knowledge Proofs, Byzantine Models, hashing, Merkle Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork ,Types of Blockchain.

UNIT II:

Ethereum Solidity: Introduction, Datatype, operator, enum, arrays, loops, Mapping, Structure, State Modifiers, Exception Handling in Solidity, Inheritance, Events, Self-Destruction, ERC Tokens, Constructors, Libraries, Compile and Deploy the Smart Contract

UNIT III:

Truffle IDE: Creating user interface, textboxes, radio buttons, drop down list, developing a DApp, Publish the DApp Connecting to DApp, truffle migrate, truffle test.

Multichain: Chain code (go) and MultiChain, Privacy and Permissions in MultiChain ,Mining in MultiChain, Multiple configurable Blockchains using MultiChain ,Setting up a Private Blockchain, Blockchain Bytes.

UNIT IV:

Hyperledger (go Lang): Introduction, architecture, Consensus, API, frameworks, setting up Development Environment using Composer, Developing and Testing business networks, Hyperledger Fabric Model Various ways to create Hyperledger Fabric Blockchain Network.

UNIT V:

Blockchain transforming business, Blockchain in governance.

Case Studies: Supply chain management, real estate, healthcare, Government sectors, bitcoin.

TEXT BOOKS:

2. Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.

REFERENCE BOOKS:

4. Blockchain Technology:Chandramouli Subramanian,Asha A George,Abhilash K A and Meena Karthikeyan,Published by University Press
5. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos Blockchain by Melanie Swa, O'Reilly
6. Philipp Hacker, Ioannis Lianos (2019). **Regulating Blockchain: Techno-Social and Legal Challenges**, OUP Oxford. (ISBN-13: 978-0198842187).

REFERENCE LINKS:

3. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
4. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits - https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html

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RECOMMENDER SYSTEMS

(PEC-III)

Pre-requisite: Data Structures

Course Objectives:

1. Understand Information Retrieval Techniques
2. Explain the Recommendation System and its application in various domain
3. Learn how to evaluate Recommender systems
4. Explain a variety of approaches for building recommender systems

Course Outcomes:

1. Apply the techniques of searching and filtering for information Retrieval (L3)
2. Analyzing classification algorithms. (L4)
3. Analyze the User-based recommendation, Item-based recommendation and build the Model based approaches (L4)
4. Design Hybrid based Recommender Systems.(L5)
5. Evaluate the Recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity. (L4)

Unit I:

Introduction: Overview of Information Retrieval, Retrieval Models, Search and Filtering Techniques: Relevance Feedback, User Profiles, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.

Unit II:

Content-based Filtering: High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval Classification algorithms.

Unit III:

Collaborative Filtering: User-based recommendation,Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.

Unit IV:

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies, Recommender systems in personalized web search, , knowledge-based recommender system, Social tagging recommender systems, Trust-centric recommendations, Group recommender systems.

Unit V:

Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs: Accuracy, Coverage, confidence, novelty, diversity, scalability, serendipity, Evaluation on historical datasets, Offline evaluations

TEXT BOOKS:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.
2. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer (2016), 1st ed.

REFERENCES:

1. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed.
2. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013), 1st ed.

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SEMANTIC WEB

(PEC-IV)

Pre-requisites: A basic understanding and knowledge of HTML and XML and related technologies.

Course Objectives:

1. To learn Web Intelligence
2. To learn Knowledge Representation for the Semantic Web
3. To learn Ontology Engineering
4. To learn Semantic Web Applications, Services and Technology.
5. Migration from document to data web.

Course Outcomes:

1. Foundation of Semantic Web Technologies Describe logic semantics and inference with OWL
2. Use ontology engineering approaches in semantic applications
3. Learn Web graph processing for various applications such as search engine, community detection.
4. Structured Web Documents in XML.
5. Describing Web Resources in RDF.

UNIT I: Foundation of Semantic Web Technologies

Thinking and Intelligent Web Applications, The Information Age ,The World Wide Web, Current web vs Semantic Web, Semantic Web Technologies ,Machine Intelligence, Artificial Intelligence, Ontology, Inference engines, Software Agents, Berners-Lee www, Semantic Road Map, Logic on the semantic Web.

UNIT II: Knowledge Representation for the Semantic

Web Ontologies and their role in the semantic web, Ontology Web Language(OWL), Three Sublanguages of OWL · Description of the OWL Language · Layering of OWL · Examples · OWL in OWL ,OWL and– Resource Description Framework(RDF)/RDFS, UML, XML/XML Schema.

Unit III: Ontology Engineering

Constructing Ontology, Ontology Development Tools, Ontology Methods, Ontology Sharing and Merging, Ontology Libraries and Ontology Mapping, Logic, Rule and Inference Engines.

UNIT IV: A query language for RDF: SPARQL

SPARQL simple Graph Patterns, Complex Graph Patterns, Group Patterns, Queries with Data Values, Filters · OWL Formal Semantics.

UNIT V: Semantic Web Applications

Services and Technology:Semantic Web applications and services, Semantic Search, e-learning, Semantic Bioinformatics, Knowledge Base ,XML Based Web Services, Creating an OWL-S Ontology for Web Services, Semantic Search Technology, Web Search Agents and Semantic Methods,

TEXT BOOKS:

1. Thinking on the Web – Berners Lee, Godel and Turing, Wiley inter science, 2008.
2. A Semantic Web Primer by Grigoris Antoniou Frank van Harmelen, The MIT Press Cambridge.
3. Foundation of Semantic Web Technologies, Pascal Hitzler, Markus and Sebastian

REFERENCE BOOKS:

1. Semantic Web Technologies, Trends and Research in Ontology Based Systems, J. Davies, R. Studer, P. Warren, John Wiley & Sons.
2. Semantic Web and Semantic Web Services -Liyang Lu Chapman and Hall/CRC Publishers,(Taylor & Francis Group)
3. Information sharing on the semantic Web – Heiner Stuckenschmidt; Frank Van Harmelen, Springer Publications.
4. Programming the Semantic Web, T. Segaran, C. Evans, J. Taylor, O'Reilly, SPD.

ANURAG UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

M.Tech (DS)

I Year M.Tech (DS) II Sem	L	T / P / D	C
	3	0	3

PREDICTIVE ANALYTICS WITH R
(PEC-IV)

Prerequisites: Basics of Statistics, Machine Learning and Basic knowledge in any Programming language

Course Objectives:

After taking the course, students will be able to

1. Use R for statistical programming, computation, graphics and modeling,
2. Write functions and use R in an efficient way
3. Fit some basic types of statistical models
4. Use R in their own research,

Course Outcomes:

After successful completion of the course students should be able to

6. Understand the basics in R programming in terms of constructs, control statements, functions,
7. Access online resources for R and import new function packages into the R workspace
8. Import, review, manipulate and explore ,summarize data-sets in R
9. Apply the R programming from a statistical perspective
10. Apply R Graphics and Tables to visualize results of various Statistical operations on data.

Unit I:

Basics of R: Introduction, R-Environment Setup, Help functions in R, Vectors – Scalars – Declarations

Basic Data Types: Vectors – Scalars – Declarations, Creating and Naming Vectors, Vector Arithmetic, Vector Sub setting,

Matrices: Creating matrices – Matrix operations – Applying Functions to Matrix Rows and Columns – Adding and deleting rows and columns – Vector/Matrix Distinction – Arrays -Class.

Unit II:

Factors: Introduction to Factors: Factor Levels, Summarizing a Factor, Ordered Factors, Comparing Ordered Factors, Common functions used with factors

Data Frame: Creating Data Frames – Matrix-like operations in frames – Merging Data Frames – Applying functions to Data frames – Sub setting of Data Frames, Extending Data Frames, Sorting Data Frames.

Lists: Creating a Named List, Accessing List Elements, Manipulating List Elements, Merging Lists, Converting Lists to Vectors, applying functions to lists

Conditionals and Control Flow: Arithmetic and Boolean operators and values, Relational Operators, Relational Operators and Vectors, Logical Operators, Logical Operators and Vectors, Conditional Statements.

Unit III:

Iterative Programming in R: Introduction, While Loop, For Loop, Looping Over List.

Functions in R: Introduction, Writing a Function in R, Nested Functions, Function Scoping, Recursion, Loading an R Package, Mathematical Functions in R, Cumulative Sums and Products, Calculus in R, Input and Output Operations.

Unit IV:

Apply Family in R: Introduction, Using Apply in R, Using Lapply in R, Using Sapply, Using Tapply in R: Split Function, Using Mapply in R,

Charts and Graphs: Introduction, Pie Chart: Chart Legend, 3D Pie Chart, Bar Chart, Box Plot, Histogram, Line Graph: Multiple Lines in Line Graph, Scatter Plot.

Unit V: Interfacing

Data Interfaces: Introduction, CSV Files: Syntax, Importing a CSV File, Excel Files: Syntax, Importing an Excel file, Binary Files: Syntax, XML Files, Web Data, Databases.

Statistical Applications: Introduction, Basic Statistics – Linear Model – Generalized Linear models – Non-linear models – Time Series and Auto-correlation – Clustering, Correlation and Covariance, T-Tests,-ANOVA.

TEXT BOOKS:

1. R Programming for Data Science by Roger D. Peng
2. The Art of R Programming by Prashanth singh, Vivek Mourya, Cengage Learning India.

REFERENCE BOOKS:

1. R for Everyone, Lander, Pearson
2. R Cookbook, PaulTeetor, Oreilly.
3. R in Action,Rob Kabacoff, Manning

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I Year M.Tech (DS) II Sem

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DATABASE STORAGE TECHNOLOGIES

(PEC-IV)

Prerequisites: DBMS

Course Objectives:

1. To provide a sound introduction to Storage and properties of storage
2. To Introduce Various Network Storage Topologies
3. To give an introduction to Physical and virtual storage systems.
4. To Explore the data center and its storage requirements
5. To Explain the concepts of Distributed Database Management System

Course Outcomes:

Student will be able to:

1. To discuss the various types of storage and their properties(L2)
2. To Identify the various network storage topologies(L2)
3. To Explain the physical and virtualization of storage(L2)
4. To explain the design of a data center and storage requirements(L3)
5. Identify the features and advantages of Distributed Databases over centralized databases (L2)

Unit -I:

STORAGE MANAGEMENT: Introduction to Storage Technology, Storage Systems Architecture, Physical and logical components of a connectivity environment, Major physical components of a disk drive and their functions, Concept of RAID and its components, Different RAID levels and their suitability for different application environments: RAID 0, RAID 1, RAID 3, RAID 4, RAID 5, RAID 0+1, RAID 1+0, RAID 6, Integrated and Modular storage systems, high-level architecture and working of an intelligent storage systems.

Unit -II:

NETWORKED STORAGE: Evolution of networked storage, Architecture, components, and topologies of FC-SAN, NAS, and IP-SAN, Benefits of the different networked storage options, Need for long-term archiving solutions and describe how CAS fulfill the need, Appropriateness of the different networked storage options for different application environments

Unit –III:

SECURING STORAGE AND STORAGE VIRTUALIZATION: Information Security, Critical security attributes for information systems, Storage security domains, Analyze the common threats in, each domain, Storage Virtualization: Forms, Configurations and Challenges, Types of Storage Virtualization: Block-level and File-Level.

Unit –IV:

DATA CENTRE: Introduction, Site Selection and Environmental Considerations, Hierarchical or Layered Architecture, Architect Roles, Goals and Skills, Architecture Precursors

Unit -V:

Distributed Database Storage: Introduction of DDB, DDBMS architectures, Homogeneous and Heterogeneous databases, Distributed data storage, Advantages of Data Distribution, Disadvantages of Data Distribution Distributed transactions, Commit protocols, Availability, Concurrency control & recovery in distributed databases, Data Replication, Data Fragmentation. Distributed database transparency features, distribution transparency.

TEXT BOOKS:

1. Robert Spalding, Storage Networks: The Complete Reference, Tata McGraw Hill, Osborne, 2003.
2. Marc Farley, Building Storage Networks, Tata McGraw Hill, Osborne. 2001.
3. Meeta Gupta, Storage Area Network Fundamentals, Pearson Education Limited, 2002
4. Mauricio Arregoces, Data Center Fundamentals, Cisco Press; 1st edition, 2003
5. Tamer Ozsu.Patrick Valdureiz , Principles of Distributed Database Systems , Third Edition,Springer

REFERENCE BOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, Sixth Edition, Tata McGraw-Hill 2006.
2. Raghu Rama Kirshna, Johannes Gchrke, Database Management System, Third Edition, TATA MC Graw Hill, 2003.
3. C J Date, AKannan, S Swamynathan, An Introduction to Database Systems, Eighth Edition Pearson 2006

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DEEP LEARNING
(PEC-IV)

Prerequisites: Basic Mathematics, P&S, Python and Machine Learning

Course Objectives:

1. To Give an exposure to Supervised Deep Learning for working with Linearly Non Separable Data
2. To provide understanding of Mathematical, Statistical and Computational challenges of building improved neural net representations. .
3. To Know the application of Convolution Neural Networks for High-Dimensional data, such as image and other data types
4. To Explore Deep Recurrent and Memory Networks for Sentiment Analysis, Machine Translation and Computer Vision tasks

Course outcomes:

1. Implement Deep Neural Networks for solving Classification and Regression Problems (L3)
2. Apply Regularization Methods to improve the way neural networks learn.(L3)
3. Analyze different optimation algorithms for training deep neural models(L4)
4. Apply the concepts of the Deep Convolution Neural networks for Image classification (L3)
5. Solve the sequence learning problems using Deep Recurrent Neural Networks and Memory Networks (L3)

UNIT I:

Introduction to Neural Networks: Challenges Motivating Deep Learning, AI vs ML vs DL, Applications of Deep Learning, Perceptron Model, Sigmoid Neuron Model, Feed Forward Neural Networks, Learning with Gradient Descent, Working of Backpropagation Algorithm, Loss Functions: Squared Error Loss, Perceptron Loss, and Cross Entropy Loss, Output Layer Functions: Sigmoid and Softmax Functions

UNIT II:

Regularization for Deep Learning: Bias and Variance Tradeoff, Regularization Need for Overfitting, Techniques of Regularization: L2 Regularization, L1 Regularization, Drop Out, Data Augmentation, and Early Stopping, Weight Initialization, Hyper-Parameters Tuning: Learning Rate and Batch Size.

UNIT III:

Optimization for Training Deep Models: Challenges to Train Deep Neural Networks: Vanishing Gradient Problem, Exploding Gradient Problem, and Unstable Gradient Problem, Optimization Algorithms: Momentum Based Gradient Descent, Nesterov Based Gradient Descent, AdaGrad, RMSProp, and Adam, Parameter Initialization Strategies

UNIT IV:

Convolutional Neural Networks: Convolution Operation: 1D Convolution Operation, 2D Convolution Operation, 2D Convolution with a 2D Filter, Padding and Stride, Motivation: How Convolution Operation related to Neural Networks, Max Pooling, CNN Architectures: Alexnet, and VGGNet, Batch Normalization, Drop Out.

UNIT V:

Recurrent Neural Networks: Introduction to Sequential Model Problems, Recurrent Neural Network Model, Computing radients in RNN, Challenge of Long- Term Dependencies, The Long Short Term Memory and other Gated RNNs.

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning (1st Edition), MIT Press,2017, ISBN 978-0262035613.
2. Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015.

REFERENCE BOOKS:

1. Bharath Ramsundar & Reza Bosagh Zadeh, Tensor Flow for Deep Learning, O’Reilly Media ,2018
2. Francois Chollet, Deep Learning with Python (1st Edition), Manning Publications Company, 2017. ISBN 978-1617294433.
3. Aurélien Géron, Hands-on Machine Learning with Scikit-Learn and TensorFlow (2nd Edition), O'Reilly Media, 2019. ISBN 978-9352139057.
4. http://faculty.neu.edu.cn/yury/AAI/Textbook/Deep%20Learning%20with%20Python.pdf
5. http://www.deeplearningbook.org/
6. https://www.pdfdrive.com/deep-learning-with-applications-using-python-chatbots-and-face-object-and-speech-recognition-with-tensorflow-and-keras-e184016771.html
7. https://www.pdfdrive.com/tensorflow-for-deep-learning-e187559485.html

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ENGLISH FOR PROFESSIONALS
(OE-I)

Introduction

The course aims at preparing the students with the tools needed for successful communication at the professional front. It is designed to improve students' academic and professional skills which the employers are currently looking for.

Objective

To prepare the students to use the language effectively in all professional pursuits

Course Outcomes:

On successful completion of this course, students will be able to

1. Analyze the language use in communicative process
2. Describe the process and product
3. Interpret the ideas in group activities
4. Apply different approaches to comprehend the written text
5. Write any technical and official correspondence within the framework

UNIT-I

Essentials of Communication:

Essentials of Grammar-Rudiments of Communications Skills(Listening, Speaking, Reading, and Writing)-Applied Grammar and Usage- Non-Verbal Communication

UNIT-II

Listening Skills:

Art of Listening- Developing Effective Listening Skills-Process of Listening, Intensive & Extensive Listening

Podcasts, Vodcasts(ICT enabled)-Five steps to Active Listening-Effective and Ineffective Listening Skills-Listening &Note-taking

UNIT-III

Speaking Skills:

Dynamics of Effective Speaking -Group Discussion-Simulated Presentations, Process & Product Descriptions- Proxemics, Paralinguistic Features

UNIT-IV

Reading Skills:

The Art of Effective Reading- Basic steps to Effective Reading-Extensive and Intensive Reading - Approaches to Efficient Reading-Reading Comprehension

UNIT-V

Writing Skills:

Art of Condensation-Descriptive Writing Techniques-Writing & Answering Memos, Circulars -Inter & Intra Official Communication -Writing Minutes of Meeting-Netiquette - E-mail & Blog Writing - Note-making

Textbook:

1. Kumar, Sanjay and Pushp Lata, *Communication Skills,* Second edition, Oxford University Press, 2015.

References:

6. Adair, John.*The Effective Communicator.* Jaico Publishing House.1995.
7. Adler, B.Ronald.*Communicating at Work*.(Seventh edition.) McGraw Hill.2004.
8. Aruna, Koneru. *Professional Communication.*McGraw Hill.2017.
9. Ibbotson,Mark.*Cambridge English for Engineering Professionals.* Cambridge University.2008.
10. *Oxford English for Careers.*Oxford University Press.

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M.Tech (DS)

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ENTRPERNEURSHIP DEVELOPMENT

(OE-I)

Course Objectives:

1. To provide insights into basic characteristics and process of entrepreneurship
2. To develop a business idea and prepare a bankable project report
3. To identify the methods to initiate ventures and the sources of finance
4. To create awareness about the legal challenges of entrepreneurship and IPR
5. To know and apply the various strategic and managerial concerns in the growth stage of the firms

Course Outcomes: At the end of the course, students will be able to

1. Interpret concepts and process of entrepreneurship.
2. Apply idea development strategies and prepare a bankable project report
3. Analyse various opportunities towards initiating ventures.
4. Recognize legal challenges of entrepreneurship.
5. Assess the strategic perspectives of entrepreneurship.

Unit- I

Introduction: Introduction to Entrepreneurship – Characteristics, Qualities, Key Elements and Skills of an Entrepreneur, entrepreneurial stress, Corporate entrepreneurship, Entrepreneurial process.

Unit -II

Business Plan Preparation: Search for business idea, project identification, project formulation and development, contents of business plan and Preparation of a Bankable Project Report.

Unit- III

Launching Entrepreneurial Venture: Opportunities identification, Methods to initiate Ventures, Creating new ventures, Acquiring existing ventures, Franchising. Sources of finance, Forms of capital requirements, funding agencies and supporting institutions.

Unit- IV:

Legal challenges of Entrepreneurship: Intellectual Property Protection – Patents, Copyrights, Trademarks and Trade Secrets. The challenges of new Venture Startups- Poor financial understanding, critical factors for new venture development, Evaluation process, Feasibility criteria approach.

Unit -V:

Strategic perspectives in Entrepreneurship: Strategic planning- Strategic Action, Strategic Positioning, Business Stabilization, Building the adaptive firms, understanding the growth stage, unique managerial concern of growing ventures.

TEXT BOOK:

1. D F Kuratko and T V Rao "Entrepreneurship- A South-Asian Perspective "Cengage Learning, 2012
2. Vasant Desai, Small Scale Industries and Entrepreneurship, HPH, 2012.

REFERENCES:

1. Rajeev Roy, Entrepreneurship, 2e, Oxford, 2012.
2. B.Janakiram and M.Rizwana, Entrepreneurship Development:Text & Cases, Excel Books, 2011.
2. Stuart Read, Effectual Entrepreneurship, Routledge, 2013.
3. Robert Hisrich et al, Entrepreneurship, 6e, TMH, 2012.
4. Nandan H, Fundamentals of Entrepreneurship, PHI, 2013
5. Shejwalkar, Entrepreneurship Development, Everest, 2011
6. Khanka, Entrepreneurship Development, S.Chand, 2012

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TECHNICAL AND BUSINESS COMMUNICATION SKILLS (OE-I)

Introduction

The course is intended to expose the students to learn and practice the five communication skills thinking, listening, speaking reading, and writingin English, the global language of communication. It reflects some of the approaches in English language teaching and learning currently in practice around the world.

Objective

To help the students to develop effective communication skills in all communicative contexts for professional advancement

Course Outcomes:

On successful completion of the course, students will be able to:

1. communicate technical and business correspondence
2. reflect on the themes discussed
3. recognize ethical implications of technical communication in professional contexts
4. identify the contemporary issues in engineering from environmental, societal, economic, and global perspectives
5. demonstrate ethical decisions in complex situations

UNIT-I

E-World & E-Communication:

E-language - E-governance - E-commerce/E-business - E-banking - E-waste

UNIT-II

Business Establishment & Infrastructure Development:

Power Supply - Industrial Park - Business Correspondence: Follow-up letters - Acceptance & Rejections - Persuasive letters - Resignation letters

UNIT-III

Technology and Society:

Robot Soldiers - For a Snapshot of a Web - Placing an order - Proposal Writing - Patents & Rights (National & International) - Intellectual Property - Nanotechnology

UNIT-IV

Ethics in Business Communication:

Ethical issues involved in Business Communication - Ethical dilemmas facing managers - Ethical Code & Communication - Standards in Daily Life - Total Quality Management - World University Ranking

UNIT-V

Management Information System:

Corporate Governance - Business Process Outsourcing - Project Management Communication - Marketing Communication

Textbook:

1. Dhanavel, P. S. *English and Communication Skills for Students of Science and Engineering.* Orient Black Swan. 2009.

References:

1. Anderson, V. Paul. *Technical Communication.* Cengage. 2014.
2. Kalkar, Anjali. et.al. *Business Communication*. Orient Black Swan. 2010.
3. Knisely, W. Charles. and Knisely, I. Karin. *Engineering Communication.* Cengage. 2015.
4. Kumar, Sanjay. and Pushp Lata. *Language and Communication skills for Engineers.* Oxford University Press. 2018.
5. Raman, Meenakshi and Singh, Prakash. *Business Communication.* (Second Edition.). Oxford University Press. 2012.

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M.Tech (DS)

I Year M.Tech (DS) II Sem

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3	0	3

PROJECT MANAGEMENT

(OE-I)

Course Objectives:

1. To understand the concept of Project Management.
2. To know about the different approaches to project screening and planning.
3. To explain about the factors of risk involved in project execution.
4. To understand about team leading and functional cooperation.
5. To know about the project performance and future trends in the project management.

Course Outcomes: At the end of the course students will be able to

1. Explain about the life cycle and other concepts of Project Management.
2. Apply different approaches to project screening and planning
3. Analyze different risk factors in project execution
4. Estimate how to lead a team, to get functional cooperation
5. Build performance evaluation reports and future trends in project management.

Unit-I

Introduction: Meaning, Need, Principles Project Lifecycle and its Phases, Project Management Research in brief, Project Management today, Organization strategy and structure and culture, Format of organization structure, Stake holder Management, Organization Culture, creating a culture for Project Management.

Unit-II

Project Identification and Planning: Defining the project, Project Identification Process, Approaches to Project Screening and Selection, Project Planning, Work Breakdown Structure, Financial Module, Getting Approval and Compiling a Project Charter, setting up a Monitoring and Controlling Process.

Unit-III

Project Execution: Initiating the Project, Controlling and Reporting Project Objectives, Conducting project evaluation, Risk, Risk Management Factors, Project Management, Four Stage Process, Risk Management an Integrated Approach, Cost Management, Creating a Project Budget.

Unit-IV

Leading Project Teams: Building a Project Team, Characteristics of an effective Project Team, achieving Cross- Functional Co-operation, Virtual Project Teams, Conflicts Management, Negotiations.

Unit-V

Performance Measurement and Evaluation: Monitoring Project Performances, Project Control Cycles, Earned Value Management, Human factors in Project Evaluation and Control, Project Termination, Types of Project Terminations, Project Follow-up. Current and Future Trends in Project Management.

TEXT BOOKS:

1. Gray, Larson, Project Management, Tata McGraw Hill, 2015
2. Jeffery K. Pinto, Project Management, Pearson Education, 2015

REFERENCES:

3. Enzo Frigenti, Project Management, Kogan, 2015
4. R. Panneerselvam & P. Senthil Kumar, Project Management, PHI, 2015
5. Thomas M. Cappels, Financially Focused Project Management, SPD, 2008.

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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

M.Tech (DS)

I Year M.Tech (DS) II Sem

L	T / P / D	C
0	4	2

DATA WRANGLING & VISUALIZATION LAB

(PCC-V LAB)

Prerequisites: Some basic knowledge of R is expected

Basic Python knowledge

Objectives:

1. Visualize data
2. Understand what plots are suitable for a type of data you have
3. Understand the data before you make a plot
4. Apply exploratory data analysis techniques with R and ggplot2
5. Visualize data by creating various graphs using R base package, lattice and ggplot2 packages

Week 1: Types of graphs using the base R package: Base Graphics

Single Continuous Variable: Histogram, Density Plot, Box-Whisker Plot

Week 2: Single Discrete Variable: Bar Chart, Two Continuous Variables: Scatter Plot

Week 3: Two Variables: One Continuous, One Discrete: Box-Whisker Plot, Pie Chart, Dot Chart, Strip Chart

Week 4: Two Variables: Both Discrete: Mosaic Plot, Stacked Bar Plot, Time series: Line Charts

Week 5: Types of graphs covered in the Lattice package Lattice package:
Histogram, Density Plot, Box-Whisker Plot.

Week 6: Graphs covered in GGPlot2 package: Commonly Used Graphs: Bar Chart, Scatter Plot, Dot Chart, Strip Chart

Week 7: Exploratory data analysis (EDA) (statistical plots for exploring one continuous or one discrete variable)

Week 8: EDA for exploring two or more variables (different statistical plots)

Week 9: introduction to Matplotlib

Week 10: Making line and Scatter plots

Week 11: Adding Labels, Titles, Axis Ticks, and Changing Line Styles

Week 12: Adjusting Plot Sizes, Adding a Legend, and Saving the Plots

Week 13: A case study to select a diamond - to explain ggplot()

REQUIRED TOOLS: R and R studio, Python

B.TECH HONORS DEGREE IN DATA SCIENCE

Serial No	Course code	Subject Name	Hours per Week			Credits
			L	T	P	
1	PC	Data Science	3	0	2	4
2	PC	Data Wrangling and Visualization	3	0	2	4
4	PEC	1. Natural language Processing 2. Deep Learning 3. Predictive analytics using R Programming 4. Sentiment Analysis	3	1	0	4
5	Project	Project work	0	0	12	6
TOTAL			**9**	**1**	**16**	**18**

**** Any other relevant course offered by MOOCs and approved by BoS**

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B.Tech (Honors -DS)

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	3	0/2/0	4

DATA SCIENCE
(PC)

Course Objectives:

1. To gain a foundational understanding of data science.
2. To understand the data exploration analysis in data science.
3. To understand and use basic machine learning algorithms for predictive modeling.
4. To understand and use the various graphics in R and Tableau for data visualization.
5. To understand the ethical and privacy issues in data science.

Course Outcomes:

1. Describe what Data Science is and the skill sets needed to be a data scientist.
2. Explain the significance of exploratory data analysis (EDA) in data science.
3. Apply basic machine learning algorithms for predictive modeling.
4. Learn to persuade effective visualization of given data.
5. Reason around ethical and privacy issues in data science conduct and apply ethical practices.

UNIT I:

Introduction To Data Science: What is Data Science, Big Data and Data Science hype – and getting past the hype,Why now? – Datafication, Current landscape of perspectives, Skill sets needed, Statistical Inference, Populations and samples, Statistical modeling, probability distributions, fitting a model, Introduction to R.

UNIT II:

Exploratory Data Analysis And The Data Science Process: Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA, The DataScience Process, Case Study.

UNIT III:

Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN), k-means, Motivating application: FilteringSpam, Why Linear Regression and k-NN are poor choices for Filtering Spam, Naive Bayes and why it works for Filtering Spam.

UNIT IV:

Data Visualization: Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects,Introduction to Tableau. Creating own visualization of a complex dataset.

UNIT V:

Data Science And Ethical Issues: Discussions on privacy, security, ethics, A look back at Data Science, Next-generation datascientists.

Text Books:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.
2. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.

Reference Books:

1. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition. ISBN 0387952845. 2009.
2. Jiawei Han, Micheline Kamber and Jian Pei. Data Mining: Concepts and Techniques, Third Edition. ISBN 0123814790. 2011.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
4. https://docs.google.com/file/d/0B6iefdnF22XQeVZDSkxjZ0Z5VUE/edit?pli=1

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DATA WRANGLING & VISUALIZATION

(PC)

Course Objectives:

15. To introduce the basic concepts of data wrangling using Python
16. To obtain the input data from a variety of sources
17. To extract the data and convert it into representations suitable for data analytics
18. To visualize the data

Course Outcomes: At the end of this course, students will be able to:

6. Use the pandas library
7. Load, store data in different file formats
8. Clean and prepare the data
9. Plot and Visualize data
10. Do data aggregation

UNIT-I

Getting started with pandas: Introduction to pandas Data Structures, Series, Data Frame, Index Objects. Data Loading, Storage, and File Formats: Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data to Text Format, Working with Delimited Formats, JSON Data

UNIT-II

Data Loading, Storage, and File Formats: XML and HTML: Web Scraping, Binary Data Formats: Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Web APIs, Interacting with Databases

UNIT-III

Data Cleaning and Preparation: Handling Missing Data, Filtering Out Missing Data, Filling In Missing Data, Data Transformation, Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers, String Manipulation, String Object Methods, Regular Expressions

UNIT-IV

Plotting and Visualization: A Brief matplotlib API Primer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot, Saving Plots to File, matplotlib

Configuration, Plotting with pandas and seaborn, Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots, Facet Grids and Categorical Data, Other Python Visualization Tools, Conclusion

UNIT-V

Data Aggregation and Group Operations: GroupBy Mechanics, Iterating Over Groups, Selecting a Column or Subset of Columns, Grouping with Dicts and Series, Grouping with Functions, Grouping by Index Levels, Data Aggregation, Column-Wise and Multiple Function Application, Returning Aggregated Data Without Row Indexes, Pivot Tables and Cross-Tabulation.

TEXT BOOKS:

7. Wes McKinney. Python for Data Analysis: Data Wrangling with pandas, NumPy and IPython. O'Reilly, 2017, 2nd Edition

8. Jacqueline Kazil and Katharine Jarmul. Data Wrangling with Python. O'Reilly, 2016

REFERENCE BOOKS:

12. Data Science Essentials in Python: Collect, Organize, Explore, Predict, Value. Dmitry Zinoriev, The Pragmatic Programmers LLC, 2016

13. TyeRattenbury, Joseph M. Hellerstein, Jeffrey Heer, Sean Kandel, and Connor Carreras. Principles of Data Wrangling: Practical Techniques for Data Preparation. O'Reilly, 2017

14. Python Data Analytics – Data Analysis and Science using Pandas, matplotlib and the Python Programming Language. Fabio Nelli, Apress, 2015

ANURAG UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

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NATURAL LANGUAGE PROCESSING

(PEC)

Prerequisites: Artificial Intelligence, Machine Learning, Python Programming

Course Objectives:

5. To learn the fundamentals of Natural Language Processing
6. To understand the use of CFG and PCFG in NLP
7. To understand the role of semantics of sentences and pragmatics
8. To apply the NLP techniques to IR applications

Course outcomes:

5. To model the language using N-grams.
6. To implement a shallow processing models to tackle morphology/syntax of a language.
7. To Examine Syntagmatic and Paradigmatic relations be used for processing the real-time applications.
8. To apply the algorithms for Discourse Analysis.

UNIT I:

Introduction : Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Text Normalization, Minimum Edit Distance, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors

UNIT II:

Word Level Analysis : Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

UNIT III:

Syntactic Analysis: Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures.

UNIT IV:

Semantics And Pragmatics : Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

UNIT V:

Discourse Analysis And Lexical Resources: Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).

TEXT BOOKS:

3. Daniel Jurafsky, James H. Martin ,"Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", Pearson Publication, 2014.
4. Deepti Chopra, Nisheeth Joshi, Iti Mathur "Mastering Natural Language Processing with Python" First Edition, Packt Publishing, 2016

REFERENCE BOOKS:

6. James Allen, "Natural Language Understanding", 2nd Edition, Benjamin, Cummings publishing company, 1995.
7. Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python" , First Edition, OReilly Media, 2009
8. Rajesh Arumugam, Rajalingappaa Shanmugamani, "Hands-On Natural Language Processing with Python" , Packt Publishing Ltd., 2018
9. http://www.pdfdrive.com/natural-language-processing-with-python-e1251452.html
10. https://learning.oreilly.com/library/view/hands-on-natural-language/9781789139495

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DEEP LEARNING
(PEC)

Prerequisites: Basic Mathematics, P&S, Python and Machine Learning

Course Objectives:

5. To Give an exposure to Supervised Deep Learning for working with Linearly Non Separable Data
6. To provide understanding of Mathematical, Statistical and Computational challenges of building improved neural net representations. .
7. To Know the application of Convolution Neural Networks for High-Dimensional data, such as image and other data types
8. To Explore Deep Recurrent and Memory Networks for Sentiment Analysis, Machine Translation and Computer Vision tasks

Course outcomes:

6. Implement Deep Neural Networks for solving Classification and Regression Problems (L3)
7. Apply Regularization Methods to improve the way neural networks learn.(L3)
8. Analyze different optimation algorithms for training deep neural models(L4)
9. Apply the concepts of the Deep Convolution Neural networks for Image classification (L3)
10. Solve the sequence learning problems using Deep Recurrent Neural Networks and Memory Networks (L3)

UNIT I:

Introduction to Neural Networks: Challenges Motivating Deep Learning, AI vs ML vs DL, Applications of Deep Learning, Perceptron Model, Sigmoid Neuron Model, Feed Forward Neural Networks, Learning with Gradient Descent, Working of Backpropagation Algorithm, Loss Functions: Squared Error Loss, Perceptron Loss, and Cross Entropy Loss, Output Layer Functions: Sigmoid and Softmax Functions

UNIT II:

Regularization for Deep Learning: Bias and Variance Tradeoff, Regularization Need for Overfitting, Techniques of Regularization: L2 Regularization, L1 Regularization, Drop Out, Data Augmentation, and Early Stopping, Weight Initialization, Hyper-Parameters Tuning: Learning Rate and Batch Size.

UNIT III:

Optimization for Training Deep Models: Challenges to Train Deep Neural Networks: Vanishing Gradient Problem, Exploding Gradient Problem, and Unstable Gradient Problem, Optimization Algorithms: Momentum Based Gradient Descent, Nesterov Based Gradient Descent, AdaGrad, RMSProp, and Adam, Parameter Initialization Strategies

UNIT IV:

Convolutional Neural Networks: Convolution Operation: 1D Convolution Operation, 2D Convolution Operation, 2D Convolution with a 2D Filter, Padding and Stride, Motivation: How Convolution Operation related to Neural Networks, Max Pooling, CNN Architectures: Alexnet, and VGGNet, Batch Normalization, Drop Out.

UNIT V:

Recurrent Neural Networks: Introduction to Sequential Model Problems, Recurrent Neural Network Model, Computing radients in RNN, Challenge of Long- Term Dependencies, The Long Short Term Memory and other Gated RNNs.

TEXT BOOKS:

3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning (1st Edition), MIT Press,2017, ISBN 978-0262035613.
4. Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015.

REFERENCE BOOKS:

8. Bharath Ramsundar & Reza Bosagh Zadeh, Tensor Flow for Deep Learning, O’Reilly Media ,2018
9. Francois Chollet, Deep Learning with Python (1st Edition), Manning Publications Company, 2017. ISBN 978-1617294433.
10. Aurélien Géron, Hands-on Machine Learning with Scikit-Learn and TensorFlow (2nd Edition), O'Reilly Media, 2019. ISBN 978-9352139057.
11. http://faculty.neu.edu.cn/yury/AAI/Textbook/Deep%20Learning%20with%20Python.pdf
12. http://www.deeplearningbook.org/
13. https://www.pdfdrive.com/deep-learning-with-applications-using-python-chatbots-and-face-object-and-speech-recognition-with-tensorflow-and-keras-e184016771.html
14. https://www.pdfdrive.com/tensorflow-for-deep-learning--e187559485.html

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PREDICTIVE ANALYTICS WITH R
(PEC)

Prerequisites: Basics of Statistics, Machine Learning and Basic knowledge in any Programming language

Course Objectives:

After taking the course, students will be able to

5. Use R for statistical programming, computation, graphics and modeling,
6. Write functions and use R in an efficient way
7. Fit some basic types of statistical models
8. Use R in their own research,

Course Outcomes:

After successful completion of the course students should be able to

11. Understand the basics in R programming in terms of constructs, control statements, functions,
12. Access online resources for R and import new function packages into the R workspace
13. Import, review, manipulate and explore ,summarize data-sets in R
14. Apply the R programming from a statistical perspective
15. Apply R Graphics and Tables to visualize results of various Statistical operations on data.

Unit I:

Basics of R: Introduction, R-Environment Setup, Help functions in R, Vectors – Scalars – Declarations

Basic Data Types: Vectors – Scalars – Declarations, Creating and Naming Vectors, Vector Arithmetic, Vector Sub setting,

Matrices: Creating matrices – Matrix operations – Applying Functions to Matrix Rows and Columns – Adding and deleting rows and columns – Vector/Matrix Distinction – Arrays -Class.

Unit II:

Factors: Introduction to Factors: Factor Levels, Summarizing a Factor, Ordered Factors, Comparing Ordered Factors, Common functions used with factors

Data Frame: Creating Data Frames – Matrix-like operations in frames – Merging Data Frames – Applying functions to Data frames – Sub setting of Data Frames, Extending Data Frames, Sorting Data Frames.

Lists: Creating a Named List, Accessing List Elements, Manipulating List Elements, Merging Lists, Converting Lists to Vectors, applying functions to lists

Conditionals and Control Flow: Arithmetic and Boolean operators and values, Relational Operators, Relational Operators and Vectors, Logical Operators, Logical Operators and Vectors, Conditional Statements.

Unit III:

Iterative Programming in R: Introduction, While Loop, For Loop, Looping Over List.

Functions in R: Introduction, Writing a Function in R, Nested Functions, Function Scoping, Recursion, Loading an R Package, Mathematical Functions in R, Cumulative Sums and Products, Calculus in R, Input and Output Operations.

Unit IV:

Apply Family in R: Introduction, Using Apply in R, Using Lapply in R, Using Sapply, Using Tapply in R: Split Function, Using Mapply in R,

Charts and Graphs: Introduction, Pie Chart: Chart Legend, 3D Pie Chart, Bar Chart, Box Plot, Histogram, Line Graph: Multiple Lines in Line Graph, Scatter Plot.

Unit V: Interfacing

Data Interfaces: Introduction, CSV Files: Syntax, Importing a CSV File, Excel Files: Syntax, Importing an Excel file, Binary Files: Syntax, XML Files, Web Data, Databases.

Statistical Applications: Introduction, Basic Statistics – Linear Model – Generalized Linear models – Non-linear models – Time Series and Auto-correlation – Clustering, Correlation and Covariance, T-Tests,- ANOVA.

TEXT BOOKS:

3. R Programming for Data Science by Roger D. Peng
4. The Art of R Programming by Prashanth singh, Vivek Mourya, Cengage Learning India.

REFERENCE BOOKS:

4. R for Everyone, Lander, Pearson
5. R Cookbook, PaulTeetor, Oreilly.
6. R in Action,Rob Kabacoff, Manning

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SENTIMENT ANALYSIS

(PEC)

Pre-requisites: Data mining, Natural Language Processing

Course Objectives:

5. To learn the fundamentals of Sentiment analysis and Opinion Mining
6. To understand the use of Sentiment analysis.
7. To understand the role of Sentiment analysis and Opinion Mining
8. To apply the Sentiment analysis in applications

Course Outcomes:

6. To apply the Sentiment analysis for **Document** level analysis (L3)
7. To model the Sentiment analysis (L3)
8. To implement a shallow processing models to tackle morphology/syntax of a language (L3)
9. To Examine Syntagmatic and Paradigmatic relations be used for processing the real-time applications (L4)
10. To apply the algorithms for Sentiment Analysis (L3)

Unit I

Introduction: What is Sentiment analysis, Types of Sentiment Analysis, Why Is Sentiment Analysis Important, Many Facets of Sentiment Analysis, Affective Computing and Sentiment Analysis Sentiment Analysis Applications, Different Levels of Analysis, Sentiment Lexicon and Its Issues, Natural Language Processing Issues, Opinion Spam Detection.

The Problem of Sentiment Analysis: Opinion Definition, Sentiment Analysis Tasks, Opinion Summarization, Opinion Summarization, Opinion Summarization.

Unit II

Document Sentiment Classification: Sentiment Classification Using Supervised Learning, Sentiment Classification Using Unsupervised Learning, Sentiment Rating Prediction Cross-Domain Sentiment Classification, Cross-Language Sentiment Classification.

Sentence Subjectivity and Sentiment Classification: Subjectivity Classification, Sentence Sentiment Classification,4.3 Dealing with Conditional Sentences, Dealing with Sarcastic Sentences, Cross-language Subjectivity and Sentiment Classification, Using Discourse Information for Sentiment Classification.

Unit III:

Aspect-based Sentiment Analysis: Aspect Sentiment Classification, Basic Rules of Opinions and Compositional Semantics. Aspect Extraction, Identifying Resource Usage Aspect, Simutaneous Opinion Lexicon Expansion and Aspect Extraction, Grouping Aspects into Categories, Entity, Opinion Holder and Time Extraction, Coreference Resolution and Word Sense Disambiguation.

Unit IV: Sentiment Lexicon Generation: Dictionary-based Approach, Corpus-based Approach

Desirable and Undesirable Facts.

Opinion Summarization: Aspect-based Opinion Summarization, Improvements to Aspect-based Opinion Summarization, Contrastive View Summarization, Traditional Summarization, Analysis of Comparative Opinions.

Unit V: Opinion Search and Retrieval: Web Search vs. Opinion Search, Existing Opinion Retrieval Techniques.

Opinion Spam Detection: Types of Spam and Spamming, Harmful Fake Reviews, Individual and Group Spamming, Types of Data, Features and Detection, Supervised Spam Detection, Unsupervised pam Detection, Spam Detection based on Atypical Behaviours, Spam Detection Using Review Graph, Group Spam Detection.

TEXT BOOKS:

3. Bing Liu. *Sentiment Analysis and Opinion Mining*, Morgan & Claypool Publishers, May 2012.
4. Eric Cambria, Dipankar Das, Sivaji Bandyopadhyay, Antonia feraco. A Practical guide to Sentiment Analysis

REFERENCE BOOKS:

3. Liu, Bing. Sentiment Analysis: Mining Opinions, Sentiments, And Emotions, Cambridge University Press.
4. Basant Agarwal, Richi Nayak, Namita Mittal, Srikanth Patnaik Deep Learning-Based Approaches for Sentiment Analysis (Algorithms for Intelligent Systems), 1st ed. 2020 Edition

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Data Science Lab

Prerequisites:

Basics of Python Programing, Basics of R programming and Statistics and probability

Course Objectives:

1. To acquire in-depth understanding of the data analysis, machine learning and other advanced data science techniques.
2. To empower students with tools and techniques for handling, managing, analyzing and interpreting data.
3. To strengthen the analytical and problem solving skill through developing real time applications.
4. To gain practical experience in programming tools for data sciences and machine learning.

Course outcomes:

1. Understand data science concepts and various use cases in different industries [L2]
2. Apply statistics and probability for data science. [L3]
3. Develop R and Python Code for Data Science solutions [L6]
4. Create powerful business dashboards with Tableau [L6]

Programming Languages/Tools:

- R
- Tableau
- Python

List of Experiments:

1. Introduction to Data Science with using Python / Revisiting of Jupiter/Installation of Libraries.
2. Apply accessing and importing and exporting data using Python.
3. Apply data preprocessing: Data manipulation and data cleaning using Python.
4. Apply Machine Learning - Linear regression using Python.
5. Apply Machine Learning - Logistic Regression using Python.
6. Introduction to R tool for data analytics science / Revisiting of Installing R Libraries.
7. Exploratory Data Analysis and apply statistics analysis and visualization using R
8. Apply K-means clustering (supervised Learning) on given datasets using R.
9. Apply K-NN (unsupervised learning) on given datasets using R.
10. Data Visualization using tableau / Installation of Tableau / Introduction to Tableau interface.
11. Create and connect to data/Visual analytics/mapping/creating dashboards and stories.

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DATA WRANGLING & VISUALIZATION LAB

Prerequisites: Some basic knowledge of R is expected

Basic Python knowledge

Course Objectives:

6. Visualize data
7. Understand what plots are suitable for a type of data you have
8. Understand the data before you make a plot
9. Apply exploratory data analysis techniques with R and ggplot2
10. Visualize data by creating various graphs using R base package, lattice and ggplot2 packages

Course outcomes:

1. Understand Data Wrangling Concepts [L2]
2. Apply graphs for data science. [L3]
3. Exploratory data analysis (EDA [L6]
4. Create powerful business representations using the tools [L6]

Programming Languages/Tools:

- R
- R-Studio
- Python

List of Experiments:

1**. Types of graphs using the base R package:** Base Graphics -
Single Continuous Variable: Histogram, Density Plot, Box-Whisker Plot
2. Single Discrete Variable: Bar Chart, Two Continuous Variables: Scatter Plot
3. Two Variables: One Continuous, One Discrete: Box-Whisker Plot, Pie Chart, Dot Chart, and Strip Chart
4. Two Variables: Both Discrete: Mosaic Plot, Stacked Bar Plot, Time series: Line Charts
5. Types of graphs covered in the Lattice package Lattice package: Histogram, Density Plot, Box-Whisker Plot.
6. Graphs covered in GGPlot2 package: Commonly Used Graphs: Bar Chart, Scatter Plot, Dot Chart, Strip Chart
7. Exploratory data analysis (EDA) (statistical plots for exploring one continuous or one discrete variable)

8. EDA for exploring two or more variables (different statistical plots)
9. Introduction to Matplotlib
10. Making line and Scatter plots
11. Adding Labels, Titles, Axis Ticks, and Changing Line Styles
12. Adjusting Plot Sizes, Adding a Legend, and Saving the Plots
13. A case study to select a diamond - to explain ggplot()

B.TECH Minor Degree in CSE

Serial No	Course code	Subject Name	Hours per Week			Credits
			L	T	P	
1	PCC	Fundamentals of Algorithms	3	0	4	5
		SELCT ANY TWO FROM 2,3,4,5,6 ….				
2	PCC	Python Programming	3	0	3	4.5
3	PCC	Introduction to Database Management Systems	3	0	3	4.5
4	PCC	Introduction to Machine Learning	3	0	3	4.5
5	PCC	Introduction to Object Oriented Programming	3	0	3	4.5
6	PCC	Fundamentals of Computer Networks	3	0	3	4.5
		Professional Electives Courses (PEC) – Choose any two courses from the following PEC				
7	PEC	1. Fundamentals of Artificial Intelligence 2. Software Engineering 3. Introduction to Data science 4. Introduction to Mobile application development 5. Introduction to Big data 6. Introduction to cloud computing ** Any other relevant course offered by MOOCs approved by internal BoS.	2 * 2	0	0	2*2 4
TOTAL			**13**		**10**	**18**

- **Out of first Six Professional Core Courses (PCC) the first course is mandatory.**
- **The student needs to choose 2 PCC from the rest of the four PCC (Sno. 2, 3, 4, 5, 6).**
- **Two courses need to be selected from the PEC.**
- **Total Theory Courses 5 => total credits 18**

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FUNDAMENTALS OF ALGORITHMS

Course Objectives:

1. Analyze different time complexity notations of algorithms.
2. Summarize the applications of non-linear data structures.
3. Describe the concepts of Advanced Trees.
4. Implementation of various Graph representations and traversals.
5. Outline the basic concepts of Hashing and Collision resolution Techniques.

Course Outcomes:

1. Analyze the performance of algorithms through asymptotic notations.
2. Apply Tree traversal algorithms in solving real time applications
3. Analyze the concepts of Advanced Trees to generate search efficiently
4. Interpret the importance of Graphs in solving real time applications
5. Implement the concepts of hashing and collision resolution algorithms

UNIT I

Introduction: Algorithm, Pseudo code for expressing algorithms, Performance

Analysis-Space complexity, Time complexity, Asymptotic Notation- Big oh notation,Omega notation, Theta notation and Little oh notation, Probabilistic analysis,Disjoint Sets- disjoint set operations, union and find operations**.**

UNIT II:

Trees: Basic terminology, Types of trees: Binary Tree: terminology, Complete and Full Binary Tree, Extended Binary Trees, Threaded Binary Trees-Inorder Threading. Representation of Trees using Arrays and Linked lists (advantages and disadvantages). Tree Traversal and Representation of Algebraic expressions; Algorithms for Tree Traversals,

Heaps: Introduction, types of Heaps – Min binary heap, Max binary heap.

UNIT III:

Advanced concepts on trees: Representation and Creation of Binary Search Trees (BST), Algorithm for Inserting, deleting and searching in BST. Representation and advantages of AVL Trees, algorithms on AVL Trees-Insertion, Rotation and Deletion. Definition and advantages of B-trees, B Tree of Order M, operations-Insertion and Searching, Introduction to Red-Black Trees and Splay Trees.

UNIT IV:

Graphs: Basic terminology, Representation of graphs: sequential representation (Adjacency, Path Matrix) Linked representation.

Graph Traversals-Breadth First Search, Depth First Search with algorithms. Definition and properties of Spanning Tree, Minimum Spanning Tree, Minimum Spanning Tree Algorithms, Dijkstra Algorithms.

UNIT V:

Hashing: General Idea, Hash Functions, Collision Resolution- Separate Chaining, Open Addressing-Linear probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing, Implementation of Dictionaries

Textbooks:

1. Seymour Lipschutz, Schaum's Outlines, Data Structures, Special Second Edition, Tata McGraw-Hill.
2. Fundamentals of computer algorithms, Ellis Horowitz,Satraj Sahni and Rajasekharam ,Galgotia publications Second Edition 2007

References:

1. Introduction to Design and Analysis of Algorithms A strategic approach ,R.C.T.LeeSS Tseng Mc GrawHill
2. Data structures and Algorithm Analysis in C++,Allen Weiss, secondedition,Pearson education
3. 1. Richard F.Gillberg & Behrouz A. Forouzan, Data Structures, A Pseudo code Approach with C, Second Edition, Cengage Learning, India Edition, 2005.
4. Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI Learning Private Limited, Delhi India.

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PYTHON PROGRAMMING

Prerequisites: None

Course Objectives:

1. Understand the basics and function of Python Programming Language
2. Understand the string operation and sequences used in Python Programming Languages

Course Outcomes:

1. Apply functions and packages in Program Design
2. Solve the problems based on decision control statements
3. Develop programs on functions
4. Analyze various String handling functions
5. Apply various file handling techniques for better data management

Unit-I

Basics of Python Programming: Features of Python, History of Python, The Future of Python, Writing and Executing First Python Program, Literal Constants, Numbers, Strings, Variables and Identifiers, Data Types, Assigning or Initializing Values to Variables, Multiple Assignment, Multiple Statements on a Single Line, Boolean, Input Operation, Comments, Reserved Words, Indentation, Operators and Expressions, Other Data Types

Unit-II

Decision Control Statements: Introduction to Decision Control Statements, Selection/Conditional Branching Statements, Basic Loop Structures/ Iterative Statements, The break Statement, The continue Statement, The pass Statement, The else Statement used with Loops.

Unit-III

Functions and Modules: Introduction, Need for Function, Function Declaration and Definition, Function Definition, Function Call, Function Parameters, Variable Scope and Lifetime, The return statement, More on Defining Functions Lambda Functions or Anonymous Functions, Documentation Strings, Recursive Functions, Modules, Packages in Python, Standard Library modules, Global(), Locals(), and Reload(), Function Redefinition.

Unit-IV

Python Strings Revisited: Introduction, Concatenating, Appending, and Multiplying Strings, Strings are Immutable, String Formatting Operator, Built-in String Methods and Functions, Slice Operation, Specifying Stride While Slicing Strings, ord() and chr() Functions, in and not in operators, Comparing Strings, Iterating String, The String Module, Regular Expressions, Meta characters in Regular Expression.

Unit-V

File Handling: Introduction, File Path, Types of Files, Opening and Closing Files, Reading and Writing Files, File Positions, Renaming and Deleting Files, Directory Methods.

Text Books

1.“ReemaThareja”, Python Programming using Problem Solving Approach, First Edition, Oxford Higher Eduction.

2.James Payne, Beginning Python using Python 2.6 and Python 3

Suggested / Reference Books

1.Kenneth A.Lambert, Fundamentals of Python

2.Charles Dierach, Introduction to Computer Science using Python

Web References:

https://www.codecademy.com/learn/learn-python

https://www.edx.org/learn/python

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INTRODUCTION TO DATABASE MANGEMENT SYSTEMS

Course Objectives:

Course Objectives of Database Management Systems are to:

6. Discuss Database management systems, databases and its applications
7. Familiarize the students with a good formal foundation on the relational model.
8. Outline the various systematic database design approaches
9. Describe the concepts of transactions and transaction processing and the issues, techniques related to concurrency and recovery manager.
10. Explore the File organizations, indexing and hashing mechanisms.

Course Outcomes:

At the end of this Database Management Systems course, students will be able to:

1. Model Entity-Relationship diagrams for enterprise level databases.
2. Formulate Queries using SQL and Relational Formal Query Languages.
3. Apply different normal forms to design the Database.
4. Summarize concurrency control protocols and recovery algorithms.
5. Identify suitable Indices and Hashing mechanisms for effective storage and retrieval of Data.

UNIT I:

Introduction to Database System Concepts: Database-System Applications, Purpose of Database Systems, View of Data, Database Language, Database Design, Database Architecture, Database Users and Administrators.

Introduction to the Relation Models and Database Design using ER Model: Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Languages, Relational Operations Overview of the Design Process, The Entity-Relationship Model, Constraints, Entity-Relationship Diagrams-Unary, Binary, ternary, Aggregation.

UNIT II:

Introduction to SQL: Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Aggregate Functions, Nested Sub queries.

Formal Relational Query Languages: The Relational Algebra, Tuple Relational Calculus.

UNIT III:

Relational Database Design: Features of Good Relational Designs, Atomic Domains and First Normal Form, Functional Dependencies, Boyce Codd Normal form, , Third Normal Form,

Transactions: Transaction Concept, A Simple Transaction Model, Storage Structure, Transaction Atomicity and Durability, Serializability.

UNIT IV:

Concurrency Control: Lock-Based Protocols, Deadlock Handling, Multiple Granularity, Timestamp-Based Protocols,

Recovery System: Failure Classification, Storage, Recovery and Atomicity, ARIES, Remote Backup Systems.

UNIT V:

File Organization: Fixed and variable length records, Sequential file organization, Buffer manager.

Indexing and Hashing: Basic Concepts, Ordered Indices, B+-Tree Index Files, B+-Tree Extensions, Static Hashing, Extendible Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices.Pearson 2006

3. P Raja Sekhar Reddy, A MallikarjunaReddy, Foundations of Database Management Systems, Lambert Academic Publishing, 2020 (e-Book)

4. https://www.pdfdrive.com/fundamentals-of-database-systems-pdf-e51477130.html

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INTRODUCTION TO MACHINE LEARNING

Course Objectives:

To understand the need for machine learning for various problem solving

1. To study the various supervised and unsupervised learning algorithms in machine learning
2. To understand the latest trends in machine learning
3. To design appropriate machine learning algorithms for problem solving

Course Outcomes:

Student will be able to:

1. Understanding fundamental concepts of machine learning and its applications (L1)
2. Applying Supervised Learning Methods to achieve the accuracy on the training data.(L3)
3. Examining Unsupervised Learning algorithms on various applications .(L4)
4. Evaluation of Ensemble learning for better prediction. (L4)
5. Designing the reinforcement learning strategies for solving real time problems.(L6)

UNIT I: Introduction to Machine Learning

What is Machine Learning, Why Machine Learning, Types of Machine Learning Systems, Challenges of Machine Learning, A first Application –Classifying Iris Species.

UNIT II: Supervised Learning

Classification and Regression, Supervised Machine Learning Algorithms, Sample Datasets, k-Nearest Neighbors, Bayes Theorem, Naive Bayes Classifiers, Decision Trees.

UNIT III: Unsupervised Learning and Preprocessing

Types of Unsupervised Learning, Challenges in Unsupervised Learning, Preprocessing and Scaling, clustering, k-Means Clustering,

UNIT IV: Ensemble Learning and Random forest

Voting Classifiers, Bagging and pasting, Random Patches and Random subspaces, Random Forest

UNIT V: Dimensionality Reduction

The curse of Dimensionality, main approaches to Dimensionality reduction, PCA,

Reinforcement Learning - Learning to Optimize Rewards.

Text Books:

1. **Introduction to Machine Learning with Python by Andreas C. Müller, Sarah Guido October 2016,O'Reilly Media, Inc.**
2. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow

   Concepts, Tools, and Techniques to Build Intelligent Systems, By Aurélien Géron · 2019

Reference Books:

1. Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
2. Ethem Alpaydin, —Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
3. Stephen Marsland, —Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
4. http://www.cs.cmu.edu/~tom/mlbook.html

ANURAG UNIVERSITY

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

B.TECH Minor Degree in CSE

B.Tech. Minor Degree in CSE	L	T / P / D	C
	3	3	4.5

INTRODUCTION TO OBJECT ORIENTED PROGRAMMING

Prerequisites: Any programming language

Course Objectives:

1. Understand the C++ program structure and also the basics of C++ Programming language.
2. Use input and output formatted stream classes and the file streams and file modes to access the files.
3. Know the template classes and functions and Runtime error and how to handle that error.

Course Outcomes:

Student will be able to:

1. Describe the important concepts of object oriented programming like object and class, Encapsulation, inheritance and polymorphism
2. Develop the applications using object oriented programming with C++.
3. Implement the concept of inheritance and polymorphism.
4. Apply I/O streams and files to develop programs for real time problems.
5. Apply advance features like templates and exception handling to make programs supporting reusability and sophistication

Unit I :

Concepts of OOP: Introduction to OOP, Procedural versus Object Oriented Programming, Principles, Benefits and applications of OOP, Procedure-Oriented Paradigms, Object Oriented Paradigm

Unit II :

C++ Basics: Overview, Program structure, namespace, identifiers, variables, constants, enumerations, operators, typecasting, control structures.

C++ Functions: Simple functions Call and Return by reference, Inline functions, Overloading of functions, default arguments, friend functions, and virtual functions.

Unit III :

Objects and classes: Basics of object and class in C++, Private and public members, static data and function members, constructors and their types, destructors, operator overloading.

Inheritance: Concept of Inheritance, types of inheritance: single, multiple, multilevel, hierarchical, hybrid, protected members, overriding, virtual base class.

Unit IV:
Polymorphism: Pointers in C++, Pointers and Objects, this pointer, virtual and pure virtual functions, implementing polymorphism.
I/O Streams: Concept of streams, cin and cout objects, C++ stream classes, Unformatted and formatted I/O, manipulators.

Unit V:
Templates: Function and class templates, overloading of template functions.
Exceptions: Basics of exception handling, exception handling mechanisms, throwing, catching mechanisms, rethrowing an exception.

Text Books:

1. E Balagurusamy, Object Oriented Programming with C++, , Sixth Edition, TATA McGraw Hill, 2013.
2. ‘Herbert Schlitz ,The Complete Reference C++,Fourth Edition, TATA McGraw Hill, 2003.

Reference Books:

1. SauravSahay, Object Oriented Programming in C++, Second Edition, Oxford University Press, 2012.
2. Steven Holzner,C++ Programming, Black Book, Dreamtech
3. Robert Lafore , Object Oriented Programming in Turbo C++,, Galgotia
4. Ashok Kamthane, Object Oriented Programming with ANSI and Turbo C++, Pearson

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INTRODUCTION TO COMPUTER NETWORKS

Prerequisites: C Programming Language and Data Structures.

Course Objectives:

1. Elaborate on the fundamental concepts of computer networks and network models.
2. Interpret the error and flow control mechanisms in the data link layer.
3. Explore the knowledge of various routing algorithms.
4. Describe the transport layer and application layer functionalities.
5. Analyze various Symmetric and Asymmetric Encryption Algorithms.

Course Outcomes:
At the end of the course, students will be able to:

6. Illustrate the functionalities of various network models and Data link Layer. (L4)
2. Analyze error and flow control mechanisms in the data link layer. (L4)
3. Examine various Routing Protocols. (L4)
4. Identify the suitable transport and application layer protocols for specific applications. . (L4)
5. Compare various Symmetric and Asymmetric Encryption Algorithms (L1)

Unit - I:

Introduction to computer Networks: Layered Tasks, OSI model, Layers in the OSI model, TCP/IP protocol Suite, Addressing.

Data Link Control: Error detection and Correction codes - parity and hamming codes.

Unit - II:

Data Link Layer: Framing, Data Link Layer protocols: Stop and wait protocol, selective repeat and Go –back N protocol, HDLC.

Unit- III:

Routing protocols: Distance Vector Routing, Link State Routing, Path Vector Routing; Network addressing: IPV4 and IPV6 Addresses, Header formats of IPV4 and IPV6.

Unit- IV:

Transport and Application Layer: Process-to-Process delivery, TCP, UDP.
Domain Name System : Domain Name Space, Distribution of Name Space, DNS in Internet, Resolution, Domain Name Space (DNS) Messages, Electronic mail, File Transfer Protocol.

Unit-V:
Cryptography: Introduction to cryptography, Attacks: Active and Passive, Symmetric-Key Cryptography: DES Structure, AES Structure, Asymmetric-Key Cryptography: RSA, Diffe-Hellman.

Text books:

1) Andrew S. Tanenbaum, Computer Networks, Third Edition.
2) Behrouz A Forouzan ,Data Communications and Networking,4th Edition, McGraw-Hill.

Reference Books:

1) William Stallings, Data Communications, Eight Edition, Pearson Publishers.
2) Sudakshina Kunda, Fundamentals of Computer Networks, Second Edition, PHI Publisher.
3) http://highered.mheducation.com/sites/0072967757/student_view0/index.html

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FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE (PE)

Pre-requisite: Programming Knowledge, Computer Organization

Course Objectives:

1. The main objective of this course is to introduce the basic concepts of artificial intelligence, its foundations
2. To analyze various search strategies in intelligent systems
3. To apply search algorithms in games
4. To learn various representations of logic and knowledge
5. To understand production systems and its components

Course Outcomes:

At the end of this course, students will be able to:

1. Understand Strong AI and Weak AI and identify problems applicable to AI
2. Compare and contrast various uninformed and informed search algorithms to find an optimal solution for a given problem
3. Apply appropriate search algorithms for winning games
4. Learn various representations applicable to logic and knowledge useful in reasoning
5. Learn to apply appropriate inference methods in production or expert systems

Unit I: Overview of Artificial Intelligence: Introduction. The Turing Test, Strong AI versus Weak AI, Heuristics, Identifying Problems Suitable for AI, Applications and Methods, Early History of AI, Recent History of AI to the Present, AI In the New Millennium

Unit II : Uninformed Search: Introduction: Search in Intelligent Systems, State-Space Graphs, Generate-and-Test Paradigm, Blind Search Algorithms, Implementing and Comparing Blind Search Algorithms **Informed Search:** Introduction, Heuristics, Informed Search Algorithms – Finding Any Solution, The Best-First Search, The Beam Search, Additional Metrics for Search Algorithms, Informed Search – Finding An Optimal Solution,

Unit III: Search Using Games: Introduction, Game Trees and Minimax Evaluation, Minimax With Alpha-Beta Pruning, Variations and Improvements To Minimax, Games of Chance and the Expectiminimax Algorithm

Unit IV: Logic in Artificial Intelligence: Introduction, Logic and Representation, PropositionalLogic, Predicate Logic – Introduction, Several Other Logics, Uncertainty and Probability **Knowledge**

Representation: Introduction, Graphical Sketches and the Human Window, Graphsand the Bridges of Königsberg Problem, Search Trees, Representational Choices, ProductionSystems, Object Orientation, Frames, Semantic Networks

Unit V: Production Systems: Introduction, Background, Production Systems and Inference Methods, Production Systems and Cellular Automata, Stochastic Processes and Markov Chains, Basic Features and Examples of Expert Systems

Text Books:

2. Stephen Lucci, Danny Kopec. Artificial Intelligence in the 21st Century. A Living Introduction.Mercury Learning and Information. 2nd Edition. 2016

Reference Books:

4. Russell, Norvig: Artificial Intelligence, A Modern Approach, Pearson Education, SecondEdition. 2004
5. Rich, Knight, Nair: Artificial Intelligence, Tata McGraw Hill, Third Edition 2009
6. Saroj Kaushik. Artificial Intelligence. Cengage Learning. 2011

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SOFTWARE ENGINEERING

(PE)

Prerequisites: Any programming language

Course objectives

1. Understand the framework activities for a given project.
2. Choose a process model for given project requirements.
3. Design various system models for a given scenario.
4. Design various testing techniques.
5. Understand metrics for Products.

Course Outcomes:

1. Outline the framework activities for a given project.
2. Apply Right process model for a given project.
3. Design various system models for a given Context.
4. Apply various testing techniques for a given project.
5. Identify various risks in project development.

Unit -I:

Introduction to Software Engineering: The evolving role of software, Changing Nature of Software, Software myths. A Generic view of process: Software engineering- A layered technology, a process framework, The Capability Maturity Model Integration (CMMI),

Process models: The waterfall model, Incremental process models, Evolutionary process model.

[TB-1,Ch-1,2,3]

Unit -II:

Agile process Model: Agile principles, Extreme programming, Dynamic System Development Methods, Feature Driven Development, Scrum framework, Sprint, Scrum master, Roles of Scrum Master, Implementing Scrum - A case study. [TB-1,Ch-4]

Software Requirements: Functional and non-functional requirements, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management. [TB-2,Ch-6,7]

Unit -III:

System models: Context Models, Behavioral models, Data models, Object models, structured methods. [TB-2,Ch-8]

Design Engineering: Design process and Design quality, Design concepts, the design model.Modeling component level design: design class based components, conducting component level design. Performing User interface design: Golden rules. [TB-1,Ch-9,11]

Unit -IV:

Testing Strategies: A strategic approach to software testing, test strategies for conventional software, Black-Box and White-Box testing, Validation testing, System testing.

Product metrics : Software Quality, Metrics for Analysis Model- function based metrics, Metrics for Design Model-object oriented metrics, class oriented metrics, component design metrics, Metrics for source code, Metrics for maintenance. [TB-1,Ch-13,14,15]

Unit -V:

Risk management: Reactive vs. Proactive Risk strategies, software risks, Risk identification, Risk projection, Risk refinement, RMMM, RMMM Plan.

Quality Management: Quality concepts, Metrics for Software Quality, Software Reviews, Formal Technical Reviews, Software Reliability, The ISO 9000 quality standards.

[TB-1,Ch-25,26]

Text Books:

1. Roger S. Pressman, Software Engineering - A practitioner‘s Approach, 6th edition. McGraw Hill International Edition, 2005.
2. Somerville, Software Engineering, 7th edition, Pearson education, 2009.

Reference Books:

1. K.K. Agarwal & Yogesh Singh, Software Engineering, New Age International Publishers,3rd edition, 2008
2. Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publishing House, 3rd edition 2005.
3. James F. Peters, Witold Pedrycz, Software Engineering - an Engineering approach, JohnWiely, 2007.
4. Waman S Jawadekar, Software Engineering Principles and Practice, The McGraw-Hill Companies, 2013.
5. https://nptel.ac.in/courses/106/105/106105182/
6. https://ff.tu-sofia.bg/~bogi/knigi/SE/Mcgraw%20Hill%20-%20Software%20Engineering%20-%20A%20Practitioner%27s%20Approach%20-%20Pressman%20(5Th%20Ed,2001,Bookmarked,Cover).pdf

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INTRODUCTION TO DATA SCIENCE

(PE)

Course Objectives:

6. To gain a foundational understanding of data science.
7. To understand the data exploration analysis in data science.
8. To understand and use basic machine learning algorithms for predictive modeling.
9. To understand and use the various graphics in R and Tableau for data visualization.
10. To understand the ethical and privacy issues in data science.

Course Outcomes:

6. Describe what Data Science is and the skill sets needed to be a data scientist.
7. Explain the significance of exploratory data analysis (EDA) in data science.
8. Apply basic machine learning algorithms for predictive modeling.
9. Learn to persuade effective visualization of given data.
10. Reason around ethical and privacy issues in data science conduct and apply ethicalpractices.

UNIT I:

Introduction To Data Science: What is Data Science, Big Data and Data Science hype – and getting past the hype,Why now? – Datafication, Current landscape of perspectives, Skill sets needed, StatisticalInference, Populations and samples, Statistical modeling, probability distributions, fitting a model, Introduction to R.

UNIT II:

Exploratory Data Analysis And The Data Science Process: Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA, The DataScience Process, Case Study.

UNIT III:

Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN), k-means, Motivating application: FilteringSpam, Why Linear Regression and k-NN are poor choices for Filtering Spam, Naive Bayes and why it works for Filtering Spam.

UNIT IV:

Data Visualization: Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects,Introduction to Tableau. Creating own visualization of a complex dataset.

UNIT V:

Data Science And Ethical Issues: Discussions on privacy, security, ethics, A look back at Data Science, Next-generation datascientists.

Text Books:

3. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.
4. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.

Reference Books:

5. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition. ISBN 0387952845. 2009.
6. Jiawei Han, Micheline Kamber and Jian Pei. Data Mining: Concepts and Techniques, Third Edition. ISBN 0123814790. 2011.
7. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
8. https://docs.google.com/file/d/0B6iefdnF22XQeVZDSkxjZ0Z5VUE/edit?pli=1

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INTRODUCTION TO MOBILE APPLICATION DEVELOPMENT

(PE)

Course Objectives:

1. Outline the usage of Android development framework.
2. Understand the main components of an Android application and its entire life Cycle.
3. Develop database programming using SQLite.
4. Identify the use of location-based service in android applications.
5. Build SMS and MMS applications using Intents.

Course Outcomes:

At the end of this Mobile Application Development course, students will be able to:

1. Analyze the architecture of android and current trends in mobile operating systems.
2. Apply suitable software tools and APIs for the design of User Interfaces to a particular mobile application.
3. Design applications for mobile devices using SQLite Database.
4. Apply the location-based services in android applications.
5. Summarize the Monitoring changes to the phone, network, data connectivity and SIM states.

UNIT I:

Introduction to Android, Features of Android, The development framework**:** Understanding the Android Software Stack, Android Application Architecture; the Dalvik Virtual Machine, Creating First Android Application, Types of Android Applications, Android Development Tools: The Android Virtual Device Manager, Android Emulator, The Dalvik Debug Monitor Service.

UNIT II:

Creating applications and Activities: Introduction to the application Manifest File, Using the Manifest Editor, Externalizing Resources: Creating Resources - Simple Values, Drawables, Layouts, Menus, Animations.The Android Activity Life cycle. **Building User Interfaces:** Fundamental Android UI design, Introducing Layouts: Defining Layouts, Using Layouts to Create Device Independent User Interfaces, Optimizing Layouts.

UNIT III:

Databases and Content Providers: Introduction to Android Databases, Introducing SQLite, Content Values and Cursors, working with SQLite Databases - Introducing the SQLite OpenHelper, querying a Database, Extracting Values from a Cursor, Adding, Updating, and Removing Rows, Creating Content Providers, Using Content Providers - Introducing the Content Resolver, Querying Content Providers, Adding, Deleting, and Updating Content

UNIT IV:

Maps and Location based services: Using the location-based services, selecting a Location Provider, selecting a Location provider, finding current location; **Creating Map-Based Activities**: Introducing Map View and Map Activity, Creating a Map-Based Activity, Maps and Fragments

UNIT V:

Telephony and SMS: Using telephony - Initiating Phone Calls, Accessing Telephony Properties and Phone State, Monitoring Changes in Phone State Using the Phone State Listener, Introducing SMS and MMS - Using SMS and MMS in Your Application, Sending SMS and MMS from Your Application Using Intents, Sending SMS Messages Using the SMS Manager.

Text Book:

1. Reto Meier, Professional Android 4 Application Development, 1stEdition, Wrox Press, Wiley Publishing, 2014.

Reference Books:

1. Pradeep Kothari, Android Application Development (with Kitkat Support), Black Book, 2014, Dreamtech Press publisher, Kogent Learning Inc., 2014
2. Erik Hellman, Android Programming: Pushing the Limits, 1st Edition, Wiley Publications, 2014.
3. Mike Wolfson, Android Developer Tools Essentials, O’Reilly Edition, 1st Edition, 2013.

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INTRODUCTION TO BIG DATA

(PE)

Prerequisite: Database management system, Java and Linux

Course Objectives:

1. Identify various tools and techniques in big data analytics
2. Distinguish Hadoop and related technologies.
3. Apply the development of applications using MapReduce, HDFS, YARN
4. Illustrate Enterprise Data Science and data visualization tools
5. Distinguish various NoSQL databases

Course Outcomes: *Students will be able to:*

6. Identify need of big data and various analytical tools [L2]
7. Analyze various components HDFS [L4]
8. Apply several data intensive tasks using Map-Reduce paradigm [L3]
9. Demonstrate the applications of Enterprise Data Science and data visualization tools [L3]
10. Compare various NoSQL databases [L4]

Unit I: Overview of Big Data Analytics: Introduction to Data Analytics and Big Data, Evolution of big data, Challenges with Traditional Large Scale Systems, characteristics (3 V's), types (structured, semi-structured and unstructured) and sources of Big Data, Distributed, Parallel Computing and Cloud Computing for big data. **Analytics Toolkit:** Components of the analytics toolkit, Analytical Sandbox: Internal, External and Hybrid.

Unit II: Hadoop Distributed File System (HDFS): Hadoop Architecture: HDFS, MapReduce, YARN, **HDFS Architecture:** Name node, Data node, Secondary Name Node, Scaling Out – Block, Data Flow, Replica.

MapReduce: Phases (Mapper, Sort and Shuffle, Reducer), **YARN:** Combiner Functions, Streaming, HDFS, filesystems, Job Scheduling, I/O, Data Integrity, Compression, Serialization, File based Data Structures, Developing a MapReduce Application.

Unit III: Hadoop Cluster and MapReduce: Hadoop Cluster specification and modes of operation, Hadoop installation and configuration, YARN configuration, Sample Map Reduce Application. HDFS Concepts-Interacting HDFS using command line-Interacting Java API.

Unit IV: Introduction to data visualization: What is data visualization, Importance of data exploration and data visualization. Fundamentals: Design principles, Dashboards, Visualization tools, Data Visualization in Healthcare and Media & Entertainment.

Unit V: Hadoop Ecosystem: Apache Spark, Zookeeper and Sqoop. Introduction to Languages and Databases: Pig, Hive. NOSQL Databases: Cassandra, Mongo, Cloudera, CouchDB, Hbase

Text Books:

1. Tom White, Hadoop: The Definitive Guide, 3rd Edition, O'Reilly, 2012.
2. Sridhar Alla, Big Data Analytics with Hadoop3, Packt Publication, 2018.
3. DT Editorial Services, Big Data: Black Book, 2016.

REFERENCES:

1. Michael Minelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business", 1st Edition, Ambiga Dhiraj, Wiely CIO Series, 2013.
2. Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", 1st Edition, IBM Corporation, 2012.
3. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", 1st Edition, Wiley and SAS Business Series, 2012.

Web Resources:

1. https://cognitiveclass.ai/learn/big-data
2. https://hadoop.apache.org/
3. https://mschermann.github.io/data_viz_reader/

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INTRODUCTION TO CLOUD COMPUTING
(PE)

Prerequisites: Computer organization and computer networks.

Course Objectives:

9. To understand the concepts of virtualization and its benefits
10. To impart fundamental concepts in the area of cloud computing.
11. To impart knowledge in applications of cloud computing.
12. To understand various services in cloud applications
13. To know the architecture of disaster recovery and security of cloud

Course Outcomes:
At the end of the course the students will be able to:

11. Compare and contrast various cloud architectures. (L4)
12. Learn & Implement Virtualization .(L3)
13. Analyze and design storage mechanisms. (L4)
14. Apply security mechanism for the Cloud. (L3)
15. Discuss Disaster recovery in Cloud .(L5)

Unit I:

Introduction to Virtualization: Objectives of virtualization, history of virtualization, benefits of virtualized technology, the virtual service desk, what can be virtualized, related forms of computing, cloud computing, software as a service – SaaS, grid computing, utility computing, virtualization processes.

Virtualization Technologies-I: Ubuntu (server edition),Altiris, Windows server, Software virtualization, VMware, Intel virtualization, Red Hat virtualization, Soft grid application, Linux virtualization, Desktop virtualization, Hardware virtualization, Resource virtualization, Processor virtualization, Application virtualization.

Unit II:

Virtualization Technologies-II: Storage virtualization, Virtualization density, Para-virtualization, OS virtualization, Virtualization software, Data Storage virtualization, Intel virtualization technology, Thinstall virtualization suite, Net framework virtualization, Windows virtualization on Fedora, Storage virtualization technologies, Virtualization level, Security monitoring and virtualization, Oracle virtualization.

Unit III:

Virtualization and Storage Management: The heart of cloud computing-virtualization, defining virtualization, why virtualize, what can be virtualized, where does virtualization happen, how does virtualization happen, on the road to storage virtualization, improving availability using virtualization, improving performance through virtualization, improving capacity through virtualization, business value for virtualization.

Unit IV:

Introduction to Cloud Computing: Cloud Introduction and overview- Components, Infrastructure and Services, Why Use Cloud Computing, Benefits and Limitations, Cloud Application Architectures, Cloud Infrastructure Models, Cloud Computing Technology- Hardware & Software Infrastructure

Cloud Computing Architecture: Requirements, Introduction to Cloud Computing Architecture, various kinds of Cloud Computing Architecture, Grid Computing, Transactional Computing, On Demand Computing, and Distributed Computing.

Unit V:

Security: Security issues in Cloud Computing - Data Security, Network Security, and Host Security

Disaster Recovery: Disaster Recovery Planning, Disasters in the Cloud, Disaster Management.

Scaling a Cloud Infrastructure- Capacity Planning, Cloud Scale.

Case Studies: Amazon S3, Google APP Engine, IBM Clouds, Oracle OBIEE

Text Books:

13. Ivanka Menken, Gerard Blokdijk ,Cloud Computing Virtualization Specialist Complete Certification Kit - Study Guide Book, 2009.
4. George Reese, Cloud Application Architectures Building Applications and Infrastructure in the Cloud, O'Reilly Media Press, 2009.

Reference Books:

7. Anthony T. Velte, Tobe J. Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Publication Person Education, 2009
8. Tom Clark, Storage Virtualization: Technologies for Simplifying Data Storage and Management, Addison-Wesley, 2005
9. Curtis Brian J.S. Chee, Cloud Computing Technologies and Strategies of the Ubiquitous Datacenter, 2010

Web Resource:

3. https://bibliotech2803.files.wordpress.com/2018/04/cloud-application-architectures-oreilly-media.pdf

Electronics and Communication Engineering

ANURAG UNIVERSITY
Department of Electronics and Communication Engineering
Board of Studies Meeting 2021
Minutes of the meeting

Date: 30th June 2021

The e-Minutes of the third Board of Studies (BoS) Meeting of the Department of Electronics and Communication Engineering (ECE), Anurag University was circulated on 16-May- 2021, to all BoS members for the e-approval of the course structure and syllabus of the new PG course M.Tech (Robotics & Automation) to be started from the academic year 2021.

The following members have responded to the meeting and given e-approval:-

Dr. K. S. Rao, Director, Chairperson
Dr. S. Satheeskumaran, HOD/ECE, AU
Dr. P. Chandrasekhar, OU
Dr. Gajendranath Choudary, IIT, Hyderabad
Dr. M. Chakravarthy, Scientist -G, DLRL
Dr. Shantha Thoutam, Startup Evangelist
Dr. D. Narendhar Singh, AU

The agenda of the BOS meeting are:

1. To approve the curriculum structure of R2021 M.Tech (Robotics & Automation).
2. To approve the syllabus of B.Tech Minor degree & Honors Degree

Agenda No.1:- Curriculum structure of M.Tech (Robotics & Automation):
Resolution: The BoS members have given e-approval for the Course structure and syllabus of M.Tech (Robotics & Automation) .

Agenda No.2: Syllabus of B.Tech Minor degree & Honors Degree
Resolution: The BoS members have given e-approval for the syllabus of Minor Degree & Honors Degree courses. In any case, if there are minor changes or amendments either in course structure or syllabus, they will be communicated to all BOS members through e-mail for e- approval.

Chairperson, BOS

ANURAG UNIVERSITY

School of Engineering

Department of Electronics and Communication Engineering

M.Tech. Robotics and Automation

Semester-I

S. No.	Category	Course	Scheme of Studies per Week			Credits
			L	T	P	
1.	PC-I	Microcontrollers and Embedded Systems	3	0	0	3
2.	PC-II	Instrumentation & Sensors	3	0	0	3
3.	PE-I	Computer Vision Wireless Sensors Networks Soft Computing	3	0	0	3
4.	PE-II	AI & Deep Learning Application of Optimization Techniques Networks & Communication	3	0	0	3
5.	PE-III	Motion Control and Path Planning Advanced Microcontrollers FPGA Based System Design	3	0	0	3
6.		Research Methodology	2	0	0	2
7.	LAB-I	Embedded Systems & IoT Laboratory	0	0	4	2
8.	LAB-II	Computer Vision & Deep Learning Laboratory	0	0	4	2
Total			**17**	**0**	**8**	**21**

Semester-II

S. No.	Category	Subject	Scheme of Studies per Week			Credits
			L	T	P	
1.	PC-III	Robot Control System	3	1	0	4
2.	PC-IV	Robot Operating System	3	1	0	4
3.	PE-IV	Computer Aided Modeling and Design Artificial Intelligence for Robotics Advanced Signal Processing	3	0	0	3
4.	PE-V	Electrical Machines and Drives IoT Applications Design and Analysis of Algorithms	3	0	0	3
5.	OE	Open Elective	3	0	0	3
6.		Audit Course	2	0	0	0
7.	LAB-III	Robot Operating System Laboratory	0	0	4	2
8.	LAB-IV	AI & Robot control lab	0	0	4	2
Total			**17**	**0**	**8**	**21**

Semester-III

S.No.	Subject	Scheme of Studies per Week			Credits
		L	T	P	
1.	Project Review I	0	0	24	12
Total		**0**	**0**	**24**	**12**

Semester-IV

S.No.	Subject	Scheme of Studies per Week			Credits
		L	T	P	
1.	Project Review II	0	0	28	14
Total		**0**	**0**	**28**	**14**

Audit Courses:

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills

Open Electives:

1. Business Analytics
2. Industrial Safety
3. Operations Research
4. Cost Management of Engineering Projects
5. Composite Materials
6. Waste to Energy
7. Intellectual Property Rights

M. Tech – I Year – I Sem **L T P C**
3 0 0 3

MICROCONTROLLERS AND EMBEDDED SYSTEMS

Course Objectives:

- To provide students with the Knowledge of Microprocessors and Microcontroller.
- To learn architecture, programming and system design used in various day to day gadgets
- To understand the necessity of peripherals and interfacing
- To learn the typical embedded system with memory elements
- To familiarize with embedded firmware

Course Outcomes:

After completing the course, students should be able to

- Acquire knowledge about microcontrollers embedded processors and their applications.
- Foster ability to understand the internal architecture and interfacing of different peripheral devices with Microcontrollers.
- Foster ability to write the programs for microcontroller.
- Foster ability to understand the role of embedded systems in industry.
- Foster ability to understand the design concept of embedded systems

UNIT-I:
8051 ARCHITECTURE

Basic organization – 8051 CPU structure – Register file – Interrupts – Timers – Port circuits – Instruction set – Timing diagram – Addressing modes – Simple Program and Applications.

UNIT-II:
PERIPHERALS AND INTERFACING

Typical Bus structure – Bus – memory organization – Timing characteristics – Extended Model and Memory Interfacing – Polling – Interfacing Basic I/O devices – Analog and Digital interfacing – PWM mode operation – Serial port application.

UNIT-III:
Introduction to Embedded Systems

Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

UNIT-IV:
Typical Embedded System:

Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

UNIT-V:
Embedded Firmware:

Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages

TEXT BOOKS:

1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.

REFERENCE BOOKS:

1. Embedded Systems - Raj Kamal, TMH.
2. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
3. Embedded Systems – Lyla, Pearson, 2013
4. An Embedded Software Primer - David E. Simon, Pearson Education

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3 0 0 3

INSTRUMENTATION & SENSORS

Course Objectives:

- To explain the concept of intelligent instrumentation and impart knowledge on automation.
- To impart knowledge about the principles and analysis of sensors.
- To build an sensing system for measurement of different measure and using different types of optical fibers

Course Outcomes:

After completing the course, students should be able to

- Familiar with the basics of measurement system and its input, output configuration of measurement system.
- Familiar with both static and dynamic characteristics of measurement system.
- Familiar with the principle and working of various sensors and transducers.
- Able to design signal conditioning circuit for various transducers.
- Able to identify or choose a transducer for a specific measurement application.

UNIT -I

Measuring System: Sensor Systems – Classification of sensors: Factors in making the measurements-accuracy, precision, resolution, repeatability, reproducibility, hysteresis, sensitivity, range, selection and standard of sensors – SI Units – Base units of SI - Errors in Measurement – Types of errors – Calibration techniques..

UNIT -II

Transducers and Flow Measurement.: Principles and classification of transducers, guidelines for selection and application of transducers, basic requirements of transducers. Different types of transducers. Flow and Level Measurement: Venturi flow meters, Electro-Magnetic flow meter- Level Measurement Techniques

UNIT -III

Displacement & Velocity Measurement: Linear and angular measurement systems – Resistance potentiometer, strain gauge, capacitive transducers and variable inductance transducers, resolvers, LVDT, ultrasonic and photo-electric sensors - linear scales, Laser Interferometers, tacho-generator, Encoders: absolute and incremental.

UNIT -IV

SENSORS FOR ROBOTICS: Classification, characteristics and calibration of different sensors, position sensors, motion sensors, force sensors, torque sensors, strain gauge sensors, pressure flow sensors, temperature sensors, tactile and proximity sensors, Principles and structures of modern micro sensors.

UNIT -V
OPTOELECTRONIC SENSORS: Photo detector, Thermal detector, Photo Conductors, Photo diodes, LED, PIN, APD, Phototransistors, solar cells, CCDs, IR and UV detectors, Detector Performance

TEXT BOOKS:

1. Nakra and Chaudhry, "Instrumentation, Measurement and Analysis”, Tata McGraw-Hil
2. Peter Elgar,”Sensors for Measurement and Control”, Addison-Wesley Longman Ltd, 1998.
3. Patranabis D, “Sensors and Transducers”, Prentice-Hall of India Private Limited, New Delhi, 2003.
4. D.V.S. Murthy, "Transducers and Instrumentation", PHI 2003.
5. Albert D Helfrick and William D Cooper, "Modern Electronic Instrumentation and Measurement Techniques" 2004, PHI.

REFERENCE BOOKS:

1. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", Springer, 3rd Ed., 2004.
2. Ernest O.Doebelin, "Measurement system", McGraw-Hill Publishing Company, 1996.
3. C. S. Rangan, ”Instrumentation: Devices and Systems” McGraw-Hill Education,1983.
4. Webster John G., "Instrumentation and Sensors Handbook", CRC Press, 1st Ed., 1999.

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3 0 0 3

COMPUTER VISION

Course Objectives:

- To illustrate shape and region analysis
- To describe Hough Transform and its applications to detect lines, circles, ellipses
- To discuss three-dimensional image analysis techniques
- To discuss motion analysis
- To explore some applications of computer vision algorithms

Course Outcomes:

After completing the course, students should be able to

- To review image processing techniques for computer vision
- To illustrate shape and region analysis
- To describe Hough Transform and its applications to detect lines, circles, ellipses
- To discuss three-dimensional image analysis techniques
- To explore some applications of computer vision algorithm

UNIT -I

Introduction to Computer Vision: Overview and State-of-the-art, The Four Rs of Computer Vision, Geometry of Image Formation, Digital Image Formation and low-level processing, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Classification of image processing operations- Arithmetic operations, Logical operations.

UNIT -II

Depth estimation and Multi-camera views, Robust Correspondence Estimation, Perspective, Edge Detection, Binocular Stereopsis: Camera and Epipolar Geometry;
Texture: Representation of texture, Analysis of using oriented pyramids, synthesizing texture and shape from texture.
Image Filtering: Linear filters and convolutions, shift invariant linear system, spatial frequency, sampling and aliasing, Filters as Templates.

UNIT III

Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.Recognition: Building blocks, Detectors and Descriptors, SIFT & Single Object Recognition, Optical Flow & Tracking, Introduction to Object Recognition and Bag-of Words Models, Constellation model, foot-of-normal method – line localization – line fitting

UNIT -IV

Use of Surface Smoothness Constraint; sources and their effects, local shading models
Edge detection: Noise, estimation derivatives, detecting edges, Feature Extraction, Edges - Canny, LOG, DOG,Color : The physics of color , Human color perceptron, representing color and color models – like RGB, HSV and **CMYK** models, Face Detection, Image Segmentation, Feature Tracking & Motion Layers.

UNIT-V

Recognition: Objects, Scenes, Activities, Object classification and detection: a part-based discriminative model (Latent SVM), Objects in Scenes. Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo;3D vision and motion : Methods for 3D vision – projection schemes – shape from shading –photometric stereo – shape from texture

TEXT BOOKS:

1. Computer Vision: A Modern Approach, D. Forsyth and J. Ponce, Prentice Hall, 2nd ed., 2015, 2nd Edition.
2. Prince, Simon JD. Computer vision: models, learning, and inference. Cambridge University Press, 2012, 1st Edition. References: 4) Computer Vision: Algorithms and Applications, by Richard Szeliski, 2011 Edition, Springer.

REFERENCE BOOKS:

1. Computer Vision: Algorithms and Applications, by Richard Szeliski, 2011 Edition, Springer.
2. Introductory Techniques for 3D Computer Vision, Emanuele Trucco and AlessandroVerri, Prentice Hall.1998, 1st Edition.

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3 0 0 3

WIRELESS SENSORS NETWORKS

Course Objectives:

- To understand the WSN node Architecture and Newtork Architecture
- To identify the Wireless Sensor Network Platforms
- To program WSN using embedded C
- To design and Develop wireless sensor node

Course Outcomes:

After completing the course, students should be able to

- Understand the basis of Sensors with its applications
- Learn the architecture and placement strategies of Sensors
- Analyze routing and congestion algorithms
- Design, develop , and carry out performance analysis of sensors on specific applications
- Explore and implement solutions to real world problems using sensor devices, enumerating its principles of working

UNIT –I

OVERVIEW OF WIRELESS SENSOR NETWORKS:

Concept of Wireless sensor network (WSN), Architecture of WSN, Challenges for designing of WSN, Enabling Technologies for Wireless Sensor Networks

Robotics**:** A brief history of Robotics**,** General structure of Robotic mechanical system, Different types of robotics systems

UNIT -II

ARCHITECTURES:

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts

UNIT -III

NETWORKING SENSORS:

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing

UNIT -IV

INFRASTRUCTURE ESTABLISHMENT:

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control

UNIT -V

SENSOR NETWORK PLATFORMS AND TOOLS:

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulation, State-centric programming

TEXT BOOKS:

1. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007

REFERENCE BOOKS:

1. Kazem Sohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols, and Applications", John Wiley, 2007.
2. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003

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3 0 0 3

SOFT COMPUTING

Course Objectives:

- To familiarize with Artificial Intelligence, Various types of production systems, characteristics of production systems
- To know the fundamentals of soft computing approaches
- To understand Neural Networks, architecture, functions and various algorithms involved
- To Understand Fuzzy Logic, Various fuzzy systems and their functions
- To know about Genetic algorithms, its applications and advances

Course Outcomes:

After completing the course, students should be able to

- Develop application on different soft computing techniques like Fuzzy, GA and Neural network
- Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.
- identify and describe soft computing techniques and their roles in building intelligent machines
- recognize the feasibility of applying a soft computing methodology for a particular problem
- Effectively use modern software tools to solve real problems using a soft computing approach and evaluate various soft computing approaches for a given problem.

UNIT-I:

Neural Networks-1(Introduction & Architecture): Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory.

Unit-II :

Neural Networks-II (Back propogation networks) Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propogation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting backpropagation training, applications.

Unit-III :

Fuzzy Logic-I (Introduction): Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion.

Unit-IV :

Fuzzy Logic –II (Fuzzy Membership, Rules): Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications.

Unit-V :

Genetic Algorithm(GA): Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications.

TEXT BOOKS:

1. S. Rajsekaran & G.A. Vijayalakshmi Pai, “Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications” Prentice Hall of India.

2. N.P.Padhy,”Artificial Intelligence and Intelligent Systems” Oxford University Press. Reference Books:
3. Siman Haykin,”Neural Netowrks”Prentice Hall of India
4. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India.
5. Kumar Satish, “Neural Networks” Tata Mc Graw Hill

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3 0 0 3

AI AND DEEP LEARNING

Course Objectives:

- To introduce the basic concepts, theories and state-of-the-art techniques of artificial intelligence
- To introduce basic concepts and applications of machine learning
- To help students to learn the application of machine learning /A.I algorithms
- To know the applications of AI in the different fields of science, medicine, finance etc

Course Outcomes:

After completing the course, students should be able to

- Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
- Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
- Demonstrate profciency developing applications in an 'AI language', expert system shell, or data mining tool.
- Demonstrate profciency in applying scientifc method to models of machine learning.
- Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.

UNIT I

INTRODUCTION: Introduction to machine learning- Linear models (SVMs and Perceptrons, logistic regression)- Intro to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates

UNIT II

DEEP NETWORKS

History of Deep Learning- A Probabilistic Theory of Deep Learning- Backpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow Networks Convolutional Networks- Generative Adversarial Networks (GAN), Semi-supervised Learning

UNIT III

DIMENTIONALITY REDUCTION

Linear (PCA, LDA) and manifolds, metric learning - Auto encoders and dimensionality reduction in networks - Introduction to Convnet - Architectures – AlexNet, VGG, Inception, ResNet - Training a Convnet: weights initialization, batch normalization, hyperparameter optimization.

UNIT IV

OPTIMIZATION AND GENERALIZATION

Optimization in deep learning– Non-convex optimization for deep networks- Stochastic OptimizationGeneralization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning - Computational & Artificial Neuroscience.

UNIT V

CASE STUDY AND APPLICATIONS

Imagenet- Detection-Audio WaveNet-Natural Language Processing Word2Vec - Joint Detection BioInformatics- Face Recognition- Scene Understanding- Gathering Image Captions

REFERENCES:

1. Cosma Rohilla Shalizi, Advanced Data Analysis from an Elementary Point of View, 2015.
2. Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.
4. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

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3 0 0 3

APPLICATION OF OPTIMIZATION TECHNIQUES

Course Objectives:
- Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems
- Learn classical optimization techniques and numerical methods of optimization
- Know the basics of different evolutionary algorithms
- Explain Integer programming techniques and apply different optimization techniques to solve various models arising from engineering areas

Course Outcomes:
After completing the course, students should be able to
- Students will be able to understand basic theoretical principles for formulation of optimization models and its solution.
- Students will be able to learn the unified and exact mathematical basis as well as the general principles of various soft computing techniques
- Students should be able to apply detailed theoretical and practical aspects of intelligent modelling, optimization and control of linear and non-linear systems.
- Direct and gradient based search techniques for single and multi-variable unconstrained optimization problems.
- Penalty and barrier function based techniques for constrained optimization problems.

UNIT I
INTRODUCTION: Introduction to optimization – adequate and optimum design – principles of optimization – statement of an optimization problem – classification – formulation of objective function, design constraints.

UNIT II
CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization –multivariable optimization with no constraints – exhaustive search, Fibonacci method, golden selection, Random, pattern and gradient search methods – Interpolation methods: quadratic and cubic, direct root method.

UNIT III
MULTIVARIABLE – UNCONSTRAINED AND CONSTRAINED OPTIMIZATION
Direct search methods – descent methods – conjugate gradient method. Indirect methods – Transformation techniques, penalty function method

UNIT IV
MODERN OPTIMIZATION TECHNIQUES
Ant Colony Optimization- Areas of Application - River Formation Dynamics Particle Swarm Optimization - Areas of Application Hill Climbing - Areas of Application - Multi-Objective Hill Climbing - Problems in Hill Climbing - Hill Climbing with Random Restarts – GRASP - Raindrop Method, Random Optimization

UNIT V
SEARCH ALGORITHMS: State Space Search - Uninformed Search - Breadth-First Search - Depth-First Search - Depth-limited Search - Iterative Deepening Depth-First Search - Random Walks Informed Search - Greedy Search- A* search - Adaptive Walks

REFERENCES:

1. Thomas Weise, “Global Optimization Algorithms – Theory and Application”,Thomas Weise, 2009.
2. Rao .S.S, “Optimization – Theory and Applications”, Wiley Eastern, New Delhi, 2009.
3. Hans Paul Schwefel, “Evolution and Optimum Seeking”, Wiley-Interscience, 1995
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin.

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3 0 0 3

NETWORKS & COMMUNICATION

Course Objectives:

- To build an understanding of the fundamental concepts of data communication and computer networking.
- To understand how errors detected and corrected that occur in transmission
- To handle collisions when many stations share a single channel
- To know about routing mechanisms and different routing protocols
- To understand transport layer functions 6. Know about different application layer protocols

Course Outcomes:

After completing the course, students should be able to

- Describe the basis and structure of Communication and communication network
- Independently understand basic Transmission Techniques.
- Identify the various Multiplexing and Multiple access technique
- Learn the knowledge of different types of Wireless Networks architecture.
- Enumerate the layers of the Wireless system protocols.

UNIT -I

Module 1: Introduction:

Communication: Overview of communication, Challenges of communication networks, Classification of communication networks

Communication Network: Fiber optics communication network, Satellite communication network, Different generations and standards of cellular communication network: 1G, 2G, 3G, 4G, 5G

UNIT -II

Module 2: Transmission Techniques:

Transmission media: Wireline vs Wireless transmission media; Wireline transmission media: Concept of Twisted Pair, Coaxial cable, Fiber optics transmission technique; Wireless transmission technique: Concept of Wireless channels: Path loss, shadowing, Fading; Modulation Technique: Amplitude shift keying (ASK), Frequency shift keying (FSK), Phase shift keying (PSK), Quadrature amplitude modulation (QAM), Orthogonal frequency division multiplexing (OFDM), Orthogonal frequency division multiple access (OFDMA)

UNIT –III: Multiplexing and Multiple access technique:

Multiplexing: Concept of multiplexing, Frequency division multiplexing (FDM), Time division multiplexing (TDM), Wavelength division multiplexing (WDM)

Multiple access: Contention free multiple access schemes: Frequency division multiple access (FDMA), Time division multiple access (TDMA), Space division multiple access (SDMA) Contention based multiple access schemes: ALOHA and CSMA

UNIT –IV: Wireless Networks:

Wireless personal area networks: Architecture and operation of Bluetooth, Wi-Fi and ZigBee networks

Wireless local area networks: Architecture and operation of Wireless local area network (WLAN)

Wireless Metropolitan Area Network: Architecture and operation of Worldwide Interoperability for Microwave Access (WiMAX)

Ad-hoc wireless networks: Design Challenges in Ad-hoc wireless networks, concept of cross layer design, Architecture and operation of Mobile Ad-Hoc network (MANET) and Wireless sensor network (WSN)

UNIT –V: Wireless system protocols:
Network layer protocol: Mobile IP, IPV4, IPv6, Dynamic host configuration protocol (DHCP)
Transport layer protocol: Transmission control protocol (TCP), User datagram protocol (UDP)

TEXT BOOKS:

1. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.
2. Sanjay Kumar, “Wireless Communication the Fundamental and Advanced Concepts” River Publishers, Denmark, 2015
3. Behrouz A. Forouzan, Data Communications and Networking, Tata McGraw-Hill, 2000

REFERENCE BOOKS:

1. Vijay K Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009
2. J. Schiller, “Mobile Communication” 2nd edition, Pearson Education, 2012
3. S. Tannenbum, D. Wetherall, “Computer Networks”, 5th edition, Pearson Education, 2013

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3 0 0 3

MOTION CONTROL AND PATH PLANNING

Course Objectives:

- To provide brief introduction to robot cognition and perception
- To understand the concepts of path planning algorithms.
- To gain knowledge on the robot programming packages used in localization and mapping.
- To analyze time complexity using various path planning Algorithms
- To apply two axis and three axis planar mechanisms

Course Outcomes:

After completing the course, students should be able to

- Illustrate the different methods of map building and the robot simulation and execution of a program
- Analyze the various path planning techniques by briefing about the robot's environment and explaining about the programs used
- Develop knowledge about simultaneous localization and mapping based techniques and paradigms.
- Elaborate the various robot programming packages for display,tele-operation and other applications.
- Describe the aspects of Imaging Techniques used in Robotic Applications.

UNIT-I

Classification of Robot: Fixed- seria,l parallel, Hybrid. Mobile-Ground (wheeled (omnidierctional, holonomic), tracked, legged), under water (submarine, fishlike), Surface (Ship like) and Aerial (Fixed wing, flapping wing, rotor based).

UNIT-II

Localization: Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, positioning beacon systems.

UNIT-III

Overview of motion planning: Configuration space, Degree of freedom, Definition, Introduction to Trajectory planning, General consideration in path description and Generation of motion, Joint space motions, Cartesian space motions, Point to point: Straight line path, Trapezoidal motion profile and S curve motion, Polynomial via point Trajectories. Application: Two axis /three axis planar mechanism Trajectory planning.

UNIT-IV

Wheeled robots:over view of path planning, Algorithms - Analysis and complexity, running time, complexity, completeness. Visibility graph, Road Maps - Generalized Voronoi Graph (GVG) - definition, properties, Cell Decompostion - Trapezoidal decomposi tion, Morse cell decomposition - variable slice, sensor based coverage, complexity coverage, Visibility based decomposition.
Control based planning, Manipulation planning, Optimal motion planning, Feedback motion planning, Randomised Kinodynamic Planning.

UNIT-V

Legged robots: Introduction, locomotion - key issues for locomotion, legged mobile robots, leg configurations & stability, Gait analysis, examples of legged robot locomotion. Case studies.

TEXT BOOKS:

1. H. Choset, K. M. Lynch, "Principles of Robot Motion: Theory, Algori thms, and Implementations",1/e, MIT Press, Bosto n, 2005.
2. Planning Algorithms, "Steven M. Lavalle", 1/e, Cambridge University Press, 2006.
3. Farbod Fahimi - "Autonomous Robots- Modeling, Path Planning, and Control",1/e Springer, 2009.
4. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011.

REFERNCE BOOKS:

1. Peter Corke , Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.
2. S. M. LaValle, “Planning Algorithms”, Cambridge University Press, 2006.
3. Thrun, S., Burgard,W., and Fox, D., Probabilistic Robotics. MIT Press, Cambridge, MA, 2005.
4. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion:Theory,Algorithms and Implementations, PHI Ltd., 2005.

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3 0 0 3

ADVANCED MICROCONTROLLERS

Course Objectives:

- To study advanced microcontroller along with the use of microcontroller.
- To interface memory and various I/O devices like A to D converter, D to A converter LED, LCD to advanced microcontrollers.
- To learn the Programming language (Embedded C) used for microcontrollers.
- To use the advanced fast microcontroller in electrical engineering related fields like Power system protection, instrumentation, power electronics, Electrical Drives and control of Electrical Equipments.

Course Outcomes:

After completing the course, students should be able to

- Describe working of PIC DSPIC 30F series
- Describe working of Peripherals of dsPIC 30F Microcontroller Architecture and Programming model
- Investigate and construct circuits for interfacing of peripheral components with MSP430
- Learn the knowledge of ARM Processors
- Illustrate the Internal Architecture ARM7TDMI processor

UNIT-I

DSPIC 30F series: Introduction to 16 bit microcontrollers - dsPIC 30F – CPU, Data memory, Program Memory - Instruction set - Programming in Assembly and CInterrupt Structure.

UNIT- II

Peripherals of dsPIC 30F: I/O Ports, Timers, Input Capture, Output Compare, Motor Control PWM, QEI,10 bit A/D Converter, UART, CAN Unit, Application Development.

UNIT-III

MSP430 and peripherals: MSP430f2274 - MSP430X22X2 device pin out, DA Package, Functional Block diagram description, Inputs, Outputs, Timers, ADC. Application Development.

UNIT IV:

ARM Processors Fundamentals: Introduction to ARM processors and its versions. ARM7, ARM9 & ARM11 comparison, advantages & suitability in embedded application. ARM7 data flow model, programmer‟s model, modes of operations, Instruction set.

UNIT-V:

Internal Architecture: Introduction to ARM7TDMI processor – Pin Description, Pinfunctionality, internal architecture, Instruction Set and Instruction Cycle timings, ARM 32- bit and THUMB (16-bit) operating modes, Switching between ARM and THUMB instructions. Types of memory – Code memory, External Memory, Internal memory, Register Set.

TEXT BOOKS:

1. DSPIC 30F, Reference Manual, Microchip.
2. Chris Nagy, “ Embedded System Design using the TI MSP 430 Series”, First Edition, Newnes,2003
3. Andrew N. Sloss, Dominic Symes, Chris Wright and John Rayfield, “ARM System Developer'

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3 0 0 3

FPGA BASED SUSTEM DESIGN

Course Objectives

- To describe general FPGA architecture, internals and use cases
- To apply design flow methodology for a given problem
- To create, synthesize and simulate various digital circuits
- To implement and debug various digital designs
- To analyze a given design based on synthesis, implementation and timing reports

Course Outcomes:

After completing the course, students should be able to

- Translate software applications to hardware logic for FPGA architecture
- Design systems by applying VHDL programming
- Design architecture for high performance computing applications
- Apply commercially available FPGA tools
- Perform different VLSI testing and implement placement techniques.

UNIT-I

Introduction to ASICs, **CMOS logic and ASIC library design:** Types of ASICs - Design Flow CMOS transistors, CMOS design rules - Combinational Logic Cell - Sequential logic cell – Data path logic cell - transistors as resistors - transistor parasitic capacitance - Logical effort - Library cell design - Library architecture.

UNIT-II

Programmable logic cells and I/O cells: Digital clock Managers Clock management- Regional clocks- Block RAM – Distributed RAM-Configurable Logic Blocks-LUT based structures – Phase locked loops- Select I/O resources –Anti fuse - static RAM - EPROM and EEPROM technology.

UNIT-III

Device Architecture: Spartan 6 -Vertex 4 architecture-Altera Cyclone and Quartus architectures.

UNIT-IV

Design Entry and Testing: Verilog and VHDL - logic synthesis - Types of simulation –Faults- Fault simulation - Boundary scan test Automatic test pattern generation.

UNIT-V

Built-in self-test. – scan test. Floor Planning, Placement and Routing: System partition - FPGA partitioning - partitioning methods - floor planning placement - physical design flow - global routing - detailed routing - special routing - circuit extraction - DRC.

TEXT BOOKS/REFERENCES:

1. M.J.S. Smith, "Application Specific Integrated Circuits", Addison Wesley Longman Inc., 1997.
2. Wolf Wayne, "FPGA Based System Design", Pearson Education.
3. Design Manuals of Altera, Xilinx and Actel.

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0 0 4 2

EMBEDDED SYSTEMS & IoT LABORATORY

Course Objectives

- To design microcomputer-based embedded systems.
- To learn microcomputer interfacing from both a hardware and software perspective
- To learn IOT Firmware and Hardware Platforms
- To design embedded systems with wireless communication modules
- To write the programs for microcontroller

Course Outcomes:

After completing the course, students should be able to

- Develop applications using arduino microcontrollers
- Interface different peripheral devices with Microcontrollers.
- Design embedded systems including hardware/software interfaces for devices like LCD displays, motors, keyboards, analog sensors and speakers.
- Design embedded system using microcontrollers embedded processors and their applications

A: Using Microcontrollers

1. Transmit a string using UART
2. Point-to-Point communication of two Motes over the radio frequency.
3. Multi-point to single point communication of Motes over the radio frequency.LAN (Subnetting).
4. I2C protocol study
5. Reading Temperature and Relative Humidity value from the sensor

B: IOT Firmware and Hardware Platforms

1. Arduino UNO
2. Arduino IDE
3. Wireless Communication modules
4. Temperature and humidity sensor modules
5. LCD display

Note: Raspberry Pi board / Beaglebone black can also be used. In these cases we need not have IDE.

M. Tech – I Year – I Sem **L T P C**
0 0 4 2

COMPUTER VISION AND DEEP LEARNING LAB

Course Objectives

- To write basic programs for computer vision and image processing algorithms
- To understand camera views, image texturing and 3D model of image
- To implement face detection and principal component analysis algorithms
- To familiarize with basic computations of Tensor Flow
- To learn CNN and other deep neural networks through

Course Outcomes:

After completing the course, students should be able to

- Develop edge detection and image segmentation based computer vision applications
- Construct 3D model from image
- Implement basic deep learning for classification problems
- Develop various Deep Learning models
- Implement Convolution Neural Networks and other deep neural networks for Image Classification

Note:

Minimum of 10 experiments should be conducted and any 5 experiments from Part –I and 5 experiments from Part –II.

Part –I: **List of programs:**

1. Write an application for Implement image geometrical operations
2. Write an application for Implementation of Edge detection operators
3. Write an application for Implementing image Projection
4. Implement Segmentation methods like Histogram Thresholding Segmentation
5. Construct 3D model from images
6. Construct 3D model from Stereo pair
7. Application for deriving SIFT,HOG and SURF features
8. Write an application for Face detection and Recognition
9. Write an application for Object detection from dynamic Background.
10. Implement Principal component analysis for dimensionality reduction
11. Write an application for foreground – background separation
12. Write an application for Content based image retrieval

List of Open Source Software/learning website:

1. Computer Vision. Ballard and Brown
2. Invitation to 3D Vision: From Images to Geometric Models: Y. Ma, S. Soatto, J. Kosecka and S. Sastry.

Part –II: Deep Learning

1. Demonstration of Basic Computations in Tensor Flow.
2. Implementation of Perceptron Model to solve binary classification problem
3. Implementation of Sigmoid model to solve binary classification problem
4. Implementation of Fully Connected Neural Network Model to solve Binary/ Multi Class Classification problem

5. Implementation of Fully Connected Neural Network Model to solve Regression Problem
6. Implementation of Hyper Parameter Tuning Algorithms
7. Implementation of Convolution Neural Networks for Image Classification.
8. Implementation of Modern and Pre Trained CNN Architectures for Image Classification.
9. Implementation of Recurrent Neural Network Models for Time Series data.
10. Implementation of Recurrent Neural Network Models for Text Data
11. Implementation of LSTM Model for Machine Translation
12. Implementation of GRU Model for seq2seq Model
13. Implementation of Auto Encoder Models for Image Generation

M. Tech – I Year – II Sem **L T P C**

3 1 0 4

ROBOT CONTROL SYSTEM

Course Objectives

- To provide knowledge on the various robotic systems with the help of mathematical models.
- To introduce the control aspects of non-linear systems.
- To learn the concepts of non-linear observer design
- To understand optimal control using few application examples

Course Outcomes:

After completing the course, students should be able to

- Describe the characteristics of a robotic system from its dynamic model.
- Analyse the stability of robotic systems with the help of theorems.
- Illustrate the various task space control schemes available.
- Discuss the various non-linear control schemes.
- Develop nonlinear observer schemes

UNIT -I

Introduction and Overview of Robotic Systems: Forward and inverse dynamics. Properties of the dynamic model and case studies. Introduction to nonlinear systems and control schemes.

UNIT -II

System Stability, Joint Space and Task Space Control Schemes: Lyapunov stability analysis, both direct and indirect methods. Lemmas and theorems related to stability analysis, Position control, velocity control, trajectory control and force control.

UNIT -III

Nonlinear Control Schemes: Proportional and derivative control with gravity compensation, computed torque control, sliding mode control, adaptive control, observer-based control and robust control.

UNIT -IV

Optimal Control: Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti's equation – Application examples.

UNIT -V

Nonlinear Observer Schemes: Design based on acceleration, velocity and position feedback. Numerical simulations using software packages.

TEXT BOOKS:

1. J J Craig, "Introduction to Robotics: Mechanics and Control", Prentice Hall, 2004.
2. A Sabanovic and K Ohnishi, "Motion Control Systems", John Wiley & Sons (Asia), 2011.
3. R Kelly, D. Santibanez, LP Victor and Julio Antonio, "Control of Robot Manipulators in Joint Space", Springer, 2005.

REFERENCE BOOKS:

1. R M Murray, Z. Li and SS Sastry, "A Mathematical Introduction to Robotic Manipulation", CRC Press, 1994.
2. J J E Slotine and W Li, "Applied Nonlinear Control", Prentice Hall, 1991.
3. Sebastian Thrun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics", MIT Press, 2005.
4. Carlos, Bruno, Georges Bastin, "Theory of Robot Control", Springer, 2012.

M. Tech – I Year – II Sem **L T P C**
3 1 0 4

ROBOT OPERATING SYSTEM

Course Objectives:

- To Introduce the basics of Robot Operating Systems and its architecture
- To provide knowledge on the hardware interfacing aspects
- To understand the applications of ROS in real world complex applications
- To introduce architecture of Robot operating systems
- To interface sensors, actuators & drivers for Robot operating systems

Course Outcomes:

After completing the course, students should be able to

- Describe the need for ROS and its significance
- Summarize the Linux commands used in robotics
- Discuss about the concepts behind navigation through file system
- Explain the concepts of Node debugging
- Analyze the issues in hardware interfacing

UNIT I: Introduction to ROS:

Introduction –The ROS Equation - History - distributions -difference from other meta-operating systems– services - ROS framework – operating system – releases.

UNIT II: Introduction to Linux Commands

UNIX commands - file system – redirection of input and output - File system security - Changing access rights – process commands – compiling, building and running commands – handling variables

UNIT III: Architecture of Operating System

File system - packages – stacks – messages – services – catkin workspace – working with catkin workspace – working with ROS navigation and listing commands

UNIT IV: Computation Graph Level

Navigation through file system -Understanding of Nodes – topics – services – messages – bags – master – parameter server.

UNIT V: Debugging And Visualization

Debugging of Nodes – topics – services – messages – bags – master – parameter – visualization using Gazebo – Rviz – URDF modeling – Xacro – launch files.

Hardware Interface: Sensor Interfacing – Sensor Drivers for ROS – Actuator Interfacing – Motor Drivers for ROS.

TEXT BOOKS:

1. Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018
2. Aaron Martinez, Enrique Fernández, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013.

REFERENCE BOOKS:

1. Jason M O'Kane, “A Gentle Introduction to ROS”, CreateSpace, 2013.
2. AnisKoubaa, “Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.
3. Kumar Bipin, “Robot Operating System Cookbook”, Packt Publishing, 2018.
4. Wyatt Newman, “A Systematic Approach to learning Robot Programming with ROS”, CRC Press, 2017.
5. Patrick Gabriel, “ROS by Example: A do it yourself guide to Robot Operating System”, Lulu, 2012.

M. Tech – I Year – II Sem **L T P C**
3 0 0 3

COMPUTER AIDED MODELING AND DESIGN

Course Objectives:

- To acquaint with the computer aided design
- To manufacture farm machinery with the help of CAD
- To use standard software tools to create engineering drawings, or other documents
- To understand surface modeling techniques and solid modeling techniques
- To familiarize with feature based modeling, assembling modeling, behavioral modeling

Course Outcomes:

After completing the course, students should be able to

- Ability to create fully constrained solid models that can be quickly modified using standard software tools
- Ability to use, identify and explain standard features in solid modeling including protrusions, revolutions, cutouts, and patterns
- Ability to use standard software tools to create engineering drawings, or other documents, to fully describe the geometries and dimensions of parts, as well as to document assemblies according to standard practice
- Ability to use standard software tools to create part assemblies and check for clearances.
- Ability to create the drawings of farm implements and their analysis.
- Ability to write the CNC part programming

UNIT-I

Introduction to CAD, Criteria for selection of CAD workstations, Shingle Design Process, Design criteria, Geometric modeling, entities, 2D & 3D Primitives. 2D & 3D Geometric Transformations: Translation, Scaling, Rotation, Reflection and Shearing, concatenation. Graphics standards: GKS IGES, PDES.

UNIT-II

Wire frame modeling: Curves: Curve representation. Analytic curves – lines, Circles, Ellipse, Coins. Synthetic curves – Cubic, Bezier, B-Spline, NURBS.

UNIT-III

Surface Modeling: Surface entities, Surface Representation. Analytic Surface – Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Synthetic Surface-Cubic, Bezier, B-spline, Coons.

UNIT-IV

Solid Modeling Techniques: Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration, Boundary Representation (B-rep) & Constructive Solid Geometry (CSG).

UNIT-V

Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioral Modeling, Conceptual Design & Top down Design. Capabilities of Modeling & Analysis Packages such as solid works, Unigraphics, Ansys, Hyper mesh. Computer Aided Design of mechanical parts and Interference Detection by Motion analysis.

TEXT BOOKS

1. Ibrahim Zeid, CAD/CAM, Theory and Practice, Mc Graw Hill, 1998.
2. Foley, Van Dam, Feiner and Hughes, Computer Graphics Principles and Practice, 2nd Ed., Addison – Wesley, 2000.
3. Martenson, E. Micheal, Geometric Modelling, John Wiley & Sons, 1995.
4. 4. Hill Jr, F.S., Computer Graphics using open GL, Pearson Education, 2003.

REFERENCE BOOK

1. P.N.Rao, CAD/CAM Principles and Applications, Mc Graw Hill, 2010, 3rd Ed.

M. Tech – I Year – II Sem **L T P C**
3 0 0 3

ARTIFICIAL INTELLIGENCE FOR ROBOTICS

Course Objectives:

- To provide an introduction to the basic principles, techniques, and applications of Artificial Intelligence.
- To emphasize the fundamentals of commercially available software tools or programming environments.
- To understand the basic areas of artificial intelligence search, knowledge representation, learning and their applications in design and implementation
- To apply intelligent agents for a variety of tasks in analysis, design, and problem solving
- To know about Lisp and Prolog and use of these languages in AI.

Course Outcomes:

After completing the course, students should be able to

- Describe human intelligence and AI Explain how intelligent system works
- Apply basics of Fuzzy logic and neural networks
- Explain Expert System and implementation
- Apply Knowledge representation and semantic in Knowledge representation
- Develop some familiarity with current research problems and research methods in AI

UNIT I

INTRODUCTION

History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents. PROBLEM SOLVING: Solving problems by searching –Informed search and exploration–Constraint satisfaction problems–Adversarial search, knowledge and reasoning– knowledge representation – first order logic.

UNIT II

PLANNING

Planning with forward and backward State space search – Partial order planning – Planning graphs– Planning with propositional logic – Planning and acting in real world.

UNIT III

REASONING

Uncertainity – Probabilistic reasoning–Filtering and prediction–Hidden Markov models–Kalman filters–Dynamic Bayesian Networks, Speech recognition, making decisions.

UNIT IV

LEARNING

Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication, perceiving and acting, Probabilistic language processing, perception.

UNIT V

AI IN ROBOTICS

Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

TEXT BOOKS:

1. Stuart Russell, Peter Norvig, “Artificial Intelligence: A modern approch”, Pearson Education, India2003.
2. Negnevitsky, M, “Artificial Intelligence: A guide to Intelligent Systems”,. Harlow: Addison-Wesley, 2002.

REFERENCE:

1. David Jefferis, “Artificial Intelligence: Robotics and Machine Evolution”, Crabtree Publishing Company, 1992.
2. Huimin Lu, Xing Lu, “Artificial Intelligence and Robotics”, Springer, 2017.

M. Tech – I Year – II Sem **L T P C**
3 0 0 3

ADVACED SIGNAL PROCESSING

Course Objectives

- To introduce Digital Signals and Systems
- To provide in depth knowledge of processing digital signals
- To understand the fundamentals of estimation theory
- To understand the fundamental of detection theory
- To introduce digital signal processors

Course Outcomes:

After completing the course, students should be able to

- Analyze discrete time signals and systems
- Explain modern digital signal processing algorithms and applications
- Apply digital systems in real time applications
- Apply algorithms for speech processing applications
- Implement algorithms using digital signal processors

UNIT I

Introduction to digital signals and System: Discrete- Time Signals: Sequences; representation of signals on orthogonal basis; Sampling and Reconstruction of signals

Discrete systems: Z-Transform, Analysis of LSI systems, Frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems.

UNIT II

Estimation Theory: Fundamentals of Estimation Theory: Role of Estimation in Communication Systems, Desirable Properties of Estimators, Minimum Variance Unbiased (MVU) Estimators, Cramer-Rao Lower Bound, Maximum Likelihood Estimation (MLE), Least Squares Estimation (LSE), Bayesian Estimators, Minimum Mean Square Error (MMSE) Estimator, Wiener and Kalman Filters

UNIT III

Detection Theory: Fundamentals of Detection Theory: Hypothesis Testing - General Modeling of Binary Hypothesis Testing Problem, Bayes' Detection, MAP Detection, ML Detection, Minimum Probability of Error Criterion, MinMax Criterion, Receiver Operating Characteristic Curves, Multiple Hypothesis Testing, Composite Hypothesis Testing ,Detection of Signals Matched Filter Approach.

UNIT IV

Speaker recognition: Human and Computer speaker recognition Principles Text dependent and Text Independent speaker recognition systems. Applications of speech Processing.

UNIT V

Introduction to DSP Processors: Introduction to various Texas processors such as TMS320C6713, TMS320C6416, DM6437 Digital Video Development Platform with Camera, DevKit8000 OMAP3530 Evaluation Kit.

TEXT BOOKS:

1. A. V. Oppenheim and R. W. Shafer, Discrete-Time Signal Processing, Prentice Hall India, 2/e, 2004.
2. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education.
3. Steven M. Kay, Statistical Signal Processing: Vol. 1: Estimation Theory,Pearson Education, 2009.
4. Steven M. Kay, Statistical Signal Processing: Vol. 2: Detection Theory, Pearson Education, 2009
5. Digital Signal Processors”, B Venkataramani and M Bhaskar TMH, 2002

M. Tech – I Year – II Sem **L T P C**
3 0 0 3

ELECTRICAL MACHINES AND DRIVES

Course Objectives:

- To know the fundamentals of electromechanical devices
- To understand different types of DC/AC and special electrical machine drives in the industry
- To understand the importance of control theory in Electrical Machines and Drives
- To familiarize with DC Motor drives and induction motor drives
- To understand power ratings and capabilities

Course Outcomes:

After completing the course, students should be able to

- Select a drive for a particular application based on power rating
- Select a drive based on mechanical characteristics for a particular drive application
- Operate and maintain solid state drives for speed control of DC machines
- Operate and maintain solid state drives for speed control 3 phase induction motor
- Operate and maintain solid state drives for speed control of 3 phase Synchronous motor

UNIT -I

Fundamentals of electromechanical devices: flux linkage/current relationships, concept of energy and co-energy, calculation of forces and torques. Power Electronic Converters: voltage control using uncontrolled switches, controlled rectification, inversion, voltage controllers, converter waveforms, acoustic noise and cooling

UNIT -II

Control Theory: Importance of Feedback control, requirement of feedback loops in drive applications, current-limit control, speed, torque and position control for electric drives, and concept of PLL in speed control application.

UNIT -III

DC Motor Drives: EMF and torque production of DC motor, dc motor types, transient and steady-state characteristics, four quadrant operation, thyristor and chopper fed dc motor drives.

UNIT -IV

Induction Motor Drives: concept of rotating magnetic field and torque production, motor types, torque-speed and torque-slip characteristics, methods of starting of squirrel cage motors, generating and braking modes, speed control using stator voltage control, variable frequency operation, rotor resistance control and slip power recovery schemes.

UNIT -V

Motor/Drive Selection: power ratings and capabilities, drive characteristics, load requirements and general application considerations.

TEXT BOOKS:

1. Dubey, G.K., Fundamentals of Electric Drives, Narosa Publications (2001).
2. Mohan, N., Electric Drives: An Integrative Approach. MNPERE, (2001).

3. Krishnan, R., Electric Motor Drives: Modeling, Analysis, and Control. Prentice Hall, (2001).

REFERENCE BOOKS:

1. Hughes, A. and Drury, B., Electric Motors and Drives: Fundamentals, Types and Applications, Newnes,4th Ed., (2014).
2. Sharkawi, Mohammed. A.El, Fundamentals of Electric Drives, PWS- Brooks/Cole Pub. Company, (2000).

M. Tech – I Year – II Sem **L T P C**

3 0 0 3

IoT APPLICATIONS

Course Objectives:

- To acquire specific scripting knowledge to develop interactive applications
- To understand the basics of android application development
- To apply the programming skills in developing application pertaining to Industrial, medical, agricultural, etc
- To know the importance of machine to machine protocols
- To understand the architecture of IoT

Course Outcomes:

After completing the course, students should be able to

- Design dynamic web forms to acquire and process user & sensor data
- Interactive forms using Java Script with a focus on internet of things
- Implement mobile application using android SDK
- Solve the need for smart systems in a distributed environment
- Understand the IoT architecture and building blocks for various domains

UNIT-I

IoT & Web Technology The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

UNIT-II

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT-III

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture-Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT-IV

IoT Applications for Value Creations Introduction, **IoT applications for industry:** Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

UNIT-V

Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart

Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

REFERENCE BOOKS:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1 st Edition, VPT, 2014
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1 st Edition, Apress Publications, 2013
3. Cuno Pfister, Getting Started with the Internet of Things, O‟Reilly Media, 2011, ISBN: 978-1-4493-9357-1

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3 0 0 3

DESIGN AND ANALYSIS OF ALGORITHMS

Course objectives:

- To familiarize with basic design concepts such as pseudocode & top-down design
- To know about various algorithm design strategies
- To understand fundamental techniques of dynamic programming
- To analyze time and space complexity
- To understand Nondeterministic Polynomial Time Problems

Course Outcomes:
After completing the course, students should be able to

- Apply design principles and concepts to algorithm design
- Have the mathematical foundation in analysis of algorithms
- Understand different algorithmic design strategies
- Analyze the efficiency of algorithms using time and space complexity theory
- Apply graph algorithms in programming

UNIT-I
Algorithm Analysis: Methodologies for Analyzing Algorithms, Asymptotic Notation, Recurrence Relations.

UNIT-II
Data Structures: Linear Data Structures (Stacks, Queues, Linked-Lists, Vectors), Trees (Binary Search Trees, AVL trees, Red-Black trees, B-trees), Hash-Tables (Dictionaries, Associative Arrays, Database Indexing, Caches, Sets) and Union-Find Structures. Searching and Sorting (Insertion and Selection Sort, Quicksort, Mergesort, Heapsort, Bucket Sort and Radix Sort), Comparison of sorting algorithms and lower bounds on sorting.

UNIT-III
Fundamental Techniques: The Greedy Method, Divide and Conquer, Dynamic Programming.

UNIT-IV
Graph Algorithms: Elementary Algorithms, i.e., Breadth-first search, Depth-first search, Topological sort, strongly connected components. Minimum Spanning Trees, Single-Source Shortest Paths, All-Pairs Shortest Paths, Maximum Flow, Network Flow and Matching, Flows and Cuts.

UNIT-V
Nondeterministic Polynomial Time Problems: P and NP, NP-Complete, NP-Hard, Important NP-Complete/Hard Problems.

TEXT BOOKS/REFERENCES:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, "Introduction to Algorithms", MIT Press, 2009, 3rd Edition
2. S. Dasgupta, C. Papadimitriou and U. Vazirani, "Algorithms", McGraw-Hill, 2006

3. J. Kleinberg and E. Tardos, "Algorithm Design", Addison Wesley, 2005
4. R. Sedgewick and K. Wayne, "Algorithms", Addison Wesley, 2011, 4th Edition
5. K. Mehlhorn and P. Sanders, "Data Structures and Algorithms: The Basic Toolbox", Springer, 2008
6. E. Lehman, T. Leighton and A. Meyer, "Mathematics for Computer Science", MIT Press, 2010

M. Tech – I Year – I Sem **L T P C**
0 0 4 2

ROBOT OPERATING SYSTEM LABORATORY

Course Objectives:
- To Introduce robot operating system with Raspberry Pi
- To provide knowledge on the hardware interfacing aspects
- To develop real world complex applications
- To introduce architecture of Robot operating systems
- To learns the working of Quadruped Robot, Autonomous mobile robot and Gesture controlled robot using ROS

Course Outcomes:
After completing the course, students should be able to
- Describe the need for ROS and its significance
- Analyze the issues in hardware interfacing
- Develop Quadruped Robot, Autonomous mobile robot
- Analyze Gesture controlled robot using ROS
- Develop Self-driving car using ROS

List of Experiments:
1. Line Following Robot using ROS with Raspberry Pi
2. Obstacle Avoidance robot
3. SLAM robot using ROS
4. Path Planning robot using ROS
5. Development of Self-driving car using ROS
6. Robotic Arm simulation using ROS
7. Drone simulation using Gazebo and ROS
8. Quadruped Robot
9. Autonomous mobile robot
10. Gesture controlled robot using ROS

M. Tech – I Year – I Sem **L T P C**

0 0 4 2

AI & ROBOT CONTROL LAB

Course Objectives:

- To write program for autonomous robot systems
- To apply AI based algorithms for robot systems
- To write program for mobile robots and autonomous robots
- To understand optimal control using few programming examples
- To understand various operators for controlling domestic robot

Course Outcomes:

After completing the course, students should be able to

- Write programs for AI based robot control algorithms.
- Analyze the stability of robotic systems
- Develop expert systems for robot control applications.
- Implement fuzzy logic and genetic algorithm for optimization
- Solve real time planning and scheduling algorithms

List of Experiments:

1. Programming in C/Matlab to implement fuzzy logic application for autonomous robot system.

2. Programming in C/Matlab to implement simulated annealing/genetic algorithm for solving inverse kinematic problems

3. Programming in C/Matlab to solve traveling salesman problem using ant colony optimization algorithm

4. Write program using Visual Prolog to create an expert system

5. Write program for obstacle avoidance in mobile robots using any one algorithm

6. Implement A* algorithm to Solve 8-puzzle problem using. Assume any initial configuration and define goal configuration clearly

7. Define the operators for controlling domestic robot; use these operators to plan an activity to be executed by the robot. For example, transferring two/three objects one over the other from one place to another. Use Means- Ends analysis with all the steps revealed.

8. Solving real time planning and scheduling problems using software like Witness/Pro-model

ANURAG UNIVERSITY

School of Engineering

Department of Electronics and Communication Engineering

HONORS DEGREE

I. AI for Signal Processing

S. No	Category	Course Title	L	T	P	Credits
1	PCC	Adaptive Signal Processing	3	0	0	3
2	PCC	Machine Learning & AI	3	0	0	3
3	PCC	Deep learning for Image processing	3	0	0	3
4	PCC	MATLAB for Signal Processing	3	0	0	3
5	PCC	Project Work	-	-	12	6
Total			**12**	**00**	**12**	**18**

II. Circuits and VLSI

S. No	Category	Course Title	L	T	P	Credits
1	PCC	Analog CMOS Circuit Design	3	0	0	3
2	PCC	Mixed Signal Design	3	0	0	3
3	PCC	System on Chip Architecture	3	0	0	3
4	PCC	RF Integrated Circuits	3	0	0	3
5	PCC	Project Work	-	-	12	6
Total			**12**	**00**	**12**	**18**

III. Embedded Systems & IoT

S.No	Category	Course Title	L	T	P	Credits
1	PCC	Embedded System Architecture	3	0	0	3
2	PCC	Introduction to Architecting Smart IoT Devices	3	0	0	3
3	PCC	Advanced Microcontrollers	3	0	0	3
4	PCC	Software Defined Networking	3	0	0	3
5	PCC	Project Work	-	-	12	6
Total			**12**	**00**	**12**	**18**

I. AI for signal processing

ADAPTIVE SIGNAL PROCESSING *

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To introduce mathematical ideas for adaptive signal processing
- To learn the importance of adaptive systems.
- To provide statistical signal processing concepts
- To familiarize with adaptive filtering algorithms
- To understand LMS and RLS algorithms

Course Outcomes:

After completing the course, students should be able to

- Visualize the domain of adaptive signal processing
- Identify a random process and formulate to extract desired information
- Evaluate the performance of various methods for designing adaptive filters through estimation of different parameters
- Develop algorithms meeting application specific performance criteria
- Implement the adaptive algorithms in software/Hardware

UNIT-I

Adaptive Systems - Definition and characteristics – Properties - Applications and examples of an adaptive system. Stochastic Processes and Models: Characterization - Mean ergodic theorem - Correlation matrix.

UNIT-II

Stochastic models - Power spectral density - Properties of power spectral Density - Linear transformations - Power spectral estimation.

UNIT-III

Wiener filters - Linear optimum filtering - Minimum mean-square error - Wiener- Hopf equations - Multiple linear regression model.

UNIT-IV

Steepest-descent algorithm - Linear prediction - Forward linear prediction, Levinson-Durbin algorithm. Kalman filter - Extended kalman filter

UNIT-V

Least-Mean-Square (LMS) adaptive filters - LMS algorithm, LMS adaptation algorithm - applications. Method of Least Squares - Data windowing, Normal equations and linear least square filters, Recursive least squares algorithm.

TEXTBOOKS

1. Simon Haykins, “Adaptive Filter Theory”, Pearson Education, Fifth Edition, 2013.

REFERENCES

1. Todd K. Moon, Wynn C. Stirling, “Mathematical Methods and Algorithms for Signal Processing” Prentice Hall, First edition, 1999.
2. John. R. Triechler, C. Richard Johnson (Jr), Michael. G. Larimore, “Theory and Design of Adaptive Filters”, Prentice Hall India Private Limited, 2004
3. Bernard Widrow and Samuel. D. Stearns, “Adaptive Signal Processing”, Pearson Education, 2001.

MACHINE LEARNING & AI

L T P C
3 0 0 3

Course Objectives:

- To introduce the basic concepts, theories and state-of-the-art techniques of artificial intelligence
- To introduce basic concepts and applications of machine learning
- To learn the application of machine learning /A.I algorithms in the different fields of science, medicine, finance etc.
- To know the concept of supervised and unsupervised learning
- To understand the principles of intelligent system design

Course Outcomes:

After completing the course, students should be able to

- Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
- Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
- Demonstrate proficiency developing applications in an 'AI language', expert system shell, or data mining tool.
- Demonstrate proficiency in applying scientific method to models of machine learning.
- Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.

UNIT – I

Supervised Learning (Regression/Classification)Basic methods: Distance-based methods, Nearest-Neighbors, Decision Trees, Naive Bayes Linear models: Linear Regression, Logistic Regression, Generalized Linear Models Support Vector Machines, Nonlinearity and Kernel Methods Beyond Binary Classification: Multi-class/Structured Outputs, Ranking.

UNIT-II

Unsupervised Learning Clustering: K-means/Kernel K-means Dimensionality Reduction: PCA and kernel PCA Matrix Factorization and Matrix CompletionGenerative Models (mixture models and latent factor models)

UNIT-III

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

UNIT-IV

Biological foundations to intelligent Systems: Artificial Neural Networks.Single layer and Multilayer Feed Forward NN, LMS and Back Propagation. Algorithm, Feedback networks and Radial Basis Function Networks.

UNIT-V

Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification Methods Fuzzy Neural Networks and some algorithms to learn the parameters of the network like GA

TEXTBOOKS:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press,2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely availableonline)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer,2007.
4. J M Zurada , "An Introduction to ANN",Jaico PublishingHouse
5. Simon Haykins, "Neural Networks", PrenticeHall

DEEP LEARNING FOR IMAGE PROCESSING*

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To give an exposure to Supervised Deep Learning for working with Linearly Non Separable Data.
- To provide understanding of Mathematical, Statistical and Computational challenges of building stable representations. .
- To know the application of Convolution Neural Networks for High-Dimensional data, such as image and other data types.
- To explore Deep Recurrent and Memory Networks for Sentiment Analysis, Machine Translation and Computer Vision tasks.
- To have an understanding of Unsupervised Deep Learning.

Course Outcomes:

After completing the course, students should be able to

- Learn the knowledge of Neural Network and model a Neuron and Express both Artificial Intelligence and Neural Network
- Demonstrate awareness Deep Networks
- Apply the Dimensionality Reduction on Image
- Explore knowledge of Optimization algorithm in deep learning
- Implement image processing applications using Deep learning algorithm

UNIT-I

INTRODUCTION: Introduction to machine learning- Linear models (SVMs and Perceptrons, logistic regression)- Intro to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates

UNIT-II

DEEP NETWORKS

History of Deep Learning- A Probabilistic Theory of Deep Learning- Backpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow Networks Convolutional Networks- Generative Adversarial Networks (GAN), Semi-supervised Learning

UNIT-III

DIMENTIONALITY REDUCTION

Linear (PCA, LDA) and manifolds, metric learning - Auto encoders and dimensionality reduction in networks - Introduction to Convnet - Architectures – AlexNet, VGG, Inception, ResNet - Training a Convnet: weights initialization, batch normalization, hyperparameter optimization.

UNIT-IV

OPTIMIZATION AND GENERALIZATION

Optimization in deep learning– Non-convex optimization for deep networks- Stochastic Optimization Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent

Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning - Computational & Artificial Neuroscience.

UNIT-V

CASE STUDY AND APPLICATIONS

Imagenet- Detection-Audio WaveNet-Natural Language Processing Word2Vec - Joint Detection BioInformatics- Face Recognition- Scene Understanding- Gathering Image Captions

REFERENCES:

1. Cosma Rohilla Shalizi, Advanced Data Analysis from an Elementary Point of View, 2015.
2. Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.
4. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

MATLAB FOR SIGNAL PROCESSING

L T P C
3 0 0 3

Course Objectives:

- To introduce Matlab basics
- To understand various Matlab function for signal processing applications
- To introduce the mathematical ideas for signal processing algorithms and applications.
- To enhance students to solve practical problems in various signal processing tasks

Course Outcomes:

After completing the course, students should be able to Outcome:

- Learn the knowledge of Analysis and Visualization with Matrices using Matlab
- Learn the knowledge of Variables and Commands using Matlab
- Thorough understanding of frequency domain analysis of discrete time signals.
- Apply the principles of Discrete Transforms for signal processing applications.
- Apply the principles of signal analysis for speech processing applications

UNIT I

Introduction to Matlab: Scope of Matlab, Matlab Toolboxes, Matlab window, Data Variables, Operators, Interactively import data into the MATLAB environment,Save and load MATLAB variables to and from disk interactively.

Analysis and Visualization with Matrices

Create matrix variables,Access and manipulate the data stored in matrices using row-column indexing , random matrix generation, Create larger array variables by combining smaller elements and using matrix-creation functions, Perform matrix and array (element-wise) operations, Compute basic descriptive statistics for a matrix of data(rank,determinant,svd...), Distinguish between the behavior of mathematical and statistical functions in MATLAB,Plot columns of a matrix as independent variables,Visualize matrix data in two and three dimensions.

UNIT-II

Variables and Commands

Issue MATLAB commands in the Command Window,Create new variables, and apply arithmetic operations and functions to existing variables,Create text variables and arrays of text,Create two-dimensional plots of vector data, Obtain help on MATLAB commands and navigate the documentation browser,Label plots and adjust plot elements such as line style and color, Use the Command History and the MATLAB Editor to write, save, and execute script files, Use code sections to partition large scripts into smaller parts, Run a script file from the Command Window

UNIT-III

Transform Theory

Review of Continuous Fourier Transform, Laplace Transform, Discrete Time Fourier transform, Z transform, Discrete transform-Relations between the transforms- Integral Transforms: Short Term Fourier Transform (STFT) – Limitations of STFT

UNIT IV

Discrete Transforms and Applications

Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Application of DSTFT in audio signal processing, Discrete Wavelet Transform (DWT), lifting applied to DWT

UNIT V

Signal Processing Applications and Algorithms

Speech Signal Separation and Denoising Using Independent
Component Analysis, Binary Image Watermarking Using Wavelet Domain
of the Audio Signal, Particle Swarm Algorithm , Genetic Algorithm , Ant Colony Optimization

TEXT BOOKS:

1. Alexander D. Poularikas, The Transforms and Applications Handbook, Second Edition, CRC Press.
2. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education.
3. S.D Apte, "Speech and Audio Processing, Wiley India Edition ", 2015.
4. Bernard Widrow and Samuel D. stearns, "Adaptive Signal Processing", Person Education, 2005.
5. Gopi ES. "Algorithm collections for digital signal processing applications using Matlab". Springer Science & Business Media; 2007 Sep 20.
6. Rutra Pratap, Getting started with MATLAB, Oxford University Press; Seventh edition (1 January 2019);

II. Circuits and VLSI

ANALOG CMOS CIRCUIT DESIGN*

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To analyze MOSFET under various parameters, which are required for the design of analog IC blocks in CMOS technology.
- To design CMOS amplifiers and how to compute various performance specifications.
- To design and improve the performance of the comparator.

Course Outcomes:

After completing the course, students should be able to

- Explain the small- and large-signal models of MOS transistors II-Understanding.
- Demonstrate the use of analog circuit analysis techniques to analyze the operation and behavior of various analog integrated circuits. II-Understanding.
- Analyze and design current mirror circuits IV-Analyzing
- Analyze and design analog operational transconductance amplifiers IV-Analyzing
- Design a two stage open loop comparator VI-Creating

UNIT -I

MOS Devices and Modeling: The MOS Transistor, Passive Components- Capacitor & Resistor, Integrated circuit Layout, CMOS Device Modeling - Simple MOS Large-Signal Model, Other Model Parameters, Small-Signal Model for the MOS Transistor, Computer Simulation Models, Sub-threshold MOS Model.

UNIT -II

Analog CMOS Sub-Circuits: MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors-Current mirror with Beta Helper, Degeneration, Cascode current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference.

UNIT -III

CMOS Amplifiers: Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures.

UNIT -IV

CMOS Operational Amplifiers: Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power- Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp.

UNIT -V

Comparators: Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators.

TEXT BOOKS:

1. Philip E. Allen and Douglas R. Holberg, “CMOS Analog Circuit Design”, Oxford University Press, International 2nd Edition/Indian Edition, 2010.
2. Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley India, 5th Edition, 2010.

REFERENCE BOOKS:

1. David A. Johns, Ken Martin, “Analog Integrated Circuit Design”, Wiley Student, Edition,2013.
2. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, TMH Edition.
3. Baker, Li and Boyce, “CMOS: Circuit Design, Layout and Simulation”, PHI.

MIXED SIGNAL DESIGN

L T P C
3 0 0 3

Course Objectives:
- To study the mixed signal of submicron CMOS circuits
- To understand the various integrated based filters and topologies
- To learn the data converters architecture, modeling and signal to noise ratio
- To study the integrated circuit of oscillators and PLLs

Course Outcomes:
After completing the course, students should be able to
- Demonstrate and design Switched Capacitor Circuits II Understanding
- Explain the building blocks of PLL and its operation II Understanding
- Solve engineering problems related to D/A Converters III Applying
- Apply appropriate techniques, and tools in development of A/D Converters III Applying
- Analyze appropriate techniques and Design Over sampling converters IV Analyzing

UNIT - I
Switched Capacitor Circuits: Introduction to Switched Capacitor circuits- basic building blocks, Operation and Analysis, Non-ideal effects in switched capacitor circuits, Switched capacitor integrators first order filters, Switch sharing, biquad filters.

UNIT - II
Phased Lock Loop (PLL): Basic PLL topology, Dynamics of simple PLL, Charge pump PLLs-Lock acquisition, Phase/Frequency detector and charge pump, Basic charge pump PLL, Non-ideal effects in PLLs-PFD/CP non-idealities, Jitter in PLLs, Delay locked loops, applications

UNIT - III
Data Converter Fundamentals: DC and dynamic specifications, Quantization noise, Nyquist rate D/A converters- Decoder based converters, Binary-Scaled converters, Thermometer-code converters, Hybrid converters

UNIT - IV
Nyquist Rate A/D Converters: Successive approximation converters, Flash converter, Two-step A/D converters, Interpolating A/D converters, Folding A/D converters, Pipelined A/D converters, Time-interleaved converters.

UNIT - V
Oversampling Converters: Noise shaping modulators, Decimating filters and interpolating filters, Higher order modulators, Delta sigma modulators with multibit quantizers, Delta sigma D/A

TEXT BOOKS:

1. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, TMH Edition, 2002.
2. Philip E. Allen and Douglas R. Holberg, “CMOS Analog Circuit Design”, Oxford University Press, International Second Edition/Indian Edition, 2010.
3. David A. Johns, Ken Martin, “Analog Integrated Circuit Design”, Wiley

Student Edition, 2013

REFERENCE BOOKS:

1. Rudy Van De Plassche, “CMOS Integrated Analog-to- Digital and Digital-to-Analog converters”, Kluwer Academic Publishers, 2003
2. Richard Schreier, “Understanding Delta-Sigma Data converters”, Wiley Inter science, 2005.
3. R. Jacob Baker, “CMOS Mixed-Signal Circuit Design”, Wiley Inter science, 2009.

SYSTEM ON CHIP ARCHITECTURE

L T P C
3 0 0 3

Course Objectives:

- To know the basic ideas involved in SoC design flow, Platform based design and architectures
- To learn different possibilities of digital testing of SoC
- To Analyze hardware/software tradeoffs, algorithms, and architectures
- To optimize the system based on requirements and implementation constraints.
- To deal with issues in system-on-chip design associated with co-design, such as intellectual property, reuse, and verification.

Course Outcomes:

After completing the course, students should be able to

- Demonstrate the abstraction in Hardware, SOC of ARM Processor II. Understanding
- Evaluate and analyze system on chip RISC Machine, three and five stage Pipeline V. Evaluating
- Explain Memory Design for SOC II. Understanding
- Develop the Interconnect Customization and Configuration III. Applying
- Explain the SOC design approaches and AES algorithm II. Understanding

UNIT – I

Introduction to the System Approach: System Architecture, Components of the system, Hardware Software, Processor Architectures, Memory, and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

UNIT – II

Processors: Introduction , Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.

UNIT – III

Memory Design for SOC: Overview of SOC external memory, Internal Memory, Size, Scratch pads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SOC Memory System, Models of Simple Processor – memory interaction.

UNIT - IV

Interconnect Customization and Configuration: Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses , Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance-Specific design, Customizable Soft Processor, Reconfiguration - overhead analysis and trade-off analysis on reconfigurable Parallelism.

UNIT – V

Application Studies / Case Studies: SOC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression.

TEXT BOOKS:

1. Michael J. Flynn and Wayne Luk, “Computer System Design System-on-Chip”, Wiely India Pvt. Ltd.
2. Steve Furber, “ARM System on Chip Architecture”, 2nd Ed., 2000, Addison Wesley Professional.

REFERENCE BOOKS:

1. Ricardo Reis, “Design of System on a Chip: Devices and Components”, 1st Ed., 2004, Springer
2. Jason Andrews, “Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology)”, Newnes, BK and CDROM.
3. Prakash Rashinkar, Peter Paterson and Leena Singh L, “System on Chip Verification – Methodologies and Techniques”, 2001, Kluwer Academic Publishers.

RF INEGRATED CIRCUITS*

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To know the noise challenges in RF IC design
- To solve design issues at Low noise amplifiers, Power amplifiers and frequency synthesizers
- To learn how to evaluate and design all CMOS RF integrated circuits
- To understand integrated circuit design for radio frequency applications

Course Outcomes:

After completing the course, students should be able to

- Demonstrate in-depth knowledge in Radio Frequency Integrated Circuits
- Analyze transceiver architecture in Radio Frequency Integrated Circuits
- Design LNA and Mixers in Radio Frequency Integrated circuits
- Explain the performance of oscillator circuits
- Analyze and design high efficiency power amplifier

UNIT – I

Introduction to RF and Wireless Technology: Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology.

UNIT–II

Basic concepts in RF Design: Nonlinearity and time variance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.

UNIT–III

Multiple Access: Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards. Transceiver Architectures: General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.

UNIT– IV

Amplifiers, Mixers and Oscillators: LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.

UNIT–V

Power Amplifiers: General considerations, linear and nonlinear Pas, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques.

TEXT BOOKS:

1. Behzad Razavi, RF Microelectronics Prentice Hall of India, 2001.
2. Thomas H. Lee, The Design of CMOS Radio Integrated Circuits**,** Cambridge University Press.

III. Embedded Systems & IoT

EMBEDDED SYSTEM ARCHITECTURE

L T P C
3 0 0 3

Course Objectives:

- To learn about the basic functions, structure, concepts and applications of embedded systems.
- To learn the method of designing and program an Embedded Systems for real time applications.
- To understand processor hardware and support hardware using in embedded systems.
- To know about the development of embedded software and implement small programs to solve well-defined problems on an embedded platform.
- To develop familiarity with tools used to develop in an embedded environment.

Course Outcomes:
After completing the course, students should be able to

- Describe the embedded system model.
- Become aware of the processor hardware
- Become aware of support hardware
- Design applications using the software middleware and applications.
- Analyze various examples of engineering issues of software

UNIT-I
INTRODUCTION TO EMBEDDED SYSTEMS -Embedded system model – embedded standards – block diagrams – powering the hardware - embedded board using von Neuman model. EMBEDDED processors: ISA architecture models – application specific ISA models – general purpose ISA models – instruction level parallelism.

UNIT-II
PROCESSOR HARDWARE: Internal processor design: ALU – registers – control unit - clock – on chip memory – processor i/o – interrupts – processor buses – processor performance.

UNIT-III
SUPPORT HARDWARE: Board memory: ROM – RAM – cache – auxiliary memory – memory management – memory performance – board buses: arbitration and timing – PCI bus example – integrating bus with components – bus performance.

UNIT-IV
SOFTWARE Middleware and applications: PPP – IP middleware – UDP – Java . application layer: FTP client – SMTP – HTTP server and client.

UNIT-V
ENGINEERING ISSUES OF SOFTWARE: Design and development: architectural patterns and reference models – creating the architectural structures – documenting the architecture – analyzing and evaluating the architecture – debugging testing, and maintaining.

REFERENCES:

1. Tammy Noergard, "Embedded system architecture", Elsevier, 2006

INTRODUCTION TO ARCHITECTING SMART IOT DEVICES

L T P C
3 0 0 3

Course Objectives:

- To develop an embedded systems device
- To reduce the time to market, many pre-made hardware and software components are available today
- To discover all the available hardware and software components, such as processor families, operating systems, boards and networks
- To architecting and implementing embedded device
- To debug and finetune device and how to make it run on a low power supply

Course Outcomes:

After completing the course, students should be able to

- Learn the knowledge of sensor devices
- Become aware of the interfacing sensor information and mcu
- Become aware of control techniques and standards
- Explore the communication for smart sensors
- Analyze packaging, testing and reliability implications of smart sensors

UNIT I
INTRODUCTION TO SENSOR DEVICES
Piezoresistive pressure sensor- Piezoresistive Accelerometer - Capacitive Sensing- Accelerometer and Microphone - Resonant Sensor and Vibratory Gyroscope - Low-Power, Low Voltage Sensors- Micro Electro Mechanical Systems Analysis and Design of MEMS Devices- Nano Sensors.

UNIT II
INTERFACING SENSOR INFORMATION AND MCU
Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control- MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration.

UNIT III
CONTROL TECHNIQUES AND STANDARDS
Control of Sensors using - State Machines, Fuzzy Logic, Neural Networks, Adaptive Control. Control Application using - CISC, RISC, DSP Control and IEEE 1451 Standards.

UNIT IV
COMMUNICATION FOR SMART SENSORS
Wireless Data Communications- RF Sensing- Telemetry- Automotive Protocols- Industrial Networks- Home Automation- MCU Protocols.

UNIT V
PACKAGING, TESTING AND RELIABILITY IMPLICATIONS OF SMART SENSORS
Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications- Testing Smart Sensors- HVAC Sensor Chip.

TEXT BOOKS

1. Randy Frank, "Understanding Smart Sensors", Artech House, Second Edition, 2011Boston,
2. Minhang Bao, "Analysis and design principles of MEMS devices", Elsevier Publications, 2005,USA.
3. Nadim Maluf and Kirt Williams, "An Introduction to Micro Electro Mechanical Systems Engineering", Second Edition, Artech House Publishers, June 2004, USA.

4. Gabriel M. Rebeiz, "RF MEMS: Theory, Design, and Technology", Wiley-Interscience; 1st edition, 2002,UK
5. John A. Pelesko and David H. Bernstein, " Modeling MEMS and NEMS", CRC Press, 2002,UK
6. Rai-choudhury, "MEMS and MOEMS Technology and Applications",PHI, 2010.
7. Ananthasuresh, "Micro and Smart Systems" Wiley Publishers,2013.

ADVANCED MICROCONTROLLERS*

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To learn architectures and programming for the of dsPIC 30F microcontroller and its peripherals.
- To understand the architectural features and instruction set of 16 bit microcontroller MSP430.
- To develop programs using the various instructions of MSP430 for different applications.
- To collect knowledge of architecture of ARM 7processor, LPC2148 and assembly programming of ARM.

Course Outcomes:

After completing the course, students should be able to

- Describe working of PIC DSPIC 30F series
- Describe working of Peripherals of dsPIC 30F Microcontroller Architecture and Programming model.
- Investigate and construct circuits for interfacing of peripheral components with MSP430.
- Learn the knowledge of ARM Processors.
- Illustrate the Internal Architecture ARM7TDMI processor

UNIT-I

DSPIC 30F series: Introduction to 16 bit microcontrollers - dsPIC 30F – CPU, Data memory, Program Memory - Instruction set - Programming in Assembly and CInterrupt Structure.

UNIT- II

Peripherals of dsPIC 30F: I/O Ports, Timers, Input Capture, Output Compare, Motor Control PWM, QEI,10 bit A/D Converter, UART, CAN Unit, Application Development.

UNIT-III

MSP430 and peripherals: MSP430f2274 - MSP430X22X2 device pin out, DA Package, Functional Block diagram description, Inputs, Outputs, Timers, ADC. Application development.

UNIT IV:

ARM Processors Fundamentals: Introduction to ARM processors and its versions. ARM7, ARM9 & ARM11 comparison, advantages & suitability in embedded application. ARM7 data flow model, programmer‟s model, modes of operations, Instruction set.

UNIT-V:

Internal Architecture: Introduction to ARM7TDMI processor – Pin Description, Pinfunctionality, internal architecture, Instruction Set and Instruction Cycle timings, ARM 32- bit and THUMB (16-bit) operating modes, Switching between ARM and THUMB instructions. Types of memory – Code memory, External Memory, Internal memory, Register Set.

TEXT BOOKS:

1. DSPIC 30F, Reference Manual, Microchip.
2. Chris Nagy, " Embedded System Design using the TI MSP 430 Series", First Edition, Newnes,2003
3. Andrew N. Sloss, Dominic Symes, Chris Wright and John Rayfield, "ARM System Developer'

SOFTWARE DEFINED NETWORKING*

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To differentiate between traditional networks and software defined networks
- To understand advanced and emerging networking technologies
- To obtain skills to do advanced networking research and programming
- To learn how to use software programs to perform varying and complex networking tasks
- To expand upon the knowledge learned and apply it to solve real world problems

Course Outcomes:

After completing the course, students should be able to

- CO1 Explain the key benefits of SDN by the separation of data and control planes K2
- Interpret the SDN data plane devices and Openflow Protocols K2
- Implement the operation of SDN control plane with different controllers K2
- Apply techniques that enable applications to control the underlying network using SDN K2
- Describe Network Functions Virtualization components and their roles in SDN K2

UNIT-I

SDN Background and Motivation: Evolving network requirements-The SDN Approach: Requirements, SDN Architecture, Characteristics of Software-Defined Networking, SDN and NFV-Related Standards: Standards-Developing Organizations, Industry Consortia, Open Development Initiatives.

UNIT-II

SDN Data plane and OpenFlow SDN data plane: Data plane Functions, Data plane protocols, Openflow logical network Device: Flow table Structure, Flow Table Pipeline, The Use of Multiple Tables, Group Table-OpenFlow Protocol.

UNIT-III

SDN Control Plane: SDN Control Plane Architecture: Control Plane Functions, Southbound Interface, Northbound Interface, Routing, ITU-T Model- OpenDaylight-REST- Cooperation and Coordination Among Controllers.

UNIT-IV

SDN Application Plane: SDN Application Plane Architecture: Northbound Interface, Network Applications, User Interface- Network Services Abstraction Layer: Abstractions in SDN, Frenetic- Traffic Engineering Measurement and MonitoringSecurity- Data Center Networking- Mobility and Wireless.

UNIT-V

Network Functions Virtualization: Background and Motivation for NFV- Virtual Machines- NFV Concepts: Simple Example of the Use of NFV, NFV Principles, High-Level NFV Framework, NFV Benefits and Requirements- NFV Reference Architecture: NFV Management and Orchestration.

TEXT BOOKS

1. William Stallings, “Foundations of Modern Networking”, Pearson Ltd.,2016.
2. Software Defined Networks: A Comprehensive Approach by Paul Goransson and Chuck Black,Morgan Kaufmann Publications, 2014
3. SDN - Software Defined Networks by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013

REFERENCE BOOKS

1. Feamster, Nick, Jennifer Rexford, and Ellen Zegura. "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98.
2. Kreutz, Diego, et al. "Software-defined networking: A comprehensive survey." Proceedings of the IEEE 103.1 (2015): 14-76.

ANURAG UNIVERSITY

School of Engineering

Department of Electronics and Communication Engineering

MINOR DEGREE

ROBOTICS

S. No.	Category	Course Title	L	T	P	Credits
1	PCC	Robotics & Automation	3	0	0	3
2	PCC	Micro-Processors and Microcontrollers	3	0	0	3
3	PCC	Embedded Systems & Robotics	3	0	0	3
4	PCC	Sensors & IoT	3	0	0	3
5	PCC	Introduction to Robot Operating System	2	0	2	3
6	PCC	Computer Vision	2	0	2	3
Total			**16**	**0**	**4**	**18**

ROBOTICS AND AUTOMATION

L T P C
3 0 0 3

Course Objectives:

- To develop the student's knowledge in various robot structures and their workspace.
- To develop student's skills in performing spatial transformations associated with rigid body motions.
- To develop student's skills in perform kinematics analysis of robot systems.
- To provide the student with knowledge of the singularity issues associated with the operation of robotic systems.
- To provide the student with some knowledge and analysis skills associated with trajectory planning.

Course Outcomes:

After completing the course, students should be able to

- Explain the fundamentals of robotics and its components
- Illustrate the Kinematics and Dynamics of robotics
- Elucidate the need and implementation of related Instrumentation & control in robotics
- Illustrate the movement of robotic joints with computers/microcontrollers.
- Explain sensors and instrumentation in robotics

UNIT-I

Introduction to Robotics: Overview of Robotics & Automation – Different Types of Robotics – Various Generations of Robots- Asimov's Laws Of Robotics –Selection of Robots-Role and design of embedded system for robotics and automation –Recent trends.

UNIT-II

Power Sources and Sensors: Hydraulic, Pneumatic And Electric Drives – Determination Of HP Of Motor And Gearing Ratio –Variable Speed Arrangements – Path Determination – Micro Machines In Robotics – Machine Vision – Ranging – Laser – Acoustic – Magnetic, Fiber Optic And Tactile Sensors-smart sensors.

UNIT-III

Manipulators, Actuators and Grippers: Construction of Manipulators – Manipulator Dynamics And Force Control – Electronic And Pneumatic Manipulator Control Circuits – End Effectors – Various Types Of Grippers – Design Considerations.

UNIT-IV

Kinematics and Path Planning: Solution Of Inverse Kinematics Problem–Multiple Solution Jacobian Work Envelop–Hill Climbing Techniques – path planning algorithms - Robot Programming Languages – Simulation and modeling of simple.

UNIT-V

Case Studies: Robot Cell Design -Intelligent Robot- Humanoid Robot -Multiple Robots –Robots in healthcare applications- Machine Interface – Robots in Manufacturing and Non- Manufacturing Applications- Self balancing robots- Micro/nano robots**.**

REFERENCES:

1. MikellP.WeissG.M.,NagelR.N.,OdrajN.G.,"IndustrialRobotics",McGraw-Hill Singapore,1996.
2. Ghosh, Control In Robotics And Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
3. Deb. S.R.,"Robotics Technology And Flexible Automation", JohnWiley, USA 1992.

4. KlafterR.D.,ChimielewskiT.A.,NeginM.,“Robotic Engineering– An Integrated Approach”, Prentice Hall Of India, New Delhi,1994.
5. Mc Kerrow P.J. “Introduction To Robotics”, Addison Wesley, USA,1991.
6. Issac Asimov “Robot”, Ballantine Books, New York,1986.
7. BarryLeatham–Jones,“ElementsOfIndustrialRobotics”PITMANPublishing,1987.
8. MikellP.Groover,MitchellWeiss,RogerN.NagelNicholasG.Odrey,“Industrial Robotics Technology, Programming And Applications“, McGrawHill Book Company1986.
9. FuK.S.GonzaleazR.C.AndLeeC.S.G.,“Robotics Control Sensing,Vision And Intelligence” McGraw Hill International Editions,1987

MICROPROCESSORS AND MICROCONTROLLERS*

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To introduce students with the architecture and operation of typical microprocessors and microcontrollers
- To familiarize the students with the programming and interfacing of microprocessors and microcontrollers
- To provide strong foundation for designing real world applications using microprocessors and microcontrollers

Course Outcomes:

After completing the course, students should be able to

- Develop an in-depth understanding of the operation of microprocessors.
- Master the assembly language programming using concepts like assembler directives, procedures, macros, software interrupts etc.
- Create an exposure to basic peripherals, its programming and interfacing techniques
- Apply the concept of Interrupts and interfacing details of 8086.
- Apply the basic concepts of serial communication in 8086.

UNIT-I:

8085 Microprocessor: Evolution of microprocessors, The 8085 Microprocessor, Microprocessor communication and bus timings, Generating control signals, 8085 MPU and its architecture and pin diagram, Decoding and Executing an Instruction, Instruction set and Assembly Language programming.

UNIT–II:

8086 Microprocessor: 8086 architecture, register organization, memory segmentation, programming model, memory Addresses, physical memory organization, signal descriptions of 8086, timing diagrams.

UNIT–III:

Instruction set and Assembly Language programming of 8086: Addressing modes, assembler directives, macros, simple programs involving logical, arithmetic expressions and string manipulations. Interrupt structure of 8086, Serial communication standards, 8251 USART architectures and interfacing, RS-232C. I/O Interface with 8255-PPI, various modes of operation and interfacing to 8086, 8257 DMA controller to 8086, Memory interfacing to 8086.

UNIT-IV:

8051 Microcontroller: Architecture, I/O ports, register set, Memory organization, Addressing modes and Instruction set of 8051, Interrupts in 8051, Interrupt Priority in the 8051.

UNIT–V:

8051 Interface: Timers/Counters and Serial communication registers in 8051, Interface with Keyboard & Displays, Serial data communication and Timer/Counter Interfacing program.

TEXT BOOKS:

1. Ramesh S Goankar, “Microprocessor Architecture Programming and Applications with the 8085, Penram International Pvt.Ltd.2013.
2. A.K. Ray & Bhurchandi Advanced Microprocessors and peripherals –, TMH publications,2012.

REFERENCE BOOKS:

1. Kenneth Ayala and Dhanunjay Gadre, ‘The 8051 microcontroller’ Penram International/ Thomson, 2008.
2. Douglas V Hall, “Microprocessors and Interfacing: Programming and Hardware”, 2 nd, TMH publications,1992.
3. 8086 Micro Processor -Kenneth J. Ayala, Penram International/ Thomson, 1995.

INTRODUCTION TO ROBOT OPERATING SYSTEM

L T P C
3 0 0 3

Course Objectives:
- Introduce the basics of Robot Operating Systems and its architecture
- Provide knowledge on the hardware interfacing aspects
- Understand the applications of ROS in real world complex applications

Course Outcomes:
After completing the course, students should be able to
- Describe the need for ROS and its significance
- Discuss about the concepts behind navigation through file system.
- Explain the concepts of Node debugging
- Analyze the issues in hardware interfacing
- Discuss about the applications of ROS

UNIT-I:
Introduction to ROS: Introduction –The ROS Equation - History - distributions -difference from other meta-operating systems– services - ROS framework – operating system – releases.

UNIT-II:
Introduction to Linux Commands: UNIX commands - file system – redirection of input and output - File system security - Changing access rights – process commands – compiling, building and running commands – handling variables

UNIT-III:
Architecture of Operating System: File system - packages – stacks – messages – services – catkin workspace – working with catkin workspace – working with ROS navigation and listing commands

UNIT-IV:
Computation Graph Level: Navigation through file system -Understanding of Nodes – topics – services – messages – bags – master – parameter server.

UNIT-V:
Debugging And Visualization: Debugging of Nodes – topics – services – messages – bags – master – parameter – visualization using Gazebo – Rviz – URDF modeling – Xacro – launch files. Hardware Interface: Sensor Interfacing – Sensor Drivers for ROS – Actuator Interfacing – Motor Drivers for ROS.

TEXT BOOKS:

1. Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018
2. Aaron Martinez, Enrique Fernández, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013.

REFERENCE BOOKS:

1. Jason M O'Kane, "A Gentle Introduction to ROS", CreateSpace, 2013.
2. AnisKoubaa, "Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.
3. Kumar Bipin, "Robot Operating System Cookbook", Packt Publishing, 2018.

4. Wyatt Newman, “A Systematic Approach to learning Robot Programming with ROS”, CRC Press, 2017.
5. Patrick Gabriel, “ROS by Example: A do it yourself guide to Robot Operating System”, Lulu, 2012.

COMPUTER VISION*

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To review image processing techniques for computer vision
- To illustrate shape and region analysis
- To describe Hough Transform and its applications to detect lines, circles, ellipses
- To discuss three-dimensional image analysis techniques
- To explore some applications of computer vision algorithms

Course Outcomes:

After completing the course, students should be able to

- Review image processing techniques for computer vision
- Illustrate shape and region analysis
- Describe Hough Transform and its applications to detect lines, circles, ellipses
- Discuss three-dimensional image analysis techniques
- Explore some applications of computer vision algorithm

UNIT-I

Introduction to Computer Vision: Overview and State-of-the-art, The Four Rs of Computer Vision, Geometry of Image Formation, Digital Image Formation and low-level processing, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Classification of image processing operations- Arithmetic operations, Logical operations.

UNIT-II

Depth estimation and Multi-camera views, Robust Correspondence Estimation, Perspective, Edge Detection, Binocular Stereopsis: Camera and Epipolar Geometry; Texture: Representation of texture, Analysis of using oriented pyramids, synthesizing texture and shape from texture. Image Filtering: Linear filters and convolutions, shift invariant linear system, spatial frequency, sampling and aliasing, Filters as Templates.

UNIT-III

Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.Recognition: Building blocks, Detectors and Descriptors, SIFT & Single Object Recognition, Optical Flow & Tracking, Introduction to Object Recognition and Bag-of Words Models, Constellation model, foot-of-normal method – line localization – line fitting

UNIT-IV

Use of Surface Smoothness Constraint; sources and their effects, local shading models Edge detection: Noise, estimation derivatives, detecting edges, Feature Extraction, Edges - Canny, LOG, DOG; Color : The physics of color , Human color perceptron, representing color and color models – like RGB, HSV and CMYK models, Face Detection, Image Segmentation, Feature Tracking & Motion Layers.

UNIT-V

Recognition: Objects, Scenes, Activities, Object classification and detection: a part-based discriminative model (Latent SVM), Objects in Scenes. Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo;3D vision and motion : Methods for 3D vision – projection schemes – shape from shading –photometric stereo – shape from texture

TEXT BOOKS:

1. Computer Vision: A Modern Approach, D. Forsyth and J. Ponce, Prentice Hall, 2nd ed., 2015, 2nd Edition.
2. Prince, Simon JD. Computer vision: models, learning, and inference. Cambridge University Press, 2012, 1st Edition. References: 4) Computer Vision: Algorithms and Applications, by Richard Szeliski, 2011 Edition, Springer.

REFERENCE BOOKS:

1. Computer Vision: Algorithms and Applications, by Richard Szeliski, 2011 Edition, Springer.
2. Introductory Techniques for 3D Computer Vision, Emanuele Trucco and AlessandroVerri, Prentice Hall.1998, 1st Edition.

EMBEDDED SYSTEMS & ROBOTICS*

(* This course is offered by NPTEL. Syllabus contents may be modified subject to the availability in NPTEL portal)

L T P C
3 0 0 3

Course Objectives:

- To introduce embedded hardware design and programming
- To introduce robotics, electronic components, electronic processors and controllers,
- To develop circuit with practical knowledge of robotic and embedded modules
- To provide the best of robotics training for real-time applications.

Course Outcomes:

After completing the course, students should be able to

- Understand the importance of embedded systems and robotics in our daily life.
- Identify different embedded devices.
- Co-related embedded systems with their university courses.
- Identify different components of embedded systems and robotics.
- Know about different features of a microcontroller. Interfaced different input/output devices with a microcontroller.

UNIT-1

INTRODUCTION TO SENSORS FOR ROBOTIC APPLICATIONS (9L) Sensor Categories, Binary Sensor, Analog versus Digital Sensors, Shaft Encoder; A/D Converter, Position Sensitive Device; Compass, Gyroscope, Accelerometer, Inclinometer, Digital Camera.

UNIT-II

ROBOTICS CONTROL ELEMENTS (9L) Actuators - DC Motors, H-Bridge, Pulse Width Modulation, Stepper Motors, Servos. Control – On Off Control, PID Control, Velocity Control and Position Control.

UNIT-III

EMBEDDED CONTROLLERS FOR ROBOTS(9L) Embedded Controllers, Interfaces, Operating System - Industrial Robots.

UNIT-IV

ROBOT KINEMATICS(9L) Evolution of robotics, Robot anatomy, Design and control issues, Manipulation and Control. Direct Kinematic Model - Denavit-Hartenberg Notation, Kinematic Relationship between adjacent links, Manipulator Transformation Matrix; Inverse Kinematic Model.

UNIT-V

MOBILE ROBOTS (9L) Concepts of Localization and path planning - Autonomous robots - Robot Operating System.

TEXT BOOKS:

1. AnisKoubaa, "Robot Operating System (ROS) The Complete Reference", First Volume, Springer, 2016
2. Thomas Bräunl, "Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems", Third Edition, Springer-Verlag Berlin Heidelberg, 2008.

3. R.K.Mittal and I.J.Nagrath, “Robotics and Control”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2003

REFERENCE BOOKS:

1. K.S. Fu, R.C. Gonzalez and C.S.G. Lee, “Robotics: Control, Sensing, Vision, and Intelligence”, McGraw-Hill, New York, 1987 Sensors & IOT

SENSORS & IOT

L T P C
3 0 0 3

Course Objectives:

- To understand the fundamentals of IoT
- To analyst the difference between M2M and IoT
- To understand the fundamentals of Sensing and Sensor Devices
- To Develop and use of emerging Sensors for IoT Technology
- To understanding of fundamentals of wireless communications to design Sensor Nodes

Course Outcomes:

After completing the course, students should be able to

- Understanding of IoT value chain structure (device, data cloud), application areas and technologies involved.
- Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, and sensing modules
- Market forecast for IoT devices with a focus on sensors
- Explore and learn about Internet of Things with the help of preparing projects designed for Raspberry Pi

UNIT-I

IoT& Web Technology The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

UNIT-II

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global valuechain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT-III

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT –IV

SENSORS FOR ROBOTICS: Classification, characteristics and calibration of different sensors, position sensors, motion sensors, force sensors, torque sensors, strain gauge sensors, pressure flow sensors, temperature sensors, tactile and proximity sensors, Principles and structures of modern micro sensors.

UNIT -V

OPTOELECTRONIC SENSORS: Photo detector, Thermal detector, Photo Conductors, Photo diodes, LED, PIN, APD, Phototransistors, solar cells, CCDs, IR and UV detectors, Detector Performance

TEXT BOOKS:

1. Patranabis D, "Sensors and Transducers", Prentice-Hall of India Private Limited, New Delhi, 2003.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1 st Edition, VPT, 2014
3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1 st Edition, Apress Publications, 2013

REFERENCE BOOKS:

1. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", Springer, 3rd Ed., 2004
2. Cuno Pfister, Getting Started with the Internet of Things, O‟Reilly Media, 2011, ISBN: 978-1-4493-9357-1

Electrical & Electronics Engineering

Minutes of Meeting

The BOS meeting of the Department of EEE, AU was held on 20-03-21 in the Electrical Simulation lab of the Department. The external members of the Board attended virtually and the meeting started at 10.00 AM. The following members have attended the meeting.

1.	Prof. P.V.N.Prasad	Chairperson, Professor, AU
2.	Dr. T. Anil Kumar	HoD & Member, Assoc. Professor, AU
3.	Dr. G. Yesuratnam	Member, Professor, O U
4.	Dr. P. Chow Reddy	Member, Director, Eesavyasa Technologies, Hyd
5.	Dr. Radhika Sudha	Member, Asst. Professor, BITS, Hyd
6.	Dr. Shiva Kumar Keerthiparti	Member, Assoc. Professor, IIT, Hyd
7.	Dr. D.M.Vinod Kumar	Member, Professor, NIT, Warangal
8.	Dr. G. Venu Madhav	Member, Assoc. Professor, AU
9.	Dr. C. Nagamani	Member, Assoc. Professor, AU
10.	Mr. CH.Srinivasa Rao	Member, Asst. Professor, AU
11.	Mrs. S.Saraswathi	Member, Asst. Professor, AU
12.	Mr. Md.Yaseen	Member, Asst. Professor, AU
13.	Mr.T. Dinesh	Special Invitee, AU

The chairperson welcomed the members and after fruit full deliberations, the following decisions were taken in the meeting.

1. The course structure of B.Tech (EEE) II, III, IV Year of R-20 was approved with certain modifications.
    - Suggested to move III Yr.-I Sem Subject (Electrical Measurements) to II Yr. -II Sem.
2. The syllabus of the B.Tech (EEE) II Year I & II Sem subjects were approved with certain modifications.
    - Suggested to add applications of DC Motors in EM-I course.
3. The course structure & syllabus of B.Tech (Hons) in Smart Grids and Electric Vehicles were approved.
4. The course structure & syllabus of B.Tech (Minor) in Electric Vehicles were approved.

5. The course structure & syllabus of M.Tech (PEED & EPS) of R-21 were approved.
6. The GATE syllabus (EE) was approved as syllabus for Ph.D Eligibility Exam, A.U.

Finally, the Chairperson thanked to all the members for their valuable suggestions.

B-Tech (EEE) Honors on “Smart Grids”

S.No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1		Introduction to Smart Grids (Online)	3	0	0	3
2		Smart Grids Planning and Operation	3	0	0	3
3		Cyber Security of Smart Grids (Online)	3	0	0	3
4		Smart Grid Protection	3	0	0	3
5		Project on Smart Grids	0	0	12	6
TOTAL			**12**	**0**	**12**	**18**

Note: *Not only above said courses, but also any other courses recommended by internal BoS members will be considered.*

Introduction to Smart Grid

Course Outcome:

- Explain the difference between conventional grids and smart grids and its self healing capacity
- Demonstrate the importance of smart grid components in deployment of smart grids
- Illustrate the importance of intelligent electronic devices and their applications for monitoring and protection.
- Investigate problems associated with distributed micro grids integrated with conventional grid system
- Analyze power quality issues of integrated smart grids for control and monitoring

Unit 1: Introduction to Smart Grid
Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid.

Unit 2: Smart Grid Technologies
Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

Unit 3: Smart Grid Technologies
Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

Unit 4: Micro grids and Distributed Energy Resources
Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources.

Unit 5: Power Quality Management in Smart Grid
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring.

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press
3. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication.

Smart Grid Planning & Operation

Course Outcomes:

- Understand the analysis and planning of Smart Grids.
- Evaluate the tools for modeling and analysis of smart grid dynamics.
- Analyze and synthesize different control schemes of smart grid operation.
- Assess the influence of smart grid on power system

Unit-1: Smart Grid Components
Smart grid concepts, smart grid components and control elements, Distributed generation resources and Energy Storage, Plug-in-Hybrid Electric Vehicles (PHEV), Smart Homes, Microgrids.

Unit-II: Analysis of Smart Grid System
Load Flow study for AC/DC smart grid analysis , Economic Dispatch, State Estimation for low voltage networks, smart grid Monitoring, smart grid standards and policies.

Unit-III: Smart Grid Planning
Planning Aspects of smart grid, Operation and control of AC, DC and hybrid smart grid, Optimal power flow, Demand side management of smart grid, Demand response analysis of smart grid, Energy, Management, Planning and Design of smart grid systems.

Unit-IV: Voltage and Frequency Regulation of Smart Grid
Automatic generation Control, Load frequency control, Tie-line power sharing, Voltage Stability, Assessment, Voltage stability Indexing, Concepts on the design of smart grid stabilizers to improve voltage stability, frequency & voltage regulations, and volt-VAR support.

Unit-V: Operation and Control of Smart Grids
Operational aspects of smart grid system, active and reactive power response, control objectives smart distribution system, architecture and different schemes of smart grid control, bottleneck in smart grid control, Ancillary Services. Advantages and disadvantages of different control schemes.

Text Books:

1. J. Momoh, “Smart Grid: Fundamentals of Design and Analysis,” Wiley-IEEE Press, 1st Edition,2012.
2. S. K. Salman, “Introduction to the Smart Grid: Concepts, Technologies and Evolution,” IET Energy Engineering Series, 1st Edition, 2017

Reference Books:

1. Mini S Thomas and J. D MacDonald, " Power System SCADA and Smart Grid," CRC Press, 1st Edition, 2015.
2. N. Hatziargyriou, "Microgrids Architecture and control", Wiley-IEEE Press Series, 1st Edition 2013.
3. D. Mah, P. Hills, Victor O.K. Li, R. Balme, "Smart Grid Applications and Developments," SpringerVerlag London, 1st Edition, 2014.
4. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, "Smart Grid: Technology and Applications," John Wiley & Sons, 1st Edition, 2015.
5. G. Strbac, D. K. Rodrigo Moreno, "Reliability Standards for the Operation and Planning of Future Electricity Networks," IEEE, 1st Edition, 2016.
6. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE, 2nd Edition 2016.

Cyber Security of Smart Grids

Course Outcome:

- Understand the key technical threat types, communication protocols and resilient smart grid Architectures.
- Deploy risk management, operational security and secure development of Smart Grid.
- Assess static and dynamic security analysis techniques to validate.
- Verify smart grid security and resiliency.

Unit-1:Smart Grid Security Challenges
Security Goals and Challenges, Importance of security, Classification of the threats, Security Analytics for AMI and SCADA, Security Analytics for EMS Modules, Overview of SMT and Probabilistic Model Checking.

Unit-2: Security in Smart Grid
Security Challenges in Smart Grid Implementation, Legal Protection of Personal Data in Smart Grid and Smart Metering Systems, Phases of smart grid system development cycle, Smart Grid Security.

Unit-3: Data Privacy in Smart Grid
Privacy of Customer-Side Networks, Smart Grid Security Protection against False Data Injection (FDI) Attacks, Smart Grid Security, Secure V2G Connections, End-to-End security with devices/equipment, sensors, controllers, actuators, communication and systems.

Unit-4: Smart Grid Threat and Cross-Domain Risk
Smart Grid threat Landscape, Smart Grid Risk Assessment, Challenges and solutions, Emerging methods and techniques for the smart grid security.

Unit-5: Smart Grid Resiliency and Cyber attack
Types of physical attack on smart grid devices, Hardware security modules, Analytics for Smart Grid Security and Resiliency, Cyber security solutions for control and monitoring system, Control centric security tools and risk assessment methodology, Secure Communications in Smart Grid: Networking and Protocals.

Reference Books:

1. Abdallah and X. Shen, "Security and Privacy in Smart Grid", *Springer Intr.*, 1st Edition, 2018.
2. Abdul Rahaman *et al.,* 'Smart grids security challenges: Classification by sources of threat', Journal of Electrical Systems and Information Technology, 5 (3), pp. 468-483, 2018.
3. A. Abur and A. G. Exposito, "Power System State Estimation: Theory and Implementation", CRC Press, 1st Edition, 2004.
4. Roy D. Yates, David J. Goodman, "Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers", Wiley, 3rd Edition, 2014.
5. J. A. Momoh, "Smart Grid: Fundamentals of Design and Analysis" Wiley India, 1st Edition, 2015.

Smart Grid Protection

Course Outcomes:

- Understand basic concepts of advanced protection systems.
- Design relay algorithms and associated hardware.
- Understand the principles of modern protection systems for substation, transformer, generator and motor.
- Evaluate the impact and influence of PMUs on the Protections schemes.

Unit-1: Introduction to Advanced Protection Systems
Basics of Electrical Protection systems, Protection system in Smart Grid, Importance and challenge of protective devices in smart grid.

Unit-2: Relays and Hardware Consideration
Basics of digital protection and relays, Advantage of microprocessor technology and its application to protection, subsystem of digital relay, Numerical relays, Protection of substation, transformer, generators and motors. Analogue signal conditioning, low pass filters, DSP based general purpose hardware, Microcontrollers and digital relay implementation procedures.

Relaying Algorithms
Classification of relaying algorithms, Algorithms for digital relaying, Full cycle and half cycle Fourier algorithms, Walsh and Haar algorithms, least square fitting algorithm, Digital harmonic filter algorithms. Microgrid Protection using Hilbert Huang and wavelet transform.

Unit-3: Wide Area Protection
Differential Protection of Transmission Lines, Distance Relaying of Multiterminal Transmission Lines, Adaptive Protection, Adaptive Out-of-Step Protection, Security Versus Dependability, Transformer, Adaptive System Restoration, Control of Backup Relay Performance, Hidden Failures, Intelligent Islanding, Supervisory Load Shedding, Concept of integrated wide area monitoring and protection (WAM & WAP).

Unit-4: System Integrity Protection Scheme (SIPS) based on PMU Technology
SIPS architecture, SIPS data archival system, SIPS applications, Data protocols, SIPS monitoring and testing functions, Example of SIPS application based on PMU technology.

Unit-5: Advanced Protection for Smart Grid
Distribution Grid Protection in Smart Grid Environment, Protection Needs for Modern Distribution Systems, Adaptive relay protection.

Text Books:

1. G. Phadke and James S. Thorp, "Computer Relaying for Power systems" John Wiley and Sons, 2^{nd} Edition, 2009.
2. Vaccaro, Alfredo Zobaa, Ahmed F, "Wide Area Monitoring, protection and control systems the enabler for smarter grids", IET publisher, 1st Edition, 2016.
3. Y. G. Paithankar and S. R. Bhide, "Fundamentals of Power System Protection" Prentice Hall of India, 2nd Edition, 2010.

Reference Books:

1. E. Amir, "Microgrids: Operation, Control, and Protection," LAP Lambert Academic Publishing, 1^{st} Edition, 2014.
2. Badriram and V. Kharma, "Power System Protection and Switchgear", TMH, 2nd Edition, 2011.
3. B. Bhalja, R. P. Maheshwari and N. G. Chothani, "Protection and Switchgear", Oxford University Press, 1st Edition, 2011.
4. T.S. Madhava Rao, "Static Relays with Microprocessor Application", TMH, 2nd Edition, 2009.

Courses under B-Tech (EEE) Honors on "Electric Vehicles"

S.No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1		Introduction to Hybrid& Electric Vehicles	3	0	0	3
2		Control of Electric Vehicles	3	0	0	3
3		E-Mobility and Charging Infrastructure (Online Course)	3	0	0	3
4		Electric Vehicles in Smart Grids (Online)	3	0	0	3
5		Project on Electric Vehicles	0	0	06	6
TOTAL			**12**	**0**	**06**	**18**

Note: *Not only above said courses, but also any other courses recommended by internal BoS members will be considered.*

Introduction to Electrical and Hybrid Vehicles

Course Outcomes:

- Understand the importance of hybrid and electric vehicles.
- Illustrate the drive-train topologies of electric vehicles & hybrid vehicles.
- Demonstrate the configuration and control of various electrical machines used in electric drive-trains.
- Choose proper Energy Storage systems for vehicles applications.
- Identify various energy management strategies.

Unit- I: Introduction:

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.
Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Unit- II: Hybrid Electric Drive-trains

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Unit- III: Electric Trains

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit- IV: Energy Storage

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit- V: Energy Management Strategies

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.
Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles, Design fundamentals, CRC Press 2003.
2. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.

References Books:

1. James lerminie, John Lowry, Electic vehicle Technology, Explaned Wiley, 2003.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.

Control of Electric Vehicles

Course Outcomes:

- Understand requirement of EV motors
- Understand suitability of electric motor & their control
- Understand speed control of Induction motor
- Understand PWM techniques of Inverter for Induction motor
- Understand different sensors and sensor less operation of motor

Unit-1: EV Motors Characteristics and DC motor

Requirement of EV motors, Comparison of EV motors, Basics of DC Motor, Torque speed characteristics, DC Motor dynamics, Field Weakening Control, Four quadrant operation.

Unit-2: DC Motor Dynamics & Control

Current Loop Control, Speed Control Loop Dynamical System Control: Gain & Phase Margins, PD Controller, PI Controller, Selecting PI Gain for Speed Controller, PI Controller Design, PI Controller with Reference model, Comparison of conventional PI Controller with PI controller with Reference Model, 2 DOF Controller with Internal Model Control, Load Torque Observer, Feedback Linearization, Simplified Modeling of Practical Current Loop.

Unit-3: Induction Motor

Rotating Magnetic Field, Basics of Induction motor, Speed-Torque Curve Leakage inductance, circle diagram, current displacement (double cage rotor), line starting, Dynamic modelling of Induction motor

Unit-4: Induction Motor Speed Control

Rotating Magnetic Field, Basics of Induction motor, Speed-Torque Curve Leakage inductance, circle diagram, current displacement (double cage rotor), line starting, Dynamic modelling of Induction motor , Rotor Field oriented control, Stator Field Oriented Control, Field Weakening Control, Variable Voltage Variable Frequency Control.

Unit-5: PWM and Inverter

Sinusoidal PWM, Injection of third order harmonics, Space Vector Modulation, Dead time & compensation, Encoders, Resolvers, R/D Converters, Hall current sensors and current sampling, Voltage Model Estimator, Current Model Estimator, Closed-loop Control.

REFERENCE BOOKS

1. K Wang Hee Nam: AC Motor Control & Electrical Vehicle Application, CR Press, Taylor & Francis Group, 2019.
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc.,
3. New York 2001.
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

E-Mobility and Charging Infrastructure

Course Outcomes:

- Elaborate various technical parameters of batteries.
- Distinguish between various types of batteries used for EV applications.
- To develop battery charger for an EV.

Unit-1: Introduction to E-Mobility
EVs : A clean mobility option, Motion and dynamic equations for vehicles, Propulsion requirements for vehicles, HEV architectures, EV architectures, Mechanical systems used in EVs and HEVs.

Unit-2: Electrical Drive system & Power Electronics for EVs applications
Electrical machines for EVs and HEVs, DC-DC Converters, Boost and Buck-Boost Converter, Multi Quadrant DC-DC Converters, Voltage Control of DC-AC Inverters Using PWM, Fundamentals of Regenerative Braking.

Unit-3: EV Batteries
Lead acid battery basics, Special characteristics of lead acid batteries, Battery life and maintenance, Battery charging, Summary Nickel-based Batteries Introduction, Nickel cadmium, Nickel metal hydride batteries, Sodium sulphur batteries, Sodium metal chloride (Zebra) batteries, The lithium polymer battery.

Unit-4: Charging Infrastructure
Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

Unit-5: EV Charging
Battery Chargers: Charge equalisation, Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods.

Reference Books:

1. James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK, Electric Vehicle Technology Explained.
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Electric Vehicles in Smart Grid

Course Outcomes:

- *Describe about vehicle electrification and impact of charging strategies.*
- *Describe the influence of EVs on power system*
- *Describe the frequency control and voltage reserve from EVs*

Unit-1: Introduction

Introduction, Impact of charging strategies, EV charging options and infrastructure, energy, economic and environmental considerations, Impact of EV charging on power grid, effect of EV charging on generation and load profile, Smart charging technologies, Impact on investment.

Unit-2:Influence of EVs on Power System

Introduction, identification of EV demand, EV penetration level for different scenarios, classification based on penetration level, EV impacts on system demand: dumb charging, multiple tariff charging, smart charging, case studies.

Unit-3: Frequency Control Reserves & Voltage Support From EVs

Introduction, power system ancillary services, electric vehicles to support wind power integration, electric vehicle as frequency control reserves and tertiary reserves, voltage support and electric vehicle integration, properties of frequency regulation reserves, control strategies for EVs to support frequency regulation.

Unit-4: ICT Solutions to Support EV Deployment

Introduction, Architecture and model for smart grid & EV, ICT players in smart grid, smart metering, information & communication models, functional and logical models, technology and solution for smart grid: interoperability, communication technologies.

Unit-5: EV Charging Facility Planning

Energy generation scheduling, different power sources, fluctuant electricity, centralized charging schemes, decentralized charging schemes, energy storage integration into Microgrid, Design of V2G Aggregator.

Reference Books:

1. Energy generation scheduling, different power sources, fluctuant electricity, centralized charging

schemes, decentralized charging schemes, energy storage integration into Microgrid, Design of V2G Aggregator.

2. Crouse W.H, Anglin D.L, "Automotive Transmission and Power Train construction", McGraw Hill, 1976.

3. Harald Naunheimer , Bernd Bertsche , Joachim Ryborz , Wolfgang Novak "Automotive Transmission: Fundamentals, Selection, Design and Application", 2nd Edition, Springer, 2011.

Courses under B-Tech (EEE) Minor on "Electric Vehicles"

S.No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1		Introduction to Electrical and Hybrid Vehicles	4	0	0	3
2		Control Aspects of Electric Vehicles	4	0	0	3
3		E-Mobility and Charging Infrastructure	4	0	0	3
4		Battery Management System (BMS) for Electric Vehicles	3	0	0	3
5		Modeling and Simulation of Electric Vehicle Components	3	0	0	6
TOTAL			**18**	**0**	**0**	**18**

Note: *Not only above said courses, but also any other courses recommended by internal BoS members will be considered.*

Introduction to Electrical and Hybrid Vehicles

Course Outcomes:

- Explain the importance of hybrid and electric vehicles.
- Illustrate the drive-train topologies of electric vehicles & hybrid vehicles.
- Demonstrate the configuration and control of various electrical machines used in electric drive-trains.
- Choose proper Energy Storage systems for vehicles applications.
- Identify various energy management strategies.

Unit- I: Introduction:

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.
Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Unit- II: Hybrid Electric Drive-trains

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Unit- III: Electric Trains

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit- IV: Energy Storage

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit- V: Energy Management Strategies

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.
Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books:

3. Iqbal Hussein, Electric and Hybrid Vehicles, Design fundamentals, CRC Press 2003.
4. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.

References Books:

4. James lerminie, John Lowry, Electic vehicle Technology, Explaned Wiley, 2003.
5. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
6. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.

Control of Electric Vehicles

Course Outcomes:

- Understand requirement of EV motors
- Understand suitability of electric motor & their control
- Understand speed control of Induction motor
- Understand PWM techniques of Inverter for Induction motor
- Understand different sensors and sensor less operation of motor

Unit-1: EV Motors Characteristics and DC motor

Requirement of EV motors, Comparison of EV motors, Basics of DC Motor, Torque speed characteristics, DC Motor dynamics, Field Weakening Control, Four quadrant operation.

Unit-2: DC Motor Dynamics & Control

Current Loop Control, Speed Control Loop Dynamical System Control: Gain & Phase Margins, PD Controller, PI Controller, Selecting PI Gain for Speed Controller, PI Controller Design, PI Controller with Reference model, Comparison of conventional PI Controller with PI controller with Reference Model, 2 DOF Controller with Internal Model Control, Load Torque Observer, Feedback Linearization, Simplified Modeling of Practical Current Loop.

Unit-3: Induction Motor

Rotating Magnetic Field, Basics of Induction motor, Speed-Torque Curve Leakage inductance, circle diagram, current displacement (double cage rotor), line starting, Dynamic modelling of Induction motor

Unit-4: Induction Motor Speed Control

Rotating Magnetic Field, Basics of Induction motor, Speed-Torque Curve Leakage inductance, circle diagram, current displacement (double cage rotor), line starting, Dynamic modelling of Induction motor , Rotor Field oriented control, Stator Field Oriented Control, Field Weakening Control, Variable Voltage Variable Frequency Control.

Unit-5: PWM and Inverter

Sinusoidal PWM, Injection of third order harmonics, Space Vector Modulation, Dead time & compensation, Encoders, Resolvers, R/D Converters, Hall current sensors and current sampling, Voltage Model Estimator, Current Model Estimator, Closed-loop Control.

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8. New York 2001.
9. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
10. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

E-Mobility and Charging Infrastructure

Course Outcomes:

- Elaborate various technical parameters of batteries.
- Distinguish between various types of batteries used for EV applications.
- To develop battery charger for an EV.

Unit-1: Introduction to E-Mobility

EVs : A clean mobility option, Motion and dynamic equations for vehicles, Propulsion requirements for vehicles, HEV architectures, EV architectures, Mechanical systems used in EVs and HEVs.

Unit-2: Electrical Drive system & Power Electronics for EVs applications

Electrical machines for EVs and HEVs, DC-DC Converters, Boost and Buck-Boost Converter, Multi Quadrant DC-DC Converters, Voltage Control of DC-AC Inverters Using PWM, Fundamentals of Regenerative Braking.

Unit-3: EV Batteries

Lead acid battery basics, Special characteristics of lead acid batteries, Battery life and maintenance, Battery charging, Summary Nickel-based Batteries Introduction, Nickel cadmium, Nickel metal hydride batteries, Sodium sulphur batteries, Sodium metal chloride (Zebra) batteries, The lithium polymer battery.

Unit-4: Charging Infrastructure

Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

Unit-5: EV Charging

Battery Chargers: Charge equalisation, Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods.

Reference Books:

6. James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK, Electric Vehicle Technology Explained.
7. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.
8. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
9. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
10. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Battery Management System (BMS) for Electric Vehicles

Course Outcomes:

- Interpret the role of battery management system.
- Identify the requirements of Battery Management System.
- Interpret the concept associated with battery charging / discharging process.
- Calculate the various parameters of battery and battery pack.
- Design the model of battery pack.

Unit-1: Introduction

Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.

Unit-2: Battery Management System Requirement

Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of-charge estimation, Cell total energy and cell total power.

Unit-3: Battery State of Charge and State of Health Estimation, Cell Balancing

Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing.

Unit-4: Modelling and Simulation

Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs.

Unit-5: Design of battery BMS

Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system.

References:

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
4. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010

5. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

Modelling and simulation of Electric vehicle components

Course Outcomes

1. To understand the modeling of Electrical Machine Drives for EV applications
2. To understand the importance of different converter topologies for EV applications
3. To develop the simulated model of various EV components
4. To acquire knowledge on development of simulation model of EV components

List of Experiments

1. Modelling and simulation of Six step VSI for EV Applications
2. Modelling of PMDC motor using MATLAB/SIMULINK
3. Simulation of Closed loop speed control drive for below and above base speeds using MATLAB/SIMULINK
4. Simulation of four quadrant drive for Brush less dc motors using MATLAB/SIMULINK
5. Simulation of Energy Management Systems for a Hybrid Electric Source for electric vehicles
6. Modelling and simulation of Ni-MH battery used for electric vehicle applications
7. Simulation of Supercapacitor based energy storage system for EV Applications
8. Modelling and simulation of induction motor drive for EV applications
9. Modelling and simulation of SRM drive for EV applications
10. Sensor less BLDC motor drive for EV applications
11. Modelling and simulation of BLDC motor drive for EV applications
12. Modelling and simulation of Electric vehicle

*****Note: Any 10 Experiments has to perform out of 12 Experiments**

Information Technology

Minutes of the Meeting of Board of Studies

The Third Board of Studies (BoS) meeting of the Department of Information Technology, Anurag University was held on Friday 11th June 2021 at 10.30 AM. Due to the ongoing pandemic of Covid-19, the meeting was conducted online.

The meeting was convened to discuss and finalize the Anurag University - R20 regulations (AU-R20):

- Course structure and syllabus of M. Tech in Cyber Security

The chairman has welcomed the members and conducted the proceedings.

The following resolutions were made in the meeting.

Item	Description	Resolution
1	Course Structure of M. Tech (Cyber Security) I and II Year of AU-R20	The BoS members had a glance of the course structure of I and II Years of M. Tech (Cyber Security). All the members appreciated and approved the course structure
2	Course Objectives and Course Outcomes	The members suggested modifications to the course objectives and outcomes of few courses in line with Bloom's taxonomy verbs. The suggestions are incorporated
3	Course syllabi of M. Tech (Cyber Security) I and II Year of AU-R20	After an elaborate discussion, the BoS has approved the syllabi of I and II Years of M. Tech (Cyber Security).
4	In case of amendments / changes in the course structure or syllabi, the Board has suggested the Chairman:	a. In any case, if there are major changes/amendments either in course structure or syllabus, the BoS meeting shall be called for its approval b. If there are any minor changes in course structure or syllabus, it will be communicated to all BoS members through email for e-approval.

The meeting was concluded with a vote of thanks.

The following members have attended the meeting:

S.No	Name	Designation in BOS
1	Dr. Atulnegi, Professor, University of Hyderabad	External Member
2	Mr. Neeraj Kapre, Asst. Manager, Campus Hiring , CapGemini, Mumbai	External Member
3	Ms. T. Niveditha, (Alumnus), Associate Consultant, Amazon India, Hyderabad	External Member
4	Dr. Prasantha Rao, Professor, Dept. of Information Technology	Internal Member
5	Mrs. Niteesha Sharma, Asst. Professor, Dept. of Information Technology	Internal Member
6	Dr. K. S. Reddy, Professor and Head, Dept. of Information Technology	Chairman
7	Other senior faculty members and doctorates were also attended	Internal Members

Sd/

Chairman, Board of Studies, Dept. of Information Technology,

Anurag University, Hyderabad.

AU-R20 REGULATIONS

Course Structure of
M. Tech – Cyber Security
(I & II Year)

Dept. of Information Technology
ANURAG UNIVERSITY
Venkatapur (V), Ghatkesar (M), Medchal (Dist), Telangana– 500 088
www.anurag.edu.in | hodit@anurag.edu.in

11th June, 2021

M.TECH (Cyber Security) I YEAR I SEMESTER [6 T + 2 P]

S. No	Course Code	Course	Hours per week			Credits
			L	T	P	
1	PCC	Design of Algorithms	3	0	0	3
2	PCC	Information Security	3	0	0	3
3	PCC	Fundamentals of Cyber Security	3	0	0	3
4	PEC-I	1. Object Oriented Programming 2. Big Data 3. Cloud Computing	3	0	0	3
5	PEC-II	1. Security of Cyber Physical Systems 2. Image Processing for Cyber Secure Systems 3. Artificial Intelligence for Cyber Systems	3	0	0	3
6	PCC	Research Methodology	2	0	0	2
7	PCC LAB	Design of Algorithms for Security	0	0	4	2
8	PCC LAB	Python Programming for Cyber Security	0	0	4	2
9	AUDIT	Audit Course	0	0	0	0
		TOTAL	**17**	**0**	**8**	**21**

M.TECH (Cyber Security) I YEAR II SEMESTER [6 T + 2 P]

S. No	Course Code	Course	Hours per week			Credits
			L	T	P	
1	PCC	Steganography and Digital Watermarking	3	0	0	3
2	PCC	Web Technologies for Cyber Security	3	0	0	3
3	PCC	Digital Forensics	2	0	0	2
4	PEC-III	1. Cyber Law and Security Policy 2. Security Assessment and Risk Analysis 3. Data Encryption and Compression	3	0	0	3
5	PEC-IV	1. Database Security 2. Web Security 3. Cloud Security	3	0	0	3
6	OEC-I	1. Entrepreneurship Development 2. Project Management 3. Technical and Business Communication Skills	3	0	0	3
7	PCC LAB	Web Technologies	0	0	4	2
8	PEC-IV LAB	1. Database Security 2. Web Security 3. Cloud Security	0	0	4	2
		TOTAL	**17**	**0**	**8**	**21**

M.TECH (Cyber Security) II YEAR I SEMESTER **[P + S]**

S. No	Course Code	Course	Hours per week			Credits
			L	T	P	
1	PROJECT	Major Project Phase I	0	0	24	12
2	SEMINAR	Seminar	0	0	0	0
		TOTAL	**0**	**0**	**24**	**12**

M.TECH (Cyber Security) II YEAR II SEMESTER **[P]**

S. No	Course Code	Course	Hours per week			Credits
			L	T	P	
1	**PROJECT**	**Major Project Phase II**	**0**	**0**	**28**	**14**
		TOTAL	**0**	**0**	**28**	**14**

ANURAG UNIVERSITY

M. Tech [Cyber Security] - I Year I Sem.

L	T / P / D	C
3	**0**	**3**

DESIGN OF ALGORITHMS

Course Objectives:
1. Analyze the asymptotic performance of algorithms.
2. Learn the major sorting algorithms and its usage in real time.
3. Illustrate Paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.
4. Synthesize the various graph algorithms to solve common engineering problems.
5. Utilize the various security algorithms in solving new problems

Course Outcomes:
At the end of this course, students will be able to:
1. Describe the Elementary Data Structures and Asymptotic Notations
2. Apply the major sorting algorithms
3. Analyze the various advanced design and analysis techniques
4. Apply the major graph algorithms to solve engineering problems.
5. Appraise the various security algorithms HMAC, MD5 and SHA.

UNIT- I:
Introduction: Review of elementary data structures (stacks, queues, linked list), analyzing algorithms, asymptotic notation, Recurrences (master theorem), Hash Tables, Binary search trees. **[TB-1]**

UNIT- II:
Sorting and Order Statistics: Heapsort, Quicksort, Priority Queues (max-priority queue), Sorting in linear time (counting sort, radix sort). **[TB-1]**

UNIT- III:
Advanced Design and Analysis Techniques: Algorithm Design Techniques: Divide-and-Conquer – Greedy (Huffman code, A task scheduling problem –Dynamic Programming (Optimal Binary Search Tree) – Amortized Analysis (Splay Trees)- Backtracking (N Queens problem) – Branch-and-Bound (LC search) techniques. **[TB-1]**

UNIT- IV:
Graph Algorithms: Review of graph Algorithms (Breadth First Search and Depth First Search) – Strongly connected components, Minimum Spanning Trees (Kruskal and Prim's), – Single-Source Shortest Paths-Dijkstra's algorithm, Bellman-Ford algorithm Single source shortest paths for directed acyclic graphs.

NP-Hard and NP-Complete Problems: Non deterministic algorithm, The Classes NP-hard and NP -complete, Clique decision problem **[TB-1]**

UNIT-V:

Security Algorithms: Security Algorithms-Hash Message Authentication Code (HMAC), Message Digest5(MD5), Secure Hash Algorithm (SHA), Data Encryption Standard (DES), DES Cipher Block Chaining (CBC) **[TB-2]**

TEXT BOOKS:

1. Thomas H. Coreman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", PHI, 3rd Edition, 2010.
2. William Stallings, Cryptography and Network Security. Pearson - Prentice Hall,4th edition,2005.

REFERENCES:

1. E. Horowitz, S. Sahni and S. Rajasekaran, "Computer Algorithms/C++", 2nd Edition, University Press, 2007.
2. E. Horowitz, S.Sahni and Dinesh Mehta, "Fundamentals of Data structures in C++", University Press, 2007.
3. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, "Design and Analysis of Algorithms", Pearson Education, Reprint 2002.
4. Behrouz Forouzan, Cryptography and Network Security. McGraw Hill,3rd Edition,2015.
5. Kaufman, Perlman and Speciner, Network Security: Private Communication in a Public World. Pearson - Prentice Hall

ANURAG UNIVERSITY

M. Tech [Cyber Security] - I Year I Sem.	L	T / P / D	C
	3	**0**	**3**

INFORMATION SECURITY

Course Objectives:

1. Explain various information security threats and controls for it.
2. Analyse legal, ethical and professional issues in Information Security and how to plan for it.
3. Identify Risk Management and Firewalls.
4. Examine Intrusion Detection techniques and cryptography.
5. Choose Physical Security and how to implement information security.

Course Outcomes:

At the end of this course, students will be able to:

1. Summarize various information security threats and controls for it.
2. Illustrate legal, ethical and professional issues in Information Security and how to plan for achieving Information Security.
3. Interpret various risk management techniques and firewalls.
4. Analysing Intrusion Detection Techniques and concepts of cryptography.
5. Demonstrate Physical Security and the way of implementing Information Security.

UNIT-I:

Introduction to Information Security: What is security, CNSS security model, Components of Information System, Approaches to Information Security, Security in SDLC, Security Professionals and organization, Information Security: Is it an art or science.

The need for Security: Threats and Attacks, Compromises to Intellectual Property, Deviations of Quality of Service, Espionage or Trespass, Human error or failure, Sabotage or vandalism, Software Attacks, Technological HW/SW failures or errors, Technological obsolescence, Thefts.

UNIT-II:

Legal, Ethical and Professional Issues in Information Security: Law and Ethics in Information Security, International Laws and Legal Bodies, Ethics and Information Security, Codes of Ethics of Professional Organizations.

Planning for Security: Information Security Planning and Governance, Information Security Policy, Standards and Practices. The Information Security Blueprint. Security Education, Training and Awareness Program. Continuity Strategies.

UNIT-III:

Risk Management: An overview of Risk Management. Risk Identification, Risk Assessment, Risk Control, Quantitative vs Qualitative Risk Management Practices, Recommended Risk Control Practices.
Security Technology-1: Access Control, Firewalls, Protecting Remote Connections.

UNIT-IV:

Security Technology-2: Intrusion Detection and Prevention Systems, Honeypots, Honeynets, Padded Cell Systems, Scanning and Analysis Tools.
Cryptography: Foundations of Cryptography, Cipher Methods, Cryptographic Algorithms, Cryptographic Tools, Protocol for secure communications.

UNIT-V:

Physical Security: Physical Access Controls, Fire Security and Safety, Failures of supporting utilities and structural collapse, Interception of data, Securing mobile and portable systems, Special Considerations for physical security.
Implementing Information Security: Information Security Project Management, Technical and non-technical Aspects of Implementation, Information System Security Certification and Accreditation.

TEXT BOOK:

1. Michael E Whiteman, Herbart J Mattord, "Principles of Information Security", Sixth Edition, Cengage Learning, 2018.

REFERENCES:

1. Mark Stamp, "Information Security, Principles and Practice", Second Edition, Wiley Publications, 2011.
2. Jason Andress, "Foundations of Information Security", No starch press, 2019.

ANURAG UNIVERSITY

M. Tech [Cyber Security] - I Year I Sem.	L	T / P / D	C
	3	**0**	**3**

FUNDAMENTALS OF CYBER SECURITY

Course Objectives:

1. Summarize major types of cyber-attacks and its objectives.
2. Discuss major cyber-attacks, computer malware programs and their impact on the world
3. Elaborates Firewall and password management.
4. Describe major cyber-security prevention mechanisms
5. Outline Cyber-Security aspects of wireless networks and routers

Course Outcomes:

At the end of this course, students will be able to:

1. Analyze the cyber security needs of an organization
2. Design operational and strategic cyber security strategies and policies.
3. Demonstrate various network security applications
4. Analyze software vulnerabilities and security solutions to reduce the risk of exploitation
5. Design and develop a security architecture for an organization

UNIT- I:

Introduction to Cyber Security Basics, Importance of Cyber Security, Cyber- attacks, objectives of cyber-attacks, Types of Cyber-attacks, Denial of Service (DoS), Distributed Denial of Service (DDoS), Man-in-the-Middle (MITM) Attacks, Crypto jacking, SQL Injection, Spamming, Cyber-terrorism, Digital Property Misappropriation, zero-day exploitation, phishing, digital vandalism, cyber-stalking, cyber frauds and forgery.

UNIT- II:

Introduction to Cyber-attacks and their impact, Equifax Data Theft, VPNFilter Cyber- attack, WannaCry Ransom Attack, Peta Cyber-attack, US Election Manipulation, Power Grid Hacking, Shadow Network attack, GitHub DDoS Attack, Under Armor Account Hacking, Types of Computer Malware, Viruses, Trojan Horse, Rootkit, Spyware, Worms, Adware, Scare-ware, Browser Hijacker.

UNIT- III:

Introduction to Computer Security, Firewall Settings, Antivirus Software, Anti-Spyware Software, Anti-Spam Software, Security Updates, Secure Browsing Settings, Scan Devices before Data Transfer, Social Engineering Attack Precautions. Password Management, Basics of Passwords, Threats to Passwords, Good and Bad about Passwords, Hacking Password, Effective Password Management, Creating and Managing Secure Passwords, Strong Password, Use of Biometrics, Two-Factor Authentication, Multi-Factor Authentication, Password Manager Tools.

UNIT-IV:

Prevention from Cyber-attacks, Algorithms and Techniques, Cyber-attack Detection, Cyber-attack Prediction, Cyber-attack Prevention , Firewalls, Activating Windows Firewall, Windows 10 firewall, Windows 7 firewall, Enabling Windows 7 firewall, Enabling Windows firewall service, Traffic Issues and rules , firewall settings, Intrusion Detection/Prevention Systems, Intrusion Detection System (IDS) , Intrusion Prevention System (IPS),,Authentication Using Hash, Message Digest , Secure Hash Algorithm ., Multi-Factor Authentication, Activating Two-Factor Authentication, Creating Application Specific Passwords , What If Your Phone with All Apps Enabled Is Lost?, Mac Computer Firewall Configuration, Virtual Private Network.

UNIT V:

Introduction to Wireless Security, LAN Vulnerabilities, Reconnaissance Vulnerability, Resource Stealing and Invasion, Rogue Access Points (APs), STA and AP Plain Text Transaction, Denial of Service (DoS), Default AP Configuration, Rogue Insiders, Protocol Vulnerabilities, Ad Hoc Network Mode Security Problems ,Wireless WAN Vulnerabilities ,IoT Vulnerabilities, Wireless Network Security Measures, Modify Default Configuration, Wireless Router Location, Update Router Software, Stronger Encryption Algorithms, MAC Address Filtering ,Useful Tips on Safe Use of Wireless Network.

TEXT BOOKS:

1. Dr Kutub Thakur Dr Al-Sakib Khan Pathan, Cyber-security Fundamentals Real-World Perspective, first edition published 2020 by CRC Press, © 2020 Taylor & Francis Group, LLC.

REFERENCES:

1. Rajkumar Singh Rathore, Aatif Jamshed, Mayank Bhusan, Fundamental of Cyber Security Principles and Theory and Practices, BPB Publications, 01-Jun-2018.
2. J. Pieprzyk, T. Hardjono and J. Seberry, Fundamentals of computer security, Springer, 2003.

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OBJECT ORIENTED PROGRAMMING
(PEC-I)

Course Objectives:
1. Impart knowledge of object-oriented features of Java.
2. Elaborate the use of Exceptions and Packages in Java.
3. Familiarize concepts of Multi-threading, and Applets.
4. Emphasize the various standard Java Extensions.
5. Describe the concepts of cryptography engines.

Course Outcomes:
At the end of this course, students will be able to:
1. Appraise the object-oriented concepts of java.
2. Identify usage of packages and exception handling.
3. Design multi-threaded applications, Applets by using Event Handling features.
4. Implement Graphical User Interface applications using Swings.
5. Summarize various cryptographic engines.

UNIT-I:

Review of Object-Oriented Concepts: Concept of class, object, Abstraction, Encapsulation, Inheritance and Polymorphism, benefits and applications of OOP.

Inheritance and polymorphism: Basic concepts, Types of inheritance, Member access rules, Usage of this and Super key word, Method Overloading, Method overriding, Abstract classes, Defining and Implementing interfaces, and Extending interfaces, Dynamic method dispatch, Usage of final keyword. **[TB-1]**

UNIT-II:

Packages: Defining, Creating and Accessing a Package, importing packages.

Exception handling - Concepts of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes. **[TB-1]**

UNIT-III:

Multi-threading: Differences between multi-threading and multitasking, thread life cycle, creating threads, thread priorities, synchronizing threads, inter thread communication.

Applets – Concepts of Applets, differences between applets and applications, life cycle of an applet, create applets, passing parameters to applets. **[TB-1]**

UNIT-IV:

Standard Java Extensions: Java Cryptographic Extension (JCE), Java Secure Sockets Extension (JSSE), Java Authentication and Authorization Service (JAAS), Java Sandbox.

Introduction to Cryptography-Need of Authentication-Author Authentication, Data Authentication, Java's Role in Authentication. **[TB-2]**

UNIT V:

Cryptographic Engines: Cryptographic Keys, Message Digest, Digital Signatures, Digital Certificates. SSL and HTTPS protocols. **[TB-2]**

TEXT BOOKS:

1. Herbert Schildt, Java- The Complete Reference, Seventh edition, Tata McGraw Hill,2006.
2. Scott Oaks, Java Security, Second Edition, O'Reilly Media,2011.

REFERENCES:

1. Bruce Eckel, Thinking in Java, Fourth Edition, Prentice Hall, 2006.
2. Y. Daniel Liang, Introduction to Java programming, Tenth Edition, Pearson education, 2014.

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BIG DATA
(PEC-I)

Course Objectives:
1. Understand the Big Data Platform and its Use cases
2. Provide an overview of Apache Hadoop
3. Provide HDFS Concepts and Interfacing with HDFS
4. Provide hands on Hadoop Eco System
5. Apply analytics on Structured, Unstructured Data.

Course Outcomes:
At the end of this course, students will be able to:
1. Identify Big Data and its Business Implications.
2. Understanding the inputs and outputs of MapReduce
3. Appraise Hadoop Environment, Architecture and Shell Commands
4. Develop Big Data Solutions using Hadoop Eco System
5. Analyze Hive Architecture and its Applications.

UNIT-I:
Overview of Big Data: Introduction –Evolving of Big Data and its importance, Types of Data, Four Vs, Drivers for Big Data, Big Data analytics, Big Data applications. Exploring the use of Big Data in Business Context-Use of Big Data in Social Networking, Business Intelligence, Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce. **[TB-1]**

UNIT II:
Introduction Hadoop: Big Data – Apache Hadoop & Hadoop Ecosystem – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization. **[TB-2]**

UNIT III:
Hadoop Distributed File System: HDFS Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering –Monitoring & Maintenance. **[TB-2]**

UNIT-IV:
Hadoop Ecosystem and Yarn: Hadoop ecosystem components - Schedulers - Fair and Capacity, Hadoop 2.0 New Features- NameNode High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN. [**TB-2]**

UNIT-V:
Hive and Hiveql, Hbase: Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting and Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts-

Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper. **[TB-2]**

TEXT BOOKS:

1. BIG DATA, Black Book TM, Dream Tech Press, 2019 Edition.
2. Tom White, "HADOOP: The definitive Guide", 4th Edition, O Reilly 2015.

REFERENCES:

1. Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, 2015.
2. Chris Eaton, Dirk deroos et al., "Understanding Big data", McGraw Hill, 2012.
3. Tom White, "HADOOP: The definitive Guide", O Reilly 2012.
4. Vignesh Prajapati, "Big Data Analytics with R and Hadoop", Packet Publishing 2013.
5. Tom Plunkett, Brian Macdonald et al, "Oracle Big Data Handbook", Oracle Press, 2014.

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CLOUD COMPUTING
(PEC-I)

Course Objectives:

14. Impart the concepts of virtualization and its benefits.
15. Discuss various Virtualization Technologies.
16. Demonstrate the use of storage virtualization.
17. Analyze various cloud architecture.
18. Describe cloud infrastructure models.

Course Outcomes:

At the end of this course, students will be able to:

1. Appreciate Virtualization Concepts.
2. Analyze various Virtualization Technologies.
3. Compare cloud storage mechanisms.
4. Draw cloud architecture.
5. Summarize cloud infrastructure models.

UNIT -I:

Introduction to Virtualization: Objectives of virtualization, history of virtualization, benefits of virtualized technology, the virtual service desk, what can be virtualized, related forms of computing, cloud computing, software as a service – SaaS, grid computing, utility computing, virtualization processes.

UNIT II:

Virtualization Technologies-I: Ubuntu (server edition), Altiris, Windows server, Software virtualization, VMware, Intel virtualization, Red Hat virtualization, Softgrid application, Linux virtualization, Desktop virtualization, Hardware virtualization, Resource virtualization, Processor virtualization, Application virtualization.

UNIT III:

Virtualization Technologies-II: Storage virtualization, Virtualization density, Para-virtualization, OS virtualization, Virtualization software, Data Storage virtualization, Intel virtualization technology, Thinstall virtualization suite, Net framework virtualization, Windows virtualization on Fedora, Storage virtualization technologies, Virtualization level, Security monitoring and virtualization, Oracle virtualization.

UNIT-IV:

Virtualization and Storage Management: The heart of cloud computing-virtualization, defining virtualization, why virtualize, what can be virtualized, where does virtualization happen, how does virtualization happen, on the road to storage virtualization, improving availability using virtualization, improving performance through virtualization, improving capacity through virtualization, business value for virtualization.

UNIT-V:

Introduction to Cloud Computing: Cloud Introduction and overview- Components, Infrastructure and Services, Why Use Cloud Computing, Benefits and Limitations, Cloud Application Architectures, Cloud Infrastructure Models, Cloud Computing Technology- Hardware & Software Infrastructure. Cloud Computing Architecture: Requirements, Introduction to Cloud Computing Architecture, various kinds of Cloud Computing Architecture, Grid Computing, Transactional Computing, On Demand Computing, and Distributed Computing.

TEXT BOOKS:

1. Ivanka Menken, Gerard Blokdijk ,Cloud Computing Virtualization Specialist Complete Certification Kit - Study Guide Book, 2009.
2. George Reese, Cloud Application Architectures Building Applications and Infrastructure in the Cloud, O'Reilly Media Press, 2009.

REFERENCES:

10. Anthony T.Velte, TobeJ.Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Publication Person Education, 2009
11. **Tom Clark, Storage Virtualization: Technologies for Simplifying Data Storage and Management, Addison-Wesley, 2005**
12. **Curtis Brian** J.S. Chee**, Cloud Computing Technologies and Strategies of the Ubiquitous Datacenter, 2010**

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SECURITY OF CYBER PHYSICAL SYSTEMS (PEC-II)

Course Objectives:
1. Describe the challenges and scientific foundation of cyber-security in various domains and networks.
2. Discuss metrics for information in cyber-security
3. Summarize national security legal aspects and Privacy laws
4. Compare different types key management strategies and challenges
5. Detailed study on Secure Registration and Remote Attestation of IoT Devices

Course Outcomes
At the end of this course, students will be able to:
1. Discuss the standards and Topologies Cyber Physical Systems
2. Collaborative outsourcing in Cyber Physical Systems
3. Describe Cyber Physical Systems security and safety aspects
4. Design Security keys for Cyber Physical Systems
5. Evaluate Secure Registration and Remote Attestation of IoT Devices.

UNIT -I:
Introduction to security in cyber physical System, Defining Security and Privacy, Defining Cyber-Physical Systems, Examples of Security and Privacy in Action, Approaches to Secure Cyber-Physical Systems, Ongoing Security and Privacy Challenges for CPSs. Network Security and privacy for cyber-physical systems, Security and Privacy Issues in CPSs, Local Network Security for CPSs, Secure Local Communication, Internet-Wide Secure Communication, Security and Privacy for Cloud-Interconnected CPSs.

UNIT -II:
Information Theoretic Metrics Quantifying Privacy in Cyber-Physical Systems, Social Perspective and Motivation, Information Theoretic Privacy Measures, Privacy Models and Protection, Smart City Scenario: System Perspective, Conclusion and Outlook.

UNIT- III:
Cyber-Physical Systems and National Security Concerns, National Security Concerns Arising from Cyber-Physical Systems, National Security Implications of Attacks on Cyber- Physical Systems, Legal Considerations of Cyber-Physical Systems and the Internet of Things, Privacy and Technology in Recent History, Privacy Law, Future Challenges.

UNIT-IV:
Key Management in CPSs, Security Goals and Threat Model, CPS Key Management Design Principles, CPS Key Management, Dynamic versus Static, Public Key versus Symmetric Key, Public Key Cryptography, Symmetric Key Cryptography, Centralized versus Distributed, Deterministic versus Probabilistic, Standard versus Proprietary, Key Distribution versus Key Revocation, Key Management for SCADA Systems,CPS Key Management Challenges and Open Research Issues.

UNIT -V:

Case Study: Secure Registration and Remote Attestation of IoT Devices, Joining the Cloud, Cloud Integration with IoT, Security and Privacy in Cloud and IoT, Technologies, Web Connectivity, Reference Scenario and Motivation, Stack4Things Architecture, Capabilities for Making IoT Devices Secure Over the Cloud, Adding Security Capabilities to Stack4Things, Conclusions

TEXT BOOK:

1. Houbing Song, Glenn A. Fink, Sabina Jeschke, Security and Privacy in Cyber-Physical Systems Foundations, Principles, and Applications, First edition, IEEE PRESS Wiley.

REFERENCES:

1. Song, Houbing, et al., eds. Cyber-physical systems: foundations, principles and applications. Morgan Kaufmann, 2016.
2. William Stallings, Cryptography and Network Security: Principles and Practice, 7^{th} Edition, Pearson edition, 2016

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IMAGE PROCESSING FOR CYBER SECURE SYSTEMS (PEC-II)

Course Objectives:

1. Analyze the importance of image processing techniques and cyber secure systems
2. Identify various enhancement Techniques for image processing
3. Evaluate security of different Bio-metric methods like Fingerprint, Face, Iris.
4. Apply different types of cyber-attacks to judge the system
5. Solve the issues of cyber security

Course Outcomes

At the end of this course, students will be able to:

1. Discuss the standards and Topologies Cyber Physical Systems
2. Collaborative outsourcing in Cyber Physical Systems
3. Describe Cyber Physical Systems security and safety aspects
4. Design Security keys for Cyber Physical Systems
5. Evaluate Secure Registration and Remote Attestation of IoT Devices

UNIT-I:

Introduction and Definitions of bio-metrics, Traditional authenticated methods and technologies. Introduction to Image Processing, Image Enhancement Techniques: Spatial Domain Methods: Smoothing, sharpening filters, Laplacian filters, Frequency domain filters, Smoothing and sharpening filters.

UNIT-II:

Image Restoration & Reconstruction: Model of Image Degradation/restoration process, Noise models, spatial filtering, inverse filtering, Minimum mean square Error filtering. Introduction to image segmentation: Image edge detection: Introduction to edge detection, types of edge detectors. Introduction to image feature extraction

UNIT-III:

Bio-metric technologies: Fingerprint, Face, Iris, Hand Geometry, Gait recognition, Ear, Voice, Palm print, On-Line Signature Verification, 3D Face Recognition, Dental Identification and DNA. Statistical measurement of Bio-metric. Bio-metrics in Government Sector and Commercial Sector. Case Studies of bio-metric system, Bio-metric Transaction. Bio-metric System Vulnerabilities.

UNIT-IV:

Introduction: Review of TCP/IP and TCP, IP Header analysis, Introduction to Cyber World, Cyber-attacks and cyber security, Information warfare and cyber terrorism, Types of cyber-attacks, Cyber Crime and Digital Fraud, Overview of Types of computer forensics i.e. Media Forensics, Network forensics (internet forensics), Machine forensic, Email forensic (e-mail tracing and investigations)

UNIT-V:

Issues in cyber security: Private ordering solutions, Regulation and Jurisdiction for global Cyber security, Copy Right-source of risks, Pirates, Internet Infringement, Fair Use, postings, criminal liability, First Amendments, Data Loss.

TEXT BOOKS:

1. Sunit Belapure and Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives, Wiley India Pvt. Ltd, 2011.
2. Rafael C. Gonza Lez, Richard E. Woods. "Digital Image Processing", Pearson

REFERENCES:

1. S.P. Tripathy, "Cyber security", Wiley Publications
2. Paul Reid, Biometrics for network security, Hand book of Pearson, 2004.
3. D. Maltoni, D. Maio, A. K. Jain, and S. Prabhakar, Handbook of Fingerprint Recognition, Springer Verlag, 2003

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ARTIFICIAL INTELLIGENCE FOR CYBER SYSTEMS (PEC-II)

Course Objectives:

4. Discuss Artificial Intelligence (AI) core concepts
5. Discuss the Email security threats with AI
6. Study the various types malware threat detection using AI techniques
7. Analyze network anomaly detection techniques
8. To outline securing user authentication

Course Outcomes:

At the end of this course, students will be able to:

6. Describe AI concepts for cyber security
7. Apply machine learning algorithms to detect Email security threats
8. Analyze and detect malware threats using AI
9. Detect the network anomaly using AI.
10. Protect sensitive information and assets.

UNIT-I:

AI Core Concepts: Introduction to AI for Cybersecurity Professionals Applying AI in cybersecurity: Evolution in AI, Types of machine learning, Algorithm and optimization, getting to know python library, AI in the context of cyber security, Setting Up Your AI for Cybersecurity Arsenal: Getting to know Python for AI and cybersecurity, Python libraries for cybersecurity

UNIT-II:

Ham or Spam? Detecting Email Cybersecurity Threats with AI: Detecting spam with Perceptrons, Spam detection with SVMs, Phishing detection with logistic regression and decision trees, Spam detection with Naive Bayes, NLP to the rescue

UNIT-III:

Malware Threat Detection: Malware analysis at a glance, telling different malware families apart, Decision tree malware detectors, Detecting metamorphic malware with HMMs, Advanced malware detection with deep learning.

UNIT-IV:

Network Anomaly Detection with AI: Network anomaly detection techniques, How to classify network attacks, Detecting botnet topology, Different ML algorithms for botnet detection

UNIT-V:

Protecting Sensitive Information and Assets

Securing User Authentication: Authentication abuse prevention, Account reputation scoring, User authentication with keystroke recognition, Biometric authentication with facial recognition

TEXT BOOK:

1. Hands-On Artificial Intelligence for Cybersecurity by Alessandro Parisi, Packt Publishing Ltd, 2019

REFERENCES:

1. Artificial Intelligence and Block chain for Future Cybersecurity Applications, Yassine Maleh, Youssef Baddi, Mamoun Alazab, Loai Tawalbeh, Imed Romdhani, Springer, 2021.
2. Introduction to Machine Learning with Python by Andreas C. Müller, Sarah Guido October 2016, O'Reilly Media, Inc.
3. Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems, By Aurélien Géron · 2019

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RESEARCH METHODOLOGY

Course Objectives:
1. Understand the research problem.
2. Know the process of literature survey, plagiarism check and ethical means of doing research.
3. Get the knowledge about technical report writing.
4. Impart awareness about the intellectual property right.
5. Know about licensing and transfer of technology.

Course Outcomes:

At the end of this course, students will be able to:
1. Formulate the research problem.
2. Analyze research related information by following research ethics.
3. Convert a technical paper into a research proposal by incorporating new ideas or concepts.
4. Apply intellectual property rights
5. Get licensing and transfer technology for innovative ideas

UNIT-I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT- II:

Effective literature studies approaches, analysis Plagiarism, Research ethics.

UNIT-III:

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT-IV:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

TEXT BOOKS:

3. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
4. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

REFERENCES:

7. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step-by-Step Guide for beginners”
8. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007
9. Mayall, “Industrial Design”, McGraw Hill, 1992
10. Niebel, “Product Design”, McGraw Hill, 1974
11. Asimov, “Introduction to Design”, Prentice Hall, 1962
12. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016

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DESIGN OF ALGORITHMS FOR SECURITY

Course Outcomes:

At the end of this course, students will be able to:

1. Develop various sorting techniques to understand the performance of an algorithm.
2. Build the different sorting techniques to choose appropriate techniques for engineering problems.
3. Demonstrate a familiarity with security algorithms and its implementation for data integrity.
4. Apply various security algorithms to represent its confidentiality.
5. Develop security programs to maintain security of the data.

List of Programs:

1. Implementation of Heap Sort
2. Implementation of Counting Sort
3. Implementation of Radix Sort
4. Perform Knapsack Problem using Greedy Solution
5. Minimum Spanning Tree using Kruskal's Algorithm
6. Implement N Queen Problem using Backtracking
7. Hash Message Authentication Code (HMAC)
8. Secure Hash Algorithm (SHA)
9. Data Encryption Standard (DES)
10. DES Cipher Block Chaining (CBC)

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

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PYTHON PROGRAMMING FOR CYBER SECURITY

Course Outcomes:

At the end of this course, students will be able to:

1. Implement DES algorithm.
2. Find the GCD of an array of ten integers.
3. Implement RSA algorithm.
4. Provide security for Small Business Network.
5. Design Virtual Private Network Over WAN.

List of Programs:

1. Write a program to perform encryption and decryption using the following algorithms
    - Ceaser cipher
    - Substitution cipher
    - Hill Cipher

2. Write a program to implement the 8 bits simplified DES algorithm logic

3. Write the RC4 logic in Python

4. Implement Rabin-Miller Primality Testing Algorithm.

5. Write a program to implement RSA algorithm.

6.Write a program to calculate the message digest of a text using the SHA-1 algorithm.

7.Calculate the message digest of a text using the MD5 algorithm.

8.Create a digital certificate of your own

9. Write a program to hide of confidential information within Image using Steganography technique.

10.Managing Security in Small Business Network

11. Virtual Private Network Over WAN
    - To Create a Virtual Private Network (VPN) over WAN
    - To evaluate application response time in the presence and absence of a firewall.

12. Eavesdropping Attacks and its prevention using SSH

- Design and implementation of a simple client/server model and running application using sockets and TCP/IP.
- To make students aware of the insecurity of default passwords, printed passwords and password transmitted in plain text.
- To teach student how to use SSH for secure file transfer or for accessing local computer using port forwarding technique.
- Comparison between Telnet and SSH for Secure Connection

TEXT BOOKS:

1. William Stallings, Cryptography and Network Security, Seventh Edition, 2017, Pearson.
2. Ivan Niven, H S Zuckerman, H L Montgomery, An Introduction to the Theory of Numbers, Fifth Edition, 1991, John Wiley & Sons.

REFERENCES:

1. B. Forouzan, Cryptography and Network Security, First Edition, 2008, McGraw-Hill.
2. Nelson, The Data Compression Book, First Edition, 1995, M&T Books.
3. Atul Kahate, Cryptography & Network Security, First Edition, 2006, TMH.

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

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STEGANOGRAPHY AND DIGITAL WATERMARKING

Course Objectives:

1. Understand the Digital Watermarking and Steganography working process
2. Apply knowledge of the embedding algorithm used by the steganography tool
3. Explain Steg analytic process
4. Analyze watermarking techniques to insert the information into the image
5. Outlines the watermarking attacks

Course Outcomes:

At the end of this course, students will be able to:

1. Analyze the importance of Digital Watermarking and Steganography
2. Identify steganography tools and different approaches to extract
3. Evaluate security assessment of watermarking
4. Apply various types of transform domain
5. Understand various risks in Digital Watermarking and Steganography

UNIT-I:

Information Hiding, Steganography and Watermarking – History of watermarking – Importance of digital watermarking – Applications – Origins & Overview of Steganography - History of Use, Covert Messaging, Null Cipher Messages, Steganography vs. Encryption, Threats Posed by Steganography Use, Steganography in the Media, Availability & Production. Digital Carriers - Used to Exploit Human Weaknesses.

UNIT-II:

Steganography Embedding Tools - Steganography Methods, Data Appending, Formatting Modification, Word Substitution, Color Palette Substitution, 24 Bit LSB Encoding, DCT Modification, PNS Modification, Covert Channels. Steganalysis - An Overview,

UNIT-III:

The Statistical Properties of Images, The Visual Steganalytic System, IQM- Based Steganalytic System, Learning Strategies, Introduction of the Support Vector Machine, Neural Networks, Principle Component Analysis, Frequency-Domain Steganalytic System. The Visual Steganalytic System, IQM- Based Steganalytic System, Learning Strategies

UNIT-IV:

Watermarking Fundamentals - Spatial-Domain Watermarking, Substitution Watermarking in the Spatial Domain, Additive Watermarking in the Spatial Domain, Frequency-Domain Watermarking, Substitution Watermarking in the Frequency Domain, Multiplicative Watermarking in the Frequency Domain, Watermarking Based on Vector Quantization, The Rounding Error Problem, The Fragile Watermark, The Block-Based Fragile Watermark, Weaknesses of the Block-Based Fragile Watermark, The Hierarchical Block-Based Fragile Watermark, The Robust Watermark.

UNIT-V:

Watermarking Attacks and Tools - Image Processing Attacks, Attacks by Filtering, Attack by Remodulation, Attack by JPEG Coding Distortion, Attack by JPEG 2000 Compression, Geometric Transformation, Attack by Image Scaling, Attack by Rotation, Attack by Image Clipping, Attack by Linear Transformation, Attack by Bending, Attack by Warping, Attack by Perspective Projection, Attack by Collage, Attack by Template, Cryptographic Attach, Protocol Attacks, Watermarking Tools.

TEXT BOOKS:

1. Information Hiding Techniques for Steganography and Digital Watermarking, Katzenbeisser, Stefan (Edt)/ Petitcolas, Fabien, A.P. (Edt), Artech House, 2000.
2. Information Hiding (Steganography and Watermarking - Attacks and Countermeasures), Johnson, Neil F./ Duric, Zoran/ Jajodia, Sushil, luwer Academic Pub, 2001.

REFERENCES:

1. Intelligent Watermarking Techniques, J-S Pan, H-C Huang, L.C. Jain, World Scientific Pub. Co., 2004
2. Digital Watermarking and Steganography Fundamentals and Techniques, By Frank Y. Shih

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WEB TECHNOLOGIES FOR CYBER SECURITY

Course Objectives:

1. State the best technologies for solving web client/server problems
2. Analyze to Use appropriate client-side or Server-side applications
3. Design and analyze real time web applications
4. Describe the principles of web security.
5. Examine the use of cryptography, how it has evolved, and some key encryption techniques used.

Course Outcomes:

At the end of this course, students will be able to:

1. Design static web pages and provide client-side authentication.
2. Design and develop web applications using JSP and MVC architecture.
3. Understand database connectivity and retrieving data using client/server database.
4. Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation.
5. Implement cyber security solutions and use of cyber security.

UNIT- I:

INTRODUCTION TO WEB: Understanding Internet and Web, Web Architecture, Web servers, protocols: HTTP, Introduction HTML: History of HTML, WWW.

CSS: Introduction to cascading style sheet, Types of style sheets.

JAVA SCRIPT: Introduction to scripting, control structures, conditional statements, Arrays functions, objects. **[TB-1]**

UNIT- II:

Servlets: Introduction, Lifecycle, Generic and HTTP servlet, passing parameters to servlet, HTTP servlet Request & Response interfaces, Deploying web Applications, Session Tracking: Hidden form fields, cookies, URL- Rewriting, session.

JSP: Introduction, Difference Between servlets & JSP, Anatomy of JSP page, JSP elements: Directives, comments, Expressions, scriptlets, Declaration, Implicit JSP objects, using Action elements. **[TB-1]**

NIT- III:

JDBC: Introduction, JDBC Drivers, Loading Driver, establishing connection, Executing SQL statement in JSP pages, MVC architecture.

Introduction to PHP: Declaring variables, data types, arrays, strings, operators, expressions, control structures, functions, reading data from web form controls like text boxes, radio buttons etc., Handling File Uploads, connecting to database (MySQL as reference), executing simple queries, handling results. [**TB-1]**

UNIT- IV:

Web Security: Web security considerations, Web languages, Introduction to different web attacks. Overview of N-tier web applications, Web Protocols, Web Organization and Addressing, Web Browsers and Web Servers, Security and Vulnerability, Web System Architecture, URL, Domain Name, Client-side and server-side scripting. Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET**). [TB-2]**

UNIT- V:

Cryptographic Techniques: Symmetric key cryptographic techniques: Introduction to Stream cipher, Block cipher: DES, AES, IDEA Asymmetric key cryptographic techniques: principles, RSA, ElGamal, Elliptic Curve cryptography, Key distribution and Key exchange protocols. **[TB-2]**

TEXT BOOKS:

1. Web Technologies, by Uttam K. Roy, Oxford Publication, First Edition, 2010.
2. W. Stallings, Cryptography and Network Security: Principles and Practice, 5th Ed. Boston, Prentice Hall, 2010.

REFERENCES:

1. The Complete Reference PHP- Steven Hozner, Tata McGraw-Hill, First Edition, 2007.
2. McClure, Stuart, Saumil Shah, and Shreeraj Shah. Web Hacking: attacks and defense. Addison Wesley. 2003
3. Sebesta, Programming World Wide Web, 4th edition, Pearson, 2008.
4. Dietel and Nieto, Internet and World Wide Web – How to program, 3rd edition, PHI/Pearson Education Asia, 2012.

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DIGITAL FORENSICS

Course Objectives:

1. Provides an in-depth study of the rapidly changing and fascinating field of computer forensics.
2. Combines both the technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
3. Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools
4. Describes Cellular Networks, Operating Systems, Cell Phone Evidence, Cell Phone Forensic Tools and global Positioning Systems
5. Explores Image Capturing, Authenticating Evidence, Hidden Data Extraction, Data Storage, File Systems, Recovery of deleted files, Cracking Passwords, Internet Crime Investigations, Web Attack Investigations.

Course Outcomes:

At the end of this course, students will be able to:

1. Understand the rapidly changing and fascinating field of computer forensics.
2. Describe technical expertise and the knowledge required to investigate, detect and prevent digital crimes.
3. Explore Network security tools, Network attacks, inside threat, incident response, Network Evidence and Investigations.
4. Understand Cellular Networks, Operating Systems, Cell Phone Evidence, Cell Phone Forensic Tools and global Positioning Systems
5. Describe Image Capturing, Authenticating Evidence, Hidden Data Extraction, Data Storage, File Systems, Recovery of deleted files, Cracking Passwords, Internet Crime Investigations, Web Attack Investigations.

UNIT-I:

Introduction: What is digital Forensics, uses of digital forensics, the digital forensic process, scientific process, role of the forensic examiner in the judicial system.

Labs and Tools: Forensic laboratories, policies and Procedures, quality assurance, digital forensic tools.

UNIT-II:

Collecting Evidence: Crime Scenes and Collecting Evidence, Protecting Cell Phones from Network Signals, Alert, Documenting the Scene, cloning, more advanced, final report.

Anti-Forensics: Hiding data, Password attacks, Data Destruction, Defragmentation as Anti-Forensic Technique.

UNIT-III:

Legal: Criminal Law—searches without a Warrant, Consent Forms, Cell Phone Searches: The Supreme Court Weighs In, Searching with a Warrant, Electronic Discovery, Expert Testimony.

Network Forensics: Introduction, Network security tools, Network attacks, inside threat, incident response, Network Evidence and Investigations, Training and Research.

UNIT-IV:

Mobile device forensics: Cellular Networks, Operating Systems, Cell Phone Evidence, Cell Phone Forensic Tools, Global Positioning Systems.

Internet and E-mail: Internet Overview, Additional Resources, Web Browsers, More advanced, E-mail, Shared E-Mail Accounts, Tracing E-Mail, Reading E-Mail Headers, Social Networking Sites.

UNIT -V:

Looking Ahead: Challenges and Concerns: Standards and Controls, Cloud Forensics, Additional Resources, Cloud Persistence-Dropbox.

Image Capturing, Authenticating Evidence, Hidden Data Extraction, Data Storage, File Systems, Recovery of deleted files, Cracking Passwords, Internet Crime Investigations, Web Attack Investigations.

TEXT BOOK:

1. John Sammons, The Basics of Digital Forensics, Elsevier, 1st Edition, 2015

REFERENCES:

1. Davidoff, S. and Ham, J., Network Forensics Tracking Hackers through Cyberspace, Prentice Hall, 2012.

2. Michael G. Solomon, K Rudolph, Ed Tittel, Broom N., and Barrett D., Computer Forensics Jump Start, Willey Publishing, Inc., 2011.

3. Marcella, Albert J., Cyber forensics: A field manual for collecting, examining and preserving evidence of computer crimes, New York, Auerbach publications, 2008.

4. Davidoff, Sherri, Network forensics: Tracking hackers through cyberspace, Pearson education India private limited, 2017.

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CYBER LAW AND SECURITY POLICY
(PEC-III)

Course Objectives:
1. Provides an in-depth study of the Legal and Jurisdictional Issues Regarding Cyber Security.
2. Knowledge on Legal and Ethical Implications Involving Social Networks and Virtual Worlds.
3. Knowledge on Legal and Ethical Implications in Cyberspace: An International Perspective.
4. Provides an in-depth study of Security Policy Sets without Frameworks**,** Information Security Policy Sets with Frameworks
5. Knowledge on Information Security Procedures and Standards.

Course Outcomes:
At the end of this course, students will be able to:
1. Understand relevant Legal and Jurisdictional Issues Regarding Cyber Security.
2. Describe Legal and Ethical Implications Involving Social Networks and Virtual Worlds.
3. Describe Legal and Ethical Implications in Cyberspace: An International Perspective.
4. Explore Security Policy Sets without Frameworks**,** Information Security Policy Sets with Frameworks
5. Understand Information Security Procedures and Standards.

UNIT-I:
Legal and Jurisdictional Issues Regarding Cyberspace: Responsibility, Jurisdiction, and the Future of "Privacy by Design", Hacking: Legal and Ethical Aspects of an Ambiguous Activity, Emerging Cybercrime Trends: Legal, Ethical, and Practical Issues, Law and Technology at Crossroads in Cyberspace: Where Do We Go From Here?, Cyber Law, Cyber Ethics and Online Gambling. **[TB-1]**

UNIT-II:
Legal and Ethical Implications Involving Social Networks and Virtual Worlds: An Overview of Child Abuses in 3D Social Networks and Online Video Games, Ethics and Legal Aspects of Virtual Worlds, Narbs as a Measure and Indicator of Identity Narratives, Cloud Based Social Network Sites: Under Whose Control? **[TB-1]**

UNIT-III:
Legal and Ethical Implications in Cyberspace: An International Perspective: Al-Qaeda on Web 2.0: Radicalization and Recruitment Strategies, Google in China: Corporate Responsibility on a Censored Internet, All's WELL that Ends WELL: A Comparative Analysis of the Constitutional and Administrative Frameworks of Cyberspace and the United Kingdom, A UK Law Perspective: Defamation Law as it Applies on the Internet, The Hellenic Framework for Computer Program Copyright Protection Following the Implementation of the Relative European Union Directives, Internet Advertising: Legal Aspects in the European Union. **[TB-1]**

UNIT-IV:
Introduction: Information Security Policy Types, Information Security Policy Sets without Frameworks**,** Information Security Policy Sets with Frameworks, Common Information SPFs, Tailoring Information SPFs, deriving a Policy Set from a Framework, Policy Statements, Specific Information Security Policies, Policy Document Examples. **[TB-2]**

UNIT-V:

Information Security Procedures and Standards, Scoping the Project, Information Security Policy Project Roles, Information Security Policy Project Phases, Information Security Policy Revision Project, Information Security Policy Project Application. **[TB-2]**

TEXT BOOKS:

1. Alfreda Dudley, James Braman, Giovanni Vincenti, Investigating Cyber Law and Cyber Ethics: Issues, Impacts and Practices, Information Science Reference.
2. Douglas J Landoll, Information security policies, procedures and standards practitioner's Reference, CRC Press

REFERENCES:

1. Anthony Reyes, Richard Brittson, Kevin O'Shea, James Steele, Cybercrime investigations: bridging the gaps between security professionals, law enforcement, and prosecutors, Syngress Publishing, 2007
2. Jennifer L. Bayuk, Jason Healey, Paul Rohmeyer, Marcus Sachs, Jeffrey Schmidt, Joseph Weiss, Cyber security policy guidebook, Wiley, 2012

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SECURITY ASSESSMENT AND RISK ANALYSIS (PEC-III)

Course Objectives:
1. Describe the concepts of risk management, Contingency Planning and Its Components.
2. Define and differentiate IR Planning Process, Developing the Incident Response Policy.
3. Illustrate Digital Forensics Methodology, eDiscovery and Anti-Forensics.
4. Explore Disaster Classifications, Forming the Disaster Recovery Team, Disaster Recovery Planning Functions.
5. Define and be able to Implementing the BC Plan, Continuous Improvement of the BC Process, Maintaining the BC Plan.

Course Outcomes:
At the end of this course, students will be able to:
1. Explore Risk Management, Contingency Planning and Its Components.
2. Describe IR Planning Process, Developing the Incident Response Policy.
3. Explore Digital Forensics Methodology, eDiscovery and Anti-Forensics.
4. Understand Disaster Classifications, Forming the Disaster Recovery Team, Disaster Recovery Planning Functions.
5. Capable of Implementing the BC Plan, Continuous Improvement of the BC Process, Maintaining the BC Plan.

UNIT-I:
Introduction: Information Security, Overview of Risk Management, Contingency Planning and Its Components, Role of Information Security Policy in Developing Contingency Plans.
Planning for Organizational Readiness: Beginning the Contingency Planning Process, Elements Required to Begin Contingency Planning, Business Impact Analysis, BIA Data Collection, Budgeting for Contingency Operations.

UNIT-II:
Incident Response: Planning: Introduction, The IR Planning Process, Developing the Incident Response Policy, Incident Response Planning, Information for attack success end case, Planning for “Before the Incident”, The CCDC, Assembling and Maintaining the Final IR Plan,
Incident Response: Detection and Decision Making: Introduction, Detecting Incidents, Technical Details: Rootkits, Intrusion Detection and Prevention Systems, Technical Details: Processes and Services, Incident Decision Making.

UNIT-III:

Incident Response: Organizing and Preparing the CSIRT: Introduction, Building the CSIRT, A Sample Generic Policy and High-Level Procedures for Contingency Plans, Outsourcing Incident Response.
Incident Response: Response Strategies: Introduction, IR Response Strategies, The Cuckoo's Egg, Incident Containment and Eradication Strategies for Specific Attacks, Handling Denial of Service (DoS) Incidents.
Incident Response: Recovery and Maintenance: Introduction, Recovery, Maintenance, Incident Forensics, Digital Forensics Methodology, eDiscovery and Anti-Forensics.

UNIT-IV:

Disaster Recovery: Preparation and Implementation: Introduction, Disaster Classifications, Forming the Disaster Recovery Team, Disaster Recovery Planning Functions, Information Technology Contingency Planning Considerations, Sample Disaster Recovery Plans.
Disaster Recovery: Operation and Maintenance: Introduction, Facing Key Challenges, Preparation: Training the DR Team and the Users, Disaster Response Phase, Recovery Phase, Resumption Phase, Restoration Phase.

UNIT-V:

Business Continuity Planning: Introduction, Business Continuity Team, Business Continuity Policy an Plan Functions, Implementing the BC Plan, Continuous Improvement of the BC Process, Maintaining the BC Plan.
Crisis Management and International Standards in IR/DR/BC: Introduction, Crisis Management in the Organization, Preparing for Crisis Management, International Standards in IR/DR/BC.

TEXT BOOK:

1. Whitman & Mattord, Principles of Incident Response and Disaster Recovery, Course Technology, ISBN: 141883663X

REFERENCES:

1. http://www.cnss.gov/Assets/pdf/nstissi_4011.pdf
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security Fifth Edition, 2014, Cengage Learning

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DATA ENCRYPTION AND COMPRESSION
(PEC-III)

Course Objectives:

1. Provides an in-depth study of the rapidly changing and fascinating field of data encryption.
2. Combines both the technical expertise and the knowledge required for Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall.
3. Knowledge on Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution.
4. Provides an in-depth study of Fundamental concept of data compression & coding, Communication model, Compression ratio, Requirements of data compression and Classification.
5. Knowledge on Entropy encoding, Statistical encoding, Source encoding and Differential encoding.

Course Outcomes:

At the end of this course, students will be able to:

1. Summarize in-depth study of the rapidly changing and fascinating field of data encryption.
2. Describe both the technical expertise and the knowledge required for Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall.
3. Explore Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution
4. Understand Fundamental concept of data compression & coding, Communication model, Compression ratio, Requirements of data compression and Classification.
5. Describe Knowledge on Entropy encoding, Statistical encoding, Source encoding and Differential encoding.

UNIT-I:

Introduction to Security: Need for security, Security approaches, Principles of security, Types of attacks.
Encryption Techniques: Plaintext, Cipher text, Substitution & Transposition techniques, Encryption & Decryption, Types of attacks, Key range & Size**. [TB-1]**

UNIT-II:

Symmetric & Asymmetric Key Cryptography: Algorithm types & Modes, DES, IDEA, Differential & Linear Cryptanalysis, RSA, Symmetric & Asymmetric key together, Digital signature, Knapsack algorithm.
User Authentication Mechanism: Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall. **[TB-1]**

UNIT-III:

Case Studies of Cryptography: Denial of service attacks, IP spoofing attacks, Secure inter branch payment transactions, Conventional Encryption and Message Confidentiality, Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution.

Public Key Cryptography and Message Authentication: Approaches to Message Authentication, SHA-1, MD5, Public-Key Cryptography Principles, RSA, Digital, Signatures, Key Management. **[TB-1]**

UNIT-IV:

Introduction: Need for data compression, Fundamental concept of data compression & coding, Communication model, Compression ratio, Requirements of data compression, Classification.

Methods of Data Compression: Data compression-- Loss less &Lossy. **[TB-2]**

UNIT-V:

Entropy encoding-- Repetitive character encoding, Run length encoding, Zero/Blank encoding; Statistical encoding-- Huffman, Arithmetic & Lempel-Ziv coding; Source encoding-- Vector quantization (Simple vector quantization & with error term); **Differential encoding**—Predictive coding, Differential pulse code modulation, Delta modulation, Adaptive differential pulse code
modulation; Transform based coding: Discrete cosine transform & JPEG standards; Fractal compression. **[TB-2]**

TEXT BOOKS:

1. B. Forouzan, Cryptography and Network Security, First Edition, McGraw-Hill, 2008
2. Nelson, The Data Compression Book, First Edition, BPB, 1995

REFERENCES:

1. Atul Kahate, Cryptography & Network Security, First Edition TMH,2006

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DATABASE SECURITY
(PEC-IV)

Course Objectives:

1. Explain security of database and the components of database.
2. Illustrate database installation of MYSQL and SQL Server.
3. Illustrate database installation of oracle and Authentication and Authorization.
4. Select SQL Injection Identification, Exploitation and Defense.
5. Choose Security Auditing and Security Testing

Course Outcomes:

At the end of this course, students will be able to:

1. Appraise Fundamentals of security of databases and the components of database.
2. Demonstrate the installation of MYSQL and SQL Server.
3. Illustrate the installation of Oracle and the concepts of Authentication and Authorization.
4. Discuss the SQL Injection Identification, Exploitation and the Defense.
5. Analyse the internals of security auditing and security testing.

UNIT-I:

Security and Information Technology: Why database security. Malware. Security Architecture, Global policies for database environment.

Database Review: Database defined. Database structure components. Database models. Relationships. Database Types. DBMS. Database similarities. Oracle Architecture. MySQL Architecture. Mycrosoft SQL server Architecture.

UNIT-II:

Database Installation: MySQL

Preinstallation Preparation. Downloading MySQL. Installation. Installation on UNIX. Configuration. Configurating MySQL on UNIX. Additional Security Suggestions.

Database Installation: SQL Server

Planning for Microsoft SQL Server Installation. Meeting the requirements. Supported Platforms. Other software prerequisites. Making the difficult decisions. Locating Help. Installation. Step-by-step installation. Additional Security Considerations for SQL server 2008.

UNIT-III:

Database Installation: Oracle

Planning for an Oracle deployment. Checking the requirements. Preinstallation Decisions. Locating Help. Installation. Step-by-step installation for windows. Quick installation for UNIX-based systems. Additional Security considerations for an oracle database.

Passwords, Profiles, Privileges and Roles

Authentication, Authorization. Inference.

UNIT-IV:

SQL Injection I : Identification

Understanding SQL injections. Identifying vulnerabilities.

SQL Injection II : Exploitation and Defense

Exploitation and Information gathering. Extracting the real data. Exploitation of Privileges and passwords. Defending against Exploitation.

UNIT-V:

Security Auditing.

Security Auditing, Database Auditing.

Security Testing.

Security Testing, Testing Methodology.

TEXT BOOK:

1. Alfred Basta, Melissa Zgola, Dana Bullaboy, Thomas L Whitlock Sr.“Database Security”, Cengage Learning, 2012.

REFERENCES:

1. Silvana Castano, “Database Security”, Addison Wesley, 1994.
2. Michael Gertz, Sushil Jajodia, “Hand book of Database Security”, Springer Publications, 2010.

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WEB SECURITY
(PEC-IV)

Course Objectives:
1. Impart Security related concepts in web-based applications.
2. Discuss the fundamental security components.
3. Outline Web-based system features with respect to its security requirements.
4. Know the fundamental mechanisms of securing a Web-based system.
5. Outline the secure development techniques.

Course Outcomes:
At the end of this course, students will be able to:
1. Appreciate security-related issues in Web-based systems and applications.
2. Design the fundamental security components of a computer system.
3. Evaluate a Web-based system with respect to its security requirements.
4. Implement security mechanisms to secure a Web-based application.
5. Demonstrate the process of developing secure networked systems.

UNIT-I: Welcome to the Wide World of Web Application Security, Security Fundamentals.

UNIT-II: -Web Application Security Principles, Authentication, Authorization.

UNIT-III: Browser Security Principles: The Same-Origin Policy Chapter, Browser Security Principles: Cross-Site Scripting and Cross-Site Request Forgery.

UNIT-IV: Database Security Principles, File Security Principles

UNIT-V: Secure Development and Deployment - Secure Development Methodologies Epilogue: The Wizard, the Giant, and the Magic Fruit Trees: A Happy Ending Index

TEXT BOOKS:

1. Bryan and Vincent, “Web Application Security, A Beginners Guide”, McGraw-Hill, 2011.

REFERENCES:

1.Oppliger, Rolf. Security Technologies for the World Wide Web, Second Edition. Artech House Publishers. 2003.

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CLOUD SECURITY
(PEC-IV)

Course Objectives:
1.Impart the knowledge of Cloud services.
2. Discuss the various security and storage mechanisms.
3. Demonstrate the need of Identity Access Management.
4. Analyze various security availability standards.
5. Identify the risk management in cloud.

Course Outcomes:
At the end of this course, students will be able to:
1.Appreciate various cloud services.
2. Analyze the security mechanisms in various levels.
3.Design the IAM architecture.
4. Summarize various access control mechanisms.
5. Outline the compliance and risk management in cloud.

UNIT- I:
Understanding the SPI framework of Cloud Computing, Cloud Services Delivery model: PaaS, IaaS and SaaS, Cloud Deployment Models: Public, Private, Community, Hybrid. Barriers to Cloud Computing Adoption in the Enterprise.

UNIT- II:
Infrastructure Security-Network Level, Host Level, Application level.
Data Security and Storage: Aspects of Data Security, Data Security Mitigation Provider Data and its Security

UNIT- III:
Identity Access Management: Need of IAM, IAM Challenges, IAM Architecture, IAM standards, protocols and specifications of cloud. Identity Management as a Service.

UNIT-IV
Security Management in the cloud, Security Management Standards, SaaS Availability Management, PaaS Availability Management, IaaS Availability Management, Access control.

UNIT-V:
Policy, Compliance and Risk Management in Cloud: Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Key Management, Security as a Cloud Service.

TEXT BOOK:

1. Tim Mather, Subra Kumaraswamy, Shahed Latif, “Cloud Security and Privacy: An Enterprise

REFERENCES:

1.Ronald L. Krutz, Russell Dean Vines, “Cloud Security”, 2010.

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ENTREPRENEURSHIP DEVELOPMENT

(OEC-I)

Course Objectives:

6. Provide insights into basic characteristics and process of entrepreneurship
7. Develop a business idea and prepare a bankable project report
8. Identify the methods to initiate ventures and the sources of finance
9. Create awareness about the legal challenges of entrepreneurship and IPR
10. Know and apply the various strategic and managerial concerns in the growth stage of the firms

Course Outcomes:

At the end of this course, students will be able to:

1. Interpret concepts and process of entrepreneurship.
2. Apply idea development strategies and prepare a bankable project report.
3. Analyse various opportunities towards initiating ventures.
4. Recognize legal challenges of entrepreneurship.
5. Assess the strategic perspectives of entrepreneurship.

UNIT I:

Introduction: Introduction to Entrepreneurship – Characteristics, Qualities, Key Elements and Skills of an Entrepreneur, entrepreneurial stress, corporate entrepreneurship, Entrepreneurial process.

UNIT II:

Business Plan Preparation: Search for business idea, project identification, project formulation and development, contents of business plan and Preparation of a Bankable Project Report.

UNIT III:

Launching Entrepreneurial Venture: Opportunities identification, Methods to initiate Ventures, creating new ventures, Acquiring existing ventures, Franchising. Sources of finance, Forms of capital requirements, funding agencies and supporting institutions.

UNIT IV:

Legal challenges of Entrepreneurship: Intellectual Property Protection – Patents, Copyrights, Trademarks and Trade Secrets. The challenges of new Venture Startups- Poor financial understanding, critical factors for new venture development, Evaluation process, Feasibility criteria approach.

UNIT V:

Strategic perspectives in Entrepreneurship: Strategic planning- Strategic Action, Strategic Positioning, Business Stabilization, Building the adaptive firms, understanding the growth stage, unique managerial concern of growing ventures.

TEXT BOOKS:

1. D F Kuratko and T V Rao "Entrepreneurship- A South-Asian Perspective "Cengage Learning, 2012
2. Vasant Desai, Small Scale Industries and Entrepreneurship, HPH, 2012.

REFERENCES:

1. Rajeev Roy, Entrepreneurship, 2e, Oxford, 2012.
2. B.Janakiram and M.Rizwana, Entrepreneurship Development:Text & Cases, Excel
3. Books, 2011.
4. Stuart Read, Effectual Entrepreneurship, Routledge, 2013.
5. Robert Hisrich et al, Entrepreneurship, 6e, TMH, 2012.
6. Nandan H, Fundamentals of Entrepreneurship, PHI, 2013
7. Shejwalkar, Entrepreneurship Development, Everest, 2011
8. Khanka, Entrepreneurship Development, S.Chand, 2012

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PROJECT MANAGEMENT
(OEC-I)

Course Objectives:

Course Objectives of Project Management are to:

6. Understand the concept of Project Management.
7. Know about the different approaches to project screening and planning.
8. Explain about the factors of risk involved in project execution.
9. Understand about team leading and functional cooperation.
10. Know about the project performance and future trends in the project management.

Course Outcomes:

At the end of this Project Management course, students will be able to:

1. Explain about the life cycle and other concepts of Project Management.
2. Apply different approaches to project screening and planning
3. Analyze different risk factors in project execution
4. Estimate how to lead a team, to get functional cooperation
5. Build performance evaluation reports and future trends in project management.

UNIT I:

Introduction: Meaning, Need, Principles Project Lifecycle and its Phases, Project Management Research in brief, Project Management today, Organization strategy and structure and culture, Format of organization structure, Stake holder Management, Organization Culture, creating a culture for Project Management.

UNIT II:

Project Identification and Planning: Defining the project, Project Identification Process, Approaches to Project Screening and Selection, Project Planning, Work Breakdown Structure, Financial Module, Getting Approval and Compiling a Project Charter, setting up a Monitoring and Controlling Process.

UNIT III:

Project Execution: Initiating the Project, Controlling and Reporting Project Objectives, conducting project evaluation, Risk, Risk Management Factors, Project Management, Four Stage Process, Risk Management an Integrated Approach, Cost Management, Creating a Project Budget.

UNIT IV:

Leading Project Teams: Building a Project Team, Characteristics of an effective Project Team, achieving Cross- Functional Co-operation, Virtual Project Teams, Conflicts Management, Negotiations.

UNIT V:

Performance Measurement and Evaluation: Monitoring Project Performances, Project Control Cycles, Earned Value Management, Human factors in Project Evaluation and Control, Project Termination, Types of Project Terminations, Project Follow-up. Current and Future Trends in Project Management.

TEXT BOOKS:

1. Gray, Larson, Project Management, Tata McGraw Hill, 2015
2. Jeffery K. Pinto, Project Management, Pearson Education, 2015

REFERENCES:

6. Enzo Frigenti, Project Management, Kogan, 2015
7. R. Panneerselvam & P. Senthil Kumar, Project Management, PHI, 2015
8. Thomas M. Cappels, Financially Focused Project Management, SPD, 2008.

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TECHNICAL AND BUSINESS COMMUNICATION SKILLS (OEC-I)

Introduction:

The course is intended to expose the students to learn and practice the five communication skills thinking, listening, speaking reading, and writing in English, the global language of communication. It reflects some of the approaches in English language teaching and learning currently in practice around the world.

Course Objective:

To help the students to develop effective communication skills in all communicative contexts for professional advancement.

Course Outcomes:

At the end of this course, students will be able to:

6. Communicate technical and business correspondence
7. Reflect on the themes discussed
8. Recognize ethical implications of technical communication in professional contexts
9. Identify the contemporary issues in engineering from environmental, societal, economic, and global perspectives
10. Demonstrate ethical decisions in complex situations

UNIT I:

E-World & E-Communication

E-language - E-governance - E-commerce/E-business - E-banking - E-waste

UNIT II:

Business Establishment & Infrastructure Development

Power Supply - Industrial Park - Business Correspondence: Follow-up letters - Acceptance & Rejections - Persuasive letters - Resignation letters

UNIT III:

Technology and Society

Robot Soldiers - For a Snapshot of a Web - Placing an order - Proposal Writing - Patents & Rights (National & International) - Intellectual Property - Nanotechnology

UNIT IV:

Ethics in Business Communication

Ethical issues involved in Business Communication - Ethical dilemmas facing managers - Ethical Code & Communication - Standards in Daily Life - Total Quality Management - World University Ranking

UNIT V:

Management Information System

Corporate Governance - Business Process Outsourcing - Project Management Communication - Marketing Communication

TEXT BOOK:

1. English and Communication Skills for Students of Science and Engineering by S P Dhanavel. Orient Black Swan. 2009.

REFERENCES:

6. Business Communication (Second Edition) by Meenakshi Raman & Prakash Singh by Oxford University Press. 2012.
7. Language and Communication skills for Engineers by Sanjay Kumar & Pushp Lata by Oxford University Press. 2018.
8. Business Communication by Anjali Kalkar, et.al. Orient BlackSwan. 2010.
9. Technical Communication by Paul V. Anderson. Cengage. 2014.
10. Engineering Communication by Charles W. Knisely & Karin I. Knisely. Cengage. 2015.

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WEB TECHNOLOGIES

Course Outcomes:
At the end of this course, students will be able to:
1. Design static web pages and provide client-side authentication.
2. Construct Dynamic web pages using Servlets and JSP.
3. Create Database and Manipulate data using MySql.
4. Implement programs using PHP.
5. Design web application using LAMP.

Week-1:
Practice Basic HTML Programs.
1) Basic Tags.
2) Lists.
3) Tables.
4) Frames.
5) Forms.

Week-2:
Design the following static web pages required for online book store application.
1) Registration page
2) Login page
3) User profile page
4) Shopping page
5) Catalog page

Week- 3:
Apply internal and external CSS (Cascading Style Sheets) for Online book store application (week 2).

Week -4:

1) Implement Alert Box, Confirm Box, Prompt Box. & Control Structures, Conditional Statements using Java Script.
2) Write JavaScript to validate the following fields of registration page

i) Username Field ii) Password Field iii) Phone Number Field iv) Email-id Field.

Week -5:
Apache Tomcat Installation Procedure**.**
Write a program to display the HELLO WORLD message using servlet.

Week - 6:
Implementation of servlets communication using doGET and doPOST methods.

Week -7:
Write a program to create and retrieve cookies using servlet.

Week -8:
Write a program to display the HELLO WORLD message using JSP

Week -9:
Perform Data Definition Language (DDL) and Data Manipulation Language (DML) commands using MySql.

Week -10:
Perform Aggregate functions and joins using MYSQL

Week -11:
Implement Database connectivity using JDBC and perform and perform the following:
i) Table creation ii) Data Manipulation.

Week -12:
Write a program to display the HELLO WORLD message using PHP.

Week -13:
Write a program to store and retrieve Registration page details using PHP.

Week -14:
Write a program to validate Login page using PHP.

Week -15:
Implement RSA Algorithm using HTML and JavaScript

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

ANURAG UNIVERSITY

M. Tech [Cyber Security] - I Year II Sem.

L	T / P / D	C
0	**4**	**2**

DATABASE SECURITY
(PEC-IV LAB)

Course Outcomes:

At the end of this course, students will be able to:

1. Explain how to create a database user to run DBSAT.
2. Demonstrate how to install DBSAT.
3. Run DBSAT Collector and DBSAT Reporter.
4. Analyse the generated report both summary and findings.
5. Summarise the generated report details.

Students are expected to complete the following activities as part of their laboratory sessions.

Week 1: Create a database user to run DBSAT.

Week 2: Installing DBSAT

Week 3: Run DBSAT Collector

Week 4: Run DBSAT Reporter

Week 5: Analyse the generated report - Summary

Week 6: Analyse the generated report – Findings

Week 7: Analyse the generated report- Details

REFERENCES:

1. Oracle Database Security Assessment Tool User Guide.
2. Ron Ben Natan, "Implementing Database Security and Auditing", Elsevier Inc. , 2005.

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

ANURAG UNIVERSITY

M. Tech [Cyber Security] - I Year II Sem.

L	T / P / D	C
0	**4**	**2**

WEB SECURITY
(PEC-IV LAB)

Course Outcomes:
At the end of this course, students will be able to:
1. Design the web applications.
2. Analyze and evaluate the cyber security needs of an organization.
3. Identify best practices for Web service development
4. Understand Web service security
5. Demonstrate the process of developing secure networked systems

Students are expected to complete the following activities as part of their laboratory sessions.

Week 1: Web Applications Security

Week 2: Cryptography

Week 3: Authentication Applications

Week 4: E-mails Security

Week 5: TCP/IP sec

Week 6: Firewalls/VPN

Week 7: Web attacks

Week 8: Web Services Security

Week 9: Java Security

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

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M. Tech [Cyber Security] - I Year II Sem.

L	T / P / D	C
0	**4**	**2**

CLOUD SECURITY
(PEC-IV LAB)

Course Outcomes:
At the end of this course, students will be able to:
1. Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services.
2. Implement appropriate safeguards and countermeasures for Cloud based IT services
3. Design cloud services that meet essential Cloud infrastructure characteristics – on demand computing, shared resources, elasticity and measuring usage.

Students are expected to complete the following activities as part of their laboratory sessions.

Module -1: Cloud Security

Console Demonstration - Identity and Access Management
Lab 1: Introduction to AWS

Module - 2: Networking & Content Delivery

Console Demonstration- VPC Wizard
Lab 2: Build your VPC and Launch a Web Server

Module - 3: Compute

Console Demonstration –EC2
Lab 3: Introduction to Amazon EC2

Module - 4: Storage

Console Demonstration –EBS
Lab 4: Working with EBS

Module -5: Database

Console Demonstration –RDS
Lab 5: Build Your DB Server and Interact with Your DB Using an App

Module -6: Auto Scaling and Monitoring

Console Demonstration –S3
Console Demonstration –S3 &EFS
Console Demonstration –Glacier
Console Demonstration –Dynamo DB

Lab 6: Scale and Load Balance Your Architecture

Module -7: Real-world Compliance Case Study Review

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

B.Tech Honors Degree in Cyber Security

S. No	Course Code	Course	Hours per week			Credits
			L	T	P	
1	PCC	Information Theory for Cyber Security	3	0	0	3.0
2	PCC	Fundamentals of Cyber Security	3	0	0	3.0
3	PCC	Web Security	3	0	0	3.0
4	PEC-I	1. Cyber Law and Security Policy 2. Security Assessment and Risk Analysis 3. Data Encryption and Compression 4. Steganography and Digital Watermarking 5. Database Security 6. Cloud Security	3	0	0	3.0
	…	OR Any other MOOCs course as suggested and approved by the BoS				
6	PROJ	Project Work	0	0	12	6
TOTAL			**12**	**0**	**6**	**18**

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B. Tech-Honors [Cyber Security]	L	T / P / D	C
	3	**0**	**3**

INFORMATION THEORY FOR CYBER SECURITY

Course Objectives:

Course Objectives of Information Theory for Cyber Security are to:

1. Explain the concept of taxonomy of Cryptography, Stream Ciphers and Block Ciphers.
2. Illustrate about public key crypto algorithms and various hash functions
3. Interpret the advanced crypto techniques and various authentication methods.
4. Explain about authorization and various authentication protocols.
5. Describe about security protocols, software flaws and malware.

Course Outcomes:

At the end of this Information Theory for Cyber Security course, students will be able to:

1. Illustrate various concepts of taxonomy of cryptography and types of ciphers.
2. Interpret about public key crypto algorithms and also about hash functions.
3. Apply the techniques of advanced crypto and concepts like two-factor authentication.
4. Analyse various techniques of authorization and authentication protocols.
5. Examine different types of security protocols, software flaws and malware.

UNIT-I:

Crypto Basics: How to speak Crypto. Classic Crypto, Modern Crypto History, a taxonomy of Cryptography, A taxonomy of Cryptanalysis.

Symmetric Key Crypto: Stream Ciphers, Block Ciphers, Integrity.

UNIT-II:

Public KEY CRYPTO: Knapsack, RSA, Diffie-Hellman, Ellipic Curve Cryptography, Public Key Notation, Uses for Public Crypto, Public Key Infrastructure.

Hash Functions: What is a cryptographic hash function, The Birthday Problem, A Birthday Attack, Non-Cryptographic Hashes, Tiger Hash, HMAC, Uses for Hash Functions, Miscellaneous Crypto-related topics.

UNIT-III:

Advanced Crypto Analysis: Enigma, RC4 as used in WEP. Linear and differential cryptanalysis. Lattice Reduction and Knapsack. RSA timing attacks.

Authentication: Authentication Methods, Passwords, Biometrics, Two-factor authentication, single sign-on and web cookies.

UNIT-IV:

Authorization: Access control matrix, multi-level security models, Compartments, Covert Channel, Inference Control, CAPTCHA, Firewalls, Intrusion Detection System.

Simple Authentication Protocols: Simple Security Protocols, Authentication Protocols, Authentication and TCP, Zero knowledge proofs.

UNIT-V:

Real World Security Protocols: SSH, SSL, IPsec, Kerberos, WEP, GSM.

Software Flaws and Malware: Software Flaws, Malware, Botnets, Miscella-neous Software based attacks.

TEXT BOOK:

1. Mark Stamp, “Information Security, Principles and Practice”, Second Edition, Wiley Publications, 2011.

REFERNCES:

1. Aiden A. Bruen, Mario A. Forcinito, “Cryptography, Information Theory and Error Correction”, John-Wiley and Sons, 2005.

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	3	**0**	**3**

FUNDAMENTALS OF CYBER SECURITY

Course Objectives:

Course Objectives of Fundamentals of Cyber Security are to:

1. Summarize major types of cyber-attacks and its objectives.
2. Discuss major cyber-attacks, computer malware programs and their impact on the World.
3. Elaborates Firewall and password management.
4. Describe major cyber-security prevention mechanisms.
5. Outline Cyber-Security aspects of wireless networks and routers.

Course Outcomes:

At the end of this Fundamentals of Cyber Security course, students will be able to:

1. Analyze the cyber security needs of an organization.
2. Design operational and strategic cyber security strategies and policies.
3. Demonstrate various network security applications.
4. Analyze software vulnerabilities and security solutions to reduce the risk of exploitation.
5. Design and develop a security architecture for an organization.

UNIT- I:

Introduction to Cyber Security Basics, Importance of Cyber Security, Cyber- attacks, objectives of cyber-attacks, Types of Cyber-attacks, Denial of Service (DoS), Distributed Denial of Service (DDoS), Man-in-the-Middle (MITM) Attacks, Crypto jacking, SQL Injection, Spamming, Cyber-terrorism, Digital Property Misappropriation, zero-day exploitation, phishing, digital vandalism, cyber-stalking, cyber frauds and forgery.

UNIT- II:

Introduction to Cyber-attacks and their impact, Equifax Data Theft, VPNFilter Cyber- attack, WannaCry Ransom Attack, Peta Cyber-attack, US Election Manipulation, Power Grid Hacking, Shadow Network attack, GitHub DDoS Attack, Under Armor Account Hacking, Types of Computer Malware, Viruses, Trojan Horse, Rootkit, Spyware, Worms, Adware, Scare-ware, Browser Hijacker.

UNIT- III:

Introduction to Computer Security, Firewall Settings, Antivirus Software, Anti-Spyware Software, Anti-Spam Software, Security Updates, Secure Browsing Settings, Scan Devices before Data Transfer, Social Engineering Attack Precautions. Password Management, Basics of Passwords, Threats to Passwords, Good and Bad about Passwords, Hacking Password, Effective Password Management, Creating and Managing Secure Passwords, Strong Password, Use of Biometrics, Two-Factor Authentication, Multi-Factor Authentication, Password Manager Tools.

UNIT-IV:

Prevention from Cyber-attacks, Algorithms and Techniques, Cyber-attack Detection, Cyber-attack Prediction, Cyber-attack Prevention , Firewalls, Activating Windows Firewall, Windows 10 firewall, Windows 7 firewall, Enabling Windows 7 firewall, Enabling Windows firewall service, Traffic Issues and rules , firewall settings, Intrusion Detection/Prevention Systems, Intrusion Detection System (IDS) , Intrusion Prevention System (IPS),,Authentication Using Hash, Message Digest , Secure Hash Algorithm ., Multi-Factor Authentication, Activating Two-Factor Authentication, Creating Application Specific Passwords , What If Your Phone with All Apps Enabled Is Lost?, Mac Computer Firewall Configuration, Virtual Private Network.

UNIT V:

Introduction to Wireless Security, LAN Vulnerabilities, Reconnaissance Vulnerability, Resource Stealing and Invasion, Rogue Access Points (APs), STA and AP Plain Text Transaction, Denial of Service (DoS), Default AP Configuration, Rogue Insiders, Protocol Vulnerabilities, Ad Hoc Network Mode Security Problems ,Wireless WAN Vulnerabilities ,IoT Vulnerabilities, Wireless Network Security Measures, Modify Default Configuration, Wireless Router Location, Update Router Software, Stronger Encryption Algorithms, MAC Address Filtering ,Useful Tips on Safe Use of Wireless Network.

TEXT BOOKS:

2. Dr Kutub Thakur Dr Al-Sakib Khan Pathan, Cyber-security Fundamentals Real-World Perspective, first edition published 2020 by CRC Press, © 2020 Taylor & Francis Group, LLC.

REFERENCES:

3. Rajkumar Singh Rathore, Aatif Jamshed, Mayank Bhusan, Fundamental of Cyber Security Principles and Theory and Practices, BPB Publications, 01-Jun-2018.
4. J. Pieprzyk, T. Hardjono and J. Seberry, Fundamentals of computer security, Springer, 2003.

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	3	**0**	**3**

STEGANOGRAPHY AND DIGITAL WATERMARKING

Course Objectives:

Course Objectives of Steganography and Digital Watermarking are to:

6. Understand the Digital Watermarking and Steganography working process.
7. Apply knowledge of the embedding algorithm used by the steganography tool.
8. Explain Steg analytic process.
9. Analyze watermarking techniques to insert the information into the image.
10. Outlines the watermarking attacks.

Course Outcomes:

At the end of this Steganography and Digital Watermarking course, students will be able to:

6. Analyze the importance of Digital Watermarking and Steganography.
7. Identify steganography tools and different approaches to extract.
8. Evaluate security assessment of watermarking.
9. Apply various types of transform domain.
10. Understand various risks in Digital Watermarking and Steganography.

UNIT-I:

Information Hiding, Steganography and Watermarking – History of watermarking – Importance of digital watermarking – Applications – Origins & Overview of Steganography - History of Use, Covert Messaging, Null Cipher Messages, Steganography vs. Encryption, Threats Posed by Steganography Use, Steganography in the Media, Availability & Production. Digital Carriers - Used to Exploit Human Weaknesses.

UNIT-II:

Steganography Embedding Tools - Steganography Methods, Data Appending, Formatting Modification, Word Substitution, Color Palette Substitution, 24 Bit LSB Encoding, DCT Modification, PNS Modification, Covert Channels. Steganalysis - An Overview,

UNIT-III:

The Statistical Properties of Images, The Visual Steganalytic System, IQM- Based Steganalytic System, Learning Strategies, Introduction of the Support Vector Machine, Neural Networks, Principle Component Analysis, Frequency-Domain Steganalytic System. The Visual Steganalytic System, IQM- Based Steganalytic System, Learning Strategies

UNIT-IV:

Watermarking Fundamentals - Spatial-Domain Watermarking, Substitution Watermarking in the Spatial Domain, Additive Watermarking in the Spatial Domain, Frequency-Domain Watermarking, Substitution Watermarking in the Frequency Domain, Multiplicative Watermarking in the Frequency Domain, Watermarking Based on Vector Quantization, The Rounding Error Problem, The Fragile Watermark, The Block-Based Fragile Watermark, Weaknesses of the Block-Based Fragile Watermark, The Hierarchical Block-Based Fragile Watermark, The Robust Watermark.

UNIT-V:

Watermarking Attacks and Tools - Image Processing Attacks, Attacks by Filtering, Attack by Remodulation, Attack by JPEG Coding Distortion, Attack by JPEG 2000 Compression, Geometric Transformation, Attack by Image Scaling, Attack by Rotation, Attack by Image Clipping, Attack by Linear Transformation, Attack by Bending, Attack by Warping, Attack by Perspective Projection, Attack by Collage, Attack by Template, Cryptographic Attach, Protocol Attacks, Watermarking Tools.

TEXT BOOKS:

3. Information Hiding Techniques for Steganography and Digital Watermarking, Katzenbeisser, Stefan (Edt)/ Petitcolas, Fabien, A.P. (Edt), Artech House, 2000.
4. Information Hiding (Steganography and Watermarking - Attacks and Countermeasures), Johnson, Neil F./ Duric, Zoran/ Jajodia, Sushil, luwer Academic Pub, 2001.

REFERENCES:

3. J-S Pan, H-C Huang, L.C. Jain, Intelligent Watermarking Techniques, World Scientific Pub. Co., 2004.
4. Frank Y. Shih, Digital Watermarking and Steganography Fundamentals and Techniques, 2nd Edition,2012.

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	3	**0**	**3**

CYBER LAW AND SECURITY POLICY
(PEC-I)

Course Objectives:

Course Objectives of Cyber Law and Security Policy are to:

6. Provides an in-depth study of the Legal and Jurisdictional Issues Regarding Cyber Security.
7. Knowledge on Legal and Ethical Implications Involving Social Networks and Virtual Worlds.
8. Knowledge on Legal and Ethical Implications in Cyberspace: An International Perspective.
9. Provides an in-depth study of Security Policy Sets without Frameworks**,** Information Security Policy Sets with Frameworks.
10. Knowledge on Information Security Procedures and Standards.

Course Outcomes:

At the end of this Cyber Law and Security Policy course, students will be able to:

6. Understand relevant Legal and Jurisdictional Issues Regarding Cyber Security.
7. Describe Legal and Ethical Implications Involving Social Networks and Virtual Worlds.
8. Describe Legal and Ethical Implications in Cyberspace: An International Perspective.
9. Explore Security Policy Sets without Frameworks**,** Information Security Policy Sets with Frameworks.
10. Understand Information Security Procedures and Standards.

UNIT-I:

Legal and Jurisdictional Issues Regarding Cyberspace: Responsibility, Jurisdiction, and the Future of "Privacy by Design", Hacking: Legal and Ethical Aspects of an Ambiguous Activity, Emerging Cybercrime Trends: Legal, Ethical, and Practical Issues, Law and Technology at Crossroads in Cyberspace: Where Do We Go From Here? Cyber Law, Cyber Ethics and Online Gambling. **[TB-1]**

UNIT-II:

Legal and Ethical Implications Involving Social Networks and Virtual Worlds: An Overview of Child Abuses in 3D Social Networks and Online Video Games, Ethics and Legal Aspects of Virtual Worlds, Narbs as a Measure and Indicator of Identity Narratives, Cloud Based Social Network Sites: Under Whose Control? **[TB-1]**

UNIT-III:

Legal and Ethical Implications in Cyberspace: An International Perspective: Al-Qaeda on Web 2.0: Radicalization and Recruitment Strategies, Google in China: Corporate Responsibility on a Censored Internet, All's WELL that Ends WELL: A Comparative Analysis of the Constitutional and Administrative Frameworks of Cyberspace and the United Kingdom, A UK Law Perspective: Defamation Law as it Applies on the Internet, The Hellenic Framework for Computer Program Copyright Protection Following the Implementation of the Relative European Union Directives, Internet Advertising: Legal Aspects in the European Union. **[TB-1]**

UNIT-IV:

Introduction: Information Security Policy Types, Information Security Policy Sets without Frameworks**,** Information Security Policy Sets with Frameworks, Common Information SPFs, Tailoring Information SPFs, deriving a Policy Set from a Framework, Policy Statements, Specific Information Security Policies, Policy Document Examples. **[TB-2]**

UNIT-V:

Information Security Procedures and Standards, Scoping the Project, Information Security Policy Project Roles, Information Security Policy Project Phases, Information Security Policy Revision Project, Information Security Policy Project Application. **[TB-2]**

TEXT BOOKS:

3. Alfreda Dudley, James Braman, Giovanni Vincenti, Investigating Cyber Law and Cyber Ethics: Issues, Impacts and Practices, Information Science Reference.
4. Douglas J Landoll, Information security policies, procedures and standards practitioner's Reference, CRC Press

REFERENCES:

3. Anthony Reyes, Richard Brittson, Kevin O'Shea, James Steele, Cybercrime investigations: bridging the gaps between security professionals, law enforcement, and prosecutors, Syngress Publishing, 2007
4. Jennifer L. Bayuk, Jason Healey, Paul Rohmeyer, Marcus Sachs, Jeffrey Schmidt, Joseph Weiss, Cyber security policy guidebook, Wiley, 2012

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	3	**0**	**3**

SECURITY ASSESSMENT AND RISK ANALYSIS (PEC-I)

Course Objectives:

Course Objectives of Security Assessment and Risk Analysis are to:

6. Describe the concepts of risk management, Contingency Planning and Its Components.
7. Define and differentiate IR Planning Process, Developing the Incident Response Policy.
8. Illustrate Digital Forensics Methodology, eDiscovery and Anti-Forensics.
9. Explore Disaster Classifications, Forming the Disaster Recovery Team, Disaster Recovery Planning Functions.
10. Define and be able to Implementing the BC Plan, Continuous Improvement of the BC Process, Maintaining the BC Plan.

Course Outcomes:

At the end of this Security Assessment and Risk Analysis course, students will be able to:

6. Explore Risk Management, Contingency Planning and Its Components.
7. Describe IR Planning Process, Developing the Incident Response Policy.
8. Explore Digital Forensics Methodology, eDiscovery and Anti-Forensics.
9. Understand Disaster Classifications, Forming the Disaster Recovery Team, Disaster Recovery Planning Functions.
10. Capable of Implementing the BC Plan, Continuous Improvement of the BC Process, Maintaining the BC Plan.

UNIT-I:

Introduction: Information Security, Overview of Risk Management, Contingency Planning and Its Components, Role of Information Security Policy in Developing Contingency Plans.

Planning for Organizational Readiness: Beginning the Contingency Planning Process, Elements Required to Begin Contingency Planning, Business Impact Analysis, BIA Data Collection, Budgeting for Contingency Operations.

UNIT-II:

Incident Response: Planning: Introduction, The IR Planning Process, Developing the Incident Response Policy, Incident Response Planning, Information for attack success end case, Planning for “Before the Incident”, The CCDC, Assembling and Maintaining the Final IR Plan,

Incident Response: Detection and Decision Making: Introduction, Detecting Incidents, Technical Details: Rootkits, Intrusion Detection and Prevention Systems, Technical Details: Processes and Services, Incident Decision Making.

UNIT-III:

Incident Response: Organizing and Preparing the CSIRT: Introduction, Building the CSIRT, A Sample Generic Policy and High-Level Procedures for Contingency Plans, Outsourcing Incident Response.

Incident Response: Response Strategies: Introduction, IR Response Strategies, The Cuckoo’s Egg, Incident Containment and Eradication Strategies for Specific Attacks, Handling Denial of Service (DoS) Incidents.

Incident Response: Recovery and Maintenance: Introduction, Recovery, Maintenance, Incident Forensics, Digital Forensics Methodology, eDiscovery and Anti-Forensics.

UNIT-IV:

Disaster Recovery: Preparation and Implementation: Introduction, Disaster Classifications, Forming the Disaster Recovery Team, Disaster Recovery Planning Functions, Information Technology Contingency Planning Considerations, Sample Disaster Recovery Plans.

Disaster Recovery: Operation and Maintenance: Introduction, Facing Key Challenges, Preparation: Training the DR Team and the Users, Disaster Response Phase, Recovery Phase, Resumption Phase, Restoration Phase.

UNIT-V:

Business Continuity Planning: Introduction, Business Continuity Team, Business Continuity Policy an Plan Functions, Implementing the BC Plan, Continuous Improvement of the BC Process, Maintaining the BC Plan.

Crisis Management and International Standards in IR/DR/BC: Introduction, Crisis Management in the Organization, Preparing for Crisis Management, International Standards in IR/DR/BC.

TEXT BOOK:

1. Whitman & Mattord, Principles of Incident Response and Disaster Recovery, Course Technology, ISBN: 141883663X

REFERENCES:

3. http://www.cnss.gov/Assets/pdf/nstissi_4011.pdf
4. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security Fifth Edition, 2014, Cengage Learning

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L	T / P / D	C
3	**0**	**3**

DATA ENCRYPTION AND COMPRESSION
(PEC-I)

Course Objectives:

Course Objectives of Data Encryption and Compression are to:

6. Provides an in-depth study of the rapidly changing and fascinating field of data encryption.
7. Combines both the technical expertise and the knowledge required for Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall.
8. Knowledge on Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution.
9. Provides an in-depth study of Fundamental concept of data compression & coding, Communication model, Compression ratio, Requirements of data compression and Classification.
10. Knowledge on Entropy encoding, Statistical encoding, Source encoding and Differential encoding.

Course Outcomes:

At the end of this Data Encryption and Compression course, students will be able to:

6. Summarize in-depth study of the rapidly changing and fascinating field of data encryption.
7. Describe both the technical expertise and the knowledge required for Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall.
8. Explore Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution.
9. Understand Fundamental concept of data compression & coding, Communication model, Compression ratio, Requirements of data compression and Classification.
10. Describe Knowledge on Entropy encoding, Statistical encoding, Source encoding and Differential encoding.

UNIT-I:

Introduction to Security: Need for security, Security approaches, Principles of security, Types of attacks.
Encryption Techniques: Plaintext, Cipher text, Substitution & Transposition techniques, Encryption & Decryption, Types of attacks, Key range & Size**. [TB-1]**

UNIT-II:

Symmetric & Asymmetric Key Cryptography: Algorithm types & Modes, DES, IDEA, Differential & Linear Cryptanalysis, RSA, Symmetric & Asymmetric key together, Digital signature, Knapsack algorithm.
User Authentication Mechanism: Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall. **[TB-1]**

UNIT-III:

Case Studies of Cryptography: Denial of service attacks, IP spoofing attacks, Secure inter branch payment transactions, Conventional Encryption and Message Confidentiality, Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution.
Public Key Cryptography and Message Authentication: Approaches to Message Authentication, SHA-1, MD5, Public-Key Cryptography Principles, RSA, Digital, Signatures, Key Management. **[TB-1]**

UNIT-IV:

Introduction: Need for data compression, Fundamental concept of data compression & coding, Communication model, Compression ratio, Requirements of data compression, Classification.

Methods of Data Compression: Data compression-- Loss less &Lossy. **[TB-2]**

UNIT-V:

Entropy encoding-- Repetitive character encoding, Run length encoding, Zero/Blank encoding; Statistical encoding-- Huffman, Arithmetic & Lempel-Ziv coding; Source encoding-- Vector quantization (Simple vector quantization & with error term); **Differential encoding**—Predictive coding, Differential pulse code modulation, Delta modulation, Adaptive differential pulse code
modulation; Transform based coding: Discrete cosine transform & JPEG standards; Fractal compression. **[TB-2]**

TEXT BOOKS:

3. B. Forouzan, Cryptography and Network Security, First Edition, McGraw-Hill, 2008.
4. Nelson, The Data Compression Book, First Edition, BPB, 1995.

REFERENCES:

2. Atul Kahate, Cryptography & Network Security, First Edition TMH,2006.

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	3	**0**	**3**

DATABASE SECURITY
(PEC-I)

Course Objectives:
Course Objectives of Database Security are to:
6. Explain security of database and the components of database.
7. Illustrate database installation of MYSQL and SQL Server.
8. Illustrate database installation of oracle and Authentication and Authorization.
9. Select SQL Injection Identification, Exploitation and Défense.
10. Choose Security Auditing and Security Testing.

Course Outcomes:
At the end of this Database Security course, students will be able to:
6. Appraise Fundamentals of security of databases and the components of database.
7. Demonstrate the installation of MYSQL and SQL Server.
8. Illustrate the installation of Oracle and the concepts of Authentication and Authorization.
9. Discuss the SQL Injection Identification, Exploitation and the Défense.
10. Analyse the internals of security auditing and security testing.

UNIT-I:
Security and Information Technology: Why database security. Malware. Security Architecture, Global policies for database environment.
Database Review: Database defined. Database structure components. Database models. Relationships. Database Types. DBMS. Database similarities. Oracle Architecture. MySQL Architecture. Mycrosoft SQL server Architecture.

UNIT-II:
Database Installation: MySQL
Preinstallation Preparation. Downloading MySQL. Installation. Installation on UNIX. Configuration. Configurating MySQL on UNIX. Additional Security Suggestions.
Database Installation: SQL Server
Planning for Microsoft SQL Server Installation. Meeting the requirements. Supported Platforms. Other software prerequisites. Making the difficult decisions. Locating Help. Installation. Step-by-step installation. Additional Security Considerations for SQL server 2008.

UNIT-III:

Database Installation: Oracle

Planning for an Oracle deployment. Checking the requirements. Preinstallation Decisions. Locating Help. Installation. Step-by-step installation for windows. Quick installation for UNIX-based systems. Additional Security considerations for an oracle database.

Passwords, Profiles, Privileges and Roles

Authentication, Authorization. Inference.

UNIT-IV:

SQL Injection I : Identification

Understanding SQL injections. Identifying vulnerabilities.

SQL Injection II : Exploitation and Defense

Exploitation and Information gathering. Extracting the real data. Exploitation of Privileges and passwords. Defending against Exploitation.

UNIT-V:

Security Auditing.

Security Auditing, Database Auditing.

Security Testing.

Security Testing, Testing Methodology.

TEXT BOOK:

2. Alfred Basta, Melissa Zgola, Dana Bullaboy, Thomas L Whitlock Sr.“Database Security”, Cengage Learning, 2012.

REFERENCES:

3. Silvana Castano, “Database Security”, Addison Wesley, 1994.
4. Michael Gertz, Sushil Jajodia, “Hand book of Database Security”, Springer Publications, 2010.

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	3	**0**	**3**

WEB SECURITY
(PEC-I)

Course Objectives:
Course Objectives of Web Security are to:
6. Impart Security related concepts in web-based applications.
7. Discuss the fundamental security components.
8. Outline Web-based system features with respect to its security requirements.
9. Know the fundamental mechanisms of securing a Web-based system.
10. Outline the secure development techniques.

Course Outcomes:
At the end of this Web Security course, students will be able to:
6. Appreciate security-related issues in Web-based systems and applications.
7. Design the fundamental security components of a computer system.
8. Evaluate a Web-based system with respect to its security requirements.
9. Implement security mechanisms to secure a Web-based application.
10. Demonstrate the process of developing secure networked systems.

UNIT-I: Welcome to the Wide World of Web Application Security, Security Fundamentals.

UNIT-II: Web Application Security Principles, Authentication, Authorization.

UNIT-III: Browser Security Principles: The Same-Origin Policy Chapter, Browser Security Principles: Cross-Site Scripting and Cross-Site Request Forgery.

UNIT-IV: Database Security Principles, File Security Principles

UNIT-V: Secure Development and Deployment - Secure Development Methodologies Epilogue: The Wizard, the Giant, and the Magic Fruit Trees: A Happy Ending Index

TEXT BOOKS:

2. Bryan and Vincent, “Web Application Security, A Beginners Guide”, McGraw-Hill, 2011.

REFERENCES:

1.Oppliger, Rolf. Security Technologies for the World Wide Web, Second Edition. Artech House Publishers. 2003.

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L	T / P / D	C
3	**0**	**3**

CLOUD SECURITY
(PEC-I)

Course Objectives:

Course Objectives of Cloud Security are to:

1. Impart the knowledge of Cloud services.
2. Discuss the various security and storage mechanisms.
3. Demonstrate the need of Identity Access Management.
4. Analyze various security availability standards.
5. Identify the risk management in cloud.

Course Outcomes:

At the end of this Cloud Security course, students will be able to:

1. Appreciate various cloud services.
2. Analyze the security mechanisms in various levels.
3. Design the IAM architecture.
4. Summarize various access control mechanisms.
5. Outline the compliance and risk management in cloud.

UNIT- I:

Understanding the SPI framework of Cloud Computing, Cloud Services Delivery model: PaaS, IaaS and SaaS, Cloud Deployment Models: Public, Private, Community, Hybrid. Barriers to Cloud Computing Adoption in the Enterprise.

UNIT- II:

Infrastructure Security-Network Level, Host Level, Application level.

Data Security and Storage: Aspects of Data Security, Data Security Mitigation Provider Data and its Security

UNIT- III:

Identity Access Management: Need of IAM, IAM Challenges, IAM Architecture, IAM standards, protocols and specifications of cloud. Identity Management as a Service.

UNIT-IV

Security Management in the cloud, Security Management Standards, SaaS Availability Management, PaaS Availability Management, IaaS Availability Management, Access control.

UNIT-V:

Policy, Compliance and Risk Management in Cloud: Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Key Management, Security as a Cloud Service.

TEXT BOOK:

2. Tim Mather, Subra Kumaraswamy, Shahed Latif, “Cloud Security and Privacy: An Enterprise.

REFERENCES:

1.Ronald L. Krutz, Russell Dean Vines, “Cloud Security”, 2010

Course Structure for B. Tech
Minor Degree in Information Technology

Dept. of Information Technology
ANURAG UNIVERSITY
Venkatapur (V), Ghatkesar (M), Medchal (Dist), Telangana– 500 088
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27th March, 2021

B.TECH Minor Degree in Information Technology

S. No	Course Code		Course	Hours per week			Credits
				L	T	P	
1	PC		Design of Algorithms	3	0	3	4.5
2	PC		Object Oriented Programming	3	0	3	4.5
3	PC		Database Management Systems	3	0	3	4.5
4	PC		Operating Systems	3	0	3	4.5
5	PC		Python Programming	3	0	3	4.5
6	PC		Web Technologies	3	0	3	4.5
7	PC		Cloud Computing	3	0	3	4.5
8	PC		Mobile Application Development	3	0	3	4.5
			TOTAL	**12**	**0**	**12**	**18**

Student has to register for any of the four courses from the list.

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	L	T / P / D	C
	3	**0**	**3**

DESIGN OF ALGORITHMS

Course Objectives:

Course Objectives of Design of Algorithms are to:

6. Appraise the fundamental concepts of data structures and their representations
7. Describe the applications of non-linear data structures
8. Summarize the concepts of Advanced Trees
9. Discuss the implementation of various Graph representations and traversals
10. Outline the basic concepts of Hashing and Collision resolution Techniques

Course Outcomes:

At the end of this Design of Algorithms course, students will be able to:

6. Summarize Static and Dynamic data structures in implementing Stack applications
7. Implement Tree traversal algorithms in solving real time applications
8. Analyze the concepts of Advanced Trees to generate search efficiently
9. Interpret the importance of Graphs in solving real time applications
10. Apply the concepts of hashing

UNIT I:

Introduction: What is data structure, Types of data structures, Static and Dynamic representation of data structure and comparison. Stacks-Definition, Operations, Applications of stacks – Representation and evaluation of expressions using Infix, Prefix and Postfix, Algorithms for conversions and evaluations of expressions from infix to prefix and postfix using stack, Towers of Hanoi, Parenthesis checker.

UNIT II:

Trees: Basic terminology, Types of trees: Binary Tree: terminology, Complete and Full Binary Tree, Extended Binary Trees, Threaded Binary Trees-Inorder Threading. Representation of Trees using Arrays and Linked lists (advantages and disadvantages). Tree Traversal and Representation of Algebraic expressions; Algorithms for Tree Traversals.

Heaps: Introduction, Types of Heaps – Min binary heap, Max binary heap.

UNIT III:

Advanced concepts on trees: Representation and Creation of Binary Search Trees (BST), Algorithm for inserting, deleting and searching in BST. Representation and advantages of AVL Trees, Algorithms on AVL Trees-Insertion, Rotation and Deletion. Definition and advantages of B-trees, B Tree of Order M, operations-Insertion and Searching, Introduction to Red-Black Trees and Splay Trees.

UNIT IV:

Graphs: Basic terminology, Representation of Graphs: sequential representation (Adjacency, Path Matrix) Linked representation.

Graph Traversals-Breadth First Search, Depth First Search with algorithms. Definition and properties of Spanning Tree, Minimum Spanning Tree, Minimum Spanning Tree Algorithms, Dijkstra Algorithms.

UNIT V:

Hashing: General Idea, Hash Functions, Collision Resolution- Separate Chaining, Open Addressing-Linear probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing, Implementation of Dictionaries.

Text Book:

3. Seymour Lipschutz, Schaum's Outlines, Data Structures, Special Second Edition, Tata McGraw-Hill,2014.

Reference Books:

1. Richard F.Gillberg & Behrouz A. Forouzan, Data Structures, A Pseudo code Approach with C, Second Edition, Cengage Learning, India Edition, 2005.
2. Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI Learning Private Limited, Delhi India,2001.
3. Horowitz and Sahani, Fundamentals of Data Structures, Galgotia Publications Pvt Ltd. Delhi India,2015.
4. A.K. Sharma, Data Structure Using C, Pearson Education India,2011

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		3	**0**	**3**

OBJECT ORIENTED PROGRAMMING

Course Objectives:

Course Objectives of Object-Oriented Programming are to:

6. Impart knowledge of core language features of Java.
7. Appraise the concepts of Inheritance and Packages.
8. Elaborate the use of Exceptions and collection frameworks in Java.
9. Familiarize Event Handling and Applets.
10. Emphasize GUI based application development.

Course Outcomes:

At the end of this Object-Oriented Programming course, students will be able to:

6. Appraise the basic concepts of java.
7. Implement inheritance and polymorphism.
8. Identify usage of collection framework and build multi-threaded applications.
9. Design Applets by using Event Handling features.
10. Implement Graphical User Interface applications using Swings.

UNIT I:

Java Basics: History of Java, Java buzzwords, data types, variables, scope and life time of variables, arrays, operators, expressions, control statements, simple java program, concepts of classes, objects, constructors, methods, access control, this keyword, static keyword, Garbage collection, Overloading methods and constructors, parameter passing.

UNIT II:

Inheritance: Introduction, forms of inheritance- specialization, specification, construction**,** extension, limitation, combination, Member access rules, super uses, using final with inheritance.

Polymorphism: Method overriding, Abstract classes, Object class

Packages and Interfaces: Defining, Creating and Accessing a Package, importing packages, differences between classes and interfaces, File, Byte Streams, Character Streams.

UNIT III:

Exception Handling - Concepts of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally, built in exceptions, creating own exception sub classes.

Package java.util- The Collection Interfaces, The Collection classes: LinkedList Class, HashSet Class. TreeSet Class, String Tokenizer, Date, Random, Scanner.

Multi-Threading: Differences between multi-threading and multitasking, thread life cycle, creating threads, thread priorities, synchronizing threads, inter thread communication.

UNIT IV:

Event Handling: Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes.

Applets – Concepts of Applets, differences between applets and applications, life cycle of an applet, create applets, passing parameters to applets.

UNIT V:

GUI Programming with Swing – Introduction, limitations of AWT, MVC architecture, components, containers. Understanding Layout Managers, Flow Layout, Border Layout, Grid Layout, Card Layout, Grid Bag Layout.

Creating a Swing Applet, Painting in Swing, A Paint example, Exploring Swing Controls- JLabel and Image Icon, JText Field, The Swing Buttons,JButton, JToggle Button, JCheck Box, JRadio Button, JTabbed Pane, JScroll Pane, JList, JCombo Box, Swing Menus, Dialogs.

Text Book:

3. Herbert Schildt, Java- The Complete Reference, Seventh edition, Tata McGraw Hill,2006.

Reference Books:

3. Bruce Eckel, Thinking in Java, Fourth Edition, Prentice Hall, 2006.
4. Y. Daniel Liang, Introduction to Java programming, Tenth Edition, Pearson education, 2014.

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	3	**0**	**3**

DATABASE MANGEMENT SYSTEMS

Course Objectives:

Course Objectives of Database Management Systems are to:

11. Discuss Database management systems, databases and its applications.
12. Familiarize the students with a good formal foundation on the relational model.
13. Outline the various systematic database design approaches.
14. Describe the concepts of transactions and transaction processing and the issues, techniques related to concurrency and recovery manager.
15. Explore the File organizations, indexing and hashing mechanisms.

Course Outcomes:

At the end of this Database Management Systems course, students will be able to:

1. Model Entity-Relationship diagrams for enterprise level databases.
2. Formulate Queries using SQL and Relational Formal Query Languages.
3. Apply different normal forms to design the Database.
4. Summarize concurrency control protocols and recovery algorithms.
5. Identify suitable Indices and Hashing mechanisms for effective storage and retrieval of Data.

UNIT I:

Introduction to Database System Concepts: Database-System Applications, Purpose of Database Systems, View of Data, Database Language, Database Design, Database Architecture, Database Users and Administrators.

Introduction to the Relation Models and Database Design using ER Model: Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Languages, Relational Operations Overview of the Design Process, The Entity-Relationship Model, Constraints, Entity-Relationship Diagrams-Unary, Binary, ternary, Aggregation.

UNIT II:

Introduction to SQL: Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Aggregate Functions, Nested Sub queries.

Formal Relational Query Languages: The Relational Algebra, Tuple Relational Calculus.

UNIT III:

Relational Database Design: Features of Good Relational Designs, Atomic Domains and First Normal Form, Functional Dependencies, Closure set of Functional dependencies, Procedure for Computing F^{+}, Boyce Codd Normal form, BCNF Decomposition Algorithm, Third Normal Form, Third Normal Form Decomposition Algorithm

Transactions: Transaction Concept, A Simple Transaction Model, Storage Structure, Transaction Atomicity and Durability, Serializability.

UNIT IV:

Concurrency Control: Lock-Based Protocols, Deadlock Handling, Multiple Granularity, Timestamp-Based Protocols, Validation-Based Protocols.

Recovery System: Failure Classification, Storage, Recovery and Atomicity, Recovery Algorithm, ARIES, Remote Backup Systems.

UNIT V:

File Organization: Fixed and variable length records, Sequential file organization, Data Dictionary, Buffer manager.

Indexing and Hashing: Basic Concepts, Ordered Indices, B+-Tree Index Files, B+-Tree Extensions, Multiple-Key Access, Static Hashing, Extendible Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices.

Text Book:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, Sixth Edition, Tata McGraw-Hill 2006.

Reference Books:

1. Raghu Rama Kirshna, Johannes Gchrke, Database Management System, Third Edition, TATA MC Graw Hill, 2003.
2. C J Date, AKannan, S Swamynathan, An Introduction to Database Systems, Eight Edition, Pearson 2006
3. P Raja Sekhar Reddy, A Mallikarjuna Reddy, Foundations of Database Management Systems, Lambert Academic Publishing, 2020 (e-Book)
4. https://www.pdfdrive.com/fundamentals-of-database-systems-pdf-e51477130.html

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OPERATING SYSTEMS

Course Objectives:

Course Objectives of Operating System are to:

1. Introduce basic concepts of operating system and process management.
2. Discuss various CPU scheduling algorithms and problems of process synchronization.
3. Demonstrate different methods for handling deadlock.
4. Describe about memory management Techniques.
5. Explore the File system, system security and protection mechanisms.

Course Outcomes:

At the end of the Operating System course, students will be able to:

1. Summarize operating system and process management concepts.
2. Apply process scheduling and synchronization related issues.
3. Outline Deadlock Prevention, Avoidance, Detection and recovery mechanisms.
4. Analyze effectively memory management concepts.
5. Illustrate various protection and security measures.

UNIT I:

Operating Systems Overview and Process Management: Introduction-What operating system do, uni-programmed and multi programmed, Operating System operations, Operating system services, System calls, Types of System calls, Operating System structure.

Process Management: Process concepts, Operations on processes, Inter process communication. Threads: overview, Multithreading models

UNIT II:

Process Scheduling and Synchronization: Process Scheduling – Basic concepts, Scheduling criteria, Scheduling algorithms, Thread scheduling.

Process Synchronization: Background, The critical section problem, Peterson's solution, Synchronization hardware, Semaphore, Classical problems of synchronization, Monitors.

UNIT III:

Deadlocks: System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Detection and avoidance, Recovery from deadlock.

UNIT IV:

Memory Management: Swapping, Contiguous memory allocation, Paging, Segmentation.

Virtual memory management - Demand paging, copy-on-write, page-replacement, Thrashing.

UNIT V:

File System, System Protection and Security: Storage management – File concept, Access methods, Directory and disk structure, File-system mounting. System protection- Goals of protection, principles of protection, Domain of protection, Access matrix.

System Security – Security problem, Program threats, System and Network threats.

Text Book:

1. Abraham Silberchatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 9th Edition, John Wiley, 2016.

Reference Books:

1. D. M. Dharmdhere, Operating Systems – A Concept based Approach, 2nd Edition, TMH, 2007.

2. Andrew S Tanenbaum, Modern Operating Systems, Third Edition, PHI, 2008.

3. Behrouz A. Forouzan, Richard F. Gilberg, Unix and Shell programming, Cengage Learning 2009.

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PYTHON PROGRAMMING

Prerequisites: Any Programming language concepts

Course Objectives:

Course Objectives of Python Programming are to:

1. Appraise the classes and objects and its usage.
2. Discuss the functions and string operations.
3. Describe the Built-in functions and Inheritance concepts.
4. Compare the Overloading and Overriding concepts.
5. Develop the programs on various packages.

Course Outcomes:

At the end of this Python Programming course, students will be able to:

1. Apply different control structures and object-oriented concepts to develop Programs.
2. Illustrate various String handling functions and Regular Expressions.
3. Solve the problems by using Inheritance and Abstract classes.
4. Build programs on Operator overloading, Overriding and Exception Handling.
5. Implement programs on various packages.

UNIT I:

Basic concepts of Object-Oriented Programming (OOP): Introduction to OOP, Procedural vs Object Oriented Programming, Concept of class, object, Abstraction, Encapsulation, Inheritance and Polymorphism, benefits and applications of OOP.

Introduction to Python: Features of Python Language, Data Types, Operators, Expressions, Control Statement, Standard I/O Operations.

UNIT II:

Functions and Modules: Declaration and Definition Function Calling, More on Defining Functions, Recursive Functions, Modules, Packages in Python, Doc Strings.

Strings and Regular Expressions: String Operations, Built-in String Methods and Functions, Comparing Strings, function in Regular Expression.

Sequence: List, Tuples, Dictionaries, Sets.

UNIT III:

Implementation of classes and objects in Python: Classes and Objects, Class Method and Self Argument. The __init__Method, Class Variables and Object Variables, The __del__ Method, Public and Private Data Members, Private Methods, Built-in Functions to Check, Get, Set and Delete Class Attributes, Garbage Collection (Destroying Objects).

Implementation of Inheritance in Python: Inheriting Classes in Python, Types of Inheritance, Abstract Classes and Interfaces, Meta class.

UNIT IV:

Implementation of Operator Overloading in Python: Introduction, Implementing Operator Overloading, Overriding Methods.

Exception Handling in Python: Introduction, Exception hierarchy, Handling Exception, Multiple Except Blocks and Multiple Exceptions, Finally Block.

UNIT V:

Python NumPy: NumPy ND array, Data Types, Functions of NumPy Array, NumPy Array Indexing, Mathematical Functions on Arrays in NumPy.

Python Pandas: Pandas Features, Dataset in Pandas, Data Frames, Manipulating the Datasets, Describing a Dataset, group by Function, Filtering, Missing Values in Pandas, Concatenating Data Frames. Import data from csv file.

Introduction to Matplotlib: Plot, Scatterplot, Introduction to Tkinter, Date and Time Packages.

Text Book:

1. Reema Thareja, Python Programming using Problem Solving Approach, First Edition, Oxford Higher Education,2017.

Reference Books:

1. Kenneth A. Lambert, Fundamentals of Python, Cengage Learning, Second Edition,2019.
2. Charles Dierach, Introduction to Computer Science using Python, Wiley Indian Edition,2013.
3. James Payne, Beginning Python using Python 2.6 and Python 3, Wrox, First Edition,2010.

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WEB TECHNOLOGIES

Course Objectives:

Course Objectives of Web Technologies are to:

1. Appraise the basics of HTML.
2. Discuss the validations used to create web pages.
3. Describe the environment used for Ajax, Servlets.
4. Understand database connectivity.
5. Develop the programs on various packages.

Course Outcomes:

At the end of this Web Technologies course, students will be able to:

1. Design static web pages and provide client-side Authentication.
2. Prepare static web pages with validations.
3. Illustrate server-side programming with java Servlets.
4. Demonstrate server-side programming with JDBC.
5. Design web application using PHP.

UNIT I:

Introduction to Web: Understanding Internet and Web, Web Architecture, Web servers, protocols: HTTP, Introduction HTML: History of HTML, WWW.

HTML Basics: Elements, Attributes, Tags, Tables, Forms, Frames.div and span tags.

UNIT II:

CSS: Introduction to cascading style sheet, Types of style sheets, page layout, selectors, pseudo classes and elements.

JAVA SCRIPT: Introduction to scripting, control structures, conditional statements, Arrays functions, objects.

UNIT III:

AJAX: Introduction, Environment, Asynchronous communication, process steps, sending and Retrieving Information, Ajax with XML.

Servlets: Introduction, Lifecycle, Generic and HTTP servlet, passing parameters to servlet, HTTP servlet Request & Response interfaces, Deploying web Applications, Session Tracking: Hidden form fields, cookies, URL- Rewriting, session

UNIT IV:

JSP: Introduction, Difference Between servlets & JSP, Anatomy of JSP page, JSP elements: Directives, comments, Expressions, scriptlets, Declaration, Implicit JSP objects, using Action elements.

JDBC: Introduction, JDBC Drivers, Loading Driver, establishing connection, Executing SQL statement in JSP pages, MVC architecture.

UNIT V:

Introduction to PHP: Declaring variables, data types, arrays, strings, operators, expressions, control structures, functions, reading data from web form controls like text boxes, radio buttons etc., Handling File Uploads, connecting to database (MySQL as reference), executing simple queries, handling results, Handling sessions and cookies.
File Handling In PHP: File operations like opening, closing, reading, writing, deleting etc.

Text Books:

1. Uttam K. Roy Web Technologies, 1st Edition,2010, Oxford Publication.
2. Steven Hozner, The Complete Reference PHP- 1st Edition,2017, Tata McGraw-Hill

Reference Books

1. Sebesta, Programming World Wide Web, 4th edition, Pearson, 2008.
2. Dietel and Nieto, Internet and World Wide Web – How to program, 3rd edition, PHI/Pearson Education Asia, 2012.
3. R. W. Sebesta, Programming World Wide Web, Fourth Edition, Pearson.
4. Dietel and Nieto Internet and World Wide Web-How to program, Pearson.

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CLOUD COMPUTING

Course Objectives:

Course Objectives of Cloud Computing are to:

19. Impart the concepts of virtualization and its benefits.
20. Discuss various Virtualization Technologies.
21. Demonstrate the use of storage virtualization.
22. Analyze various cloud architecture.
23. Acquire the knowledge of disaster recovery and security in cloud.

Course Outcomes:

At the end of this Cloud Computing course, students will be able to:

1. Appreciate Virtualization Concepts.
2. Analyze various Virtualization Technologies.
3. Compare cloud storage mechanisms.
4. Draw cloud architecture.
5. Apply security mechanism for cloud computing.

UNIT I:

Introduction to Virtualization: Objectives of virtualization, history of virtualization, benefits of virtualized technology, the virtual service desk, what can be virtualized, related forms of computing, cloud computing, software as a service – SaaS, grid computing, utility computing, virtualization processes.

Virtualization Technologies-I: Ubuntu (server edition), Altiris, Windows server, Software virtualization, VMware, Intel virtualization, Red Hat virtualization, Softgrid application, Linux virtualization, Desktop virtualization, Hardware virtualization, Resource virtualization, Processor virtualization, Application virtualization. **[TB-1]**

UNIT II:

Virtualization Technologies-II: Storage virtualization, Virtualization density, Para-virtualization, OS virtualization, Virtualization software, Data Storage virtualization, Intel virtualization technology, Thinstall virtualization suite, Net framework virtualization, Windows virtualization on Fedora, Storage virtualization technologies, Virtualization level, Security monitoring and virtualization, Oracle virtualization.

UNIT III:

Virtualization and Storage Management: The heart of cloud computing-virtualization, defining virtualization, why virtualize, what can be virtualized, where does virtualization happen, how does virtualization happen, on the road to storage virtualization, improving availability using virtualization, improving performance through virtualization, improving capacity through virtualization, business value for virtualization. **[TB-1]**

UNIT IV:

Introduction to Cloud Computing: Cloud Introduction and overview- Components, Infrastructure and Services, Why Use Cloud Computing, Benefits and Limitations, Cloud Application Architectures, Cloud Infrastructure Models, Cloud Computing Technology- Hardware & Software Infrastructure. Cloud Computing Architecture: Requirements, Introduction to Cloud Computing Architecture, various kinds of Cloud Computing Architecture, Grid Computing, Transactional Computing, On Demand Computing, and Distributed Computing. [TB-2]

UNIT V:

Security: Security issues in Cloud Computing - Data Security, Network Security, and Host Security. **Disaster Recovery:** Disaster Recovery Planning, Disasters in the Cloud, Disaster Management. **Scaling a Cloud Infrastructure**- Capacity Planning, Cloud Scale.

Case Studies: Amazon S3, Google APP Engine, IBM Clouds, Oracle OBIEE. **[TB-2]**

Text Books:

1. Ivanka Menken, Gerard Blokdijk ,Cloud Computing Virtualization Specialist Complete Certification Kit - Study Guide Book, 2009.

2. George Reese, Cloud Application Architectures Building Applications and Infrastructure in the Cloud, O'Reilly Media Press, 2009.

Reference Books:

13. Anthony T.Velte, TobeJ.Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, Publication Person Education, 2009
14. **Tom Clark, Storage Virtualization: Technologies for Simplifying Data Storage and Management, Addison-Wesley, 2005**
15. **CurtisBrian** J.S. Chee**, Cloud Computing Technologies and Strategies of the Ubiquitous Datacenter, 2010**

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	3	**0**	**3**

MOBILE APPLICATION DEVELOPMENT

Course Objectives:
Course Objectives of Mobile Application Development are to:

1. Outline the usage of Android development framework.
2. Understand the main components of an Android application and its entire life Cycle.
3. Develop database programming using SQLite.
4. Identify the use of location-based service in android applications.
5. Build SMS and MMS applications using Intents.

Course Outcomes:

At the end of this Mobile Application Development course, students will be able to:

1. Analyze the architecture of android and current trends in mobile operating systems.
2. Apply suitable software tools and APIs for the design of User Interfaces to a particular mobile application.
3. Design applications for mobile devices using SQLite Database.
4. Apply the location-based services in android applications.
5. Summarize the Monitoring changes to the phone, network, data connectivity and SIM states.

UNIT I:
Introduction to Android: Features of Android, The development framework**:** Understanding the Android Software Stack, Android Application Architecture; the Dalvik Virtual Machine, Creating First Android Application, Types of Android Applications, Android Development Tools: The Android Virtual Device Manager, Android Emulator, The Dalvik Debug Monitor Service.

UNIT II:

Creating applications and Activities: Introduction to the application Manifest File, Using the Manifest Editor, Externalizing Resources: Creating Resources - Simple Values, Drawable, Layouts, Menus, Animations. The Android Activity Life cycle. **Building User Interfaces:** Fundamental Android UI design, Introducing Layouts: Defining Layouts, Using Layouts to Create Device Independent User Interfaces, Optimizing Layouts.

UNIT III:

Databases and Content Providers: Introduction to Android Databases, Introducing SQLite, Content Values and Cursors, working with SQLite Databases - Introducing the SQLiteOpenHelper, querying a Database, Extracting Values from a Cursor, Adding, Updating, and Removing Rows, Creating Content Providers, Using Content Providers - Introducing the Content Resolver, Querying Content Providers, Adding, Deleting, and Updating Content

UNIT IV:

Maps and Location based services: Using the location-based services, selecting a Location Provider, selecting a Location provider, finding current location; **Creating Map-Based Activities**: Introducing Map View and Map Activity, Creating a Map-Based Activity, Maps and Fragments.

UNIT V:

Telephony and SMS: Using telephony - Initiating Phone Calls, Accessing Telephony Properties and Phone State, Monitoring Changes in Phone State Using the Phone State Listener, **Introducing SMS and MMS -** Using SMS and MMS in Your Application, Sending SMS and MMS from Your Application Using Intents, Sending SMS Messages Using the SMS Manager.

Text Book:

2. Reto Meier, Professional Android 4 Application Development, First Edition, Wrox Press, Wiley Publishing, 2014.

Reference Books:

4. Pradeep Kothari, Android Application Development (with Kitkat Support), Black Book, 2014, Dreamtech Press publisher, Kogent Learning Inc., 2014
5. Erik Hellman, Android Programming: Pushing the Limits, First Edition, Wiley Publications, 2014.
6. Mike Wolfson, Android Developer Tools Essentials, O’Reilly Edition, First Edition, 2013.

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DESIGN OF ALGORITHMS LAB

Course Outcomes:

At the end of this Design of Algorithms Lab course, students will be able to:

1. Develop the programs on stacks and its applications.
2. Demonstrate the operations on Trees.
3. Code the implementation of various advanced trees.
4. Design and implementation of programs on BST and Graph Traversals.
5. Develop the programs on Hashing and Dictionaries.

List of Experiments:

Week 1:

1.Review of Stack and Queue Operations using arrays and Linked Lists

Week 2:

2. Program to convert infix to postfix notation

3. Program to evaluate postfix notations

Week 3:

4.Program to implement towers of Hanoi

5.Program to implement parenthesis checker

Week 4:

6. Program to illustrate tree traversals
   a) In order b) Preorder c) Post order

Week 5:

7. Program to illustrate insertion, deletion and searching in Binary Search Tree

Week 6:

8. Program to implement Heaps
   a) Min Heap b) Max Heap

Week 7:

9. Program to illustrate Insertion on AVL Trees

10. Program to illustrate deletion and Rotation on AVL Trees

Week 8:

11.Program to implement B-Trees.

a) Insertion b) Search c) Display

Week 9:

12. Program to illustrate Graph traversals.
   a) Breadth First Search
   b) Depth First Search

Week 10:

13. Program to implement.

a) Prim's algorithm b) Kruskal's algorithm

Week 11:

14. Program to Implement Dijkstra algorithm.

Week 12 & 13:

15. Program to implement Hashing and collision resolution techniques.

Week 14:

16. Program to implement Dictionaries.

Week 15:

Review

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

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OBJECT ORIENTED PROGRAMMING LAB

Course Outcomes:

At the end of this Object-Oriented Programming Lab course, students will be able to:

1. Implement simple Java Programs.
2. Develop the programs using interfaces and packages
3. Demonstrate the use of threads and Exception handling.
4. Design Applet programs.
5. Develop GUI applications using Swings.

List of Experiments:

Week 1:

1. Write a Java Program to define a class, define instance methods for setting and retrieving values of instance variables and instantiate its object
3. Demonstrate the use of static keyword and this keyword.

Week 2:

3. Write a program to illustrate types of constructors and constructor overloading

4. Write a Java program to demonstrate the use of String class and its methods.

Week 3:

5. Write a program to illustrate parameter passing Techniques

6. Write a java program to illustrate Recursion and nested class

Week 4:

7. Write a program to demonstrate the use of inheritance.

8. Write a java program to demonstrate the concept of polymorphism

Week 5:

9. Write a program to illustrate Files.

10. Demonstrate the use of I/O Streams.

Week 6:

11. Write a program to illustrate the use of packages.

12. Write a program to illustrate Interfaces.

Week 7:

13. Write a program to illustrate try, catch, throw, throws and finally keywords

14. Write a program to implement the concept of User defined Exceptions.

Week 8:

15. Write a program to illustrate Multithreading.

16. Write a program to illustrate thread priorities.

Week 9:

17. Write a program to illustrate Thread Synchronization.

18. Write a program to illustrate Inter Thread Communication.

Week 9:

19. Write a program to illustrate collection classes and interfaces.

20. Write a program to illustrate String Tokenizer, Date, Random and Scanner classes.

Week 10:

21.Write a program to illustrate Event Handling (keyboard, Mouse events)

Week 11:

22. Develop an applet in Java that displays a simple message.

23. Develop an applet in Java that receives an integer in one text field, and computes its factorial Value and returns it in another text field, when the button named "Compute" is clicked

Week 12:

24**.** Write a program to develop a calculator application using Swings

Week 13:

Review.

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

ANURAG UNIVERSITY

B.Tech. IT - [Minor]

L	T / P / D	C
0	3	1.5

DATABASE MANAGEMENT SYSTEMS LAB

Course Outcomes:

At the end of this Database Management Systems Lab course, students will be able to:

1. Apply different types of SQL commands to create, manipulate and access data from database.
2. Construct database by using various integrity constraints.
3. Develop basic PL/SQL programs.
4. Implement PL/SQL Programs using procedures, functions and cursors.
5. Create trigger for given problem.

List of Experiments:

Week 1:
Data Base user creation, Data definition Language commands, Data Manipulation commands, Data Control Language Commands, Transaction Control Language commands.

Week 2:
1. Database Schema for a customer-sale scenario

Customer (Cust id: integer, cust_name: string)

Item (item_id: integer,item_name: string, price: integer)

Sale (bill_no: integer, bill_data: date, cust_id: integer, item_id: integer, qty_sold: integer)

For the above schema, perform the following—

a) Create the tables with the appropriate integrity constraints

b)Insert around 10 records in each of the tables

c)List all the bills for the current date with the customer names and item numbers

d)List the total Bill details with the quantity sold, price of the item and the final amount

e)List the details of the customer who have bought a product which has a price>200

f)Give a count of how many products have been bought by each customer

g)Give a list of products bought by a customer having cust_id as 5

h)List the item details which are sold as of today i)Create a view which lists out the bill_no, bill_date, cust_id, item_id, price, qty_sold, amount

Create a view which lists the daily sales date wise for the last one week

Week 3:

2. Database Schema for a Student Library scenario

Student (Stud_no : integer,Stud_name: string)

Membership (Mem_no: integer,Stud_no: integer)

Book (book_no: integer, book_name:string, author: string)

Iss_rec(iss_no:integer, iss_date: date, Mem_no: integer, book_no: integer)

For the above schema, perform the following—

a) Create the tables with the appropriate integrity constraints

b) Insert around 10 records in each of the tables

c) List all the student names with their membership numbers

d) List all the issues for the current date with student and Book names

e) List the details of students who borrowed book whose author is CJDATE

f) Give a count of how many books have been bought by each student

g) Give a list of books taken by student with stud_no as 5

h) List the book details which are issued as of today

i) Create a view which lists out the iss_no, iss _date, stud_name, book name

j) Create a view which lists the daily issues-date wise for the last one week

Week 4:

3 Database Schema for a Employee-pay scenario

employee (emp_id : integer,emp_name: string)

Department (dept_id: integer,dept_name:string)

Paydetails (emp_id : integer,dept_id: integer, basic: integer, deductions: integer, additions: integer, DOJ: date)

Payroll (emp_id : integer, pay_date: date)

For the above schema, perform the following—

a)Create the tables with the appropriate integrity constraints b)Insert around 10 records in each of the tables

c)List the employee details department wise

d)List all the employee names who joined after particular date

e)List the details of employees whose basic salary is between 10,000 and 20,000

f)Give a count of how many employees are working in each department

g)Give a names of the employees whose netsalary>10,000

h)List the details for an employee_id=5

i)Create a view which lists out the emp_name, department, basic, deductions, netsalary

j)Create a view which lists the emp_name and his netsalary

Week 5:

4. Database Schema for a Video Library scenario

Customer (<u>cust_no: integer</u>,cust_name: string)

Membership (<u>Mem_no: integer</u>, cust_no: integer)

Cassette (<u>cass_no:integer</u>, cass_name:string, Language: String)

Iss_rec(<u>iss_no: integer</u>, iss_date: date, mem_no: integer, cass_no: integer)

For the above schema, perform the following—

a) Create the tables with the appropriate integrity constraints

b)Insert around 10 records in each of the tables

c)List all the customer names with their membership numbers

d)List all the issues for the current date with the customer names and cassette names

e)List the details of the customer who has borrowed the cassette whose title is " The Legend"

f)Give a count of how many cassettes have been borrowed by each customer

g)Give a list of books which has been taken by the student with mem_no as 5

h)List the cassettes issues for today

i)Create a view which lists outs the iss_no, iss_date, cust_name, cass_name

j)Create a view which lists issues-date wise for the last one week

Week 6:

5. Database Schema for a student-Lab scenario

Class (class_no: string,descrip: string)

Student (stud_no: integer, stud_name: string, class_no: string)

Lab (mach_no: integer, Lab_no: integer, description: String)

Allotment (Stud_no: Integer, mach_no: integer, dayof week: string)

For the above schema, perform the following—

a) Create the tables with the appropriate integrity constraints

b) Insert around 10 records in each of the tables

c) List all the machine allotments with the student names, lab and machine numbers

d) List the total number of lab allotments day wise

e) Give a count of how many machines have been allocated to the 'CSIT' class

f) Give a machine allotment etails of the stud_no 5 with his personal and class details

g) Count for how many machines have been allocatedinLab_no1 for the day of the week as "Monday"

h) How many students class wise have allocated machines in the labs

i)Create a view which lists out the stud_no, stud_name, mach_no, lab_no, dayofweek

j) Create a view which lists the machine allotment details for "Thursday".

Week 7:

6. Write a program to find largest number from the given three numbers.

7. Simple programs using loop, while and for iterative control statement.

8. Write a program to check whether the given number is Armstrong or not

9. Write a program to generate all prime numbers below 100.

Week 8:

10. Write a program to demonstrate the GOTO statement.

11. Write a program to demonstrate %type and %row type attributes

Week 9:

12. Write a program to demonstrate predefined exceptions

13. Write a program to demonstrate user defined exceptions

14. Create a cursor, which displays all employee numbers and names from the EMP table.

Week 10:

15. Create a cursor, which update the salaries of all employees who works in dept no 10.
16. Create a cursor, which displays names of employees having salary > 50000.

Week 11:

17. Create a procedure to find reverse of a given number
18. Create a procedure to update the salaries of all employees whose salary is between 25000 to 50000

Week 12:

19. Create a procedure to demonstrate IN, OUT and INOUT parameters
20. Create a function to check whether given string is palindrome or not.

Week 13:

21. Create a function to find sum of salaries of all employees working in depart number 10.
22. Create a trigger before/after update on employee table for each row/statement.

Week 14:

23. Create a trigger before/after delete on employee table for each row/statement.
24. Create a trigger before/after insert on employee table for each row/statement.

Week 15:

Review

Text Book:

1. Ivan Bayross, SQL, PL/SQLThe programming Language of Oracle, 3rd Revised Edition, Publications, 2008.

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

ANURAG UNIVERSITY

B.Tech. IT - [Minor]

L	T / P / D	C
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OPERATING SYSTEMS LAB

Course Outcomes:

At the end of this Operating Systems Lab course, students will be able to:

1. Understand system calls behavior and implement that can offer operating system services
2. Implement CPU scheduling algorithms multithreading
3. Implement the producer and consumer problem
4. Implement the dead lock avoidance using banker's algorithm
5. Implement page replacement algorithms

List of Experiments:

1. Write a program using the following system calls of UNIX operating system: fork, exec, getpid, exit, wait, close, stat, opendir, readdir
2. Write a program to implement multithreading?
3. Give the list of processes, their CPU burst times and arrival times, display or print the Gantt chart for FCFS and SJF. For each of the scheduling policy compute and print the average waiting time and average turnaround time
4. Give the list of processes, their CPU burst times and arrival times, display or print the Gantt chart for Priority and Round Rabin. For each of the scheduling policy compute and print the average waiting time and average turnaround time.
5. Implement producer consumer problem using semaphore?
6. Write a program to implement Banker's algorithm for deadlock avoidance?
7. Write a program to implement page replacement algorithms (FCFS, Optimal, LRU)

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ANURAG UNIVERSITY

B.Tech. IT - [Minor]

	L	T / P / D	C
	0	**3**	**1.5**

PYTHON PROGRAMMING LAB

Course Outcomes:

At the end of this Python Programming Lab course, students will be able to:

1. Develop programs on data types, operators and expressions
2. Apply the data structures in real time scenarios
3. Write programs on strings and functions
4. Implement programs on class and related concepts
5. Solve various exception handling programs and implement the packages

Week 1:

Installation and Environment set up of Python & Programs on Data types

Week 2:

Programs on Standard I/O, Operators and Expressions

Week 3:

Programs on Functions

Week 4:

Programs on lists and Tuples

Week 5:

Programs on Dictionaries

Week 6:

Programs on Strings and string operations

Week 7:

Programs on Regular Expressions

Week 8:

Programs on class & object, static and instance method implementation

Week 9:

Programs on Inheritance and Polymorphism

Week 10:

Programs on Stacks and Queues

Week 11:

Programs on Exception Handling, Database Connectivity, Executing queries

Week 12:

Demonstration of Numpy Package

Week 13:

Demonstration of Pandas Package

Week 14:

Demonstration of Matplotlib Package and Tkinter Package

Week 15:

Demonstration of Date and Time Packages

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ANURAG UNIVERSITY

B.Tech. IT - [Minor]	L	T / P / D	C
	0	**3**	**1.5**

WEB TECHNOLOGIES LAB

Course Outcomes:

At the end of this Web Technologies lab course, students will be able to:

6. Design static web pages and validate using java script.
7. Construct Dynamic web pages using Servlets and JSP.
8. Create Database and Manipulate data using MySQL.
9. Implement database connectivity using JDBC.
10. Develop programs using PHP.

Week 1:
Practice Basic HTML Programs.

6) Basic Tags.
7) Lists.
8) Tables.
9) Frames.
10) Forms.

Week 2:
Design the following static web pages required for online book store application.

6) Registration page
7) Login page
8) User profile page
9) Shopping page
10) Catalog page

Week 3:
Apply internal and external CSS (Cascading Style Sheets) for Online book store application (week 2).

Week 4:
Implement Alert Box, Confirm Box, Prompt Box. & Control Structures, Conditional Statements using Java Script.

Week 5:
Write JavaScript to validate the following fields of registration page[Book Store Application]

i) Username Field ii) Password Field iii) Phone Number Field iv) Email-id Field.

Week 6:
Apache Tomcat Installation Procedure**.**
Write a program to display the HELLO WORLD message using servlet.

Week 7:
Implementation of servlets communication using doGET and doPOST methods.

Week 8:
Write a program to create and retrieve cookies using servlet.

Week 9:
Write a program to display the HELLO WORLD message using JSP

Week 10:
Perform Data Definition Language (DDL) and Data Manipulation Language (DML) commands using MySql.

Week 11:
Implement Database connectivity using JDBC and perform and perform the following:
i) Table creation ii) Data Manipulation.

Week 12:
Write a program to display the HELLO WORLD message using PHP.

Week 13:
Write a program to store and retrieve Registration page details using PHP.

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

ANURAG UNIVERSITY

B.Tech. IT - [Minor]

L	T / P / D	C
0	3	1.5

CLOUD COMPUTING LAB

Course Outcomes:

At the end of this Cloud Computing Lab course, students will be able to:

1. Run their application on the instantiated VMs over different hypervisors.
2. Simulate their sample proposed system.
3. Setup a private cloud with open-source cloud tools and deploy simple cloud services.
4. Familiarize with the SaaS features.
5. Implement the PaaS oriented Applications.

Week 1: Installation of various hypervisors and instantiation of VMs with image file using open-source hypervisors such as Virtual Box, VMWare Player, Xen and KVM.

Week 2: Client server communication between two virtual machine instances, execution of chat application.

Week 3: Creation of simple network topology using open-source network virtualization tools (like mininet and others).

Week 4: Implementation of various scheduling mechanisms using open-source cloud simulator.

Week 5: Familiarization and usage of the following cloud services with open-source cloud tools (like Eucalyptus, Openstack, Open Nebula and others)

Week 6: Familiarization and usage of collaborative applications (SaaS).

Week 7: Implementing applications of PaaS

References:

https://mitmecsept.wordpress.com/cloud-computing-lab/

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester.

ANURAG UNIVERSITY

B.Tech. IT - [Minor]	L	T / P / D	C
	0	**3**	**1.5**

MOBILE APPLICATION DEVELOPMENT LAB

Course Outcomes:

At the end of this Mobile Application Development Lab course, students will be able to:

1. Develop user interfaces for the Android platform.
2. Implement various mobile applications using Emulators.
3. Create database for mobile applications using SQLite Database.
4. Perform location-based services in android applications.
5. Create telephony and SMS for android applications.

List of Experiments:

1. Develop an application that Uses GUI Components, Font and Colors
2. Develop an application that Uses Layout Managers and Event Listeners.
3. Develop a Native Calculator Application.
4. Write an application that Draws Basic Graphical Primitives on The Screen.
5. Develop an application that Makes Use of Database.
6. Develop a Native application that Uses GPS Location Information.
7. Implement an application that Writes Data to The SD Card.
8. Implement an application that Creates an Alert Upon Receiving A Message.
9. Write a Mobile application that Creates Alarm Clock

Note: The above experiments are for indicative purpose only. However, the concerned faculty member can add few more experiments in addition to the existing. In such cases the concerned faculty member should get the syllabus approval from the chairman-BoS before the start of the semester**.**

Mechanical Engineering

Minutes of BoS Meeting of Mechanical Engineering (PG)

held on 15th June, 2021

The meeting of all the members of Board of Studies - **Mechanical Engineering,** Anurag University, was held on 15.06.2021 at 11:00 A.M. in virtual mode on Google Meet.

The following members were Present/Absent for the meeting:

S. No.	Name & Details of Members	Designation	Present/ Absent
1	Dr. A.V. Sita Rama Raju Professor, Dept. of Mechanical Engineering, A.U.	Chairman	Present
2	Dr.S.Madhu Professor & Head, Dept. of Mechanical Engineering, A.U.	Head of Mech. Engg. & Member	Present
3	Dr Venkatesham B Associate Professor Dept. of Mechanical & Aerospace Engineering, Indian Institute of Technology Hyderabad.	Member - Outside Subject Expert	Present
4	Dr. Srinivasa Prakash Regalla Dean (Institute-wide), Practice School Division Professor, Department of Mechanical Engineering, BITS, Hyderabad Campus	Member - Outside Subject Expert	Present
5	Mr Krishna Prasad B S Delivery Head, Automotive OEMs Tech Mahindra, Hyderabad	Member – Industry Expert	Present
6	Mr.B.Venkatram Reddy, Senior Manager, CYIENT, Hyderabad	Member – Industry Expert	Present
7	Dr. R. Venkat Reddy Professor, Dept. of Mechanical Engineering, A.U.	Member	Present
8	Dr Ravikanth Raju Associate Professor, Dept. of Mechanical Engineering, A.U.	Member	Present
9	Dr. Sikindar Baba Associate Professor, Dept. of Mechanical Engineering, A.U.	Member	Present
10	Mr. K. Srinivasa Chalapathi Associate Professor, Dept. of Mechanical Engineering, A.U.	Member	Present
11	Mr. Manish Kumar Madal Partner Pipe Supports Company	Member – Alumni	Present

At the start of the meeting, Chairman welcomed Hon'ble members of the Board of Studies.

With the permission of the chairman, the proceedings of BoS started.

To discuss and approve M.Tech. (Digital Manufacturing) Curriculum structure and syllabi as per R21 Regulations:

1. Members have discussed the draft copy of structure & syllabi of M.Tech. (Digital Manufacturing) as per R21 regulations based on AICTE model curriculum and **approved** with the following suggestions:

    (i) The board members have advised to categorize the core and professional elective courses in a particular sequence.

    (ii) In the I Sem., under PEC-II, in the course titled “Mechanical Behavior and Characterization of Materials”, in the Unit I, the general mechanical behavior of materials is discussed. It is advised to add suitable behavioral aspects of materials related to additive manufacturing.

    (iii) In the I Sem., under PEC-II, in the course titled “Intelligent Manufacturing Systems” include more number of reference books.

    (iv) In the I Sem., under PEC-III, in the course titled “Powder Metallurgy”, it is advised to include powder metallurgy applications related to additive manufacturing.

    (v) In the I Sem., under PEC-III, in the course titled “Product Design for Manufacturing and Assembly”, the Unit – IV consisting of conventional sheet metal working is to be replaced by the content related to design for additive manufacturing.

    (vi) It is suggested to explore the CATIA for virtual prototyping.

    (vii) Board members have advised to have the content in the laboratory of second semester i.e., Digital Manufacturing Lab., as a continuation of pervious laboratory i.e., Virtual Prototyping Lab., by having the experiments in the form of execution.

    The modified syllabi as per the above suggestions is enclosed in the file in word format.

2. Internal members of BoS are authorized to make necessary minor changes as per the guidelines of Academic Council.

BoS-Chairman

ANURAG UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

M. Tech. (Digital Manufacturing) R21

I YEAR I SEMESTER

Category	Course Title	L	T	P	C
PCC-I	CAD for Additive Manufacturing	3	-	-	3
PCC-II	Additive Manufacturing Processes	3	-	-	3
PEC-I	1. Materials, Energy Sources and Bonding Mechanisms 2. Polymer Engineering 3. Geometric Dimensioning and Tolerancing	3	-	-	3
PEC-II	1. Mechanical Behavior and Characterization of Materials 2. Powder Metallurgy 3. Metrology and Computer Aided Inspection	3	-	-	3
PEC- III	1. Surface Coatings 2. Advanced Composite Technologies 3. Product Design for Manufacturing and Assembly	3	-	-	3
-	Research Methodology	2	-	-	2
Laboratory I	Virtual Prototyping Lab.	-	-	4	2
Seminar I	Seminar-I	-	-	4	2
Total		**17**	**0**	**8**	**21**

I YEAR II SEMESTER

Category	Course Title	L	T	P	C
PCC-III	CNC and Additive Manufacturing Machines and Systems	4	-	-	4
PCC-IV	Industry 4.0 and IIOT	4	-	-	4
PEC-IV	1. Rapid Tooling and Industrial Applications 2. Optimization Methods for Engineering Design 3. Intelligent Manufacturing Systems	3	-	-	3
PEC-V	1. Micro and Nano Manufacturing 2. Re-Engineering 3. Sustainable Manufacturing	3	-	-	3
OEC-I	1. Database Management System 2. Non-Destructive Testing	3	-	-	3
AUDIT COURSE	Pedagogy Studies	-	-	-	-
Laboratory II	Additive Manufacturing Lab.	-	-	4	2
Seminar II	Seminar-II	-	-	4	2
Total		**17**	**0**	**8**	**21**

II YEAR I SEMESTER

Category	Course Title	L	T	P	C
PROJ	Project work Review I	-	-	24	12

II YEAR II SEMESTER

Category	Course Title	L	T	P	C
PROJ	Project work Review II	-	-	28	14

ANURAG UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERINGI

M. Tech. I Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	CAD for Additive Manufacturing						PCC-I
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	3
	3	-	-	-			

Course Objectives: The objectives of this course are to:

1. gain knowledge of conceptual design and codes for transformation in CAD
2. perceive the students with the knowledge of curves and surfaces
3. inculcate skills of implementing concepts of design of solids and applications
4. understand data formats and data processing
5. impart knowledge on modelling of AM process

Course Outcomes: At the end of this course, students will be able to:

1. apply conceptual design and geometric transformation techniques in CAD
2. develop mathematical models to represent curves and surfaces
3. develop mathematical models for solids and identify STL file problems
4. apply repair algorithms and determine part orientation for minimum build time and part errors
5. model the AM process for optimum part quality

UNIT-I

Introduction to Conceptual Design and CAD: Introduction to Design Theories, develop a concept, implement a concept, creative methods for design, Introduction to CAD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Geometric Modelling, Transformations of Geometry, Developing algorithms/computer codes for transformations.

UNIT-II

Design of Curves: Hermite Cubic segments, Curve Trimming and Blending, Bezier segments, Bezier- subdivision, Degree elevation, Composite Bezier, B-spline, Properties of basic functions, Continuity, NURBS, Developing algorithms/computer codes for curves.

Design of Surfaces: Surface entities, surface representation, surface analysis, design of analytical and synthetic surfaces, Developing algorithms/computer codes for surfaces.

UNIT-III

Design of Solids: Solid entities, Boolean operations, B-rep of Solid Modeling, CSG approach of solid modeling, Advanced modeling methods.

CAD Data Exchange Formats and Applications: CAD Data exchange formats, Finite element analysis, 3D digitizing: Reengineering, Additive Manufacturing (AM).

UNIT-IV

AM Data Formats: Tessellated Models, STL Format, STL File Problems, STL File Manipulation and Repair Algorithms, AMF files, 3MF, XML, Meta Data, PLY, STEP for AM Application Protocols (AP).

AM Data Processing: Part Orientation and Support Structure Generation, Model Slicing and Contour Data Organization, Direct and Adaptive Slicing, Hatching Strategies and Tool Path Generation.

UNIT-V

Modelling of AM Process: Surface Roughness due to Staircase Effect, Part Build-time, Fabrication Cost, Optimal Orientation, Quantification of Building Inaccuracy and Part Stability.

Text Books:

1. Engineering Design/ George E Dieter/ McGraw Hill, 2001.
2. Product Design / Kevin N. Otto, Kristin L. Wood/ Pearson Education, 2004.
3. Mathematical Elements for Computer Graphics / David F. Rogers, J. A. Adams/ TMH, 2008.

Reference Books:

1. Geometric Modeling / Michael E. Mortenson/ Wiley, NY,1997.
2. Computer Aided Engineering Design/ Anupam Saxena, Birendra Sahay/ Springer, 2005.
3. Rapid Prototyping: Laser-based and OtherTechnologies / Patri K.Venu vinod and Weiyin Ma/ Springer, 2004.
4. Laser-Induced Materials and Processes for RapidPrototyping / L.Lu,J.Y.H.Fuh and Y.S. Wong/ Springer, 2001.
5. 3D Printing and Additive Manufacturing: Principles &Applications / Chua Chee Kai, Leong Kah Fai/ 4th Edition, World Scientific, 2015.

ANURAG UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">ADDITIVE MANUFACTURING PROCESSES</td><td>PCC-II</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. associate with additive manufacturing processes
2. explore the applications of various AM processes in various fields
3. articulate the techniques of various heat-treated AM processes
4. recognize the importance DED process and understand the behavior of AM materials
5. describe the process guidelines and post processing of AM parts

Course Outcomes: At the end of this course, students will be able to:

1. understand the AM processes and its working principle
2. contrast between Vat photopolymerization and extrusion based AM processes
3. interpret the suitable material and process for fabricating AM component
4. apply the knowledge of DED and AM materials to enhance the quality of additive AM components
5. improve the quality of the AM product in different aspects

UNIT-I

Introduction to Additive Manufacturing (AM): Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM.

UNIT-II

Vat Photopolymerization AM Processes: Stereolithography (SL), Materials, Process Modeling, SL resin curing process, SL scan patterns, Micro-stereolithography, Mask Projection Processes, Two-Photon vat photopolymerization, Process Benefits and Drawbacks, Applications of Vat Photopolymerization, Material Jetting and Binder Jetting AM Processes.

Extrusion-Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, Bio-Extrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.

UNIT-III

Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

UNIT-IV

Directed Energy Deposition AM Processes: Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes.

Materials science for AM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship.

UNIT-V

Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques.

Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

Text Books:

1. Additive Manufacturing Technologies: 3DPrinting, Rapid Prototyping, and Direct Digital Manufacturing/ Ian Gibson, David W Rosen, Brent Stucker/ 2nd Edition, Springer, 2015.
2. Rapid Prototyping: Laser-based and Other Technologies / Patri K. Venu vinod and Weiyin Ma/ Springer, 2004.
3. 3D Printing and Additive Manufacturing: Principles & Applications/ Chua Chee Kai, Leong Kah Fai/ 4th Edition, World Scientific, 2015.

Reference Books:

1. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling/ D.T. Pham, S.S. Dimov/ Springer 2001.
2. Rapid Prototyping: Principles and Applications in Manufacturing/ Rafiq Noorani/ John Wiley & Sons, 2006.
3. Additive Manufacturing Processes/ Sanjay Kumar/ Springer edition,2020.

ANURAG UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	MATERIALS, ENERGY SOURCES AND BONDING MECHANISMS						PEC-I
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	4
	4	-	-	-			

Course Objectives: The objectives of this course are to:

1. learn the materials and its properties used for AM
2. impart the knowledge of laser beam energy in AM
3. understand the use of laser beam in AM
4. gain knowledge on electron beam and its use in AM
5. know the utilization of electron beam technology, plasma and other sources of energy in AM

Course Outcomes: At the end of this course, students will be able to:

1. outline the essential properties of materials used in AM
2. investigate various forms of laser beam energy used in AM
3. explore the applications of laser beam in AM
4. investigate various forms of electron beam energy used in AM
5. application of electron beam energy, plasma and other sources of energy in AM

UNIT-I

Introduction: Energy Sources for Material Processing, and Classification of Energy Sources

Materials for AM: Atomic Structure and Bonding, Nature of Polymers, Thermoplastics and Thermosetting Polymers, Types of Polymerizations, Properties of Polymers, Degradation of Polymers, Metal and Ceramic Powders, Compaction and Sintering of Powders, Composites, Functionally Graded Materials (FGM's).

UNIT-II

Laser Beam: Introduction, Electromagnetic Radiation, Energy Levels, Interaction of Radiation and Matter; Generation of Laser beam: Spontaneous and Stimulated Emission, Population Inversion, Resonant Cavity; Properties of Laser Light: Line Width, Beam

Divergence Angle, Coherence, Radiance, Focusing Properties of Laser Radiation, and Power. Types Of Lasers, Laser Optics: Light Beam Deflectors, Q-Switches, Optical Isolators, Beam Profilers, Beam Homogenizers; Laser Beam Interaction with Various forms of Materials; other Applications.

UNIT-III

Laser Additive Manufacturing (AM): Classification, Processing Philosophy, and Metallurgical Mechanisms Classification of Laser AM Processes and Metallurgical Mechanisms, Laser Sintering (LS), Laser Melting (LM), Laser Metal Deposition (LMD), Classes of Materials for AM and Processing Mechanisms, For LM and LMD—Pure Metals Powder, For LM and LMD—Alloys Powder, For LS and LMD—Multi-Component Metals/Alloys Powder Mixture, Metal Matrix Composites (MMCs), Material/Process Considerations and Control Methods, General Physical Aspects and Design Strategies of Materials for AM, Microstructural Properties of AM-Processed Parts, Mechanical Properties and Performance Aspects of AM-Processed Parts, Structure/Property Stability of AM-Processed Parts.

UNIT-IV

Electron Beam: Introduction, Wave Properties, and Characteristics - Constructive Interference and Destructive Interference; Generation of Electron Beam: Free Electrons, Cathode, Anode, Control Electrode, Focusing Lens, Deflecting System, Beam Correction System, and Vacuum.

Parameters: Accelerating Voltage, Power Density, Beam Current, Lens Current, Focal Position, Beam Speed, Beam Deflection; Process Related Effects: Liquid and Vapour Phases, Effect of Vacuum, Solidification, and Heat Affected Zone, Internal Thermal Stresses; Electron beam Interaction with different forms of Material; other Applications.

UNIT-V

Electron Beam Technology: EBT in Additive Manufacturing- Powder Bed Fusion- Electron Beam Melting - Materials - Powder Metallurgy Requirements for EBM - Powder Manufacturing - Gas Atomization - Induction Plasma Atomization - Armstrong Process - Hydride-Dehydride - Characterization - Parameter Development - Build Setup and Process - Latest literature

Plasma Arc: Introduction, Basic Properties, Characteristics, and Types; Plasma Production; Parameters; Plasma with Various Forms of Material Interaction; Applications.

Other Sources: Ultrasonic, Hybrid, and etc.

Text Books:

1. Rapid Prototyping: Laser-based and Other Technologies / Patri K. Venuvinod and Weiyin

Ma/ Springer, 2004.
2. Laser Additive Manufacturing of High-Performance Materials/ Dongdong Gu/ Springer, 2015.
3. Lasers: Fundamentals and applications/ K. Thyagarajan, Ajoy Ghatak/ 2nd Ed., Springer, 2010.

Reference Books:

1. Industrial applications of Lasers / Ready, J.F/ Academic Press, 2nd Ed., 1997.
2. Laser Fundamentals / Willium T Selfvast/ Cambridge Univ. Press, 2008.
3. Laser Material Processing/ William M. Steen/ Springe, 1991.
4. Electron Beam welding / Schultz H/ Woodhead Publishing, 1994.
5. Principles of Plasma Discharge and Materials Processing/ Lieberman M.A. and Lichtenberg A/ J Wiley Interscience, 1994.
6. Additive Manufacturing of Metals: The Technology, Materials, Design and Production / Li Yang ·Keng Hsu · Brian Baughman Donald Godfrey ,Francisco Medina Mamballykalathil Menon Soeren Wiener/ Springer, 2017.

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">POLYMER ENGINEERING</td><td>PEC-I</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
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Course Objectives: The objectives of this course are to:

1. learn the fundamentals of polymer technology and their classifications
2. classify the polymerization kinetics and learn about polycondensation mechanism
3. understand various techniques of polymerization in making nanocomposites
4. provide detailed knowledge of polymer processing
5. know the different polymer processing techniques and their applications in additive manufacturing

Course Outcomes: At the end of this course, students will be able to:

1. infer the basic properties of polymers
2. interpret kinetics of polymerization and understand mechanism of polycondensation
3. develop techniques of polymerization and nanocomposites
4. evaluate the effect of polymer processing techniques on polymer structure
5. design of polymeric devices and polymers used for additive manufacturing

UNIT-I
Basic Concepts: Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD], various methods of determination of MWD.

UNIT-II
Kinetics and Mechanism: Polymerization Kinetics Free radical polymerization, Mechanism of Polycondensation

UNIT-III
Techniques of Polymerization and nanocomposites: Techniques of polymerization, bulk, emulsion, suspension, Polymer composites and nano-composites

UNIT-IV

Polymer Processing: Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques and the effect of these processing techniques on polymer structure

UNIT-V

Designing of polymeric devices and polymers used for Additive Manufacturing : Aspects of designing polymeric devices and polymer additives, Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc

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Text Books:

1. Principles of Polymerization/ G Odian/ Wiley Inerscience John Wiley and Sons, 4th edition, 2005.
2. Polymer Science / V.R. Gowarikar/ New Age Int., 2002.
3. Text book of Polymer Science / F.W. Billmeyer Jr/ Inter science Publisher John Wiley and Sons, 3rd edition 1999

Reference Books:

1. Fundamentals of Polymer Engineering/ Anil Kumar and Rakesh Gupta/ CRC Press, 2003.
2. Principles of Polymer Systems/ Ferdinand Rodriguez/ McGraw-Hill Inc.,US; 2nd edition, 1983.
3. Polymer Science/ V. R. Gowarikar, N.V. Vishwanathan, Jayadev Sreedhar/ NEW AGE, 2006.

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	GEOMETRIC DIMENSIONING AND TOLERANCING						PEC-I
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	3
	3	-	-	-			

Course Objectives: The objectives of this course are to:

1. understand the fundamentals of dimensioning and principles of tolerancing
2. study and use of symbols
3. impart knowledge of the datum reference frames
4. gain knowledge of various types of tolerances
5. understand profile and runout tolerances

Course Outcomes: At the end of this course, students will be able to:

1. interpret GDT symbols on a print
2. apply appropriate symbols
3. implement knowledge of the datum reference frames
4. indicate different types of tolerances
5. illustrate profile and runout tolerances

UNIT-I
Introduction:

Scope, Definitions, Fundamental Rules, Units of Measure, Types of Dimensioning, Application of Dimensions, Dimensioning Features, Location of Features

Principles of Tolerancing:

Direct Tolerancing Methods, Tolerance Expression, Interpretation of Limits, Single Limits, Tolerance Accumulation, Limits of Size, Applicability of Modifiers on Geometric Tolerance Values and Datum Feature References, Screw Methods, Gears and Splines, Boundary Conditions, Angular Surfaces, Conical Tapers, Flat Tapers, Radius, Tangent Plane, Statistical Tolerancing.

UNIT-II
Symbology:

Use of Notes to Supplement Symbols, Symbol Construction, Feature Control Frame Symbols, Feature Control Placement, Definition of Tolerance Zone, Tabulated Tolerances

UNIT-III

Datum Reference Frames:

Degrees of Freedom, Degrees of Freedom Constrained by Primary Datum Features, Regardless of Material Boundary, Constraining Degrees of Freedom of a Part, Datum Feature Simulator, Theoretical and Physical Application of Datum Feature Simulators, Datum Reference Frame, Datum Features and Controls, Specifying Datum Features in an Order of Precedence, Establishing Datums, Multiple Datum Features, Mathematically Defined Surface, Multiple Datum reference Frames, Functional Datum Features, Rotational Constraint about a Datum Axis or Point, Application of MMB, LMB and RMB to Irregular Features of Size, Datum Feature Selection Practical Applications, Simultaneous Requirements, Restrained Condition, Datum Reference Frame Identification, Customized Datum Reference Frame Construction, Application of a Customized Datum Reference Frame, Datum Targets

UNIT-IV

Form Tolerances:

Form Control, Specifying Form Tolerances, Application of Free-State Symbol

Orientation Tolerances:

Orientation Control, Orientation Symbols, Specifying Orientation Tolerances, Tangent Plane, Alternative Practice

Location Tolerances:

Positional Tolerancing, Positional Tolerancing Fundamentals – I and II, Pattern Location, Coaxial Feature Controls, Tolerancing for Symmetrical Relationships

UNIT-V

Profile Tolerances:

Profile, Tolerance Zone Boundaries, Profile Applications, Material Condition and Boundary Condition Modifiers as Composite Profile, Multiple Single-Segment Profile Tolerancing, Combined Controls

Runout Tolerances:

Runout, Runout Tolerance, types of Runout Tolerances, Applications, Specification

Text Books:

1. Geometric Dimensioning and Tolerancing / P.S. Gill/ S. K. Kataria & Sons, 2009.
2. Geometric Dimensioning and Tolerancing: Applications and Techniques for Use in Design: Manufacturing, and Inspection/ James D. Meadows/ CRC Press, 1995.
3. Simplified GD & T: Based on ASME-Y 14.5-2009/ Ashok Kumar/ 2nd Edition, Azuko Publishing 2009.

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. **Reference Books:**

1. Fundamentals of Geometric Dimensioning and Tolerancing/ Krulikowski
2. Dimensioning and Tolerance Handbook/ Drake, P. J/ McGraw-Hill, Inc., New York
3. Handbook of Geometrical Tolerancing: Design, Manufacturing and Inspection/ Henzold, G/ John Wiley & Sons, Chichester.
4. Computational Surface and Roundness Metrology / Muralikrishnan, B. and J. Raja/ Springer, USA.

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td></td><td></td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">MECHANICAL BEHAVIOR AND CHARACTERIZATION OF MATERIALS</td><td>PEC-II</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
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Course Objectives: The objectives of this course are to:

1. gain the basic knowledge of mechanical behaviour of materials
2. understand the phenomenon of creep and fatigue
3. study the different fracture mechanisms and their procedures
4. impart knowledge of analysis on the occurrence of fracture
5. understand the importance of various material characterization techniques

Course Outcomes: At the end of this course, students will be able to:

1. summarize the mechanical behavior of ductile and brittle materials
2. analyze creep and fatigue mechanisms for various materials
3. develop fracture mechanism maps and criteria
4. analyze the reasons for failure of materials due to fracture
5. choose appropriate characterization technique to evaluate the behavior of materials

UNIT-I

Introduction: A brief review of elastic and plastic deformation, dislocations and their properties. Dislocations in FCC, BCC and HCP metals, interactions with point defects and other dislocations. Tensile behavior, evaluation of strength and ductility parameters, Effect of strain rate and temperature on tensile behavior, and Protevin Le-Chatelier effect.

UNIT-II

Creep: Types and mechanisms of creep deformation, Creep under combined stresses, deformation mechanism maps, Super plasticity, environmental effects, remaining life assessment.

Fatigue: High and low cycle fatigue, process of fatigue fracture, effect of mean stress, Cyclic stress/strain response of materials, establishment of cyclic stress/ strain curve, transition fatigue life, Coffin-Manson relationship, Evaluation of parameters, characterizing resistance against high cycle and Low cycle fatigue, Creep fatigue interaction, environmental effects, thermochemical fatigue.

UNIT-III

Fracture Mechanics: Brief review of the basic concepts of linear elastic and elastic-plastic fracture mechanics, stress intensity parameter, J- integral and crack tip opening displacement as fracture criteria, standard procedures for experimental determination of these parameters.

UNIT-IV

Failure analysis: Analyzing Fractures, Micro mechanisms of brittle and ductile fracture, fracture mechanism maps, fractography, Visual Examination & Management of Applied Failure Analysis, Manage Failure Analysis.

UNIT-V

Materials characterization techniques: Optical microscopy techniques, Quantitative metallography, Scanning electron microscopy: Image formation methods in SEM. Applications.

Text Books:

1. Mechanical Metallurgy/ George E. Dieter/ McGraw Hill, 2nd Edition, 2005.
2. Introduction to Fracture Mechanics/ Hellan K/ McGraw Hill, 2002.
3. Mechanical Behavior of Materials at Elevated Temperatures/ J.E.Dorn/ McGrawHill, 2000.

Reference Books:

1. Engineering Materials I : Introduction to Properties, Applications and Design / M.F Ashby and David R H Jones.
2. Deformation and Fracture Mechanics of Engineering Materials/ Richard W. Hertzberg, Richard P. Vinci, Jason L. Hertzberg/ 5th Edition, Wiley, 2012.
3. Mechanical Properties and Deformation Behavior of Materials Having Ultra-Fine Microstructures/ M. Nastasi, Don M. Parkin, Herbert Gleiter/ Springer; Softcover reprint of the original 1st edition, 2012.

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	POWDER METALLURGY						PEC-II
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	3
	3	-	-	-			

Course Objectives: The objectives of this course are to:

1. understand different powder preparation techniques
2. learn the characterization techniques of powders
3. know the different powder compaction techniques
4. familiarize the sintering process and properties of the products
5. understand powder metallurgy techniques required for the manufacture of various components

Course Outcomes: At the end of this course, students will be able to:

1. distinguish different powder preparation techniques
2. analyze powders characterization
3. apply the different powder compaction techniques
4. evaluate the sintered products and their properties
5. apply powder metallurgy techniques to manufacture various products

UNIT-I

General Concepts: Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM

Powder Production Techniques: Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes, Performance Evaluation of different Processes, Design & Selection of Process.

UNIT-II

Characterization Techniques: Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle Friction, Compressibility, Powder Structure, Chemical Characterization

UNIT-III

Microstructure Control in Powder: Importance of Microstructure Study, Microstructures of Powder by Different techniques

Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, Isostatic Pressing, Injection Molding, Powder Extrusion, Slip Casting, Tape Casting, Analysis of Defects of Powder Compact, Laser Engineering Net Shaping (LENS), 3D Printers for Ceramics

UNIT-IV

Sintering: Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering, Sintering Variables, Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques, Defects Analysis of Sintered Components

UNIT-V

Application of Powder Metallurgy: Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc. A few case studies.

Text Books:

1. Powder Metallurgy – Science, Technology and Materials/ Anish Upadhyaya and G S Upadhyaya/ Universities Press, Hyderabad, 2011
2. Introduction to Powder Metallurgy/ J. S. Hirschhorn/ American Powder MetallurgyInstitute, Princeton, NJ, 1976.
3. Powder Metallurgy- Science, Technology andApplications/ P. C. Angelo and R. Subramanian/ PHI, New Delhi, 2008.

Reference Books:

1. Powder Metallurgy/ ASM International/ ASM Hand Book, vol. 7
2. Powder Metallurgy Technology/ Cambridge International Science Publishing, 2002.
3. Powder Metallurgy: An Advanced Technique of Processing Engineering Materials/ B K Datta/ 2nd edition, PHI, 2014

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">METROLOGY AND COMPUTER AIDED INSPECTION</td><td>PEC-II</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. study the various methods for measurement of surface roughness
2. discuss the various forms errors
3. familiarize with the working of optical measuring instruments
4. understand the principles of laser and advances in metrology
5. impart the knowledge on computer imaging systems and image analysis

Course Outcomes: At the end of this course, students will be able to:

1. differentiate between accuracy, precision, fits and tolerances and also know the techniques of surface roughness measurement
2. identify measurement errors and suggest suitable techniques to minimize them
3. analyze the methods and devices for dimensional metrology
4. assess the dimensions by computer aided inspection techniques
5. analyze the image processing techniques used in metrology

UNIT-I

INTRODUCTION: Accuracy, precision, limits fits and tolerances, types of assemblies, linearand angular measurements, design of limit gauges for different applications.

SURFACE ROUGHNESS MEASUREMENT: Definitions – Types of Surface Texture: Surface Roughness Measurement Methods- Comparison, Contact and Non-Contact type roughness measuring devices, 3D Surface Roughness Measurement, Nano Level Surface Roughness Measurement – Instruments.

UNIT-II

MEASUREMENT OF FORM ERRORS: Straightness, flatness, alignment errors-surface texture-various measuring instruments-run out and concentricity, Computational techniques in measurement of form errors.

UNIT-III

INTERFEROMETRY: Introduction, Principles of light interference – Interferometers –

Measurement and Calibration – Laser Interferometry.

UNIT-IV

COMPUTER AIDED LASER METROLOGY: Tool Makers Microscope, Coordinate Measuring Machines – Applications, Laser Micrometer, Laser Scanning gauge. Computer Aided Inspection techniques - In-process inspection, Machine Vision system-Applications, LASER micrometer, Optical - LASER interferometers-applications.

UNIT-V

IMAGE PROCESSING FOR METROLOGY: Overview, Computer imaging systems, Image Analysis, Preprocessing, Human vision system, Image model, Image enhancement, grey scale models, histogram models, Image Transforms – Examples.

Text Books:

1. A text-book of Metrology/ M. Mahajan/ DhanpatRai& Co, 2009.
2. Engineering Metrology/ K. J. Hume/ 1970, Mc Donald & Co (Publishers), London.
3. Metrology for Engineers/ J.F.W. Galyer and C.R.Shotbolt/ ELBS Edition, 5/e, 1993

Reference Books:

1. Engineering Metrology/ Thomas. G. G/ Butterworth PUB.1974.
2. Engineering Metrology/ R. K. Jain/ Khanna Publishers, 19/e, 2005.
3. Manufacturing Engineering and Technology/ Serope Kalpakjian and Steven R. Schmid/ Pearson Publication.

ANURAG UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	SURAFCE COATINGS						PEC-III
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	3
	3	-	-	-			

Course Objectives: The objectives of this course are to:

1. know the various material powders for spraying
2. impart the knowledge on various thermal spray techniques
3. understand the pre and post surface treatment processes
4. know the physics and chemistry of thermal spraying
5. identify the corrosive resistance coatings

Course Outcomes: At the end of this course, students will be able to:

1. use appropriate powders for spraying for a given application
2. evaluate optimum process parameters for different thermal spray techniques
3. apply the pre and post treatment techniques based on application
4. develop thermal coatings with knowledge of physical and chemical mechanisms
5. evaluate the coated surfaces for physical, chemical and mechanical properties

UNIT-I

Materials Used for Spraying - Methods of Powders Production - Atomization - Sintering or Fusion - Spray Drying (Agglomeration) - Cladding - Mechanical Alloying (Mechanofusion) - Self-propagating High-temperature Synthesis (SHS) - Other Methods - Methods of Powders Characterization - Grain Size - Chemical and Phase Composition - Internal and External Morphology - High-temperature Behaviour - Apparent Density and Flowability - Feeding, Transport and Injection of Powders - Powder Feeders - Transport of Powders - Injection of Powders

UNIT-II

Thermal Spraying Techniques - Introduction - Flame Spraying - Principles - Process Parameters - Coating Properties - Atmospheric Plasma Spraying (APS) - Principles - Process Parameters - Coating Properties - Arc Spraying (AS) - Principles - Process Parameters - Coating Properties - Detonation-Gun Spraying (D-GUN) - Principles - Process Parameters -

Coating Properties - High-Velocity Oxy-Fuel (HVOF) Spraying - Principles - Process Parameters - Coating Properties - Vacuum Plasma Spraying (VPS) - Principles - Process Parameters - Coating Properties - Controlled-Atmosphere Plasma Spraying (CAPS) - Principles -Process Parameters - Coating Properties - Cold-Gas Spraying Method (CGSM) - Principles - Process Parameters - Coating Properties - New Developments in Thermal Spray Techniques

UNIT-III

Pre-Spray Treatment - Introduction-Surface Cleaning - Substrate Shaping - Surface Activation – Masking

Post-Spray Treatment - Heat Treatment - Electromagnetic Treatment - Furnace Treatment - Hot Isostatic Pressing (HIP) - Combustion Flame Re-melting - Impregnation - Inorganic Sealants - Organic Sealants - Finishing - Grinding - Polishing and Lapping

UNIT-IV

Physics and Chemistry of Thermal Spraying - Jets and Flames - Properties of Jets and Flames - Momentum Transfer between Jets or Flames and Sprayed Particles - Theoretical Description - Experimental Determination of Sprayed Particles' Velocities - Examples of Experimental Determination of Particles Velocities - Heat Transfer between Jets or Flames and Sprayed Particles - Theoretical Description - Methods of Particles' Temperature Measurements - Chemical Modification at Flight of Sprayed Particles - Coating Build-Up - Impact of Particles - Particle Deformation - Particle Temperature at Impact - Nucleation, Solidification and Crystal Growth - Mechanisms of Adhesion - Coating Growth - Mechanism of Coating Growth

UNIT-V

Corrosion resistive Coatings - Organic, metallic, and high-temperature coatings for corrosion resistance

Methods of Coatings Characterization - Methods of Microstructure Characterization - Methods of Chemical Analysis - Crystallographic Analyses - Microstructure Analyses - Other Applied Methods - Mechanical Properties of Coatings - Adhesion Determination - Hardness and Microhardness - Elastic Moduli, Strength and Ductility - Properties Related to Mechanics of Coating Fracture - Friction and Wear - Residual Stresses

Text Books:

1. The Science and Engineering of Thermal Spray Coatings/ Lech Pawlowski/ Wiley, 2008.
2. Thermal Barrier Coatings/ Huibin Xu, Hongbo Guo/ Wood Head Publishing, 2011.
3. Paintings and Coatings: Applications and Corrosion Resistance/ Schweitzer P.A./ CRCPress, 2005.

Reference Books:

1. Science & Technology of surface coatings / Chapman and Anderson
2. Materials, finishing & coating/ Charles Wick and Raymond / TME Handbook Vol.3
3. Metal Pretreatment for Corrosion Control/ N.D. Banik.
4. Protective coatings for Metals/ Burns and Bradley
5. Engineering Coatings/ Grainger

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	ADVANCED COMPOSITE TECHNOLOGIES						PEC-III
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	3
	3	-	-	-			

Course Objectives: The objectives of this course are to:

1. gain knowledge on various types of composites and reinforcements
2. impart knowledge of metal matrix composites and their properties
3. understand the processing of polymer matrix composites
4. know about ceramic matrix composites processing
5. learn about the nano composites and their testing methods

Course Outcomes: At the end of this course, students will be able to:

1. compare and contrast between various composite materials and their reinforcements
2. select appropriate constituent materials to develop metal matrix composites
3. choose appropriate constituent materials to develop polymer matrix composites
4. make use of appropriate constituent materials to develop polymer matrix composites
5. summarize various nano composites and testing methods

UNIT-I

Introduction:

Overview of the course, history and basic concept of composites, Types and constituents, reinforcement and matrices, interface and mechanism of strengthening.

Fundamental concepts:

Definition and Classification of Composites, particulate and dispersion hardened composites,continuous and discontinuous fibre reinforced composites MMC, PMC, CMC.

UNIT-II

Metal Matrix Composites Processing: Liquid state processes, solid state processes and in situ processes.

Interface: Role, reactions, bonding mechanisms and bond strength.

Properties and applications: Strength, stiffness, creep, fatigue and fracture; thermal, damping and tribological properties.

UNIT-III

Polymer Matrix Composites Processing: Hand layup and spray technique, filament winding, pultrusion, resin transfer molding, bag and injection molding, sheet molding compound.

Matrix resins-thermoplastics and thermosetting matrix resins.
Reinforcing fibers- Natural fibers (cellulose, jute, coir etc.), carbon fiber, glass fiber, Kevlar fiber, etc.
Particulate fillers-importance of particle shape and size.
Coupling agents-surface treatment of fillers and fibers, significance of interface in composites. short and continuous fibre reinforced composites, critical fibre length, and anisotropic behavior.

UNIT-IV
Ceramic Matrix Composites Processing: Cold pressing & sintering, hot pressing reaction bonding processes, infiltration, in-situ chemical reaction, Sol-Gel and polymer pyrolysis, self-propagating high temperature synthesis. Carbon- carbon composites, Interfaces.
Rule of mixtures. Stress, strain transformations.

UNIT-V

Nanocomposites: introduction to Nanocomposites, advantages disadvantages

Test methods: Quality assessment, physical and mechanical property characterization.

Text Books:

1. Composite Materials Science and Engineering/ Chawla/ Springer.
2. An introduction to composite materials/ Hull/ Cambridge.
3. Steven L. Donaldson/ ASM Handbook Composites Volume 21, 2001.

Reference Books:

1. Composite Materials, Science and Engineering/ Krishan K. Chawla/ Springer, 2001.
2. Process Modelling in Composites Manufacturing/ Suresh G. Advani, E. Murat Sozer/ 2nd Ed. CRC Press, 2009.
3. Advanced Composite Materials/ Ashutosh Tiwari, Mohammad Rabia Alenezi, Seong Chan Jun/ Wiley, 2016.

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. I Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	PRODUCT DESIGN FOR MANUFACTURING AND ASSEMBLY						PEC-III
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	3
	3	-	-	-			

Course Objectives: The objectives of this course are to:

1. understand various fundamentals of assembly and design recommendations for product development
2. know the fundamental principles of design for high-speed automatic assembly
3. learn the design aspects of machining and injection molding processes
4. impart the knowledge on AM design
5. gain knowledge of the automated assembly systems

Course Outcomes: At the end of this course, students will be able to:

1. summarize the quality aspects of design for manufacture and assembly
2. apply high speed automation rules for product design and assembly
3. adapt the concept of DFM for machining processes
4. implement the design rules for AM
5. develop the DFMA methods for assembly automation

UNIT-I

Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design? Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

UNIT-II

High speed Automatic Assembly & Robot Assembly: Design of Parts for High-Speed Feeding and Orienting, Additional Feeding Difficulties, High-Speed Automatic Insertion, General Rules for Product Design for Automation, Design of Parts for Feeding and Orienting, Product Design for Robot Assembly.

UNIT-III

Design for Machining and Injection Molding: Machining Using Single-Point & Multi point cutting tools, Choice of Work Material, Shape of Work Material, Machining Basic Component Shapes, Cost Estimating for Machined Components, Injection Molding Materials, The Molding Cycle, Injection Molding Systems, Molding Machine Size, Molding Cycle Time, Estimation of the Optimum Number of Cavities, Design Guidelines.

UNIT-IV

Design for AM: AM technology selection, build strategies, AM unique capabilities, exploring design freedoms, Design tools for AM Minimum feature size, Surface finish, Elimination of support structures, hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Guidelines for internal geometry like flow paths, cooling channels, cavities and others, Guidelines for making lightweight objects

UNIT-V

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated *as*sembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

Text Books:

1. Product design for manufacturing and assembly/ Geoffrey Boothroyd and loan Marinescu
2. Assembly Automation and Product Design / Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 3rd Edition,2010.
3. Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.

Reference Books:

1. Computer Aided Assembly/ A. Delbrainbre
2. Design and Manufacturing/ Surender Kumar & Goutham Sutradar /Oxford & IBH publishing Co. Pvt. Ltd. New Delhi, 1998
3. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing/ Gibson, Rosen, Stucker/ Springer, 2009.

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I M. Tech. I Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	RESEARCH METHODOLOGY						-
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
None	L	T	D	P	40	60	2
	2	-	-	-			

Course Objectives: The objectives of this course are to:

6. understand the research problem
7. know the process of literature survey, plagiarism check and ethical means of doing research
8. get the knowledge about technical report writing
9. impart awareness about the intellectual property rights
10. know about licensing and transfer of technology

Course Outcomes: At the end of this course, students will be able to**:**

1. formulate the research problem
2. analyze research related information by following research ethics
3. convert a technical paper into a research proposal by incorporating new ideas or concepts
4. apply intellectual property rights
5. get licensing and transfer technology for innovative ideas

UNIT I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II:

Effective literature studies approaches, analysis Plagiarism, Research ethics

UNIT III:

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT IV:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

UNIT V:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Text Books:

5. Research methodology: an introduction for science & engineering students/ Stuart Melville and Wayne Goddard
6. Research Methodology: A Step by Step Guide for beginners/ Ranjit Kumar, 2nd Edition,

Reference Books:

13. Resisting Intellectual Property/ Halbert/ Taylor & Francis Ltd, 2007
14. Industrial Design/ Mayall/ McGraw Hill, 1992
15. Product Design/ Niebel/ McGraw Hill, 1974
16. Introduction to Design/ Asimov/ Prentice Hall, 1962
17. Intellectual Property in New Technological Age/ Robert P. Merges, Peter S. Menell, Mark A. Lemley/ 2016

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<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">VIRTUAL PROTOTYPING LAB.</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">50</td><td rowspan="2">50</td><td rowspan="2">2</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>3</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. impart the knowledge of drafting 2D and 3D models
2. use open-source code for various analytical and synthetic curves
3. draft solid models associated with all the necessary dimensions, tolerances and annotations
4. make use of CAD Data Exchange formats
5. perform different Simulations on virtual prototyping softwares

Course Outcomes: At the end of this course, students will be able to:

1. model geometries of complex parts in sketcher model
2. develop open-source codes for analytical and synthetic curves
3. create complex engineering assemblies using appropriate assembly constraints.
4. identify and correct the problems in STL files during modeling
5. estimate build-time and material consumption for a given model

(A minimum of 10 experiments is to be conducted)

LIST OF EXPERIMENTS:

1. Introduction to Solid Modeling Packages
2. Working with sketch mode of Solid Modeling Package
3. Working with creating features (Extrude & Revolve)
4. Develop open-source code for various analytical and synthetic curves
5. Working with various editing tools in Solid Modelling
6. Working with advanced modeling tools (Sweep, Blend & Swept Blend)
7. Assembly modeling using appropriate assembly constrains
8. Working with CAD Data Exchange formats: IGES, ACIS, DXF STL, AMF
9. Identification of STL file problems using MAGICS Software

10. Application of repair algorithms to make the model error-free using MAGICS Software
11. Part orientation, support and Tool path generation in CURA Software.
12. Build-time calculation, amount of model and support material consumption usingCURA Software.
13. Converting CT/MRI scan data into STL file using MIMICS software (Demo)

Text Books: Lab Instruction Manual.

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<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="5">CNC AND ADDITIVE MANUFACTURING MACHINES AND SYSTEMS</td><td>PEC-I</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. understand NC, CNC and DNC systems
2. learn about drive systems and their salient features
3. know the concept of manual and APT part programs
4. study the Adaptive Control Systems and latest developments in CNC systems
5. gain knowledge about the construction and development of AM machine elements

Course Outcomes: At the end of this course, students will be able to:

1. classify and distinguish NC, CNC and DNC systems
2. distinguish between various drive systems and their salient features
3. develop manual and APT part programs for complex profiles
4. apply adaptive control Systems and latest developments in CNC systems
5. understand the construction and to develop AM machine elements

UNIT-I
CNC Systems: Introduction to NC/CNC/DNC machine tools, Classification of NC /CNC machine tools, Advantage, disadvantages of NC/CNC machine tools, Application of NC/CNC.
Design of CNC Machine: Constructional features of CNC machine tools, CNC tooling and fixturing system, Designation of axis in CNC systems.

UNIT-II
System Drives and Devices: Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features, Control aspects: Interpolators & Controllers.

UNIT-III
Part Programming: CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc.), Special part programming, Advanced part programming, Computer aided part programming (APT).

UNIT-IV
Adaptive control systems: Introduction, Adaptive control with optimizations (ACO), Adaptive control with constraints (ACC) and their features

Modern developments: Machining Centre, Turing Centre, Communication networking, Virtual NC systems and concept of CIM

UNIT-V

Construction of Basic AM Machines: Construction of AM Machine - Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors, Environmental controller for temperature, oxygen level, humidity etc.

Text Books:

1. Yoram Koren, *Computer Control of Manufacturing Systems*, McGraw Hill International, Singapore, 2006.
2. John Stenerson and Kelly Curran, *Computer Numerical Control: Operation and Programming*, PHI, New Delhi, 2009.
3. B S Pabla and M Adithan, CNC Machines, New Age International publishers, New Delhi, 2005

Reference Books:

1. TC Chang, RA Wysk and HP Wang, *Computer Aided Manufacturing*, PHI, New Delhi, 2009.
2. James V. Valentino and Joseph Goldenberg, *Introduction to Computer Numerical Control*, 5th Edition, Prentice Hall, Englewood Cliff, New Jersey, 2012.
3. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
4. Amit Bandyopadhyay, Susmita Bose, Additive Manufacturing, 2nd Edition, CRC Press, 2019

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Course Code	Course Title						PCC/PEC/OEC
	INDUSTRY 4.0 and IIoT						OEC
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives: The objectives of this course are to:

1. understand how the Industry 4.0 is influencing the present manufacturing scenario
2. know about the overview of IIoT
3. learn to interface the various elements of IIoT
4. impart the knowledge of developing IIoT application modules
5. study the various case studies of IIoT applications

Course Outcomes: At the end of this course, students will be able to:

1. explore how Industry 4.0 will change the current manufacturing technologies and processes by digitizing the value chain
2. discuss the overview of IoT in the context of industrial applications.
3. interface the hardware and software components related IIoT
4. develop IIoT application modules to suit the various industrial needs
5. disucss the case studies of IIoT

I M. Tech. II Semester (Digital Manufacturing)

UNIT-I

Introduction to Industry 4.0

Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis

UNIT-II

Introduction to IIoT

Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.

UNIT-III

Elements of IIoT

Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

UNIT-IV

IIoT Application Development

Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

UNIT-V

Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

Text Books:

1. Vijay Madisetti, Arshdeep Bahga, *Ïnternet of Things, "A Hands on Approach*", University Press.
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "*Introduction to Internet of Things: A practical Approach",* ETI Labs.
3. Pethuru Raj and Anupama C. Raman, "*The Internet of Things: Enabling Technologies, Platforms, and Use Cases*", CRC Press.

Reference Books:

1. Adrian McEwen, "*Designing the Internet of Things"*, Wiley.
2. Raj Kamal, "*Internet of Things: Architecture and Design*", McGraw Hill.
3. Cuno Pfister, *"Getting Started with the Internet of Things"*, O Reilly Media.

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I M. Tech. II Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	RAPID TOOLING AND INDUSTRIAL APPLICATIONS						PEC-IV
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	4
	4	-	-	-			

Course Objectives: The objectives of this course are to:

1. know the working principle and process parameters of rapid tooling methods
2. understand Rapid tooling process modeling
3. familiarize with the soft tooling and firm tooling methods
4. impart knowledge of the hard tooling methods
5. learn the different Rapid Tooling applications in medical and automobile domains

Course Outcomes: At the end of this course, students will be able to:

1. outline the working principle and process parameters of rapid tooling methods
2. develop Rapid tooling process modeling for different manufacturing methods
3. apply the suitable soft tooling and firm tooling methods for the given application
4. evaluate the suitable hard tooling method for different industrial applications
5. enumerate the Rapid Tooling applications for medical and automobile applications

UNIT-I

Introduction: Conventional Tooling, Rapid Tooling, Differences between Conventional and Rapid Tooling, Classification of Rapid Tooling: Direct and Indirect Tooling methods; Soft, Bridge (firm) and Hard Tooling methods.

Indirect Methods for Rapid Tool Production and Rapid Bridge Tooling: Introduction to Bridge tooling, CAFÉ Bridge tooling, Direct AIM Rapid Bridge tooling, Rapid Tool Rapid Bridge tooling, Shrinkage Variation, Random-noise Shrinkage.

UNIT-II

Rapid Tooling Process Modeling: Introduction to modeling, Concurrent Rapid Product and Process Development, Finite Element Modeling and Simulation, Injection-moulding, Die-casting, Blow-moulding, Thermo-forming Processes modeling.

The Express Tool Process: Introduction, High-Thermal-Conductivity Materials, Conformal Cooling Channels, The Express Tool Process, Finite-Element Analysis of Express Tools, Express Tool Process Characteristics, Case studies of Express Tools.

UNIT-III

Direct Soft Tooling/Firm Tooling Methods: Role of direct soft tooling methods in tool production, SLS of Sand Casting & Copper PA Moulds, EOS Direct Croning^{TM} Process, Direct AIM (Direct ACES TM Injection Moulds), SL Composite Tooling, 3DP^{TM} Ceramic Shells, Topographic Shape Formation (TSF) tools.

Indirect Soft Tooling/Firm Tooling Methods: Role of indirect soft tooling methods in tool production, Metal Deposition Tools, Silicon rubber mould/RTV/Vacuum Casting, Epoxy tools, Spin casting with Vulcanized Rubber moulds, Castable Resin moulds, Castable Ceramic moulds, Plaster moulds, Casting (Investment/Die/Spin/Sand Castings).

UNIT-IV

Direct Hard Tooling Methods: Role of Direct Hard tooling methods in tool production, EOS DirectTool/ Direct Metal Laser Sintering, DTM RapidTool, LOM Tooling in Ceramic, ProMetal Rapid Tooling, Laser Engineered Net Shaping (LENS).

Indirect Hard Tooling Methods: Role of indirect hard tooling methods in tool production, Fusible metallic cores, 3D Keltool, Cast Aluminum and Zinc Kirksite Tooling, EDM Electrodes, Ecotool**.**

UNIT-V

Rapid Tooling in the Medical Device Industry: Introduction, Investment Casting and Conventional Wax Pattern Tooling, Conventional Tooling Manufacture Vs. Rapid Tooling Manufacture, Medical Case studies like Hip Stem and Knee implants.

Rapid Tooling in the Automotive Industry: Approaching Niche Vehicle Markets, Accelerating Product Developments, Utilizing Rapid Prototyping and Manufacturing, Machining Laminates, Rapid Prototype Stages, Subsequent Casting Operations, Rapid Tooling Developments (Case Studies.)

Text Books:

1. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping & Rapid Tooling/ D.T. Pham and S.S Dimov/ Springer, 2001.
2. Rapid Tooling Technologies and Industrial Applications/ Peter Hilton and Paul F Jacobs/ Marcel Dekker Inc, New York, 2001.
3. A Text book of Rapid Prototyping/ Ramesh S/ Ane Books Pvt Ltd, New Delhi, 2015

Reference Books:

1. Understanding Additive Manufacture: Rapid Prototyping, RapidTooling and Rapid Manufacture/ Andreas Gebhardt/ Hanser Publishers, 2013.
2. Rapid Prototyping: Principles & Applications/ Chua Chee Kai and Leong Kah Fai/ World Scientific, 2003.
3. Rapid Tooling Guidelines for SandCasting/ Wanlong Wang, Henry W. Stoll and James G. Conley/ Springer, 2010.
4. Rapid Prototyping/ M Adithan/ Atlantic Publishers and distributors (P) ltd, New Delhi, 2016

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I M. Tech. II Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	OPTIMIZATION METHODS FOR ENGINEERING DESIGN						PEC-IV
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	3
	3	-	-	-			

Course Objectives: The objectives of this course are to:

1. provide fundamental knowledge of optimization techniques
2. acquire knowledge on linear, integer, and geometric programming
3. understand the significance of one-dimensional minimization methods
4. learn about the unconstrained optimization techniques
5. know the constrained optimization techniques

Course Outcomes: At the end of this course, students will be able to:

1. classify the optimization problems and techniques
2. describe different methods of optimization
3. apply dynamic programming and one-dimensional minimization methods to practical problems
4. analyze the various unconstrained optimization techniques
5. implement the various constrained optimization techniques

UNIT-I

Introduction: Statement of an Optimization Problem and Classification of Optimization Problems.
Optimization Techniques: Single-Variable Optimization, Multivariable Optimization without any Constraints, with Equality and Inequality Constraints.

UNIT-II

Linear Programming: Simplex Methods, Sensitivity Analysis, Transportation Problem.

Integer Programming: Graphical Representation, Integer Polynomial Programming.

Geometric Programming: Formulation and Solutions of Unconstrained and Constrained geometric programming problem.

UNIT-III

Dynamic Programming: Multistage Decision Processes.

One-Dimensional Minimization Methods: Elimination methods: Fibonacci Method, Golden Section Method, Interpolation methods: Quadratic Interpolation Method, Cubic Interpolation Method.

UNIT-IV

Unconstrained Optimization Techniques: Univariate, Conjugate Gradient Method and Variable Metric Method.

UNIT-V

Constrained Optimization Techniques: Characteristics of a constrained problem; Direct Method of feasible directions; Indirect Method of interior and exterior penalty functions.

Text Books:

1. Optimization Theory and Applications/ Rao, S. S/ Wiley Eastern Ltd., 2^{nd} Edition, 2004.
2. Optimization Methods for Engineering Design/ Fox, R. L/ Addison Wesley, 2001.
3. Optimization for Engineering Design/ K Deb.

Reference Books:

1. Optimization concepts and applications in engineering/ A. D. Belegundu and T. R. Chandrupatla.
2. Linear and Nonlinear programming/ S. Nash and A.sofer.
3. Introduction to Optimum Design/ J. S. Arora/ MCGraw-Hill, 1989
4. Engineering Optimization-Methods and Applications/ G. V. Reklaitis, A. Ravindran and K. M. Ragsdell/ Wiley, 1983

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<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">INTELLIGENT MANUFACTURING SYSTEMS</td><td>PEC-IV</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
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Course Objectives: The objectives of this course are to:

1. gain knowledge of CIM systems
2. know the basics of knowledge based systems
3. provide sufficient knowledge on machine learning
4. study about automated process planning
5. understand group technology and related algorithms

Course Outcomes: At the end of this course, students will be able to:

1. discuss the structure and functional areas of various CIM systems
2. interface the components of knowledge based systems
3. discuss the concept of machine learning and applications in manufacturing
4. practice automated process planning
5. apply group technology algorithms

UNIT-I

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems — MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

UNIT II

Components of Knowledge Based Systems — Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition

UNIT III

Machine Learning -- Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

UNIT IV

Automated Process Planning — Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) — Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KRSES.

UNIT V

Group Technology: Models and Algorithms - Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation — Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

Text Books:

1. Intelligent Manufacturing Systems/ Andre Kusaic
2. Artificial Neural Networks/ Yagna Narayana
3. Automation, Production Systems and CIM/ Groover M.P.

Reference Books:

1. Design and Neural Networks/ Hamid R. Parsaei and Mohammad Jamshidi/Wassarman.
2. Implementation of Intelligent Manufacturing Systems/ PHI, 2009
3. Expert Systems Applications in Engineering and Manufacturing/ A. B. Badiru/ PrenticeHall, New Jersey, 1992.
4. Artificial Intelligence in Manufacturing Research/ J. Paulo Davim (Editor)/ Nova Science Publisher, New York, 2010.

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I M. Tech. II Semester (Digital Manufacturing)

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">MICRO AND NANO MANUFACTURING</td><td>PEC-V</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
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Course Objectives: The objectives of this course are to:

1. understand the basics of nano technology
2. identify the techniques used in synthesis and processing of nano materials
3. describe the various characterization techniques
4. recognize the importance micro fabrication techniques and its operations
5. know about nano fabrication and importance of MEMS devices

Course Outcomes: At the end of this course, students will be able to:

1. infer the significance of nano technology and its basics
2. apply the various techniques for synthesis and processing of nano-materials
3. articulate methods for characterizing micro and nano-manufactured components
4. choose the suitable micro manufacturing methods
5. implement nano fabrication techniques and choose appropriate MEMS equipment’s for a viable precise product

UNIT-I

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology, Scaling Laws/Sizing effects, Nano materials-safety precautions.

UNIT-II

Nano-materials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nano-materials- sol-gel process, Liquid solid reactions; Gas Phase synthesis of nano-materials-Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation(CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing(GPC).

UNIT-III

Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

UNIT-IV

Micro fabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining

UNIT-V

Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.
MEMS devices and applications: Pressure sensor, Inertial sensor, Optical MEMS and RF-MEMS, Micro-actuators for dual-stage servo systems.

Text Books:

1. Fundamentals of Microfabrication: The Science of Miniaturization/ Marc Madou/ SecondEdition CRC Press, 2002.
2. Microfabrication and Nanomanufacturing/ Mark James Jackson/ CRC Press, 2005.
3. Introduction toNanoscience and Nanotechnology/ Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore/ CRC Press, 2009.

Reference Books:

1. Physical Principles of Electron Microscopy: An Introduction to TEM,SEM, and AEM / Ray F. Egerton/ Springer, 2005.
2. Thermal Analysis of Materials/ Robert F Speyer/ Marcel Dekker Inc , New York, 1994.
3. Elements of X-Ray Diffraction/ B.D. Cullity / 3rd edition, Prentice Hall , 2002.
4. MEMS and Microsystems: Design and Manufacture/ Tai-Ran Hsu/ McGraw- Hill,2008.

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<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">RE-ENGINEERING</td><td>PEC-V</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. understand the Re- Engineering and its importance
2. impart knowledge of Re- Engineering methodologies techniques
3. study the suitability of Re-Engineering systems
4. relate the Re-Engineering and additive manufacturing models
5. understand the concepts of Re-Engineering in Automotive, Aerospace, Medical industry

Course Outcomes: At the end of this course, students will be able to:

1. illustrate the steps involved in re-engineering of a given component
2. apply the methodologies and techniques for reengineering of hardware and software products
3. select an appropriate re-engineering system according to its suitability
4. integrate between Re-Engineering and Additive Manufacturing
5. apply Re-Engineering models in Automotive, Aerospace, Medical sectors

I M. Tech. II Semester (Digital Manufacturing)

UNIT-I

Introduction: Reverse engineering, Re-Engineering–The Generic Process

Geometric Modelling using Point Cloud Data: Point Cloud acquisition, Surface Modelling from a point clouds, Meshed or Faceted Models, Planar Contour Models, Points to Contour Models, Surface Models, Segmentation and Surface Fitting for Prismatic objects and Free Form Shapes.

UNIT-II

Methodologies and Techniques for Re-Engineering: The Potential for Automation with 3-D Laser Scanners, What Is Not Re-Engineering, What is Computer-aided (Forward)

Engineering, What Is Computer-aided Reverse Engineering, Computer Vision and Re-Engineering

Re-Engineering–Hardware and Software: Contact Methods Noncontact Methods, Destructive Method.

UNIT-III

Selecting a Re-Engineering System: The Selection Process, Some Additional Complexities, Point Capture Devices, Triangulation Approaches, "Time-of-flight" or Ranging Systems, Structured-light and Stereoscopic Imaging Systems, issues with Light-based Approaches, Tracking Systems, Internal Measurement Systems, X-ray Tomography, Destructive Systems, Some Comments on Accuracy, Positioning the Probe, Post processing the Captured Data, Handling Data Points, Curve and Surface Creation, Inspection Applications, Manufacturing Approaches.

UNIT-IV

Integration Between Re-Engineering and Additive Manufacturing: Modeling Cloud Data in Re-Engineering, Data Processing for Rapid Prototyping, Integration of RE and RP for Layer-based Model Generation, Adaptive Slicing Approach for Cloud Data Modeling, Planar Polygon Curve Construction for a Layer, Determination of Adaptive Layer Thickness.

UNIT-V

Re-Engineering in Automotive, Aerospace, Medical sectors: Legal Aspects of Re-Engineering: Copyright Law, Re-Engineering, Recent Case Law, Barriers to Adopting Re-Engineering. A discussion on a few benchmark case studies.

Text Books:

1. Product Design: Techniques in Reverse Engineering and New Product Development/ K. Otto and K. Wood/ Prentice Hall, 2001.
2. Reverse Engineering: An Industrial Perspective/ Raja and Fernandes/ Springer-Verlag 2008.
3. Computer Aided Engineering Design/ Anupam Saxena, Birendra Sahay/ Springer, 2005.

Reference Books:

1. Engineering Design and Rapid Prototyping/ Ali K. Kamrani and Emad Abouel Nasr/ Springer, 2010.
2. RE as necessary phase by rapid product development / Sokovic and Kopac/ Journal of Materials Processing Technology 2005
3. Reversing: Secrets of Reverse Engineering / Eldad Eila/ Wiley (April 15, 2005)

ANURAG UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. II Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	SUSTAINABLE MANUFACTURING						PEC-V
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	4
	4	-	-	-			

Course Objectives: The objectives of this course are to:

1. understand the basic concepts of sustainability in manufacturing
2. compare and Contrast between 3R and 6R sustainable principles and methods
3. articulate the various sustainable manufacturing tools
4. recognize the need for analyzing life cycle in sustainable manufacturing process
5. be aware of the green manufacturing and green supply techniques

Course Outcomes: At the end of this course, students will be able to:

1. explain the concept of sustainable manufacturing related to current technologies
2. apply the different sustainable methods in real time
3. categorize the sustainable manufacturing tools for green manufacturing
4. perform carbon footprint analysis and life cycle assessment (LCA) specific to manufacturing systems and processes
5. develop green manufacturing process, lean manufacturing and green supply chain techniques

UNIT-I

Introduction: Concept of sustainability, manufacturing, operations, processes, practices, Resources in manufacturing, five M's, system approach to manufacturing, Basic experimental design, factor identification, quantification, comparison, Motivations and Barriers to Green Manufacturing, Environmental Impact of Manufacturing, Strategies for Green Manufacturing. Metrics for Green Manufacturing, Metrics Development Methodologies.

UNIT-II

Management of waste & pollution: Types, sources and nature of wastes, waste processing, green processing & engineering operations, Energy recovery, and 3 R & 6 R principle. Types of pollution and management: -Anti pollution approaches & guide lines.

Environment friendly materials : Materials for sustainability , eco-friendly and new age energy efficient and smart materials, alternative manufacturing practices , materials and selection of manufacturing processes, control on use of renewable materials , Bio-degradable materials recycling of materials

UNIT-III

Sustainable Manufacturing Tools : Principles of green manufacturing and its efficiency, Green manufacturing and sustainability, System model architecture and module, Design and planning, control or tools for green manufacturing (Qualitative Analysis), Consumption Analysis, Life Cycle Analysis, Efficiency, Sustainability tools). Standards for green manufacturing (ISO 14000 and OHSAS 18000), Waste stream mapping and application, Design for environment and for sustainability – Discuss the Product Life Cycle of manufactured goods.

UNIT-IV

Life Cycle Analysis: Remanufacture and disposal , tools for LCA, Optimization for achieving sustainability in unit manufacturing, Green manufacturing Lean models, value analysis, carbon footprint, analysis for carbon footprint Green manufacturing: sustainability framework Green manufacturing techniques: factors effecting sustainability.

UNIT-V

Green manufacturing techniques: Dry and near-dry machining, edible oil based cutting fluids Green manufacturing techniques: cryogenic machining for eco-efficiency Green manufacturing, Lean manufacturing, Lean techniques for green manufacturing Waste assessment and strategies for waste reduction in green manufacturing.

Green Supply Chain: Carbon footprints in transportation Green Supply chain: techniques and implementation Green Supply chain, Logistics management Green Supply Chain as Product Life Cycle Management, Case Studies : Green packaging and supply chain, implementation of lean manufacturing at industries

Text Books:

1. Design of Experiments/ Montgomery Douglas/ John Wiley and Sons, Inc. 2017.
2. Green manufacturing: fundamentals and applications/ Dornfeld, D.A. ed/ Springer Science & Business Media, 2012.
3. Materials and the environment: eco-informed material choice/ Ashby, M. F/ Elsevier, 2012.

Reference Books:

1. Sustainability in the process industry/ Klemes, J/ McGraw-Hill. 2011.
2. Green Management/ M.Karpagam, Geetha Jaikumar/ Ane Books Pvt.Ltd. 2010.
3. Design for Environment: A guide to sustainable ProductDevelopment Sustainable Development/ M.K. Ghosh Roy/ Ane Books Pvt.Ltd, 2009.
4. Handbook of Sustainable Manufacturing/ G. Atkinson, S. Dietz, E. Neumayer/ Edward Elgar Publishing Limited, 2007.

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. II Semester (Digital Manufacturing)

<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="5">DATABASE MANAGEMENT SYSTEM</td><td>OEC</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2">Any programming language.</td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. provide a sound introduction to Database management systems, Databases and its applications
2. familiarize the participant to give a good formal foundation on the relational model of data
3. present SQL and procedural interfaces to SQL comprehensively
4. give an introduction to systematic database design approaches conceptual design, logical design, schema refinement and physical design
5. introduce the concepts of transactions and transaction are processing and the issues and techniques relating to concurrency and recovery manager

Course Outcomes: At the end of this course, students will be able to

1. design Entity-Relationship Model for enterprise level databases
2. develop the database and provide restricted access to different users of database and formulate the Complex SQL queries.
3. analyze various Relational Formal Query Languages and various Normal forms to carry out Schema refinement
4. use suitable Indices and Hashing mechanisms for real time implementation
5. analyze various concurrency control protocols and working principles of recovery algorithms

UNIT-I: Database System Applications, database system VS file system- view of data- data abstraction – instances and schemas – data models – the ER Model – Relational model – other models – Database languages – DDL – DML – database Access for applications programs – database users and administrator – transaction management – database system structure – storage manager – the query processor – history of database systems – database design and ER diagrams – Beyond ER design entities of ER model – concept design with the ER model – conceptual design for large enterprises.

UNIT-II: Relational Model: introduction to the relational model – integrity constraint over relations – enforcing integrity constraints – querying relational data – logical database design – introduction to views – destroying / altering tables and views.

Relational Algebra and Calculus : relational algebra – selection and projection set operations – renaming – joins – division – examples of algebra overviews – relational calculus – tuple relational calculus – domain relational calculus – expressive power of algebra and calculus.

UNIT–III: Form of basic SQL Query – examples of basic SQL Queries – introduction to nested queries – correlated nested queries set – comparison operators – Aggressive operators -Null values – comparison using null values – logical connectivity's – AND, OR and NOTR – impact on SQL constructs – Outer joins – disallowing NULL values – complex integrity constraints in SQL Triggers and Active Database. Schema refinement – problems caused by redundancy – decompositions – problem related to decomposition – reasoning about FDS – FIRST, SECOND, THIRD Normal forms – BCNF – Lossless join decomposition – Dependency preserving Decomposition – Schema refinement in database design – Multi valued dependencies – forth Normal Form.

UNIT-IV: Overview of Transaction Management: ACID properties – Transactions and schedules – concurrent execution of transaction – lock based concurrency control – performance locking – transaction support in SQL – Introduction to crash recovery.

Concurrency Control: Serializability and recoverability – introduction to lock management – lock conversions dealing with dead locks – specialized locking techniques concurrency without locking.

Crash Recovery: introduction to ARIES – the log – other recovery related structures – the write- Ahead Log Protocol – check pointing – recovering form a system crash – media recovery – other approaches and interaction with concurrency control.

UNIT-V: Overview of Storage and Indexing : data on external storage – File organization and indexing – cluster indexing, primary and secondary indexes – index data structures – hash based indexing tree base indexing –comparison of file organizations – indexes and performance Tuning.

Storage data: Disks and Files: the Memory Hierarchy – redundant Arrays of independent – Disks – disk space management – buffer manager – files of records – page formats – record formats.

Tree structure Indexing: introduction for tree indexes – indexed sequential access methods

(ISAM)-B+ Tress: A dynamic Index structure.

Hash based Indexing: Static Hashing – extendable hashing – Linear Hashing – Extandable vs Linear hashing.

Text Books:

1. Database Management Systems/ Raghurama Krishnan, Johannes Gehrke/ TATA McGraw hills 3rd Edition
2. Database systems Concepts/ Silberschatz, Korth/ McGraw hill, IV Edition

Reference Books:

1. Database Management Systems/ P.Radha Krishna/ Hi-TECH Publications 2005
2. Introduction to Database Management Systems / C.J.Date/ Pearson Education
3. Database Systems design, Implemantation and Management/ Rob & Coronel/ 5th Edition, Thomson
4. Database Management Systems/ Elmasri Navrate/ Pearson Education
5. Database Management Systems /Mathew Leon, Leon Vikas
6. Database Systems / Connoley/ Pearson Education

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. II Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	NON-DESTRUCTIVE TESTING						OEC
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P	40	60	3
	3	-	-	-			

Course Objectives: The objectives of this course are to:

1. know the principles of NDT methods
2. understand the ultrasonic testing method
3. learn thermography and radiography techniques to identify the failures
4. impart knowledge on the applications of eddy current and acoustic emission methods
5. get acquainted with the using of magnetic particle inspection

Course Outcomes: At the end of this course, students will be able to:

1. outline the principles of NDT methods
2. apply the ultrasonic testing method for failure identification
3. utilize thermography and radiography techniques to identify underlying failure sites
4. distinguish the applications of eddy current and acoustic emission methods
5. analyze the flaws using magnetic particle inspection

UNIT-I

Introduction to NDT, Liquid penetrant test: Physical Principles, Procedure for penetrant testing, penetrant testing materials, Penetrant testing methods, sensitivity, Applications and limitations, typical examples.

UNIT-II

Ultrasonic testing: Basic properties of sound beam, Ultrasonic transducers, Inspection methods, Techniques for normal beam inspection, Techniques for angle beam inspection, Flaw characterization techniques, Applications of ultrasonic testing, Advantages and limitations.

UNIT-III

Thermography: Basic principles, Detectors and equipment, techniques, applications.
Radiography: Basic principle, Electromagnetic radiation sources, radiographic imaging, Inspection techniques, applications, limitations, typical examples.

UNIT-IV

Eddy current test: Principles, instrumentation for ECT, techniques, sensitivity, advanced eddy Current test methods, applications, limitations.

Acoustic emission: Principle of AET, Technique, instrumentation, sensitivity, applications, Acoustic emission technique for leak detection.

UNIT-V

Magnetic particle inspection: Principle of MPT, Procedure used for testing a component, sensitivity, limitations.

NDT of Composites: Codes and conventions - Difficulties - Few Case Studies.

Text Books:

1. Non Destructive Testing/ J Anderson, S Ramachandran, T Rajasanthosh Kumar/ Airwalk Publications, Chennai, 2017.
2. Non-Destructive Test and Evaluation of Materials/ J Prasad and C G Krishna Das/ Second Edition, McGraw Hill Education (India) Private Limited, 2011.
3. Nondestructive Evaluation: Theory, Techniques and Applications/ Peter J. Shull/ Marcel Dekkar, 2002.

Reference Books:

1. Non Destructive Testing and Quality Control/ ASM Metals Hand Book/ Vol. 17, ASM, 1989.
2. Non Destructive Testing Hand Book/ P. Mclntire (Ed.)/ Vol. 4, American Society for Non Destructive Society, 2010.
3. Introduction to Nondestructive Testing: A Training Guide/ Paul E. Mix/ Second Edition, John Wiley & Sons, Inc, New Jersey, 2005

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SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. II Semester (Digital Manufacturing)

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>PCC/PEC/OEC</td></tr>
<tr><td></td><td colspan="6">PEDAGOGY STUDIES</td><td>Audit Course</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2">Research Methodology and Teaching Learning Methods.</td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>2</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. Review existing evidence on the review topic to inform program design and policy making undertaken by the DFID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes: At the end of this course, students will be able to:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Syllabus:

Units Content Hours:

1. **Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions and Overview of methodology and Searching.
   Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education
2. **Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage:** quality assessment of included studies
   - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
   - Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic

strategies

3. **Professional development:** alignment with classroom practices and follow-up support
   - Peer support
   - Support from the head teacher and the community
   - Curriculum and assessment
   - Barriers to learning: limited resources and large class sizes
4. **Research gaps and future directions:**
   - Research design
   - Contexts
5. **Model Curriculum of Engineering & Technology PG Courses [Volume-I] [46]**
   - Pedagogy
   - Teacher education
   - Curriculum and assessment
   - Dissemination and research impact

Suggested Text Books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell
6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

ANURAG UNIVERSITY

School of Engineering

Department of Mechanical Engineering

Courses for B. Tech. Honors in Additive Manufacturing under R20 Regulations

Sl. No.	Code	Course	Hours per week L	T	P	Cre
1	PCC	3D Printing Machines, Tooling & Systems	3	1	-	4
2	PCC	Materials and applications of 3D printing	3	1	-	4
3	PCC	*Relevant course from NPTEL	2	-	-	2
4	PCC	Additive Manufacturing Lab.	-	-	4	2
5	PW	Project Work	-	-	12	6
		Total	8	2	16	1

*Depending on the availability of online courses related to additive manufacturing subjected to the approval by the internal BoS.

ANURAG UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech. II Semester (Digital Manufacturing)

Course Code	Course Title						PCC/PEC/OEC
	ADDITIVE MANUFACTURING LAB.						
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	3	50	50	2

Course Objectives: The objectives of this course are to

1. understand the development of STL files
2. learn the CAD data processing using RP software
3. gain knowledge of slicing the STL files
4. model and fabricate working models
5. construct low-cost desktop 3D Printer

Course Outcomes: At the end of this course, students will be able to:

1. Develop STL file for CAD models with appropriate support structures and orientation
2. Implement the CAD data processing using different RP software
3. Perform Slicing of STL files
4. Model and fabricate working models using AM processes
5. Construct low-cost desktop 3D Printer and test its performance

(A minimum of 10 experiments are to be conducted)

LIST OF EXPERIMENTS:

1. Generating STL files from the CAD Models & Working on STL files
2. Modeling Creative Designs in CAD Software
3. Processing the CAD data in CURA software
4. Processing the CAD data in Flash Print software
5. Processing the CAD data in Catalyst software
6. Error finding in dimensions by CURA software
7. Optimizing build-time and material consumption by Simulation in Catalyst Software
8. Fabricating the physical part by sending the tool path data to RP machine
9. Removing the supports & post processing (cleaning the surfaces)
10. Evaluating the quality of the fabricated part in terms of surface finish and dimensional accuracy.

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11. Modeling of Metal Parts in CAD Software.
12. Body/head/Object scanning using 3D Scanner.
13. Slicing of corrected STL files using CURA Software
14. Building and testing a low-cost desktop 3D printer. (Group activity)

Text Books:

1. Lab Instruction Manual.

Department of Mechanical Engineering
Courses for B. Tech. Honors in Additive Manufacturing under R20 Regulations

Sl. No.	Code	Course	Semester	Hours per week			Credits
				L	T	P	
1	PCC	3D Printing - Machines, Tooling & Systems	IV	3	1	-	4
2	PCC	Materials and applications of 3D printing	V	3	1	-	4
3	PCC	*Relevant course from NPTEL	VI	2	-	-	2
4	PCC	Additive Manufacturing Lab.	VII	-	-	4	2
5	PW	Project Work	VII	-	-	12	6
	Total			8	2	16	**18**

*Depending on the availability of online courses related to additive manufacturing subjected to the approval by the internal BoS

Anurag University

School of Engineering

<table>
<tr><td></td><td colspan="5">Course Title</td><td></td><td></td><td></td></tr>
<tr><td>Course Code</td><td colspan="7" rowspan="2">3D PRINTING-MACHINES, TOOLING AND SYSTEMS</td><td rowspan="2"></td></tr>
<tr><td>PCC</td></tr>
<tr><td>Prerequisite</td><td colspan="5">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2">Fundamentals of CAD, Introduction to 3D Printing</td><td>L</td><td>T</td><td>D</td><td>P</td><td>Total Hours</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">4</td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>-</td><td>4</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. understand the need of 3D Printing
2. know about the liquid-based 3D Printing systems
3. know about the solid based 3D Printing systems
4. know the applications Rapid tooling
5. construction and usage of 3D Printing machines

Course Outcomes: At the end of this course, students will be able to:

1. outline the importance of 3D Printing
2. compare and contrast the liquid-based 3D Printing systems
3. compare and contrast the solid based 3D Printing systems
4. classify the different rapid tooling systems
5. develop the 3D Printing Machine

UNIT-I

Introduction: Need for 3D Printing, Historical Development, Fundamentals of 3D Printing, 3D Printing Process Chain, Advantages and Limitations of 3D Printing, Classification of 3D Printing Systems as per ASTM Standards, Role of 3D Printing in Industry 4.0, Comparison between 3D Printing and CNC Machining

UNIT-II

Liquid Based 3D Printing Systems: Working Principle, Processes, Applications, Advantages & Disadvantages.

Vat Photopolymerization: Stereo Lithography Apparatus (SLA), Direct Light Processing (DLP), and Continuous Direct Light Processing (CDLP)

Material Jetting: Material Jetting, Drop-on-Demand Material jetting

Material Extrusion: Fused Deposition Modeling (FDM)

Binder Jetting: 3D Printing

UNIT-III

Solid Based 3D Printing Systems: Working Principle, Processes, Applications, Advantages & Disadvantages.

Sheet Lamination: Laminated Object Manufacturing (LOM), Ultrasonic Additive Manufacturing (UAM)

Powder Bed Fusion: Selective Laser Sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM)

Direct Energy Deposition: Laser Engineered Net Shaping (LENS), Electron Beam Additive Manufacturing (EBAM)

UNIT-IV

Rapid Tooling: Conventional Tooling, Rapid Tooling, Differences between Conventional and Rapid Tooling, Classification of Rapid Tooling: Direct and Indirect Tooling methods; Soft, Bridge (firm) and Hard Tooling methods

UNIT-V

Construction of Basic 3D Printing Machines: Construction of 3D Printing Machine - Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors, Environmental controllers: temperature, oxygen level & humidity

TEXT BOOKS:

1. Additive Manufacturing Technologies: 3D Printing, Rapid prototyping and Direct Digital Manufacturing – Ian Gibson, David W Rosen, Brent Strucker, Springer, Second Edition, 2010
2. "3D Printing and Additive Manufacturing Principles and Applications", Chee Kai Chua, Kah Fai Leong, Fifth Edition, World Scientific
3. "Rapid Prototyping: Laser-based and Other Technologies", Patri K. Venuvinod and Weiyin Ma, Springer, 2004

REFERENCE BOOKS:

1. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
2. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.
3. Rapid Prototyping: Theory and Practice, Ali K. Karmani / Emand Abouel Nasr, Springer 2006.
4. Understanding Additive Manufacture: Rapid Prototyping / Rapid Tooling and Rapid Manufacture / Andreas Gebhardt / Hanser Publishers / 2013.

5. Additive Manufacturing and 3D Printing Technology : Principles and Applications/ G. K. Awari , C. S. Thorat , Vishwjeet Ambade , D. P. Kothari / CRC Press/ 2021

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SCHOOL OF ENGINEERING

<table>
<tr><td></td><td colspan="5">Course Title</td><td></td><td></td><td></td></tr>
<tr><td>Course Code</td><td colspan="7" rowspan="2">MATERIALS AND APPLICATIONS OF ADDITIVE MANUFACTURING</td><td rowspan="2">--</td></tr>
<tr><td>PCC</td></tr>
<tr><td>Prerequisite</td><td colspan="5">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td>Total Hours</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">4</td></tr>
<tr><td>3</td><td>1</td><td>-</td><td>-</td><td>4</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. know about various materials used in Additive Manufacturing
2. learn the concepts of polymers and their processing for Additive Manufacturing
3. study the characterization techniques of powder metallurgy
4. know the powder shaping process and sintering techniques
5. discuss the applications of Additive Manufacturing in various fields

Course Outcomes: At the end of this course, students will be able to:

1. acquire the knowledge on various materials used in Additive Manufacturing
2. classify polymers and explain polymer processing methods
3. describe mechanical and chemical characterization of various powder metallurgical components
4. analyze the defects in sintered components and evaluate various mechanical properties
5. apply various Additive Manufactured components in real time problems

UNIT-I

Introduction: Materials used in AM, Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc.

UNIT-II

Concepts of Polymers: Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD]

Polymer Processing: Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Molding and casting of polymers, Polymer processing techniques

UNIT-III

Concepts of Powder Metallurgy: Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM, Powder processing: Mechanical and Chemical methods, Atomization of Powder

Characterization Techniques: Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle Friction, Compression ability, Powder Structure, Chemical Characterization

Microstructure Control in Powder: Importance of Microstructure Study, Microstructures of Powder by Different techniques

UNIT-IV

Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, Isotactic Pressing, Injection Molding, Powder Extrusion, Slip Casting, Tape Casting

Sintering: Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering, Modern Sintering Techniques, Evaluation of Physical & Mechanical Properties, Structure-Property Correlation Study, Defects Analysis of Sintered Components

UNIT-V

Applications: Aerospace, Automotive, Manufacturing, Architectural Engineering, Medical, Biomedical, Dental, Bio-printing, Food, Art, Jewelry, Toys, Tissue & Organ Engineering

TEXT BOOKS:

1. Principles of Polymerization/G Odian/ Wiley Inerscience John Wiley and Sons, 4th edition/ 2005
2. Powder Metallurgy Technology/ Cambridge International Science Publishing/ 2002
3. Additive Manufacturing and 3D Printing Technology :Principles and Applications/ G. K. Awari , C. S. Thorat ,VishwjeetAmbade , D. P. Kothari /CRC Press/ 2021

REFERENCE BOOKS:

1. 3D Printing and Additive Manufacturing Principles and Applications/Chee Kai Chua, Kah Fai Leong / Fifth Edition, World Scientific
2. Microfabrication and Nanomanufacturing/ CRC Press, 2005
3. Powder Metallurgy- Science, Technology and Applications/P. C. Angelo and R. Subramanian/ PHI, New Delhi, 2008
4. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM//Ray F. Egerton / Springer, 2005
5. Additive Manufacturing : Fundamentals and Advancements/Manu Srivastava, Sandeep Rathee, Sachin Maheshwari, TK Kundra/ResearchGate/2019

ANURAG UNIVERSITY
SCHOOLOF ENGINEERING

<table>
<tr><td></td><td colspan="6">Course Title</td><td></td><td></td><td></td></tr>
<tr><td>Course Code</td><td colspan="6" rowspan="2">ADDITIVE MANUFACTURING LAB.</td><td colspan="3" rowspan="2">--</td></tr>
<tr><td>PCC</td></tr>
<tr><td>Prerequisite</td><td colspan="5">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td>Total Hours</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="2">2</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>4</td><td>-</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. model complex geometry of engineering components
2. make use of point cloud data to reconstruct industrial and medical components
3. learn the process parameters of SLM and LENS Additive Manufacturing (AM) machines to improve the quality of the parts produced
4. know the post-processing techniques to improve surface finish of fabricated components
5. learn construction of low-cost desktop 3D Printer and test its performance

Course Outcomes: After completion of this course, the students will be able to:

1. apply the knowledge for making the common parts and machine elements
2. adopt the process of making industrial and medical parts
3. analyze the mechanical properties of components produced by AM process
4. describe surface roughness characteristics of AM parts
5. create AM machine of high working efficiency with low cost

LIST OF EXPERIMENTS:

1. Modelling of parts in CAD Software
2. Body/head scanning using 3D scanner
3. Object Scanning using 3D scanner
4. Slicing of corrected STL files in SLM RP Tools Software
5. Process Parameters like laser power and scan speed Optimization in PSW Software for fabrication on SLM RP Machine
6. Laser path generation in DMDCAM Software for fabrication on LENS Machine
7. Laser path generation in UG CAM Software for fabrication on Micro stereo lithography (MSL) RP machine
8. Fabrication of metal parts on SLM RP Machine
9. Fabrication of metal parts on LENS RP Machine
10. Building and testing a low-cost desktop 3D printer

REFERENCE BOOKS:

1. Additive Manufacturing Technologies: 3D Printing, Rapid prototyping and Direct Digital Manufacturing – Ian Gibson, David W Rosen, Brent Strucker, Springer, Second Edition, 2010
2. "3D Printing and Additive Manufacturing Principles and Applications", Chee Kai Chua, Kah Fai Leong, Fifth Edition, World Scientific
3. "Rapid Prototyping: Laser-based and Other Technologies", Patri K. Venuvinod and Weiyin Ma, Springer, 2004.
4. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
5. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.

ANURAG UNIVERSITY

School of Engineering

Department of Mechanical Engineering

Courses for B. Tech. Minor in 3D Printing under R20 Regulations

Sl. No.	Code	Course Title	Semester	Hours per week			Credits
				L	T	P	
1		Fundamentals of CAD	IV	3	-	-	3
2		3D Printing - Machines, Tooling & Systems	V	3	-	-	3
3		*Relevant course from NPTEL	VI or VII	3	-	-	3
4		*Relevant course from NPTEL	VI or VII	3	-	-	3
5		*Relevant course from NPTEL	VI or VII	3	-	-	3
6		Computer Aided Drafting Lab.	VI or VII	-	-	3	1.5
7		3D-Printing Lab.	VI or VII	-	-	3	1.5
Total							**18**

*Depending on the availability of online courses related to 3D Printing subjected to the approval by the internal BoS

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<table>
<tr><td></td><td colspan="7">Course Title</td><td></td></tr>
<tr><td>Course Code</td><td colspan="7" rowspan="2">FUNDAMENTALS OF CAD</td><td rowspan="2"></td></tr>
<tr><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td>Total Hours</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td><td>3</td></tr>
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Course Objectives: The objectives of this course are to:

1. know the basics of CAD and devices used
2. study the current available CAD hardware
3. learn the various types of modeling used in CAD
4. identify the types of CAD modeling techniques and utilize them
5. get acquainted with the techniques and skills to use data exchange formats

Course Outcomes: At the end of this course, students will be able to:

1. understand the fundamentals of CAD and devices used
2. explain the various hardware components associated with CAD
3. evaluate the objects or models using geometric transformations and manipulations
4. model the components using solid and surface modeling software
5. exchange product data and its formats

UNIT-I:
Fundamentals of CAD: Introduction to Computer Aided Design (CAD), Design process, Application of computers for Design and Manufacturing, Benefits of CAD, Brief overview of computer peripherals for CAD

UNIT-II:
CAD Hardware: Introduction to hardware specific to CAD, CRT, Random scan technique, raster scan technique, DVST, Raster display, Display systems, sequential scanning and interfaced scan

UNIT-III:
Geometric Modeling: Introduction to Geometric Model, Types of modeling, Curve representation
Wireframe Modeling: Introduction, advantages, limitations and applications, Wire frame entities-analytic and synthetic basics

UNIT-IV:
Surface Modeling: Introduction, advantages, limitations and applications, surface entities, Basic definitions of analytic surfaces - planar surface, ruled surface, tabulated

cylinder, surface of revolution; Basic definitions of synthetic surfaces - Bezier surface, B-spline surface

Solid Modeling: Introduction, advantages, limitations and applications, Solid Entities, Solid Representation schemes – Boundary Representation (B-Rep) scheme, Constructive Solid Geometry (CSG) scheme

UNIT-V:
Product Data Exchange: Introduction, Graphics Standards, Types of translators, Importance of formats in 3D Printing, Data exchange formats - IGES, STEP and STL

TEXT BOOKS:

1. CAD/CAM Theory and Practice, Ibrahim Zeid, Tata McGraw Hill
2. Mastering CAD/CAM, Ibrahim Zeid, Tata McGraw Hill
3. CAD/CAM-Computer Aided Design and Manufacturing, Mikell P. Groover, E.W. Zimmers, Pearson Education/Prentice Hall

REFERENCE BOOKS:

1. CAD/CAM, Principles and Applications, Rao, McGraw Hill Education
2. Automation, Production Systems & Computer Integrated Manufacturing, Mikell P. Groover,Pearson Education Limited
3. Computer Aided Design and Manufacturing, Lalit Narayan, Prentice Hall India Learning Private Limited
4. CAD / CAM / CIM / Radhakrishnan and Subramanian, New Age Publications
5. Principles of Computer Aided Design and Manufacturing, FaridAmirouche, Pearson Education Limited

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<table>
<tr><td></td><td colspan="7">Course Title</td><td></td></tr>
<tr><td>Course Code</td><td colspan="7" rowspan="2">3D PRINTING-MACHINES, TOOLING AND SYSTEMS</td><td rowspan="2"></td></tr>
<tr><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2">Fundamentals of CAD, Introduction to 3D Printing</td><td>L</td><td>T</td><td>D</td><td>P</td><td>Total Hours</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">3</td></tr>
<tr><td>3</td><td>-</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td></td><td colspan="8">Course Objectives: The objectives of this course are to:
6. understand the need of 3D Printing
7. know about the liquid-based 3D Printing systems
8. know about the solid based 3D Printing systems
9. know the applications Rapid tooling
10. construction and usage of 3D Printing machines

Course Outcomes: At the end of this course, students will be able to:
6. outline the importance of 3D Printing
7. compare and contrast the liquid-based 3D Printing systems
8. compare and contrast the solid based 3D Printing systems
9. classify the different rapid tooling systems
10. develop the 3D Printing Machine</td></tr>
</table>

UNIT-I

Introduction: Need for 3D Printing, Historical Development, Fundamentals of 3D Printing, 3D Printing Process Chain, Advantages and Limitations of 3D Printing, Classification of 3D Printing Systems as per ASTM Standards, Role of 3D Printing in Industry 4.0, Comparison between 3D Printing and CNC Machining

UNIT-II

Liquid Based 3D Printing Systems: Working Principle, Processes, Applications, Advantages & Disadvantages.

Vat Photopolymerization: Stereo Lithography Apparatus (SLA), Direct Light Processing (DLP), and Continuous Direct Light Processing (CDLP)

Material Jetting: Material Jetting, Drop-on-Demand Material jetting

Material Extrusion: Fused Deposition Modeling (FDM)

Binder Jetting: 3D Printing

UNIT-III

Solid Based 3D Printing Systems: Working Principle, Processes, Applications, Advantages & Disadvantages.

Sheet Lamination: Laminated Object Manufacturing (LOM), Ultrasonic Additive Manufacturing (UAM)

Powder Bed Fusion: Selective Laser Sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM)

Direct Energy Deposition: Laser Engineered Net Shaping (LENS), Electron Beam Additive Manufacturing (EBAM)

UNIT-IV

Rapid Tooling: Conventional Tooling, Rapid Tooling, Differences between Conventional and Rapid Tooling, Classification of Rapid Tooling: Direct and Indirect Tooling methods; Soft, Bridge (firm) and Hard Tooling methods

UNIT-V

Construction of Basic 3D Printing Machines: Construction of 3D Printing Machine - Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors, Environmental controllers: temperature, oxygen level & humidity

TEXT BOOKS:

1. Additive Manufacturing Technologies: 3D Printing, Rapid prototyping and Direct Digital Manufacturing – Ian Gibson, David W Rosen, Brent Strucker, Springer, Second Edition, 2010
2. "3D Printing and Additive Manufacturing Principles and Applications", Chee Kai Chua, Kah Fai Leong, Fifth Edition, World Scientific
3. "Rapid Prototyping: Laser-based and Other Technologies", Patri K. Venuvinod and Weiyin Ma, Springer, 2004

REFERENCE BOOKS:

1. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
2. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.
3. Rapid Prototyping: Theory and Practice, Ali K. Karmani / Emand Abouel Nasr, Springer 2006.
4. Understanding Additive Manufacture: Rapid Prototyping / Rapid Tooling and Rapid Manufacture / Andreas Gebhardt / Hanser Publishers / 2013.
5. Additive Manufacturing and 3D Printing Technology : Principles and Applications/ G. K. Awari , C. S. Thorat , Vishwjeet Ambade , D. P. Kothari / CRC Press/ 2021

ANURAG UNIVERSITY
SCHOOLOF ENGINEERING

<table>
<tr><td></td><td colspan="7">Course Title
COMPUTER AIDED DRAFTING LAB.</td><td></td></tr>
<tr><td>Course Code</td><td colspan="7" rowspan="2"></td><td rowspan="2">--</td></tr>
<tr><td>--</td></tr>
<tr><td>Prerequisite</td><td colspan="5">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2">--</td><td>L</td><td>T</td><td>D</td><td>P</td><td>Total Hours</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="2">1.5</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>3</td><td>3</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. understand features of CAD software for the development of models
2. learn import and export of CAD data
3. practice generation of .stl files
4. practice simple geometries of parts in sketch mode
5. visualize free form shapes in part mode

Course Outcomes: At the end of this course, students will be able to:

1. develop CAD models for 3D printing
2. import and Export CAD data
3. generate .stl file
4. draw simple geometries of parts in sketch mode
5. generate free form shapes in part mode to visualize parts

List of Experiments:

I. Introduction to AUTOCAD software:

1. Introduction to Basic 2D geometric modeling entities
2. Learning and Practice of 2D drawing of a single component
3. Converting a 2D component into 3D component by using various 3D modeling entities

II. Introduction to Solid Modeling & Pro/E Package

4. Working with sketch mode of Pro/E or SOLIDWORKS
5. Working with the tools like Pattern, Copy, Rotate, Move and Mirror, Working with advanced modeling tools (Sweep, Blend & Swept Blend)
6. Working with creating features (Extrude & Revolve), Working with the tools like Hole, Round, Chamfer and Rib; Generating, editing and modifying commands
7. Exercise-1 on solid modeling
8. Exercise-2 on solid modeling

9. Exercise-3 on solid modeling
10. Working with CAD Data Exchange file formats: IGES, ACIS, DXF and STL
11. Identification of STL file problems using MAGICS software
12. Application of repair algorithms to make the model error-free using MAGICS software

REFERENCE BOOKS:

1. Engineering graphics with Auto CAD- R.B. Choudary/Anuradha Publishers

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<table>
<tr><td></td><td colspan="6">Course Title</td><td></td><td></td><td></td></tr>
<tr><td>Course Code</td><td colspan="8" rowspan="2">3D-PRINING LAB.</td><td rowspan="2">--</td></tr>
<tr><td>--</td></tr>
<tr><td>Prerequisite</td><td colspan="5">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td colspan="2">Credits</td></tr>
<tr><td rowspan="2"></td><td>L</td><td>T</td><td>D</td><td>P</td><td>Total Hours</td><td rowspan="2">--</td><td rowspan="2">--</td><td colspan="2" rowspan="2">-</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Course Objectives: The objectives of this course are to:

1. know the basic concepts of 3D printing
2. understand the various file formats in 3D printing
3. draw the various parts and assemblies
4. understand processes in 3D printing
5. learn various fabrication setups as per the industry need

Course Outcomes: After completion of this course, the students will be able to:

1. compare and contrast technical and practical issues related to 3D printing process
2. develop STL file for CAD models with appropriate support structures and orientation
3. build complex engineering assemblies in plastic material with minimum build-time
4. evaluate the process parameters of 3D printing machine to improve the quality of the parts produced
5. model and fabricate working models using 3D printing

LIST OF EXPERIMENTS:

1. Study 3D Printing machine and its technology

2. Generate STL files from the CAD Models and work on them

3. Modelling innovative designs in CAD Software

4. Processing the CAD data in **Catalyst** and **Cura** softwares

5. Optimizing build-time Simulation in **Catalyst** Software

6. Optimizing material consumption Simulation in **Catalyst** Software

7. Transfer the tool path data for fabricating the physical part on 3D printing machine

8. Removing the supports and post processing

9. Evaluating the quality of the fabricated part in terms of surface finish and dimensional accuracy

10. Evaluating the fabricated part for its suitability to a given application

REFERENCE BOOKS:

1. Additive Manufacturing Technologies: 3D Printing, Rapid prototyping and Direct Digital Manufacturing – Ian Gibson, David W Rosen, Brent Strucker, Springer, Second Edition, 2010
2. "3D Printing and Additive Manufacturing Principles and Applications", Chee Kai Chua, Kah Fai Leong, Fifth Edition, World Scientific
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5. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.

Item 5

Presentation of the minutes of the BoS in Pharmacy, along with the course structure and syllabi of the programs to be offered by the School of Pharmacy from the academic year 2021-22

Minutes of the Board of Studies (BoS) Meeting in Pharmacy held on 31st March 2021 in Online Mode

The Board of studies meeting of School of Pharmacy was conducted online due to Pandemic situation. BoS members both internal as well as external members were present in the virtual mode for the meeting and discussed elaborately the course structure and curriculum of UG, PG and PhD program of Pharmacy.

AGENDA:

1. To review the UG second year B Pharm and Pharm D course structure and approve the changes in the syllabus.
2. To approve detailed PG syllabus of Pharmaceutics, Industrial Pharmacy, Pharmaceutical analysis and Pharmacology of second year PG Programme for the Academic year 2021-2022.
3. To Discuss the AU-PhD program with respect to Eligibility test and also approve the subjects allocated for course work.
4. To introduce new PG M Pharmacy course Pharmaceutical Regulatory affairs and also discuss and approve the course structure and syllabus for the same

BoS MEMBERS

1. Dr Vasudha Bakshi-Chairperson, BOS.
2. Dr A. Madhu Babu-Head of the Department
3. Dr M .Ram Mohan-Associate Professor-SOP, AU.
4. Ms Swapna-Assistant Professor-SOP, AU.
5. Dr Yogeshwari-Professor-BITS, Hyderabad-Subject Expert
6. Dr Chandraiah Godugu-Associate Professor-NIPER-Hyderabad-Subject Expert
7. Dr Praveen Bommu-Industry Expert
8. Dr Vure Prasad-Industry Expert
9. Dr Rajesh-Alumni-AU

The Chairperson BoS initiated the meeting by presenting the course curriculum of B Pharmacy and M Pharmacy Courses of School of Pharmacy, Anurag University. Chairperson emphasized the strength of the courses and their curriculum structure as per the Pharmacy Council of India guidelines. The members discussed and put a note about the curriculum structure that the syllabi covered in B Pharm and M Pharm is on par with the standards set by Pharmacy Council of India.

The Members discussed elaborately the following

Item 1: To confirm and approve the syllabus of UG second year B. Pharm and Pharm D program under regulation 2020

The BOS members reviewed the proposed course structure and syllabus of UG program which is based on Pharmacy council of India curriculum.

Following suggestions of BOS were incorporated

1. The units in Physical Pharmaceutics subject, were rearranged in a stepwise approach.
2. In Medicinal Chemistry subject the contents of the subtopics were concised.
3. National Service Scheme (NSS) subject title was modified to National sports organization and National Service Scheme (NSO and NSS)
4. In Pharmaceutical engineering some of topics were included for giving better practical orientation to the benefit of the students.

Item 2: To discuss and approve detailed syllabus of Pharmaceutics, Industrial Pharmacy, Pharmaceutical analysis and Pharmacology of second year PG Programme for the Academic year 2021-2022 (PCI Regulations)

The members suggested to plan four project review meetings for PG students and attending of three review meetings is mandatory.

Item 3: To consider and approve the panel of examiners for theory and practical examinations of UG/PG courses for the academic year 2021-22.

The BOS members approved the proposed list of examiners for theory and practical examinations of UG and PG courses for the academic year 2021-22. Further, the members authorized the Chairperson BOS to change the examiners as per requirement.

Item 4: To discuss and approve the following aspects with respect to AU-Phd Program

a. The BOS considered and approved the PhD eligibility test based on GPAT syllabus and the distribution of marks for the same.
b. The BOS discussed and approved the following PhD course works with curriculum for the same:
    1. Modern Pharmaceutics
    2. Pharmacological Screening
    3. Clinical Pharmacy Practice
    4. Modern Pharmaceutical Analytical Techniques

c. BOS members discussed and approved the list of journals (Indexed in Scopus and UGC/Elsevier/SCI journal) to publish their research work in various conferences.

Item 5: To discuss the new M Pharmacy Pharmaceutical Regulatory affairs course structure and approve the syllabus of the same

The members discussed in detail the course structure of Pharmaceutical regulatory affairs and also approved the syllabus which is as per the pharmacy council of India.

The members suggested to incorporate the latest topics such as advanced technology in Novel Drug Delivery systems, 3D printing etc., and also industry oriented topics has to be incorporated which will enhance the career opportunities for the outgoing students.

Members suggested the chemistry orientation has to be strengthened especially for PG specialization such as medicinal chemistry, pharmaceutical chemistry and combinatorial chemistry which are presently the need of the hour for developing novel drug formulations.

Members also insisted to encourage interdisciplinary research activities which will not only strength the industry institution interaction but also help in establishing an incubation centre (an initiative by Government of India, Atal Incubation centre).

Finally the meeting was concluded by vote of thanks by Dr. A. Madhu Babu.

ANURAG UNIVERSITY

B.PHARMACY

B.Pharmacy: I YEAR I SEMESTER (R20 Regulation)

COURSE STRUCTURE

Course Code	Category	Course name	Lectures	T/P	Credits
A61001	PS	Human Anatomy and Physiology-I	3	1	3
A61002	PS	Pharmaceutical Analysis	3	1	3
A61003	PS	Pharmaceutics	3	1	3
A61004	PS	Pharmaceutical Inorganic Chemistry	3	1	3
A61005	HS	Communication Skills	2	0	2
A61006/A61007	BS	Remedial Mathematics# / Remedial Biology$	$3^{\#}/2^{\$}$	0	$3^{\#}/2^{\$}$
A61201	PS	Human Anatomy and Physiology-I Lab	0	4	2
A61202	PS	Pharmaceutical Analysis Lab	0	4	2
A61203	PS	Pharmaceutics Lab	0	4	2
A61204	PS	Pharm. Inorganic Chemistry Lab	0	4	2
A61205	HS	Communication Skills Lab	0	2	1
A61206	BS	Remedial Biology Lab	0	2	1
		Total	17/16	24	$26^{\#}/26^{\$}$

$Applicable ONLY for the students who have studied Mathematics / Physics / Chemistry at HSC and appearing for Remedial Biology (RB) course.

#Applicable ONLY for the students who have studied Physics / Chemistry / Botany / Zoology at HSC and appearing for Remedial Mathematics (RM) course.

B.PHARMACY: I YEAR II SEMESTER COURSE STRUCTURE

Course Code	Category	Course name	Lectures	T/P	Credits
A62001	PS	Human Anatomy and Physiology-II	3	1	3
A62002	PS	Pharmaceutical Organic Chemistry-I	4	1	4
A62003	BS	Biochemistry	3	1	3
A62004	BS	Pathophysiology	3	1	3
A62005	CS	Computer Applications in Pharmacy	3	0	3
A62006	MC	Environmental Sciences	2	0	0
A62201	PS	Human Anatomy and Physiology-II Lab	0	4	2
A62202	PS	Pharmaceutical Organic Chemistry-I Lab	0	4	2
A62203	BS	Biochemistry Lab	0	4	2
A62204	CS	Computer Applications in Pharmacy Lab	0	2	1
		Total	18	18	23

A Student shall be promoted from I Year to II Year only if he/she fulfills the academic requirements of securing 50% of average credits (25) up to I Year II Semester, from all the examinations, whether or not the candidate takes the examination.

B.PHARMACY: II YEAR I SEMESTER COURSE STRUCTURE

Course Code	Category	Course name	Lectures	T/P	Credits
A63001	PS	Pharmaceutical Organic Chemistry-II	3	1	4
A63002	PS	Physical Pharmaceutics-I	3	1	4
A63003	BS	Pharmaceutical Microbiology	3	1	4
A63004	PC	Pharmaceutical Engineering	3	1	4
A63005	MC	NSO & NSS	0	0	0
A63201	PS	Pharmaceutical Organic Chemistry-II Lab	0	4	2
A63202	PS	Physical Pharmaceutics-I Lab	0	4	2
A63203	BS	Pharmaceutical Microbiology Lab	0	4	2
A63204	PC	Pharmaceutical Engineering Lab	0	4	2
		Total	12	20	24

B.PHARMACY: II YEAR II SEMESTER COURSE STRUCTURE

Course Code	Category	Course name	Lectures	T/P	Credits
A64001	PS	Pharmaceutical Organic Chemistry-III	3	1	4
A64002	PC	Medicinal Chemistry-I	3	1	4
A64003	PS	Physical Pharmaceutics-II	3	1	4
A64004	PC	Pharmacology-I	3	1	4
A64005	PC	Pharmacognosy and Phytochemistry-I	3	1	4
A64006	MC	Gender sensitization	1	0	0
A64201	PC	Medicinal Chemistry-I Lab	0	4	2
A64202	PS	Physical Pharmaceutics-II Lab	0	4	2
A64203	PC	Pharmacology-I Lab	0	4	2
A64204	PC	Pharmacognosy and Phytochemistry-I Lab	0	4	2
		Total	16	21	28

A Student shall be promoted from II Year to III Year only if he/she fulfills the academic requirements of securing 60% of average credits (44 I-I,I-II and II-I) from all the examinations, whether or not the candidate takes the examination.

B.PHARMACY: III YEAR I SEMESTER (R20 Regulation) COURSE STRUCTURE

Course Code	Category	Course name	Lectures	T/P	Credits
A65001	PC	Medicinal Chemistry II	3	1	4
A65002	PC	Industrial Pharmacy – I	3	1	4
A65003	PC	Pharmacology II	3	1	4
A65004	PC	Pharmacognosy and Phytochemistry - II	3	1	4
A65005	PS	Pharmaceutical Jurisprudence	3	1	4
A65006	MC	Human Values and Professional Ethics	1	0	0
A65201	PC	Industrial PharmacyI – Practical	0	3	2
A65202	PC	Pharmacology II – Practical	0	3	2
A65203	PC	Pharmacognosy and Phytochemistry II – Practical	0	3	2
		Total	16	14	26

B.PHARMACY: III YEAR II SEMESTER COURSE STRUCTURE

Course Code	Category	Course name	Lectures	T/P	Credits
A66001	PC	Medicinal Chemistry - III	4	1	4
A66002	PC	Pharmacology – III	4	1	4
A66003	PC	Herbal Drug Technology	3	1	3
A66004	PC	Biopharmaceutics and Pharmacokinetics	3	1	3
A66005	PS	Pharmaceutical Biotechnology	3	1	3
A66006	PC	Quality Assurance	3	1	3
A66201	PC	Medicinal chemistry III – Practical	0	3	2
A66202	PC	Pharmacology III – Practical	0	3	2
A66203	PC	Herbal Drug Technology – Practical	0	3	2
		Total	20	15	26

Note: All the end examinations (Theory and Practical) are of Three hours duration.

T – Tutorial **P – Practical**

A Student shall be promoted from III Year to IV Year only if he/she fulfills the academic requirements of securing 60% of average credits (76 I-I,I-II,II-I,II-II and III-I) from all the examinations, whether or not the candidate takes the examination.

B.PHARMACY: IV YEAR I SEMESTER (R17 Regulation) COURSE STRUCTURE

Course Code	Category	Course name	Lectures	T/P	Credits
A67001	PC	Instrumental Methods of Analysis	4	1	4
A67002	PC	Industrial Pharmacy-II	4	1	4
A67003	PC	Pharmacy Practice	4	0	4
A67004	PC	Novel Drug Delivery Systems	4	1	4
A67201	PC	Instrumental Methods of Analysis Lab	0	4	2
A67202	PS	Practice School	0	12	6
		Total	16	19	24

B.PHARMACY: IV YEAR II SEMESTER COURSE STRUCTURE

<table>
<tr><th>Course Code</th><th>Category</th><th>Course name</th><th>Lectures</th><th>T/P</th><th>Credits</th></tr>
<tr><td>A68001</td><td>PC</td><td>Biostatistics and Research Methodology</td><td>4</td><td>0</td><td>4</td></tr>
<tr><td>A68002</td><td>PC</td><td>Social and Preventive Pharmacy</td><td>3</td><td>1</td><td>3</td></tr>
<tr><td></td><td></td><td>Open Elective-I</td><td rowspan="7">3</td><td rowspan="7">1</td><td rowspan="7">3</td></tr>
<tr><td>A68003</td><td>PC</td><td>Pharma Marketing Management</td></tr>
<tr><td>A68004</td><td>PC</td><td>Pharmaceutical Regulatory Science</td></tr>
<tr><td>A68005</td><td>PS</td><td>Pharmacovigilance</td></tr>
<tr><td>A68006</td><td>PC</td><td>Quality Control and Standardization of Herbals</td></tr>
<tr><td>A68007</td><td>PC</td><td>Advanced Instrumentation Techniques</td></tr>
<tr><td></td><td></td><td>Open Elective-II</td></tr>
<tr><td>A68008</td><td>PC</td><td>Cell and Molecular Biology</td><td rowspan="5">3</td><td rowspan="5">1</td><td rowspan="5">3</td></tr>
<tr><td>A68009</td><td>PC</td><td>Cosmetic Science</td></tr>
<tr><td>A68010</td><td>PC</td><td>Pharmacological Screening Methods</td></tr>
<tr><td>A68011</td><td>PC</td><td>Computer Aided Drug Design</td></tr>
<tr><td>A68012</td><td>PC</td><td>Dietary Supplements and Nutraceuticals</td></tr>
<tr><td>A68201</td><td>PC</td><td>Project Work</td><td>0</td><td>12</td><td>6</td></tr>
<tr><td></td><td></td><td>Total</td><td>13</td><td>15</td><td>19</td></tr>
</table>

Note: All the end examinations (Theory and Practical) are of Three hours duration.

T – Tutorial **P – Practical**

M – PHARMACY (PHARMACEUTICS)
(R20) COURSE STRUCTURE

M.PHARMACY: I YEAR I SEMESTER COURSE STRUCTURE

Code	Group	Subject	Hrs/Wk	Credits
A41001	Theory	Modern Pharmaceutical Analytical Techniques	4	4
A41005	Theory	Drug Delivery Systems	4	4
A41006	Theory	Modern Pharmaceutic	4	4
A41007	Theory	Regulatory Affairs	4	4
A41203	Lab	Pharmaceutics Practical I	12	6
A41204	-	Seminar/Assignment	7	4
		Total Credits	**35**	**26**

M.PHARMACY: I YEAR II SEMESTER COURSE STRUCTURE

Code	Group	Subject	Hrs/Wk	Credits
A42005	Theory	Research Methodology and	4	4
A42006	Theory	Molecular Pharmaceutics (Nano Tech and Targeted DDS)	4	4
A42007	Theory	Advanced Biopharmaceutics & Pharmacokinetics	4	4
A42008	Theory	Computer Aided Drug Delivery	4	4
A42009	Theory	Cosmetic and Cosmeceuticals	4	4
A42203	Lab	Pharmaceutics Practical II	12	6
A42204	-	Seminar/Assignment	7	4
		Total Credits	**39**	**30**

M.PHARMACY: II YEAR-I SEMESTER COURSE STRUCTURE

Code	Group	Sub	Hrs/Wk	Credits
		Comprehensive Viva-Voce	-	4
-	-	Project work Review I	24	12
		Total Credits	**24**	**16**

M.PHARMACY: II YEAR - II SEMESTER COURSE STRUCTURE

Code	Group	S	Hrs/Wk	Credits
-	-	Project work Review II	8	6
-	-	Project Evaluation (Viva-	16	12
		Total Credits	**24**	**16**

M – PHARMACY (INDUSTRIAL PHARMACY)

M.PHARMACY (IP): I YEAR – I SEMESTER COURSE STRUCTURE

Code	Group	Subject	Hrs/Wk	Credits
A41001	Theory	Modern Pharmaceutical Analytical Techniques	4	4
A41011	Theory	Pharmaceutical Formulation Development	4	4
A41012	Theory	Novel Drug Delivery Systems	4	4
A41013	Theory	Intellectual Property Rights	4	4
A41207	Lab	Industrial Pharmacy Practical I	12	6
A41208	-	Seminar/Assignment	7	4
		Total Credits	**35**	**26**

M.PHARMACY (IP): I YEAR – II SEMESTER COURSE STRUCTURE

Code	Group	Subject	Hrs/Wk	Credits
A42005	Theory	Research Methodology and Biostatistics	4	4
A42007	Theory	Advanced Biopharmaceutics& Pharmacokinetics	4	4
A42014	Theory	Scale Up and Technology Transfer	4	4
A42015	Theory	Pharmaceutical Production Technology	4	4
A42016	Theory	Entrepreneurship Management	4	4
A42207	Lab	Industrial Pharmacy Practical II	12	6
A42208	-	Seminar/Assignment	7	4
		Total Credits	**39**	**30**

M.PHARMACY (IP): II YEAR - I SEMESTER COURSE STRUCTURE

Code	Group	Sub	Hrs/Wk	Credits
		Comprehensive Viva-Voce	-	4
-	-	Project work Review I	24	12
		Total Credits	**24**	**16**

M.PHARMACY (IP): II YEAR - II SEMESTER COURSE STRUCTURE

Code	Group	S	Hrs/Wk	Credits
-	-	Project work Review II	8	6
-	-	Project Evaluation (Viva-Voce)	16	12
		Total Credits	**24**	**16**

M – PHARMACY (PHARMACOLOGY)

M – PHARMACY (PHARMACOLOGY) I YEAR –I SEM COURSE STRUCTURE

Code	Group	Subject	Hrs/Wk	Credits
A41001	Theory	Modern Pharmaceutical Analytical Techniques	4	4
A41002	Theory	Advanced Pharmacology-I	4	4
A41003	Theory	Pharmacological and Toxicological Screening Methods-I	4	4
A41004	Theory	Cellular and Molecular	4	4
A41201	Lab	Pharmacology Practical I	12	6
A41202	-	Seminar/Assignment	7	4
		Total Credits	**35**	**26**

M – PHARMACY (PHARMACOLOGY) I YEAR –II SEM COURSE STRUCTURE

Code	Group	Subject	Hrs/Wk	Credits
A42001	Theory	Advanced Pharmacology-II	4	4
A42002	Theory	Pharmacological and Toxicological Screening Methods-II	4	4
A42003	Theory	Principles of Drug Discovery	4	4
A42004	Theory	Clinical Research and	4	4
A42005	Theory	Research Methodology and	4	4
A42201	Lab	Pharmacology Practical II	12	6
A42202	-	Seminar/Assignment	7	4
		Total Credits	**39**	**30**

M – PHARMACY (PHARMACOLOGY) II YEAR - I SEM COURSE STRUCTURE

Code	Group	Subj	Hrs/Wk	Credits
		Comprehensive Viva-Voce	-	4
-	-	Project work Review I	24	12
		Total Credits	**24**	**16**

M – PHARMACY (PHARMACOLOGY) II YEAR –II SEM COURSE STRUCTURE

Code	Group	Subj	Hrs/Wk	Credits
-	-	Project work Review II	8	6
-	-	Project Evaluation (Viva-Voce)	16	12
		Total Credits	**24**	**16**

M – PHARMACY (PHARMACEUTICAL ANALYSIS)

M – PHARMACY (PHARMA. ANALYSIS) I YEAR- I SEM COURSE STRUCTURE

Code	Group	Subject	Hrs/Wk	Credits
A41001	Theory	Modern Pharmaceutical Analytical Techniques	4	4
A41008	Theory	Advanced Pharmaceutical Analysis	4	4
A41009	Theory	Pharmaceutical Validation	4	4
A41010	Theory	Food Analysis	4	4
A41205	Lab	Pharmaceutical Analysis Practical I	12	6
A41206	-	Seminar/Assignment	7	4
		Total Credits	**35**	**26**

M – PHARMACY (PHARMA. ANALYSIS) I YEAR –II SEM COURSE STRUCTURE

Code	Group	Subject	Hrs/Wk	Credits
A42010	Theory	Advanced Instrumental Analysis	4	4
A42011	Theory	Modern Bio-Analytical Techniques	4	4
A42012	Theory	Quality Control & Quality A	4	4
A42013	Theory	Herbal and Cosmetic Analysis	4	4
A42005	Theory	Research Methodology and Biostatistics	4	4
A42205	Lab	Pharmaceutical Analysis Practical II	12	6
A42206	-	Seminar/Assignment	7	4
		Total Credits	**39**	**30**

M – PHARMACY (PHARMA. ANALYSIS) II YEAR- I SEM COURSE STRUCTURE

Code	Group	S	Hrs/Wk	Credits
		Comprehensive Viva-Voce	-	4
-	-	Project work Review I	24	12
		Total Credits	**24**	**16**

M – PHARMACY (PHARMA. ANALYSIS) II YEAR – II SEM COURSE STRUCTURE

Code	Group	S	Hrs/Wk	Credits
-	-	Project work Review II	8	6
-	-	Project Evaluation (Viva-Voce)	16	12
		Total Credits	**24**	**16**

ANURAG UNIVERSITY

M. PHARM (PHARMACEUTICAL REGULATORY AFFAIRS) - (R20) COURSE STRUCTURE AND SYLLABUS

M. PHARM (PHARMA. REGULATORY AFFAIRS) I YEAR I SEMESTER

Code	Group	Subject	Hrs/Wk	Credits
	Theory	Good Regulatory Practice	4	4
	Theory	Drug Regulatory Affairs	4	4
	Theory	Intellectual Property Rights	4	4
	Theory	Documentation and Regulatory	4	4
	Lab	Regulatory Affairs Practical I	12	6
	-	Seminar/Assignment	7	4
		Total Credits	**35**	**26**

M. PHARM (PHARMA. REGULATORY AFFAIRS) I YEAR II SEMESTER

Code	Group	Subject	Hrs/Wk	Credits
	Theory	Regulatory aspects of medical devices	4	4
	Theory	Regulatory aspects of herbals and biologicals	4	4
	Theory	Regulatory aspects of food and Nutraceuticals	4	4
	Theory	Clinical research and Pharmacovigilance	4	4
	Lab	Regulatory Affairs Practical II	12	6
	-	Seminar/Assignment	7	4
		Total Credits	**35**	**26**

M. PHARM (PHARMA. REGULATORY AFFAIRS) II YEAR - ISEMESTER

Code	Group	Subject	Hrs/Wk	Credits
		Comprehensive Viva-Voce	-	4
-	-	Project work Review I	24	12
		Total Credits	**24**	**16**

M. PHARM (PHARMA. REGULATORY AFFAIRS) II YEAR - IISEMESTER

Code	Group	Subject	Hrs/Wk	Credits
-	-	Project work Review II	8	6
-	-	Project Evaluation (Viva-Voce)	16	12

M. PHARM (PHARMACEUTICAL REGULATORY AFFAIRS)

(R20) COURSE STRUCTURE ANDSYLLABUS

I YEAR ISEMESTER

Code	Group	Subject	Hrs/Wk	Credits
	Theory	Good Regulatory Practice	4	4
	Theory	Drug Regulatory Affairs	4	4
	Theory	Intellectual Property Rights	4	4
	Theory	Documentation and Regulatory Writing	4	4
	Lab	Regulatory Affairs Practical I	12	6
	-	Seminar/Assignment	7	4
		Total Credits	**35**	**26**

I YEAR IISEMESTER

Code	Group	Subject	Hrs/Wk	Credits
	Theory	Regulatory aspects of medical devices	4	4
	Theory	Regulatory aspects of herbals and biologicals	4	4
	Theory	Regulatory aspects of food and Nutraceuticals	4	4
	Theory	Clinical research and Pharmacovigilance	4	4
	Lab	Regulatory Affairs Practical II	12	6
	-	Seminar/Assignment	7	4
		Total Credits	**35**	**26**

II YEAR - ISEMESTER

Code	Group	Subject	Hrs/Wk	Credits
		Comprehensive Viva-Voce	-	4
-	-	Project work Review I	24	12
		TotalCredits	**24**	**16**

II YEAR - IISEMESTER

Code	Group	Subje	Hrs/Wk	Credits
-	-	Project work Review II	8	6
-	-	Project Evaluation (Viva-Voce)	16	12

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs) Good Regulatory Practice (Professional Core - I)

Course Objective: This course is designed to impart fundamental knowledge on various Good Regulatory Practices viz., cGMP, GLP, GALP and GDP for Pharmaceuticals, Cosmetics, Food & Nutraceuticals, Medical devices, In-vitro Diagnostic Medical Devices (IVDs) and biological products and understand the rationale behind these requirements and will propose ways and means of complying with them.

Course Outcome: At completion of this course it is expected that students will be able to understand

- The key regulatory and compliance elements with respect to Good Manufacturing Practices, Good Laboratory Practices, Good Automated Laboratory Practices and Good Documentation Practices.
- Prepare and implement the check lists and SOPs for various Good Regulatory Practices.
- Implement Good Regulatory Practices in the Healthcare and related Industries.
- Prepare for the readiness and conduct of audits and inspections.

UNIT - I

Current Good Manufacturing Practices: Introduction, US Cgmp Part 210 and Part 211.EC Principlesof GMP (Directive 91/356/EEC) Article 6 to Article 14 and WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force (GHTF) Guidance docs.

UNIT - II

Good Laboratory Practices: Introduction, USFDA GLP Regulations (Subpart A to Subpart K), Controlling the GLP inspection process, Documentation, Audit, goals of Laboratory Quality Audit, Audit tools, Future of GLP regulations, relevant ISO and Quality Council of India (QCI) Standards

UNIT - III

Good Automated Laboratory Practices: Introduction to GALP, Principles of GALP, GALP Requirements, SOPs of GALP, Training Documentation,21 CFR Part 11, General check list of 21CFR Part 11, Software Evaluation checklist, relevant ISO and QCI Standards.

UNIT - IV

Good Distribution Practices: Introduction to GDP, Legal GDP requirements put worldwide, Principles, Personnel, Documentation, Premises and Equipment, Deliveries to Customers, Returns, Self- Inspection, Provision of information, Stability testing principles, WHO GDP, USP GDP (Supply chain integrity), relevant CDSCO guidance and ISO standards

UNIT - V

Quality management systems: Concept of Quality, Total Quality Management, Quality by design, Six Sigma concept, Out of Specifications (OOS), Change control. Validation: Types of Validation, Types of Qualification, Validation master plan (VMP), Analytical Method Validation. Validation of utilities, [Compressed air, steam, water systems, Heat Ventilation and Air conditioning (HVAC)]and Cleaning Validation. The International Conference on Harmonization (ICH) process, ICH guidelines to establishquality, safety and efficacy of drug substances and products, ISO 13485, Sch MIII and other relevant CDSCO regulatory guidance documents.

Text and Reference Books

1. Good Laboratory Practice Regulations, by Sandy Weinberg, Fourth Edition Drugs and thePharmaceutical Sciences, Vol.168
2. Good Pharmaceutical Manufacturing practice, Rational and compliance by John Sharp, CRCPress
3. Establishing a cGMP Laboratory Audit System, A practical Guide by David M. Bleisner, WileyPublication.
4. How to practice GLP by PP Sharma, Vandana Publications.
5. Laboratory Auditing for Quality and Regulatory compliance by Donald C. Singer, Drugs andthe Pharmaceutical Sciences, Vol.150.
6. Drugs & Cosmetics Act, Rules & Amendments

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs) Drug Regulatory Affairs (Professional Core - II)

Course Objectives: The topics which are present in the Drug regulatory affairs are very much usefulwhich increases the knowledge regarding the regulatory aspects in the pharmaceutical industries.

Course Outcomes:

- Students will come to know the different competent regulatory authorities globally.
- Students be aware of technical aspects pertaining to the marketing authoritization application(MAA)
- The regulatory guidelines and directions framed by the regulatory authorities will be helpful toplace the drug products in market for marketing approvals.

UNIT - I

Drug Regulatory Aspects (India)

1. Indian drug regulatory authorities, Central and State regulatory bodies (FDA)
2. Drugs and Cosmmetics Act and Rules with latest Amendments (Selective)
3. Special emphasis – Schedule M and Y
4. New drugs – Importation, Registration, development, Clinical Trials, BE NOC & BE studies
5. Various Licences – Test Lic., Import lic., for testing of drugs and API's, Manufacturing Contract andLoan licence manufacturing.

UNIT - II

Good Manufacturing Practices (GMP)

1. Indian GMP certification, WHO GMP certification.
2. ICH guidelines for stability testing and other relevant ones (Q1-Q10)
3. Export permissions and manufacturing for semi-regulated countries
4. Understanding of the plant layouts with special emphasis on the environment & safety. (HVAC,Water Systems, Stores Managemant, Effluent etc.)
5. Quality Assurance and Qulaity Control – Basic understanding for in-built quality.

UNIT - III

A detailed study of regulatory aspects that affect drug product design, manufacture and distribution ina developed country such as USA and in a developing country such as Brazil, Hatch Waxmann Act; Bolar Provisions and other FDA Regulations. Regulatory aspects of pharmaceutical and bulk drug manufacture, regulatory drug analysis.

UNIT - IV

Documentation related to manufacturing, cleaning methods, retention samples and records, qualitycontrol, batch release documents, distribution records, complaints and recalls.

Quality, safety and legislation for cosmetic products and herbal products.

UNIT - V

Governing Regulatory Bodies across the globe.

Country Authority Submission

a. U.S Food & Drug Administration USDMF
b. Canada Therapeutic Product Directorate DMF
c. Europe
    1) European Medicines Agency (EMEA/ National Authorities) EDMF
    2) European Directorate for Quality of Medicines CEP/COS & Health Care Products.
    3) MHRA – Medicines and Health Care Products Regulatory Agency
d. Product Filing
e. Responding Regulatory Deficiencies
f. Final Approval Procedure

Preparation, review and submission of Drug Master Files to Regulatory Authorities as per theirspecific requirements.

Text and Reference Books

1. Original laws published by Govt. of India.
2. Text Book of Forensic Pharmacy by Mithal B. M.; Vallabh Prakashan, New Delhi.
3. Laws of Drugs in India by Hussain.
4. Text Book of Forensic Pharmacy by Jain N. K.; Vallabh Prakashan, New Delhi.
5. Pharmaceutical Regulatory Affairs - Selected Topics, CVS Subramanyam and J Thimmasetty, Vallabh Prakashan Delhi - 2013

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs) Intellectual Property Rights (Professional Elective - I)

Course Objective: Various types of Intellectual Property Rights Patentable Subject History of Indian Patent Protection, Patent filing procedure in India, Opposition- pre-grant opposition and post-grant opposition, Patent filing procedure under PCT, advantages, patent search and literature and Salient features of Indian Patents are discussed in detail.

Course Outcome: The clear information about the patent laws, intellectual property rights anddrug regulation in India and abroad is gained by the students.

UNIT - I
Introduction, Types of Intellectual Property Rights (Patents, Trademarks, Copyrights, Geographical Indications Industrial Designs and Trade secrets), Patentable Subject Matter (Novelty, Non- Obviousness, Utility, enablement and Best mode),

UNIT - II

a. History of Indian Patent Protection, Rationale behind Patent System, Objectives and Advantages of Patent System, and future challenges. Indian Patents Act 1970, Definitions and Key Terminology, Types of Patent applications, Inventions not patentable (section 3 and4).
b. Patent filing procedure in India (Patent Prosecution), Specifications (Provisional and Complete), Claims- types of claims and legal importance of claims, Grant of patent, Rights ofPatentee and co-owners
c. Opposition - pre-grant opposition and post-grant opposition, Anticipation, Infringement, Compulsory Licensing, revocation of patents, and power of Controller.
d. Patent filing procedure under PCT, advantages, patent search and literature

UNIT - III

a. Salient features of Indian Patents (Amendments) Act 1999, 2002 and 2005. US andEuropean Patent System,
b. Background, Salient Features and Impact of International Treaties / Conventions like
    1. Paris Convention, Berne convention
    2. World Trade Organization (WTO)
    3. World Intellectual Property Organization (WIPO)
    4. Trade Related Aspects of Intellectual Property Rights (TRIPS)
    5. Patent Co-operation Treaty (PCT), Madrid Protocol

UNIT - IV

a. PCT Application procedure and review procedure

b. National phase application procedure for US& EU
c. Patent prosecution procedure in US and EU
d. WIPO and its role in IPR
e. Hatch- Waxman provision for IPR

UNIT - V

a. Patent in validation process in India, US and Europe
b. IPR related to copyright, trade mark, trade secret and geographical indication.
c. Patent application writing
d. Claim construction and claims.

Recommended Books:

1. Research Methodology concepts and cases by Depak Chawla, Neena Sondhi
2. Draft manual of Patent Practice and Procedure -2008, The Patent Office, India
3. Manual of Patent Office Practice and Procedure -2010
4. Original Laws Published by Govt. of India
5. Protection of Industrial Property rights by P. Das and Gokul Das
6. Law and Drugs, Law Publications by S.N. Katju
7. Laws of drugs in India, Hussain
8. New drug approval process, 5th edition, by Guarino
9. Commercial Manual on Drugs and Cosmetics 2004, 2nd edition
10. Drugs and Cosmetics act by Vijay Malik
11. Good Manufacturing Practices for Pharmaceuticals, S.H. Wiling, Vol. 78, Marcel Decker.
12. fda.org, wipo.int, patentlawlinks.com, hc-sc.gc.ca, ich.org, cder.org
13. Current good manufacturing practices for pharmaceuticals by Manohar A. Potdar
14. Pharmaceutical Regulatory affairs –selected topics. CVS subhramanyam and J Thimmasettee. Delhi, Vallabh Prakashan, 2012

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs) Total Quality Management (Professional Elective - I)

Course Objectives: Total quality management constitutes very useful chapter like –good manufacturing practices, GLP, GCP, ICH etc. Which increases the knowledge of students in various quality control & regulatory aspects.

Course Outcomes: Total quality management helps the students to learn the established regulatory guidelines in GMP, GCP, GLP, USFDA, WHO, ISO etc to become a perfect budding pharmacist. It is very useful to students to acquire vast knowledge regarding the quality control aspects of different regulatory bodies as per their requirements throughout the world.

UNIT - I

Concepts and Philosophy of TQM, GLP, GMP (orange guide).

UNIT – II

Drug regulatory and accrediting agencies of the world (USFDA, TGA, ICH, WHO, ISO etc.)

UNIT - III

Good manufacturing practices: Organization and personnel, responsibilities, training, hygiene. Premises: Location, design, plant layout, construction, maintenance and sanitation, environmental control, utilities and services like gas, water, maintenance of sterile areas, control of contamination. Equipments: Selection, purchase specifications, maintenance, clean-in-place, sterilize-in-place, methods (TP and STP). Raw materials: Purchase specifications, maintenance of stores, selection of vendors, controls on raw materials and finished dosage forms. Manufacture of and controls on dosage forms: Manufacturing documents, master formula, batch formula records, standard operating procedures, quality audits of manufacturing processes and facilities. In process quality controls on various dosage forms; sterile and non–sterile, standard operating procedures for various operations like cleaning, filling, drying, compression, coating, disinfections, sterilization, membrane filtration etc., Packaging and labelling control, line clearance, reconciliation of labels, cartons and other packaging materials. Quality Control Laboratory: Responsibilities, good laboratory practices, routine controls instruments, reagents, sampling plans, standard test procedures, protocols, non-clinical testing, controls on animal house. Data generation and storage, quality control documents, retention samples, records and audits of quality control facilities. Finished products release, quality review, quality audits, batch release document.

UNIT - IV

Regulatory Considerations for Pre-clinical and Clinical Evaluation: Pre-clinical requirements currently in use. Regulatory requirements of single dose and repeat dose toxicity studies. Study of specific toxicities such as mutagenicity, carcinogenicity and teratoginicity. Animal pharmacokinetics and toxicokinetics. Regulatory requirements of clinical evaluation, pharmacokinetics in man genetic polymorphism. Design and interpretation of clinical trials. Quality assurance standards as per ISO.

UNIT - V

Globalization of drug industry, present status and scope of pharmaceutical industry in India. WHO andNABL certification, ICH guidelines for manufacturing and quality assurance of drug formulation.

Text and Reference Books:

1. Guidelines for Developing National Drug Policies; WHO Publications, 1998.
2. Quality Assurance of Pharmaceuticals–A Compendium of Guidelines and Related Materials,Vol.–1; WHO Publications.
3. A Guide to Total Quality Management by Kaushik Maitra and Sedhan K. Ghosh.
4. GMP by Mehra.
5. How to Practice GMP by P.P. Sharma.
6. ISO 9000 and Total Quality Management by Sadhan K. Ghosh.
7. Good Manufacturing Practices for Pharmaceuticals-A Plan for Total Quality Control by Sidney H. Willing & James R Stoker. (Drugs & Pharm. Sciences) Vol. 78; Marcel Dekker Inc.
8. OPPI-Quality Assurance, USP.
9. Current good manufacturing practices for pharmaceuticals by Manohar A. Potdar
10. Quality assurance and quality management in pharmaceutical industry by Y. Anjaneyulu andmarayya
11. Total Quality Management, An integrated Approach by D. R. Kiran, BS Publications
12. Total Quality Management, 3rd edition by Joel E. Ross. CRC press

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs) Pharmaceutical Validation (Professional Elective - I)

Course Objective: The main purpose of the subject is to understand about validation and how it can be applied to industry and thus to improve the quality of the products. The subject covers the complete information about validation, types, methodology and application.

Course Outcome: Upon completion of the subject student shall be able to

- Explain the aspect of validation
- Carryout validation of manufacturing processes
- Apply the knowledge of validation to instruments and equipments

UNIT - I

Introduction: Definition of Qualification and Validation, Advantage of Validation, Streamlining of Qualification & Validation process and Validation Master Plan.

Qualification: User Requirement Specification, Design Qualification, Factory Acceptance Test (FAT)/Site Acceptance Test (SAT), Installation Qualification, Operational Qualification, Performance Qualification, Re- Qualification (Maintaining status -Calibration Preventive Maintenance, Change management), Qualification of Manufacturing Equipment, Qualification of Analytical Instruments and Laboratory equipments.

UNIT - II

Qualification of analytical instruments: Electronic balance, pH meter, UV-Visible spectrophotometer, FTIR, GC, HPLC, HPTLC

Qualification of Glassware: Volumetric flask, pipette, Measuring cylinder, beakers and burette.

UNIT - III

Qualification of laboratory equipments: Hardness tester, Friability test apparatus, tap density tester, Disintegration tester, Dissolution test apparatus.

Validation of Utility systems: Pharmaceutical water system & pure steam, HVAC system, Compressed air and nitrogen.

UNIT - IV

Cleaning Validation: Cleaning Validation - Cleaning Method development, Validation and validationof analytical method used in cleaning. Cleaning of Equipment. Cleaning of Facilities. Cleaning in place(CIP).

UNIT - V

Analytical method validation: General principles, Validation of analytical method as per ICHguidelines and USP.

- Validate the manufacturing facilities

References:

1. T. Loftus & R. A. Nash, "Pharmaceutical Process Validation", Drugs and Pharm Sci. Series, Vol.129, 3rd Ed., Marcel Dekker Inc., N.Y.
2. The Theory & Practice of Industrial Pharmacy, 3rd edition, Leon Lachman, Herbert A.Lieberman, Joseph. L. Karig, Varghese Publishing House, Bombay.
3. Validation Master plan by Terveeks or Deeks, Davis Harwood International publishing.Validation of Aseptic Pharmaceutical Processes, 2nd Edition, by Carleton & Agalloco, (MarcelDekker).
4. Michael Levin, Pharmaceutical Process Scale-Up‖, Drugs and Pharm. Sci. Series, Vol. 157, 2nd Ed., Marcel Dekker Inc., N.Y.
5. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance inthe Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider
6. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. Cloud,Interpharm Press
7. Validation of Pharmaceutical Processes: Sterile Products, Frederick J.Carlton (Ed.) and JamesAgalloco (Ed.), Marcel Dekker, 2nd Ed.
8. Analytical Method validation and Instrument Performance Verification by Churg Chan, HeimanLam

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs) Stability of Drugs and Dosage Forms (Professional Elective - II)

Course Objectives: These topics are designed impart a specialized knowledge to preserve the properties of drugs and dosage forms during manufacture storage and shelf life. The understanding ofproperties and evaluation of stability during storage, by solution and solid state against several factorsof degradation.

Course Outcomes: The students should describe the evaluation of stability of solutions, solids andformulations against adverse conditions. The students should be able to suggest the measures to retain stability and storage conditions for retaining the efficacy of the products.

UNIT - I

Drug decomposition mechanisms:

1. Hydrolysis and acyltransfers: Nature of reaction, structure and utility, stabilization ofPharmaceutical examples.
2. Oxidation: Nature of oxidation, kinetics of oxidation, oxidation pathways of pharmaceutical,Interest Inhibition of oxidation
3. Photolysis: Energetics of photolysis, kinetics photolysis, photolytic reactions ofpharmaceutical interest, prevention of photolytic reactions.

UNIT - II

Solid state chemical decomposition: Kinetic of solids state decomposition, Pharmaceutical examples of solid-state decomposition, Pure drugs, drug excipient and drug-drug interaction in solid state, methods of stabilization.

Physical stability testing of dosage forms:

1. Solids – tablets, capsules, powder and granules
2. Disperse systems
3. Microbial decomposition
4. Over-view, physical stability of novel drug carriers, liposomes, niosomes, nano-particles.

UNIT - III

Identification and quantitative determination of preservatives, Antioxidants, colouring materials,emulsifiers and stabilizers in Pharmaceutical formulation. Analysis of drugs from biological samples including, selection of biological sample, extraction of drugsby various methods as LLE, SPE and Membrane filtration.Factors affecting extraction of drugs.

UNIT - IV

General method of analysis to determine the quality of raw materials used in cosmetic industry. IndianStandard Specifications (ISI) laid down for sampling and testing of various cosmetics in finished form by the Bureau of Indian Standards.

UNIT - V

Methods of analysis to determine the quality of cosmetics in the finished forms such as Hair care products, Skin care products, Baby care products, Dental products, Personal hygiene products, Colour cosmetics, Ethnic products, Colour makeup preparation, Lipsticks, Hair setting lotions and Eyeshadows. Toxicity testing in cosmetics and Safety and Legislation of Cosmetic products.

Stability studies: Concept of stability studies.

a) cGMP& ICH guidelines for Accelerated stability Testing.

b) Interaction of containers & closure Compatibility Testing.

Reference Books:

1. Comprehensive Pharmacy Review 5th Edition by Leon Shargel, Alan H. Mutnick, Paul F. Souney, Larry N. Sawnson – 2004.
2. A. H. Beckett and J. B. Stenlake Practical Pharmaceutical Chemistry, Part I and Part II, 4th Edition. 3. G. H. Jeffery, J. Basset, J. Mendham, R. C. Denny (Rev. by) Vogels Text Book of Quantitative Chemical Analysis, 5th Edition 1989, ELBS.
3. The Controller of Publications; New Delhi, Govt. of India, Indian Pharmacopoeia, Vol. I and Vol. II - 2010.
4. J. B. Wilkinson and R. J. Moore, Herry's Cosmeticology; Longman Scientific and Technical Publishers, Singapore.
5. P.D. Sethi; Quantitative Analysis of Drugs in Pharmaceutical Formulations, 3rd Edition - 1997,
6. Classification of cosmetics raw materials and adjuncts IS 3958 of Indian Standards Institution (BIS).
7. Cosmetic and toilet goods – methods of sampling IS 3958 of Indian Standards Institution (BIS).
8. Methods of sampling and test for various cosmetics as laid down by Bureau of IndianStandards.
9. Drug stability: Principles and practices by Jens T. Carstensen
10. Stability Testing of Drug Products by W. Grimm.
11. Stability of Drugs and Dosage Forms by Yoshioka and Stella.

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs)

Pharmaceutical Formulation Technology (Professional Elective - II)

Course Objective: Students will know the preformulation studies, methodology, different excipients used in solid dosage forms and their evaluation with references to production technologies. The students also know the optimization techniques and their applications in pharmaceutical industries.

Course Outcome: Students shall explain the preformulation parameters, apply ICH guidelines and evaluate drug, drug excipients compatibility. Students also explain about formulation and development, use of excipients in tablets, powders, capsules, micro-encapsules and coating techniques. They also learn and apply the statistical design in different formulations.

UNIT - I

Preformulation: Goals of preformulation, solid state manipulation and characterization. pH dependent solubility of drug, equilibrium solubility, intrinsic dissolution of drug, particle size distribution.

Flow of Powders: Physical properties and importance. Angle of repose, Cars index, compressibility, bulk density, tapped density.

UNIT - II

Excipients used in various dosage forms like tablets, capsules, emulsions, suspensions, semisolids and sterile products. Knowledge of packing materials. Drug- excipient compatibility- Drug stability, factors affecting stability, stabilization methods.

UNIT - III

Tablets: Types of tablets, granulation methods, highlighting operations such as mixing, drying,milling, blending, lubrication and compression.

Tablet coating: Types of coating, steps involved in coating process- pan coating and fluid bedcoating and problems associated with coating.

Hard Gelatin Capsules: General principles and steps involved in the production of drug loadedhard gelatin capsules, filling operation, filling of powders, granules and pellets.

UNIT - IV

Dissolution: Principles of dissolution, factors influencing dissolution, official methods andapparatus. Dissolution of immediate release, controlled release and delayed release products.

UNIT - V

Stability testing: Chemical degradation and preventive measures. Various stability testingconditions and use of stabilizers in packing

Text Books:

1. Pharmaceutics - The Science of Dosage form design by ME Aulton.
2. Pharmaceutical Dosage forms - Tablets (Vol I, II and III) by Lieberman, Lachman andSchwartz.
3. Pharmaceutical Dosage forms - Capsules (Vol I, II and III) by Avis, Lieberman andLachman.
4. Pharmaceutical Dosage forms – Disperse systems (Vol I, II and III) by Avis, Liebermanand Lachman.
5. Modern Pharmaceutics by Gilbert S. Banker and Christopher T. Rhodes.
6. Pharmaceutical statistics by Bolton Industrial Pharmacy - Selected Topics, CVSSubramanyam and J Thimmasetty, Vallabha Prakashan Delhi - 2013

Reference Books:

1. The Theory and Practice of industrial Pharmacy by Leon Lachman, Herbert A. Lieberman.
2. Remington's Science and Practice of Pharmacy by A. Gennaro.
3. Ansel's Pharmaceutical Dosage form and Drug delivery system by Loyd V. Allen, Jr.Nicholas G. Popovich, Howard C. Ansel.
4. Generic Drug Product Development by Leon Shargel and Isadore Kanfer.
5. Dispensing for Pharmaceutical Students by SJ Carter.

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs)
Documentation and Regulatory Writing (Professional Elective - II)

Course Objective: This course is designed to impart fundamental knowledge on documentationand general principles involved in regulatory writing and submission to agencies.

Course Outcomes: Upon completion of the course the student shall be able to,

- Know the various documents pertaining to drugs in pharmaceutical industry
- Understand the basics of regulatory compilation
- Create and assemble the regulation submission as per the requirements of agencies
- Follow up the submissions and post approval document requirements

UNIT - I

Documentation in pharmaceutical industry: Exploratory Product Development Brief (EPDB) for Drug substance and Drug product, Product Development Plan (PDP), Product Development Report (PDR), Master Formula Record, Batch Manufacturing Record and its calculations, Batch Reconciliation, Batch Packaging Records, Print pack specifications, Distribution records, Certificate of Analysis (CoA), Site Master File and Drug Master Files (DMF).

UNIT - II

Dossier preparation and submission: Introduction and overview of dossiers, contents and organization of dossier, binders and sections, compilation and review of dossier. Paper submissions, overview and modules of CTD, electronic CTD submissions; Electronic submission: Planning electronic submission, requirements for submission, regulatory bindings and requirements, Tool and Technologies, electronic dossier submission process and validating the submission, Electronic Submission Gateway (ESG). None CTD electronic submissions (NeeS), Asian CTD formats (ACTD) submission. Organizing, process and validation of submission. Submission in Sugam system of CDSCO.

UNIT - III

Audits: Introduction, Definition, Summary, Types of audits, GMP compliance audit, Audit policy, Internal and External Audits, Second Party Audits, External third-party audits, Auditing strategies, Preparation and conducting audit, Auditing strategies, audit analysis, audit report, audit follow up. Auditing/inspection of manufacturing facilities by regulatory agencies. Timelines for audits/inspection. GHTF study group 4 guidance document. ISO 13485.

UNIT - IV

Inspections: Pre-approval inspections, Inspection of pharmaceutical manufacturers, Inspection ofdrug distribution channels, Quality systems requirements for national good manufacturing practice inspectorates, inspection report, model certificate of good manufacturing practices, Root cause analysis, Corrective and Preventive action (CAPA).

UNIT - V

Product life cycle management: Prior Approval Supplement (PAS), Post Approval Changes [SUPAC], Changes Being Affected in 30 Days (CBE-30), Annual Report, Post marketing Reporting Requirements, Post approval Labeling Changes, Lifecycle Management, FDA Inspection and Enforcement, Establishment Inspection Report (EIR), Warning Letters, Recalls, Seizure and Injunctions. ISO Risk Management Standard.

Text and Reference Books:

1. Compliance auditing for Pharmaceutical Manufacturers. Karen Ginsbury and Gil Bismuth,Interpharm/CRC, Boca Raton, London New York, Washington D.C.
2. Pharmaceutical Manufacturing Handbook, Regulations and Quality by Shayne Cox Gad.Wiley- Interscience, A John Wiley and sons, Inc., Publications.
3. Handbook of microbiological Quality control. Rosamund M. Baird, Norman A. Hodges,Stephen
4. P. Denyar. CRC Press. 2000.
5. Laboratory auditing for quality and regulatory compliance. Donald C. Singer, Raluca-loana Stefan, Jacobus F. Van Staden. Taylor and Francis (2005).
6. Implementing Juran's Road Map for Quality Leadership: Benchmarks and Results, By Al Endres, Wiley, 2000
7. Understanding, Managing and Implementing Quality: Frameworks, Techniques and Cases,By Jiju Antony; David Preece, Routledge, 2002
8. Organizing for High Performance: Employee Involvement, TQM, Reengineering, and Knowledge Management in the Fortune 1000: The CEO Report By Edward E. Lawler; Susan Albers Mohrman; George Benson, Jossey-Bass, 2001
9. Corporate Culture and the Quality Organization By James W. Fairfield-Sonn, Quorum Books, 2001
10. The Quality Management Sourcebook: An International Guide toMaterials and Resources By Christine Avery; Diane Zabel, Routledge, 1997

11. The Quality Toolbox, Second Edition, Nancy R. Tague, ASQ Publications
12. Juran's Quality Handbook, Sixth Edition, Joseph M. Juran and Joseph A. De Feo, ASQPublications
13. Root Cause Analysis, The Core of Problem Solving and Corrective Action, Duke Okes,2009, ASQ Publications
14. International Medical Device Regulators Forum (IMDRF) Medical Device Single AuditProgram (MDSAP)

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs)
Research Methodology and IPR

Course Objectives:

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

Course Outcomes: At the end of this course, students will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT - I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a goodresearch problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation,Necessary instrumentations

UNIT - II:

Effective literature studies approaches, analysis, Plagiarism, Research ethics

UNIT - III:

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format ofresearch proposal, a presentation and assessment by a review committee

UNIT - IV:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

References:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in NewTechnological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs) Regulatory Practice and Documentation Lab (Laboratory - I)

List of Experiments:

1. Case studies (4 Nos.) of each of Good Pharmaceutical Practices.
2. Documentation for in process and finished products Quality control tests for Solid,liquid, Semisolid and Sterile preparations.
3. Preparation of SOPs, Analytical reports (Stability and validation)
4. Protocol preparation for documentation of various types of records (BMR, MFR, DR)Labeling comparison between brand & generics.
5. Preparation of regulatory dossier as per Indian CTD format and submission in SUGAM
6. Case studies on response with scientific rationale to USFDA Warning Letter
7. Preparation of submission checklist of IMPD for EU submission.
8. Comparison study of marketing authorization procedures in EU.

M.Pharm I Year I Sem (Pharmaceutical Regulatory Affairs) Drug Regulation And Registration Lab (Laboratory - II)

List of Experiments:

1. Case studies on Change Management/ Change control. Deviations and Corrective &Preventive Actions (CAPA)
2. Import of drugs for research and developmental activities
3. GMP Audit Requirements as per CDSCO
4. Preparation of checklist for registration of IND as per ICH CTD format.
5. Preparation of checklist for registration of NDA as per ICH CTD format.
6. Preparation of checklist for registration of ANDA as per ICH CTD format.
7. Comparative study of DMF system in US, EU and Japan
8. Preparation of regulatory submission using eCTD software
9. Documentation of raw materials analysis as per official monographs
10. Preparation of audit checklist for various agencies
11. Preparation of submission to FDA using eCTD software
12. Preparation of submission to EMA using eCTD software
13. Preparation of submission to MHRA using eCTD software

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs) Regulatory Aspects of Medical Devices

(Professional Core - III)

Course Objective: This course is designed to impart the fundamental knowledge on the medical devices and in vitro diagnostics, basis of classification and product life cycle of medical devices, regulatory requirements for approval of medical devices in regulated countries like US, EU and Asian countries along with WHO regulations. It prepares the students to learn in detail on the harmonization initiatives, quality and ethical considerations, regulatory and documentation requirements for marketing medical devices and IVDs in regulated countries.

Course Outcome: Upon completion of the course, the student shall be able to know;

- Basics of medical devices and IVDs, process of development, ethical and qualityconsiderations.
- Harmonization initiatives for approval and marketing of medical devices and IVDs.
- Regulatory approval process for medical devices and IVDs in India, US, Canada, EU, Japanand ASEAN.
- Clinical evaluation and investigation of medical devices and IVDs.

UNIT - I

Medical Devices: Introduction, Definition, Risk based classification and Essential Principles of MedicalDevices and IVDs. Differentiating medical devices IVDs and Combination Products from that of pharmaceuticals, History of Medical Device Regulation, Product Lifecycle of Medical Devices and Classification of Medical Devices.

IMDRF/GHTF: Introduction, Organizational Structure, Purpose and Functions, Regulatory Guidelines, Working Groups, Summary Technical Document (STED), Global Medical Device Nomenclature (GMDN).

UNIT - II

Ethics: Clinical Investigation of Medical Devices, Clinical Investigation Plan for Medical Devices, GoodClinical Practice for Clinical Investigation of medical devices (ISO 14155:2011) Quality: Quality System Regulations of Medical Devices: ISO 13485, Quality Risk Management of Medical Devices: ISO 14971, Validation and Verification of Medical device, Adverse Event Reporting of Medical device

UNIT - III

USA: Introduction, Classification, Regulatory approval process for Medical Devices (510k) Premarket Notification, Pre-Market Approval (PMA), Investigational Device Exemption (IDE) and In vitro Diagnostics, Quality System Requirements 21 CFR Part 820, Labeling requirements 21 CFR Part 801, Post marketing surveillance of MD and Unique Device Identification (UDI). Basics of In vitro diagnostics, classification and approval process.

UNIT - IV

European Union: Introduction, Classification, Regulatory approval process for Medical Devices (Medical Device Directive, Active Implantable Medical Device Directive) and In vitro Diagnostics (In Vitro Diagnostics Directive), CE certification process. Basics of In vitro diagnostics, classification and approval process.

UNIT - V

ASEAN, China & Japan: Medical Devices and IVDs, Regulatory registration procedures, Quality System requirements and clinical evaluation and investigation. IMDRF study groups and guidance documents.

Reference Books:

1. FDA regulatory affairs: a guide for prescription drugs, medical devices, and biologics byDouglas J. Pisano, David Mantus.
2. Medical Device Development: A Regulatory Overview by Jonathan S. Kahan
3. Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, Medical Devices byJohn J. Tobin and Gary Walsh
4. Compliance Handbook for Pharmaceuticals, Medical Devices and Biologics by CarmenMedina
5. Country Specific Guidelines from official websites.

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs) Regulatory Aspects of Herbals And Biologicals (Professional Core - IV)

Course Objective: This course is designed to impart fundamental knowledge on Regulatory Requirements, Licensing and Registration, Regulation on Labelling of Biologics in India, USA and Europe It prepares the students to learn in detail on Regulatory Requirements for biologics, Vaccines and Blood Products

Course Outcome: **Upon the completion of the course the student shall be able to :**

- Know the regulatory Requirements for Biologics and Vaccines
- Understand the regulation for newly developed biologics and biosimilars
- Know the pre-clinical and clinical development considerations of biologics
- Understand the Regulatory Requirements of Blood and/or Its Components Including BloodProducts and label requirements

UNIT - I

India: Introduction, Applicable Regulations and Guidelines, Principles for Development of Similar Biologics, Data Requirements for Preclinical Studies, Data Requirements for Clinical Trial Application,Data Requirements for Market Authorization Application, Post-Market Data for Similar Biologics, Pharmacovigilance. GMP and GDP.

UNIT - II

USA: Introduction to Biologics; biologics, biological and biosimilars, different biological products, difference between generic drug and biosimilars, laws, regulations and guidance on biologics/ biosimilars, development and approval of biologics and biosimilars (IND, PMA, BLA, NDA, 510(k), pre-clinical and clinical development considerations, advertising, labelling and packing of biologics.

UNIT - III

European Union: Introduction to Biologics; directives, scientific guidelines and guidance related to biologics in EU, comparability/ bio similarity assessment, Plasma master file, TSE/ BSE evaluation, development and regulatory approval of biologics (Investigational medicinal products and biosimilars),pre-clinical and clinical development considerations; stability, safety, advertising, labelling and packing of biologics in EU.

UNIT - IV

Vaccine regulations in India, US and European Union: Clinical evaluation, Marketing authorization, Registration or licensing, Quality assessment, Pharmacovigilance, Additional requirements Blood and Blood Products Regulations in India, US and European Union: Regulatory Requirements of

Blood and/or Its Components Including Blood Products, Label Requirements, ISBT (International Society of Blood Transfusion) and IHN (International Haemovigilence Network)

UNIT - V

Herbal Products: Quality, safety and legislation for herbal products in India, USA and European Union.

Text and Reference Books:

1. FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics,Douglas J. Pisano, David S. Mantus ; Informa ,2008
2. Biological Drug Products: Development and Strategies; Wei Wang, Manmohan Singh;wiley,2013
3. Development of Vaccines: From Discovery to Clinical Testing; Manmohan Singh, Indresh K.Srivastava; Wiley, 2011
4. www.who.int/biologicals/en
5. www.fda.gov/BiologicsBloodVaccines/GuidanceComplianceRegulatoryInformation/
6. www.ihn-org.com
7. www.isbtweb.org
8. Guidelines on Similar Biologics: Regulatory Requirements for Marketing Authorization in India
9. www.cdsco.nic.in
10. www.ema.europa.eu › scientific guidelines › Biologicals
11. www.fda.gov/biologicsbloodVaccines/GuidanceCompliance Regulatory Information (Biologics)

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs) Regulatory Aspects of Food and Nutraceuticals (Professional Elective - III)

Course Objective: This course is designed to impart the fundamental knowledge on Regulatory Requirements, Registration and Labeling Regulations of Nutraceuticals in India, USA and Europe. It prepares the students to learn in detail on Regulatory Aspects for nutraceuticals and food supplements.

Course Outcome: Upon completion of the course, the student shall be able to

a. Know the regulatory Requirements for nutraceuticals
b. Understand the regulation for registration and labeling of nutraceuticals and food supplementsin India, USA and Europe.

UNIT - I

Nutraceuticals: Introduction, History of Food and Nutraceutical Regulations, Meaning of Nutraceuticals, Dietary Supplements, Functional Foods, Medical Foods, Scope and Opportunities in Nutraceutical Market.

UNIT - II

Global Aspects: WHO guidelines on nutrition. NSF International: Its Role in the Dietary Supplements and Nutraceuticals Industries, NSF Certification, NSF Standards for Food And Dietary Supplements. Good Manufacturing Practices for Nutraceuticals.

UNIT - III

India: Food Safety and Standards Act, Food Safety and Standards Authority of India: Organization and Functions, Regulations for import, manufacture and sale of nutraceutical products in India, Recommended Dietary Allowances (RDA) in India.

UNIT - IV

USA: US FDA Food Safety Modernization Act, Dietary Supplement Health and Education Act. U.S. regulations for manufacture and sale of nutraceuticals and dietary supplements, Labelling Requirements and Label Claims for Dietary Supplements, Recommended Dietary Allowances (RDA) in the U.S

UNIT - V

European Union: European Food Safety Authority (EFSA): Organization and Functions. EU Directivesand regulations for manufacture and sale of nutraceuticals and dietary supplements. Nutrition labelling. European Regulation on Novel Foods and Novel Food Ingredients. Recommended Dietary Allowances (RDA) in Europe.

Text and Reference Books:

1. Regulation of Functional Foods and Nutraceuticals: A Global Perspective by Clare M. Hasler(Wiley Online Library)
2. Nutraceutical and Functional Food Regulations in the United States and Around the World byDebasis Bagchi (Academic Press, Elsevier)
3. http://www.who.int/publications/guidelines/nutrition/en/
4. http://www.europarl.europa.eu/RegData/etudes/STUD/2015/536324/IPOL_STU(2015)536324_EN.pdf
5. Handbook of Nutraceuticals by Yashwant Pathak (CRC Press)
6. Food Regulation: Law, Science, Policy and Practice by Neal D. Fortin (Wiley)
7. Country Specific Guidelines from official websites.

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs)
Biostatistics and Research Methodology (Professional Elective - III)

Course Objective: The student shall know the introduction, scope of biostatistics and Research work,calculation and present of the data. It also informs the students, how the present research work writing and correlating.

Course Outcome: The student will be known the Biostatistics arrangement, presentation, and formation of tables and charts. They also know the correlation and regression & application of differentmethods, analysis of data and also learn how to write dissertation, thesis and Research paper.

UNIT - I

Introduction and scope of biostatistics: Use of statistics in Pharmacy. Population and Sample collection. Stages of research, types of data and methods of data collections. Data arrangement and presentation, formation of table and charts.

UNIT - II

Measures of central tendency: computation of means, median and mode from grouped and ungrouped data.

Measure of dispersion: computation of variance, standard deviation, standard error and their coefficients.

UNIT - III

Measures of Correlation and Regression: Experimental designing, planning of an experiment,replication, and randomization. Probit analysis.

Probability rules: Binomial, Poison and Normal distribution.

Hypothesis testing: Student't' test, Chi square test, Analysis of Variance (ANOVA): 1-way, 2-way, 3-ways

UNIT - IV

Developing a research question, Resources for research question, Literature Review: TraditionalQualitative Review, Meta-Analysis—A Quantitative Review Preparation of Research Proposal Variables—Definition of Variable, Types of variables (Dependent and Independent variables,Confounded variables), Measurement of variables, Types of measurement scales and theircomparison. Reliability and Validity of Measurements.

UNIT - V

The research report paper writing/ thesis writing Different parts of the research paper

1. Title-Title of project with authors' name

2. Abstract – Statement of the problem, Background list in brief and purpose and scope
3. Key words
4. Methodology- subject, apparatus, instrumentation and procedure
5. Results – tables, graphs figure and statistical presentation
6. Discussion support or non-support of hypothesis, practical and theoretical implications
7. Conclusion
8. Acknowledgements
9. References
10. Errata
11. Importance of Spell check for entire projects
12. Uses of footnotes

Text Books:

1. Deepak Chawla Neena Sondhi, Research Methodology Concepts and Cases, Vikasbooks publishers
2. Donald H. McBurney -Theresa L. White "Research Methods" (Cengage learning IndiaPvt. Ltd)

Reference Books:

1. Remington's Pharmaceutical Sciences
2. Theory & Practice of Industrial Pharmacy by Lachman
3. Statistics for business and economics 3rd edition by Vikas books publications
4. Biostatistics & Computer applications by GN Rao and NK Tiwari
5. Sokal, R.R. and Rohlf, F.J. 1987. An Introduction to Biostatistics. W.H. Freeman andCompany.
6. Bailey, N.T.J. 1981. Statistical Methods in Biology. English University Press.
7. Mitchell, K. and Glover, T. 2001. Introduction to Biostatistics. McGraw Hill, Publishing Co.
8. Biostatistics and Computer Applications by G.N. Rao and N.K. Tiwari
9. Fundamentals of Biostatistics by Khan and Khanum
10. Research Methodology by R K Khanna bis and Suvasis Saha
11. Research methods and Quantity methods by G. N. Rao
12. A practical approach to PG dissertation.

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs)
Nano Based Drug Delivery Systems (Professional Elective – III)

Course Objective - To develop expertise regarding suitability and evaluation of nanomaterials, able to apply the properties to the fabrication of nanopharmaceutical, evaluate the intensity of dosage forms and availability for targeting and controlled delivery.

Course Outcomes – The students should be able to select the right kind of materials, able to developnano formulations with appropriate technologies, evaluate the product related test and for identified diseases

UNIT - I – Introduction to Nanotechnology

a. Definition of nanotechnology
b. History of nanotechnology
c. Unique properties and classification of nanomaterials
d. Role of size and size distribution of nanoparticles properties.
e. Marketed formulations based on nanotechnology and science behind them

UNIT - II – Synthesis of Nanomaterials Physical, chemical and biological MethodsMethods for synthesis of

- Gold nanoparticles
- Magnetic nanoparticles
- Polymeric nanoparticles
- Self – assembly structures such as liposomes, Niosomes, transferasomes, micelles,aquasomes and nanoemulsions

UNIT - III - Biomedical applications of Nanotechnology

a. Nanotechnology products used for in vitro diagnostics
b. Improvements to medical or molecular imaging using nanotechnology
c. Targeted nanomaterials for diagnostic and therapeutic purpose

UNIT - IV

Design of nanomaterials for drug delivery, pulmonary and nasal drug delivery, nanomaterials forcancer therapy and cardiovascular diseases. Localized drug delivery systems.

UNIT - V

Characterization including the principles, size reduction, analysis of nanoparticles, size, PDI, sizeseparation, stability, methods of analysis regarding integrity and release of drugs

Recommended Books:

1. Nanomedicine and Nanoproducts: Applications, Disposition and Toxicology in the Humanbody, Eiki Igarashi, CRC press. 2015
2. Nanotechnology and Drug Delivery Volume one and two: Nanoplatforms in Drug Delivery,Jose L. Arias, CRC press
3. Nano: The Essentials: Understanding Nanoscience and Nanotechnology, T. Pradeep, TataMcGraw-Hill Publishing Company Limited, New Delhi, 2008.
4. Nanocrystals: Synthesis, Properties and Applications, C. N. R. Rao, P. J. Thomas and G.U.Kulkarni, Springer (2007)
5. Nanostructures and Nanomaterials: Synthesis, Properties and Application, Guozhong Gao,Imperial College Press (2004)
6. Nano chemistry: A Classical Approach to Nanomaterials – Royal Society for Chemistry,Cambridge, UK (2005)
7. Nanocomposite science and technology, pulickel M. Ajayan, Linda S. Schadler, paul V.Braun, Wiley - VCH Verlag, Weiheim (2003)
8. Nanoscale materials in chemistry, Edited by Kenneth J. Klabunde, John Wiley & Sons,2009
9. Nanoparticles as Drug carriers, Vladimir P Torchiling, Imperial College Press, USA, 2006
10. Introduction to Nano Science and Technologies, Ankaneyulu Yerramilli, BS Publications.2016
11. Nanoparticles as Drug carriers, Vladimir P Torchiling, Imperial College Press, USA, 2006

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs)
Clinical Research and Pharmacovigilance (Professional Elective - IV)

Course Objectives: This subject will provide a value addition and current requirement for thestudents in clinical research and pharmacovigilance. It will teach the students on conceptualizing, designing, conducting, managing and reporting of clinical trials. This subject also focuses on global scenario of pharmacovigilance in different methods that can be used to generate safety data. It will teach the students in developing drug safety data in pre-clinical, clinical phases of drug development and post market surveillance.

Course Outcomes: Upon completion of the course, the student shall be able to;

- explain the regulatory requirements for conducting clinical trial
- Demonstrate the types of clinical trial designs
- Explain the responsibilities of key players involved in clinical trials
- Execute safety monitoring, reporting and close-out activities
- Explain the principles of Pharmacovigilance
- Detect new adverse drug reactions and their assessment
- Perform the adverse drug reaction reporting systems and communication in pharmacovigilance

UNIT - I
Regulatory Perspectives of Clinical Trials:

Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH- GCP) guidelines Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant-Schedule Y, ICMR, Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process

UNIT - II
Clinical Trials: Types and Design:

Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, Contract Research Organization and its management.

UNIT - III
Clinical Trial Documentation:

Guidelines to the preparation of documents, Preparation of protocol, Investigator Brochure, Case Report Forms, Clinical Study Report Clinical Trial Monitoring-Safety Monitoring in CT Adverse Drug Reactions: Definition and types. Detection and reporting methods. Severity and seriousness assessment.

predictability and preventability assessment. Management of adverse drug reactions; Terminologies of ADR.

UNIT - IV

Basic aspects, terminologies and establishment of pharmacovigilance:

History and progress of pharmacovigilance, Significance of safety monitoring, Pharmacovigilance in India and international aspects, WHO international drug monitoring Program, WHO and Regulatory terminologies of ADR, evaluation of medication safety, establishing pharmacovigilance centres in Hospitals, Industry and National Programs related to pharmacovigilance. Roles and responsibilities in Pharmacovigilance.

UNIT - V

Methods, ADR reporting and tools used in pharmacovigilance:

International classification of diseases, International Nonproprietary names for drugs, Passive and Active surveillance, Comparative observational studies, Targeted clinical investigations and Vaccine safety surveillance. Spontaneous reporting system and Reporting to regulatory authorities, Guidelinesfor ADRs reporting. Argus, Aris G Pharmacovigilance, VigiFlow, Statistical methods for evaluating medication safety
data.

References:

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health; 2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice. E6; May 1996.230
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.
7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Textbook of Pharmacovigilance: Concept and Practice. G.P. Mohanta and P. K. Manna. 2016, Pharma Med Press.
9. A textbook of Clinical Pharmacy Practice: Essential Concepts and Skills. Second Edition, 2012, University Press

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs)Nutraceuticals

(Professional Elective - IV)

Course Objectives: The students will expose to characteristic features of various phytochemicals as nutraceuticals in various diseased conditions and also know the role of antioxidant in free radical induced disease conditions and will expose to various food laws and regulations.

Course Outcomes: Helps the student to understand the importance of Nutraceuticals in variouscommon problems with the concept of free radicals

UNIT - I

a. Definitions of Functional foods, Nutraceuticals and Dietary supplements. Classification of Nutraceuticals, Health problems and diseases that can be prevented or cured by Nutraceuticals i.e. weight control, diabetes, cancer etc.

b. Source, Name of marker compounds and their chemical nature, Medicinal uses and health benefitsof following used as nutraceuticals/functional foods: Spirulina, Soyabean, Ginseng, Garlic, Broccoli, Gingko, Flaxseeds

UNIT - II

Phytochemicals as nutraceuticals: Occurrence and characteristic features (chemical nature medicinalbenefits) of following

a) Carotenoids- α and β-Carotene, Lycopene, Xanthophylls, lutein
b) Sulfides: Diallylsulfides, Allyltrisulfide.
c) Polyphenolics: Reservetrol
d) Flavonoids- Rutin , Naringin, Quercitin, Anthocyanidins, catechins, Flavones
e) Prebiotates / Probiotics.: Fructo oligosaccharides, Lactobacillum
f) Phytoestrogens: Isoflavones, daidzein, Geebustin, lignans
g) Tocopherols

UNIT - III

a. Introduction to free radicals: Free radicals, reactive oxygen species, production of free radicals in cells, damaging reactions of free radicals on lipids, proteins, Carbohydrates, nucleic acids.

b. Measurement of free radicals: Lipid peroxidation products, lipid hydroperoxide, malondialdehyde.

UNIT - IV

a. Free radicals in Diabetes mellitus, Inflammation, Ischemic reperfusion injury, Cancer, Atherosclerosis, Free radicals in brain metabolism and pathology, kidney damage, muscle damage.Free radicals involvement in other disorders. Free radicals theory of ageing.

b. Antioxidants: Endogenous antioxidants – enzymatic and nonenzymatic antioxidant defence, Superoxide dismutase, catalase, Glutathione peroxidase,

Glutathione Vitamin C, Vitamin E, α- Lipoic acid, melatonin
Synthetic antioxidants: Butylatedhydroxy Toluene, Butylatedhydroxy Anisole.

UNIT - V

Food Laws and Regulations; FDA, FPO, MPO, AGMARK. HACCP and GMPs on Food Safety.Adulteration of foods.

Regulations and Claims – Current Products: Label Claims, Nutrient Content Claims, Health Claims,Dietary Supplements Claims

References:

1. Dietetics by Sri Lakshmi
2. Role of dietary fibres and nutraceuticals in preventing diseases by K. T. Agusti and P. Faizal:BS Publication.
3. Advanced Nutritional Therapies by Cooper. K.A., (1996).
4. The Food Pharmacy by Jean Carper, Simon & Schuster, UK Ltd., (1988).
5. Prescription for Nutritional Healing by James F.Balch and Phyllis A. Balch 2nd Edn., AveryPublishing Group, NY (1997).
6. G. Gibson and C. Williams Editors *2000 Functional foods* Woodhead Publ. Co. London.
7. Goldberg, I. *Functional Foods*. 1994. Chapman and Hall, New York.
8. Labuza, T.P. 2000 Functional Foods and Dietary Supplements: Safety, Good Manufacturing Practice (GMPs) and Shelf Life Testing in *Essentials of Functional Foods* M. K. Sachmidl and T.P. Labuza eds. Aspen Press.
9. Handbook of Nutraceuticals and Functional Foods, Third Edition (Modern Nutrition)
10. Shils, ME, Olson, JA, Shike, M. 1994 *Modern Nutrition in Health and Disease*. Eighth edition.Lea and Febiger

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs) Advanced Drug Delivery Systems (Professional Elective - IV)

Course Objectives: The students shall apply the pharmacokinetic and pharmacodynamic principlesin the design of CDDS. They also apply the design, evaluation and applications related to oral, parenteral, transdermal, implants, bio adhesives and targeted drug delivery systems.

Course Outcomes: Students will select the drugs for CDDS design of the formulation fabrication ofsystems of above drug delivery systems with relevant applications.

UNIT - I

Fundamentals of controlled drug delivery systems, pharmacokinetic and pharmacodynamic basis of controlled drug delivery. Design, fabrication, evaluation and applications of the following controlled releasing systems

a. Controlled release oral drug delivery systems
b. Parenteral controlled release drug delivery systems

UNIT - II

Design, fabrication, evaluation and applications of the following

a. Implantable Therapeutic systems
b. Transdermal delivery systems
c. Ocular and Intrauterine delivery systems
d. Vaccine delivery: Delivery systems used to promote uptake, absorption enhancers, oralimmunization, controlled release microparticles form vaccine development

UNIT - III

Biochemical and molecular biology approaches to controlled drug delivery of

a. Bioadhesive drug delivery systems
b. Nasal drug delivery systems
c. Drug delivery to Colon

UNIT - IV

Biochemical and molecular biology approaches to control drug delivery of

a. Liposomes
b. Niosomes
c. Microspheres
d. Nanoparticles
e. Resealed erythrocytes

UNIT - V

Drug targeting to particular organs

a. Delivery to lungs

b. Delivery to the brain and problems involved

c. Drug targeting in neoplasams

Text Books:

1. Novel Drug Delivery System by Yie W. Chien.
2. Controlled Drug Delivery by Joseph R. Robinson and Vincent H. L. Lee.
3. Controlled and Novel Drug Delivery Systems by N. K. Jain.
4. Targeted and Controlled Drug Delivery (Novel carrier systems) by S. P. Vyas and Khar.
5. Modern Pharmaceutics by Gilbert S. Banker and Christopher T. Rhodes.
6. Advances in Drug Delivery, Vol 1, 2, 3 by Y. Madhusudan Rao, A.V. Jithan
7. Oral Drug Delivery Technology, 2nd ed, by Aukunuru Jithan

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs)

Regulatory Aspects of Herbals and Biological Lab (Laboratory - III)

List of Experiments:

1. Preparation of Biologics License Applications (BLA)
2. Preparation of documents required for Vaccine Product Approval
3. Comparison of clinical trial application requirements of US, EU and India of Biologics
4. Preparation of Checklist for Registration of Blood and Blood Products
5. Registration requirement comparison study in 5 emerging markets (WHO) and preparingcheck list for market authorization
6. Registration requirement comparison study in emerging markets (BRICS) and preparingcheck list for market authorization
7. Registration requirement comparison study in emerging markets (China and SouthKorea) and preparing check list for market authorization
8. Registration requirement comparison study in emerging markets (ASEAN) and preparingcheck list for market authorization
9. Registration requirement comparison study in emerging markets (GCC) and preparingcheck list for market authorization
10. Preparation of document required for the approval of herbal products of diverse dosageforms(3products) as per regulations requirements

Practical work shall be carried out based on the theory syllabus.

M.Pharm I Year II Sem (Pharmaceutical Regulatory Affairs)

Regulatory Aspects of Medicinal Devices Lab (Laboratory - IV)

List of Experiments:

1. Checklists for 510k and PMA for US market
2. Checklist for CE marking for various classes of devices for EU
3. STED Application for Class III Devices
4. Audit Checklist for Medical Device Facility
5. Clinical Investigation Plan for Medical Devices
6. Preparation and submission of medical devices for approval (3 products)
7. GMP of manufacturing of medical devices of diverse nature (3 products)
8. preparation and submission of nutraceuticals devices for approval (3 products)

Practical work shall be carried out based on the theory syllabus

M.Pharm II Year I Sem (Pharmaceutical Regulatory Affairs) Analytical Method Validation (Professional Elective - V)

Course Objectives: This topic will impart knowledge about analytical validation within pharmaceuticalenvironment, its design and execution. This also gives about validation parameters and few instrumental validation.

Course Outcomes: Upon completion of this subject the student will know about importance of validation, its parameter along with ICH limits and validations of analytical instruments

UNIT – I

Analytical Validation within the Pharmaceutical Environment

Regulatory Requirements, Integrated and Continuous Validation, General Planning and Design of Validation Studies, Evaluation and Acceptance Criteria, Statistical Tests.

UNIT - II

Performance Parameters, Calculations and Tests

a) **Precision:** Precision Levels, Acceptable Ranges for Precisions, Sources to Obtain andSupplement Precisions, Specificity
b) **Specificity:** Demonstration of Specificity by Accuracy, Chromatographic Resolution, Peak Purity(Co-elution)
c) **Accuracy:** Drug Substance, Drug Product, Impurities/Degradants and Water, Cleaning ValidationMethods, Acceptance Criteria

UNIT - III

d) **Linearity:** Unweighted Linear Regression, Weighted Linear Regression, Non-linear and Other Regression Techniques
e) **Detection and Quantitation Limit:** Analytical Detector Responses, Requirements for DL/QL in Pharmaceutical Impurity Determination, Approaches Based on the Blank, Determination of DL/QL from Linearity, Precision-based Approaches, Comparison of the Various Approaches
f) **Robustness:** Terminology and Definitions, Fundamentals of Robustness Testing, Examples of Computer-assisted Robustness Studies

UNIT - IV

Qualification of Analytical Equipment

Introduction, Terminology, An Overview of the Equipment Qualification Process, Documentation of theEQ Process, Phases of Equipment Qualification, Design Qualification (DQ), Installation Qualification (IQ), Operational Qualification (OQ), Performance Qualification (PQ)

UNIT - V

Acceptance Criteria and Analytical Variability

Introduction, Analytical Variability, Uncertainty of the Uncertainty, Estimating the Analytical Uncertainty, Acceptance Criteria, Assay of Drug Substances, Assay of Active Ingredients in Drug Products, Dissolution Testing, Stability Testing

References

1. Method validation in Pharmaceutical Analysis by J. Emer and J.H. McB. Miller. WILEYpublications

M.Pharm II Year I Sem (Pharmaceutical Regulatory Affairs) Pharmaceutical Industry Management (Professional Elective - V)

Course Objective: This particular study of the course aimed at achieving, enabling the student effectively manage a given organization in planning, hiring, personnel, selection training and other infrastructures maintenance apart from design, lay-out and handling of the equipment.

Course Outcome: This subject aims at validation of different process, equipment methods and effective management of waste materials.

UNIT - I

Human Resource management: Human resource planning, job analysis and design, recruitment, Personnel selection, orientation and placement, training and development, supervision, performance appraisal key result area and key performance area remuneration and salaries, Compensation and incentives, industrial relations, motivation.

UNIT - II

Entrepreneurship and Project Management - Quality Assurance Management:

Total quality management, Organization and personnel, responsibilities, training, hygiene Premises: Location, design, layout, construction, maintenance, and sanitations, environmental control, sterile areas, control contamination, Equipments procedure and documentation for selection, purchase, speciation, installation and maintenance, clean in place, sterilization in place.

UNIT - III

Production management:

Production organization, objectives and policies of good manufacturing practices, layout of buildings, services, equipments and their maintenance, materials management, handling and transportation, inventory management and control, production planning and control, selection of vendors, purchase cycle, sales forecasting, budget and cost control.

UNIT - IV

Process validation: General Principles of Validation, Regulatory basis, validation of pharmaceutical equipment and processes, validation of analytical methods.

UNIT - V

Industrial Hazards and Pollution Management:

Chemical hazards, gas hazards, fire and explosion hazards, safety management.

Water pollution, water Pollution abatement and effluent treatment, Air Pollution, air Pollution Control Devices. Solid waste, Solid Waste Management, Noise Pollution, Noise Abatement, Effluent Analysis and Treatment-Methods, Effluent Treatment in Formulation Plants, Effluent Treatment in Synthetic Drugs Industry, Effluent Treatment in Fermentation Industry, Introduction of Echo Pharmacovigilance.

References:

1. Unit operations of Chemical Engineering by Warren L. McCabe, Julian C. Smith, PeterHarriott.
2. The Theory and Practice of industrial Pharmacy by Leon Lachman, Herbert A. Lieberman.
3. Pharmaceutical Process validation by Robert A. Nash, Alfred H. Wachter.
4. Modern Pharmaceutics by Gilbert S. Banker and Christopher T. Rhodes.
5. Pharmaceutical production management, C.V.S. Subrahmanyam, Vallabh Prakash.

Text Books

1. Remington’s Science and Practice of Pharmacy by A. Gennaro.
2. Bentley’s Text book of Pharmaceutics by EA Rawlins.

M.Pharm II Year I Sem (Pharmaceutical Regulatory Affairs) Pharmaceutical Production Technology (Professional Elective - V)

Course Objective: The students shall know about the pilot plant scale up techniques for manufacturing of tablets capsules, suspensions, emulsions and semisolids. The students also know about the filling of capsules, compression machines, sterilizers for formulation of parenterals and also know about the propellants, DPI, MDI and their quality control. The students also know about the cosmetics and neutraceuticals.

Course Outcomes: Students will know about the scale up and pilot plant techniques used for all pharmaceutical dosage forms like tablets, capsules, parenterals, aerosols, cosmetics and nutraceuticals.

UNIT - I

Pilot plant scale-up techniques used in pharmaceutical manufacturing

a. **Pilot plant:** Technology transfer from R&D to pilot plant to pilot scale considerations of steps involved with manufacture, layout design, facility, equipment selection of tablets, capsules, suspensions, emulsions & semisolids.
b. **Scale up:** Importance, Scale up process-size reduction, mixing, blending, granulation, compression, coating involved in tablets, capsules & liquid-liquid mixing.

UNIT - II

Formulation development of parenteral dosage forms: Advances in materials and production techniques, filling machines, sterilizers, product layout.

UNIT - III

Pharmaceutical Aerosols: Advances in propellants, metered dose inhaler designs, dry powder inhalers, selection of containers and formulation aspects in aerosols formulation, manufacture and quality control.

UNIT - IV

a. **Cosmetics:** Formulation approaches, preparation & method of manufacturing labeling& Q.C. of anti ageing products, sun screen lotion and fairness creams.
b. **Nutraceuticals:**
    1. Introduction, source, manufacture and analysis of glucosamine and cartinine.
    2. Monographs: General and specific properties of glucosamine & cartinine.
    3. A brief overview of role of nutraceuticals in cancer prevention & cardio vascular disorders.

UNIT - V

Aseptic processing operation

- **a.** Introduction, contamination control, microbial environmental monitoring, microbiological testing of water, microbiological air testing, characterization of aseptic process, media and incubation condition, theoretical evaluation of aseptic operations.
- **b.** Air handling systems: Study of AHUs, humidity & temperature control.

Text Books:

1. Pharmaceutics - The Science of Dosage form design by ME Aulton.
2. The Theory and Practice of industrial Pharmacy by Leon Lachman, Herbert A. Lieberman.
3. Remington's Science and Practice of Pharmacy by A. Gennaro.
4. Ansel's Pharmaceutical Dosage form and Drug delivery system by Loyd V. Allen, Jr. Nicholas G. Popovich, Howard C. Ansel.
5. Pharmaceutical Dosage forms - Parenterals (Vol I, II and III) by Avis, Lieberman andLachman.
6. Scale up techniques – Pharmaceutical process by Michael Levin, Marcel Dekker

Reference books:

1. Bentley`s Text Book of Pharmaceutics by EA Rawlins.
2. Generic Drug Product Development by Leon Shargel.
3. Dispensing for Pharmaceutical Students by SJ Carter.
4. Modern Pharmaceutics by Gilbert S. Banker and Christopher T. Rhodes.
5. Nutraceuticals, 2nd edition by Brian lock wood

M.Pharm (Pharmaceutical Regulatory Affairs)

English for Research Paper Writing (Audit Course - I & II)

Prerequisite: None

Course objectives: Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at veryfirst-time submission

UNIT-I:

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT-II:

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT-III:

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT-IV:

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT-V:

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Text Books/ References:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York DordrechtHeidelberg London, 2011

M.Pharm (Pharmaceutical Regulatory Affairs) Disaster Management (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction andhumanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice frommultiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance inspecific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches,
- planning and programming in different countries, particularly their home country or the countriesthey work in

UNIT-I:

Introduction:

Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

Disaster Prone Areas in India:

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT-II:

Repercussions of Disasters and Hazards:

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides andAvalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT-III:

Disaster Preparedness and Management:

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-IV:

Risk Assessment Disaster Risk:

Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT-V:

Disaster Mitigation:

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Text Books/ References:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company.
2. Sahni, Pardeep Et. Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall ofIndia, New Delhi.
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep &DeepPublication Pvt. Ltd., New Delhi.

M.Pharm (Pharmaceutical Regulatory Affairs) Sanskrit for Technical Knowledge (Audit Course - I & II)

Prerequisite: None

Course Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancingthe memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledgefrom ancient literature

Course Outcomes: Students will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

UNIT-I:

Alphabets in Sanskrit,

UNIT-II:

Past/Present/Future Tense, Simple Sentences

UNIT-III:

Order, Introduction of roots,

UNIT-IV:

Technical information about Sanskrit Literature

UNIT-V:

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TEXT BOOKS/ REFERENCES:

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya SanskritSansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

M.Pharm (Pharmaceutical Regulatory Affairs)Value Education (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course outcomes: Students will be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

UNIT-I:
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

UNIT-II:
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration.Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT-III:
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness.

UNIT-IV:
Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT-V:
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Scienceof reincarnation, Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

Text Books/ References:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford UniversityPress, New Delhi

M.Pharm (Pharmaceutical Regulatory Affairs) Constitution of India (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes: Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

UNIT-I:

History of Making of the Indian Constitution: History Drafting Committee, (Composition &Working), **Philosophy of the Indian Constitution:** Preamble**,** Salient Features.

UNIT-II:

Contours of Constitutional Rights & Duties: Fundamental Rights Right to Equality**,** Right to Freedom**,** Right against Exploitation**,** Right to Freedom of Religion**,** Cultural and Educational Rights**,** Right to Constitutional Remedies, Directive Principles of State Policy**,** Fundamental Duties.

UNIT-III:

Organs of Governance: Parliament**,** Composition**,** Qualifications and Disqualifications**,** Powers and Functions**,** Executive**,** President**,** Governor**,** Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions.

UNIT-IV:

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT-V:

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Text Books/ References:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

M.Pharm (Pharmaceutical Regulatory Affairs)

Pedagogy Studies (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to:

- Review existing evidence on the review topic to inform programme design and policy makingundertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes: Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms indeveloping countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions,and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum andguidance materials best support effective pedagogy?

UNIT-I:

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.

UNIT-II:

Thematic overview: Pedagogical practices are being used by teachers in formal and informalclassrooms in developing countries. Curriculum, Teacher education.

UNIT-III:

Evidence on the effectiveness of pedagogical practices, Methodology for the indepth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the scho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV:

Professional development: alignment with classroom practices and follow-up support, Peer support,Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes

UNIT-V:

Research gaps and future directions: Research design**,** Contexts**,** Pedagogy**,** Teacher education**,** Curriculum and assessment**,** Dissemination and research impact.

Text Books/ References:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal ofCurriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

M.Pharm (Pharmaceutical Regulatory Affairs) Stress Management by Yoga (Audit Course - I & II)

Prerequisite: None

Course Objectives:

- To achieve overall health of body and mind
- To overcome stress

Course Outcomes: Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

UNIT-I:

Definitions of Eight parts of yog. (Ashtanga)

UNIT-II:

Yam and Niyam.

UNIT-III:

Do`s and Don't's in life.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT-IV:

Asan and Pranayam

UNIT-V:

i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

TEXT BOOKS/ REFERENCES:

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur 2."Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

M.Pharm (Pharmaceutical Regulatory Affairs) Personality Development through Life Enlightenment Skills **(Audit Course - I & II)**

Prerequisite: None

Course Objectives:
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes: Students will be able to
- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

UNIT-I:

Neetisatakam-Holistic development of personality
- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

UNIT-II:
Neetisatakam-Holistic development of personality
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

UNIT-III:
Approach to day to day work and duties.
- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

UNIT-IV:
Statements of basic knowledge.
- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad Bhagwad Geeta:

UNIT-V:
- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

Text Books/ References:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department),Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya SanskritSansthanam, New Delhi.

Item 6

Presentation of the course structure of BBA Program of the Department of Management, to be offered from the academic year 2021-22

BBA-Business Analytics

I Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-1	Principles & Practices of Management	3	1	0	4
2	CC-2	Managerial Economics	3	1	0	4
3	CC-3	Financial Accounting	3	1	0	4
4	CC-4	Business Mathematics	3	1	0	4
5	SEC-1	Productive Tools- Lab	0	0	4	2
6	LC-E1	English for Empowerment	3	0	0	3
7	LC-E2	English Language Skills lab	0	0	2	1
8	AECC-1	Gender Sensitization	2	0	0	2
Total (6L+4T+2L)						**24**

BBA-Business Analytics

I Year II Semester

S. N0	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Introduction to Human Resource Management	3	1	0	4
2	CC-6	Introduction to Marketing Management	3	1	0	4
3	CC-7	Introduction to Financial Management	3	1	0	4
4	CC-8	Business Statistics-I	3	1	0	4
5	SEC-2	Logical Reasoning and Quantitative Analysis (LRQA)	1	1	0	2
6	LC-E3	The Power of Data Storytelling	3	0	0	3
7	LC-E4	Art of Articulation Lab	0	0	2	1
8	AECC-2	Human Values of Professional Ethics	2	0	0	2
Total (7L+5T+1L)						**24**

BBA-Business Analytics

II Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-9	Business Research	3	1	0	4
2	CC-10	Business Analytics	3	1	0	4
3	CC-11	Organizational Behavior	3	1	0	4
4	GE-1	1. Business Statistics-II 2. Tax Management ***3.*** Innovation and Technology Management	3	1	0	4
5	SEC-3	Mini Project and Report Writing	0	0	4	2
6	DSE-1	Data Base Concepts-I (RDBMS)	3	1	0	4
Total (5L+5T+1L)						**22**

BBA-Business Analytics

II Year II Semester

0	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-12	Business Law & Environment	3	1	0	4
2	CC-13	Production & Operations Management	3	1	0	4
3	CC-14	Project Management	3	1	0	4
4	SEC-4	Business Plan Preparation Seminar	0	0	6	3
5	SEC-5	Data Analysis and Visualization	0	0	4	2
6	DSE-2	Introduction to Python and Introduction to R-Programming	3	1	0	4
Total (4L+4T+2L)						**21**

BBA-Business Analytics

III Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-15	E-Commerce	3	1	0	4
2	CC-16	Management Information System	3	1	0	4
3	GE-2	1. Business Forecasting 2. International Business 3. Sales and Distribution Management	3	1	0	4
3	DSE-3	Predictive Analytics & Decision Making	3	1	0	4
4	DSE-4	Data Mining for Business Decisions	3	1	0	4
5		Internship	0	0	6	3
Total (5L+5T+1 internship)						**23**

BBA-Business Analytics

III Year II Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-15	Fundamentals of Entrepreneurship	3	1	0	4
2	DSE-5	Open Elective 1. Quantitative Financial Analytics 2. Elements of Actuarial Science 3. Health Care Analytics	3	1	0	4
3	DSE-6	Data Base Concepts (Big Data)	3	1	0	4
4		Comprehensive Viva-Voce	0	0	0	2
5		Project	0	0	20	10
Total (3L+3T+1 Project+1 Viva)						**24**

Summary of Courses with Credits for BBA

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** **(**Human Values of Professional Ethics, Gender sensitization)	2	2	4
2	**Skill Enhancement Courses (SEC)** (Productive Tools-lab, LRQA, Mini Project and Report Writing, Business Plan Preparation Seminar, Data Analysis and Visualization)	5	4*2 1*3	11
3	**Language Courses (LC)** **(**English for Empowerment, English Language Skills lab, The Power of Data Storytelling, Art of Articulation Lab	4	2*3 2*1	8
4	**Core Courses (CC)**	17	4	68
5	**Discipline Specific Electives (DSE)**	6	4	24
6	**Generic Electives (GE)**	2	4	8
7	**Project (PROJ)**	1	10	10
8	**Comprehensive Viva-voce**	1	2	2
9	**Internship**	1	3	3
		39		**138**

BBA-Digital Marketing

I Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-1	Principles & Practices of Management	3	1	0	4
2	CC-2	Managerial Economics	3	1	0	4
3	CC-3	Financial Accounting	3	1	0	4
4	CC-4	Business Mathematics	3	1	0	4
5	SEC-1	Productive Tools- Lab	0	0	4	2
6	LC-E1	English for Empowerment	3	0	0	3
7	LC-E2	English Language Skills lab	0	0	2	1
8	AECC-1	Gender Sensitization	2	0	0	2
Total (6L+4T+2L)						**24**

BBA-Digital Marketing

I Year II Semester

S. N0	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Introduction to Human Resource Management	3	1	0	4
2	CC-6	Introduction to Marketing Management	3	1	0	4
3	CC-7	Introduction to Financial Management	3	1	0	4
4	CC-8	Business Statistics-I	3	1	0	4
5	SEC-2	Logical Reasoning and Quantitative Analysis (LRQA)	1	1	0	2
6	LC-E3	The Power of Data Storytelling	3	0	0	3
7	LC-E4	Art of Articulation Lab	0	0	2	1
8	AECC-2	Human Values of Professional Ethics	2	0	0	2
Total (7L+5T+1L)						**24**

BBA-Digital Marketing

II Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-9	Business Research	3	1	0	4
2	CC-10	Business Analytics	3	1	0	4
3	CC-11	Organizational Behavior	3	1	0	4
4	GE-1	4. Business Statistics-II 5. Tax Management ***6.*** Innovation and Technology Management	3	1	0	4
5	SEC-3	Mini Project and Report Writing	0	0	4	2
6	DSE-1	Social Media Marketing	3	1	0	4
Total (5L+5T+1L)						**22**

BBA-Digital Marketing

II Year II Semester

0	**Code**	**Course Name**	**Hours per week**			**Credits**
			L	**T**	**P**	
1	CC-12	Business Law & Environment	3	1	0	4
2	CC-13	Production & Operations Management	3	1	0	4
3	CC-14	Project Management	3	1	0	4
4	SEC-4	Business Plan Preparation Seminar	0	0	6	3
5	SEC-5	Data Analysis and Visualization	0	0	4	2
6	DSE-2	Digital Marketing	3	1	0	4
Total (4L+4T+2L)						**21**

BBA-Digital Marketing

III Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-15	E-Commerce	3	1	0	4
2	CC-16	Management Information System	3	1	0	4
3	GE-2	4. Business Forecasting 5. International Business 6. Sales and Distribution Management	3	1	0	4
3	DSE-3	Open Elective: 1. Marketing Analytics 2. Web Analytics 3. Content Marketing	3	1	0	4
4	DSE-4	B2B Marketing	3	1	0	4
5		Internship	0	0	6	3
Total (5L+5T+1 internship)						**23**

BBA-Digital Marketing

III Year II Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-15	Fundamentals of Entrepreneurship	3	1	0	4
2	DSE-5	Digital Advertising Strategy	3	1	0	4
3	DSE-6	Customer Analytics	3	1	0	4
4		Comprehensive Viva-Voce	0	0	0	2
5		Project	0	0	20	10
Total (3L+3T+1 Project+1 Viva)						**24**

Summary of Courses with Credits for BBA

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** **(**Human Values of Professional Ethics, Gender sensitization)	2	2	4
2	**Skill Enhancement Courses (SEC)** (Productive Tools-lab, LRQA, Mini Project and Report Writing, Business Plan Preparation Seminar, Data Analysis and Visualization)	5	4*2 1*3	11
3	**Language Courses (LC)** **(**English for Empowerment, English Language Skills lab, The Power of Data Storytelling, Art of Articulation Lab	4	2*3 2*1	8
4	**Core Courses (CC)**	17	4	68
5	**Discipline Specific Electives (DSE)**	6	4	24
6	**Generic Electives (GE)**	2	4	8
7	**Project (PROJ)**	1	10	10
8	**Comprehensive Viva-voce**	1	2	2
9	**Internship**	1	3	3
		39		**138**

BBA-FinTech

I Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-1	Principles & Practices of Management	3	1	0	4
2	CC-2	Managerial Economics	3	1	0	4
3	CC-3	Financial Accounting	3	1	0	4
4	CC-4	Business Mathematics	3	1	0	4
5	SEC-1	Productive Tools- Lab	0	0	4	2
6	LC-E1	English for Empowerment	3	0	0	3
7	LC-E2	English Language Skills lab	0	0	2	1
8	AECC-1	Gender Sensitization	2	0	0	2
Total (6L+4T+2L)						**24**

BBA-FinTech

I Year II Semester

S. N0	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Introduction to Human Resource Management	3	1	0	4
2	CC-6	Introduction to Marketing Management	3	1	0	4
3	CC-7	Introduction to Financial Management	3	1	0	4
4	CC-8	Business Statistics-I	3	1	0	4
5	SEC-2	Logical Reasoning and Quantitative Analysis (LRQA)	1	1	0	2
6	LC-E3	The Power of Data Storytelling	3	0	0	3
7	LC-E4	Art of Articulation Lab	0	0	2	1
8	AECC-2	Human Values of Professional Ethics	2	0	0	2
Total (7L+5T+1L)						**24**

BBA-FinTech

II Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-9	Business Research	3	1	0	4
2	CC-10	Business Analytics	3	1	0	4
3	CC-11	Organizational Behavior	3	1	0	4
4	GE-1	7. Business Statistics-II 8. Tax Management ***9.*** Innovation and Technology Management	3	1	0	4
5	SEC-3	Mini Project and Report Writing	0	0	4	2
6	DSE-1	Foundations, Payments and Regulations	3	1	0	4
Total (5L+5T+1L)						**22**

BBA-FinTech

II Year II Semester

0	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-12	Business Law & Environment	3	1	0	4
2	CC-13	Production & Operations Management	3	1	0	4
3	CC-14	Project Management	3	1	0	4
4	SEC-4	Business Plan Preparation Seminar	0	0	6	3
5	SEC-5	Data Analysis and Visualization	0	0	4	2
6	DSE-2	Introduction to Python and Introduction to R-Programming	3	1	0	4
Total (4L+4T+2L)						**21**

BBA-FinTech

III Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-15	E-Commerce	3	1	0	4
2	CC-16	Management Information System	3	1	0	4
3	GE-2	7. Business Forecasting 8. International Business 9. Sales and Distribution Management	3	1	0	4
3	DSE-3	Applications of AI, InsurTech and Real estate Technology	3	1	0	4
4	DSE-4	Lending, Crowd funding and Modern Investing	3	1	0	4
5		Internship	0	0	6	3
Total (5L+5T+1 internship)						**23**

BBA-FinTech

III Year II Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-15	Fundamentals of Entrepreneurship	3	1	0	4
2	DSE-5	Open Elective 1. Financial Risk Analytics 2. Technology Disruptions in Fintech 3. Insurtech 4. Big Data	3	1	0	4
3	DSE-6	Blockchain and Applications	3	1	0	4
4		Comprehensive Viva-Voce	0	0	0	2
5		Project	0	0	20	10
Total (3L+3T+1 Project+1 Viva)						**24**

Summary of Courses with Credits for BBA

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** (Human Values of Professional Ethics, Gender sensitization)	2	2	4
2	**Skill Enhancement Courses (SEC)** (Productive Tools-lab, LRQA, Mini Project and Report Writing, Business Plan Preparation Seminar, Data Analysis and Visualization)	5	4*2 1*3	11
3	**Language Courses (LC)** (English for Empowerment, English Language Skills lab, The Power of Data Storytelling, Art of Articulation Lab	4	2*3 2*1	8
4	**Core Courses (CC)**	17	4	68
5	**Discipline Specific Electives (DSE)**	6	4	24
6	**Generic Electives (GE)**	2	4	8
7	**Project (PROJ)**	1	10	10
8	**Comprehensive Viva-voce**	1	2	2
9	**Internship**	1	3	3
		39		**138**

BBA- Supply Chain Management

I Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-1	Principles & Practices of Management	3	1	0	4
2	CC-2	Managerial Economics	3	1	0	4
3	CC-3	Financial Accounting	3	1	0	4
4	CC-4	Business Mathematics	3	1	0	4
5	SEC-1	Productive Tools- Lab	0	0	4	2
6	LC-E1	English for Empowerment	3	0	0	3
7	LC-E2	English Language Skills lab	0	0	2	1
8	AECC-1	Gender Sensitization	2	0	0	2
Total (6L+4T+2L)						**24**

BBA- Supply Chain Management

I Year II Semester

S. N0	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Introduction to Human Resource Management	3	1	0	4
2	CC-6	Introduction to Marketing Management	3	1	0	4
3	CC-7	Introduction to Financial Management	3	1	0	4
4	CC-8	Business Statistics-I	3	1	0	4
5	SEC-2	Logical Reasoning and Quantitative Analysis (LRQA)	1	1	0	2
6	LC-E3	The Power of Data Storytelling	3	0	0	3
7	LC-E4	Art of Articulation Lab	0	0	2	1
8	AECC-2	Human Values of Professional Ethics	2	0	0	2
Total (7L+5T+1L)						**24**

BBA- Supply Chain Management

II Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-9	Business Research	3	1	0	4
2	CC-10	Business Analytics	3	1	0	4
3	CC-11	Organizational Behavior	3	1	0	4
4	GE-1	10. Business Statistics-II 11. Tax Management ***12.*** Innovation and Technology Management	3	1	0	4
5	SEC-3	Mini Project and Report Writing	0	0	4	2
6	DSE-1	Warehouse Management	3	1	0	4
Total (5L+5T+1L)						**22**

BBA- Supply Chain Management

II Year II Semester

0	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-12	Business Law & Environment	3	1	0	4
2	CC-13	Production & Operations Management	3	1	0	4
3	CC-14	Project Management	3	1	0	4
4	SEC-4	Business Plan Preparation Seminar	0	0	6	3
5	SEC-5	Data Analysis and Visualization	0	0	4	2
6	DSE-2	Supply Chain Management	3	1	0	4
Total (4L+4T+2L)						**21**

BBA- Supply Chain Management

III Year I Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-15	E-Commerce	3	1	0	4
2	CC-16	Management Information System	3	1	0	4
3	GE-2	10. Business Forecasting 11. International Business 12. Sales and Distribution Management	3	1	0	4
3	DSE-3	Supply Chain Logistics	3	1	0	4
4	DSE-4	Supply Chain Operations	3	1	0	4
5		Internship	0	0	6	3
Total (5L+5T+1 internship)						**23**

BBA- Supply Chain Management

III Year II Semester

Sl. No	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-15	Fundamentals of Entrepreneurship	3	1	0	4
2	DSE-5	Open Electives 1. Supply Chain Analytics 2. SCM Strategy 3. Supply Chain Principles	3	1	0	4
3	DSE-6	Customer Analytics	3	1	0	4
4		Comprehensive Viva-Voce	0	0	0	2
5		Project	0	0	20	10
Total (3L+3T+1 Project+1 Viva)						**24**

Summary of Courses with Credits for BBA

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** **(**Human Values of Professional Ethics, Gender sensitization)	2	2	4
2	**Skill Enhancement Courses (SEC)** (Productive Tools-lab, LRQA, Mini Project and Report Writing, Business Plan Preparation Seminar, Data Analysis and Visualization)	5	4*2 1*3	11
3	**Language Courses (LC)** **(**English for Empowerment, English Language Skills lab, The Power of Data Storytelling, Art of Articulation Lab	4	2*3 2*1	8
4	**Core Courses (CC)**	17	4	68
5	**Discipline Specific Electives (DSE)**	6	4	24
6	**Generic Electives (GE)**	2	4	8
7	**Project (PROJ)**	1	10	10
8	**Comprehensive Viva-voce**	1	2	2
9	**Internship**	1	3	3
		39		**138**

Item 7

Presentation of the minutes of the BoS in Agricultural Sciences, along with the course structure and syllabi of the B.Sc (Hons) Agriculture program to be offered by the School of Agricultural Sciences from the academic year 2021-22

School of Agricultural Sciences

Minutes of the First Board Of Studies meeting to finalize the syllabus for B.Sc (Hons) Agriculture Held On 12th JUNE 2021 At 10.00 AM Virtually

Members Present

1. Dr. P.Narayan Reddy, Dean , School of Agricultural Sciences , Anurag University.
2. Dr. M. Devender Reddy , Dean, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Gajapathi, Pitamahal, Orissa
3. Dr. P.Chandrasekhar Rao, Dean of P.G. Studies (Retired), PJTSAU, Rajendranagar, Hyderabad
4. Dr. A.Manohar Rao, Professor (Retired), PJTSAU, Hyderabad
5. Dr. D.Raja Ramreddy, Dean of Student Affairs(Retired), PJTSAU, Rajendranagar
6. Sri. G.V. Subba Reddy,Vice President Marketing, Coramadel International Ltd, Secunderabad
7. Dr. P. Krishna Redd, Professor, IIIT, Gachibowli, Hyderabad
8. Dr. M.P. Thakur, Dean, Faculty of agriculture Indira Gandhi Krishi Vishwa Vidyalaya, Raipur
9. Dr. B.Sharath Babu, Director, (Retired), NBPGR,Hyderabad
10. Dr.Kareemulla, (Special Invitee), Senior scientist, NAARM, Rajendranagar, Hyderabad

The first meeting of board of studies committee constituted for finalizing the syllabus of B.Sc(Hons) Agriculture course was conducted on 12-06-2021 virtually under the chairmanship of Dr. P.Narayan Reddy, Dean School of Agricultural Sciences Anurag University. It is decided to follow the syllabus recommended by Indian Council of Agricultural Research (ICAR) with some changes as permitted by ICAR to suit local needs and finalized the following course structure for four years and the syllabus for the first year.

1. It is resolved to introduce a course on I T workshop in the first year
2. To introduce Python language course in the second year
3. To introduce an elective course on IOT, AI and machine learning applications in agriculture
4. Resolved to discuss and finalize changes in second and third year syllabus in Agricultural economics to include more topics in marketing and market intelligence

5. Resolved to follow the following credits for the four years duration of the course

Total number of credits = 185

Up to Third of credits= 145 (Theory 79 + Practical 57) + Elective Courses =09

Fourth year first semester; Rural Agricultural Work Experience (RAWE) Agro Attachment (AIA) = 20

Second semester: Experiential Learning Programme (ELP)/Hand on Training (HOT) = 20

Department wise Distribution of Courses

Agronomy

S. No	Course No	Department and Title of Course	Credits
1	AGRO 101	Agriculture Heritage*	1(1+0)*
2	AGRO 102	Fundamentals of Agronomy	3(2+1)
3	AGRO 103	Introductory Agrometeorology and Climate Change	2 (1+1)
4	AGRO 104	Introduction to Forestry	2 (1+1)
5	AGRO 201	Crop Production Technology – I (Cereals, Millets and Pulses)	3 (2+1)
6	AGRO 202	Crop Production Technology –II	3 (2+1)
7	AGRO 203	Farming Systems and Sustainable Agriculture	1 (1+0)
8	AGRO 204	Irrigation Water Management	2 (1+1)
9	AGRO 301	Geoinformatics and Nanotechnology for Precision Farming	2 (1+1)
10	AGRO 302	Practical Crop Production	1 (0+1)
11	AGRO 303	Rainfed Agriculture & Watershed Management	2(1+1)
12	AGRO 304	Principles of Organic Farming	2(1+1)
TOTAL			**24(14+10)**

Genetics and Plant Breeding

S. No	Course No	Department and Title of Course	Credits
1	GPBR 111	Fundamentals of Genetics	3(2+1)
2	GPBR 211	Fundamentals of Plant Breeding	3(2+1)
3	GPBR 311	Crop Improvement-I (Cereals, Millets, Pulses and Oilseeds)	2 (1+1)
4	GPBR 312	Crop Improvement-II (Fibres, Sugars, Starches, Narcotics, Vegetables, Fruits and Flowers)	2 (1+1)
5	GPBR 313	Intellectual Property Rights	1(1+0)
6	GPBR 314	Principles of Seed Technology	3(2+1)
TOTAL			**14(9+5)**

Soil Science and Agricultural Chemistry

S. No	Course No	Department and Title of Course	Credits
1	SSAC 121	Fundamentals of Soil Science	3(2+1)
2	SSAC 221	Manures, Fertilizers and Soil Fertility Management	3(2+1)
3	SSAC 321	Problematic Soils and their Management	2(1+1)
		TOTAL	**8(5+3)**

Entomology

S. No	Course No	Department and Title of Course	Credits
1	ENTO 131	Fundamentals of Entomology I (Insect Morphology and Taxonomy)	3(2+1)
2	ENTO 231	Fundamentals of Entomology II (Insect Ecology and Concepts of IPM)	2(1+1)
3	ENTO 331	Pests of Field crops & Stored Grain and their Management	3(2+1)
4	ENTO 332	Pest of Horticultural Crops and their Management and Beneficial insects	3(2+1)
		TOTAL	**11(7+4)**

Agricultural Economics

S. No	Course No	Department and Title of Course	Credits
1	AECO 141	Fundamentals of Economics	3 (3+0)
2	AECO 241	Agricultural Finance and Co-operation	2 (1+1)
3	AECO 242	Agricultural Marketing, Trade and Prices	3 (2+1)
4	AECO 341	Farm Management, Production and Resource Economics	2 (1+1)
		TOTAL	**10(7+3)**

Agricultural Engineering

S. No	Course No	Department and Title of Course	Credits
1	AENG 151	Soil and Water Conservation Engineering	2(1+1)
2	AENG 251	Farm Machinery and Power	2 (1+1)
3	AENG 252	Renewable Energy and Green Technology	2 (1+1)
4	AENG 351	Protected Cultivation and Post-harvest technologies	2 (1+1)
		TOTAL	**8 (4+4)**

Crop Physiology

S. No	Course No	Department and Title of Course	Credits
1	CPHY 161	Introductory Biology*	2(1+1)*
2	CPHY 162	Fundamentals of Crop Physiology	3(2+1)
3	CPHY 261	Eco-physiology	2(1+1)
4	CPHY 361	Environmental Studies and Disaster Management	2(1+1)
		TOTAL	**9 (5+4)**

Plant Pathology

S. No	Course No	Department and Title of Course	Credits
1	PATH 171	Fundamentals of Plant Pathology I	3(2+1)
2	PATH 271	(Plant Pathogens – An Introduction) Fundamentals of Plant Pathology II	2(1+1)
3	PATH 371	(Plant Pathology Principles) Diseases of Field and Horticultural	3 (2+1)
4	PATH 372	Crops and their Management -I (Field Crops) Diseases of Field and Horticultural Crops	2 (1+1)
5	PATH 373	and their Management-II (Horticultural Crops) Principles of Integrated Pest and Disease Management	2(1+1)
		TOTAL	**12 (7+5)**

Horticulture

S. No	Course No	Department and Title of Course	Credits
1	HORT 181	Fundamentals of Horticulture	2 (1+1)
2	HORT 182	Production Technology of Fruits and Plantation Crops	2 (1+1)
3	HORT 281	Production Technology for Vegetables and Spices	2 (1+1)
4	HORT 282	Production Technology for Ornamental Crops, Medicinal & Aromatic Plants and Landscaping	2 (1+1)
5	HORT 381	Post-harvest Management and Value Addition of Fruits and Vegetables	2 (1+1)
TOTAL			**10 (5+5)**

Agricultural Extension

S. No	Course No	Department and Title of Course	Credits
1	AEXT 190	Human Values & Ethics (non gradial)	1(1+0)**
2	AEXT 191	Rural Sociology & Educational Psychology	2(1+1)
3	AEXT 291	Fundamentals of Agricultural Extension	3(2+1)
4	AEXT 292	Entrepreneurship Development and Business Communication	2(1+1)
5	AEXT 391	Communication Skills and Personality Development	2(1+1)
TOTAL			**10 (6+4)**

Biochemistry and Biotechnology

S. No	Course No	Department and Title of Course	Credits
1	BICM 101	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
2	BICM 300	Principles of Food Science and Nutrition	2(2+0)
TOTAL			**5 (4+1)**

Animal Production

S. No	Course No	Department and Title of Course	Credits
1	LSPM 201	Live-stock and Poultry Management	3 (2+1)
TOTAL			**3 (2+1)**

Agricultural Microbiology

S. No	Course No	Department and Title of Course	Credits
1	AMBE 101	Agricultural Microbiology	2(1+1)
TOTAL			2(1+1)

Statistics and Computer Applications

S. No	Course No	Department and Title of Course	Credits
1	SMCA 101	Elementary Mathematics*	2(1+1)*
2	SMCA 102	IT WORKSHOP	1(0+1)
3	SMCA 201	Statistical Methods	2(1+1)
4	SMCA 202	PYTHON LANGAUGE	1(0+1)
TOTAL			6(3+3)

English

S. No	Course No	Department and Title of Course	Credits
1	ENGL 101	Comprehension & Communication Skills in English	2 (1+1)
TOTAL			2 (1+1)

Physical Education

S. No	Course No	Department and Title of Course	Credits
1	COCA 100	NSS/NCC/Physical Education & Yoga Practices**	2 (0+2)**
2	COCA 200	Education Tour**	2 (0+2)**
TOTAL			4(0+4)**

Elective Courses

Agronomy

S. No	Course No	Department and Title of Course	Credits
1	ELCT 305	Agricultural Waste Management	3(2+1)
2	ELCT 306	Weed Management	3(2+1)

Genetics and Plant Breeding

3	ELCT 315	Commercial Plant Breeding	3(1+2)

Soil Science and Agricultural Chemistry

4	ELCT 222	Soil, Plant, Water and Seed Testing	3(1+2)

Entomology

5	ELCT 333	Bio pesticides and Bio fertilizers	3(2+1)
6	ELCT 334	Agrochemicals	3(2+1)

Agricultural Economics

7	ELCT 342	Agribusiness Management	3(2+1)

Plant Physiology

8	ELCT 362	Micro-propagation Technologies	3(1+2)

Plant Pathology

9	ELCT 272	Food Safety Issues	3(2+1)

Horticulture

10	ELCT 283	Hi-tech. Horticulture	3(2+1)
11	ELCT 382	Landscaping	3(2+1)
12	ELCT 383	Protected Cultivation	3(2+1)

Statistics and Computer Applications

13	ELECT 307	IOT, AI and Machine learning applications in Agriculture	3(2+1)
TOTAL			**39(23+16)**

Semester wise Distribution of Courses

I Semester

S. No	Course No	Course Title	Credits
1	AGRO 101	Agriculture Heritage*	1(1+0)*
2	AGRO 102	Fundamentals of Agronomy	3(2+1)
3	BICM 101	Fundamentals of Plant Biochemistry and Biotechnology	3(2+1)
4	ENGL 101	Comprehension and Communication Skills in English	2 (1+1)
5	SMCA 101	Elementary Mathematics*	2(1+1)*
6	SMCA102	IT Worksop	1(0+1)
7	SSAC 121	Fundamentals of Soil Science	3(2+1)
8	AECO 141	Fundamentals of Economics	3(3+0)
9	HORT 181	Fundamentals of Horticulture	2 (1+1)
10	AEXT 190	Human Values and Ethics (non gradial)	1(1+0)**
11	AEXT 191	Rural Sociology and Educational Psychology	2 (1+1)
12	COCA 100	NSS/NCC/Physical Education and Yoga Practices**	2 (0+2)**
TOTAL			**25 (15+10)**

II Semester

S. No	Course No	Course Title	Credits
1	AMBE 101	Agricultural Microbiology	2(1+1)
2	AGRO 103	Introductory Agrometeorology and Climate Change	2 (1+1)
3	AGRO 104	Introduction to Forestry	2 (1+1)
4	GPBR 111	Fundamentals of Genetics	3(2+1)
5	ENTO 131	Fundamentals of Entomology I (Insect Morphology and Taxonomy)	3(2+1)
6	AENG 151	Soil and Water Conservation Engineering	2(1+1)
7	CPHY 162	Fundamentals of Crop Physiology	3(2+1)
8	PATH 171	Fundamentals of Plant Pathology I	3(2+1)
9	HORT 182	(Plant Pathogens - An Introduction) Production Technology of Fruits and Plantation Crops	2 (1+1)
		TOTAL	**22 (13+9)**

III Semester

S. No	Course No	Course Title	Credits
1	AGRO 201	Crop Production Technology - I (Cereals, Millets and Pulses)	3 (2+1)
2	GPBR 211	Fundamentals of Plant Breeding	3 (2+1)
3	ENTO 231	Fundamentals of Entomology II (Insect Ecology and Concepts of IPM)	2(1+1)
4	AECO 241	Agricultural Finance and Co-operation	2 (1+1)
5	AENG 251	Farm Machinery and Power	2 (1+1)
6	CPHY 261	Eco-physiology	2(1+1)
7	PATH 271	Fundamentals of Plant Pathology II (Plant Pathology Principles)	2(1+1)
8	HORT 281	Production Technology for Vegetables and Spices	2 (1+1)
9	AEXT 291	Fundamentals of Agricultural Extension	3(2+1)
10	COCA 200 SMCA202	Education Tour** Python language	2(0+2) 1(0+1)

TOTAL			**24 (12+11/)**

IV Semester

S. No	**Course No**	**Course Title**	**Credits**
1	AGRO 202	Crop Production Technology - II (Oilseeds, Fibre, Sugar, Tobacco and Fodder crops)	3 (2+1)
2	AGRO 203	Farming Systems and Sustainable Agriculture	1 (1+0)
3	AGRO 204	Irrigation Water Management	2 (1+1)
4	SMCA 201	Statistical Methods	2(1+1)
5	LSPM 201	Live-stock and Poultry Management	3 (2+1)
6	SSAC 221	Manures, Fertilizers and Soil Fertility Management	3(2+1)
7	AECO 242	Agricultural Marketing, Trade and Prices	3 (2+1)
8	AENG 252	Renewable Energy and Green Technology	2 (1+1)
9	HORT 282	Production Technology for Ornamental Crops, Medicinal and Aromatic Plants and Landscaping	2 (1+1)
10	AEXT 292	Entrepreneurship Development and Business Communication	2(1+1)
11	ELCT222/272/283/307	Elective Course	3 credit
TOTAL			23 (14+09) + 3 credit***

V Semester

S. No	Course No	Course Title	Credits
1	AGRO 301	Geoinformatics and Nanotechnology for Precision Farming	2 (1+1)
2	AGRO 302	Practical Crop Production	1 (0+1)
3	BICM 300	Principles of Food Science and Nutrition	2(2+0)
4	GPBR 311	Crop Improvement - I (Cereals, Millets, Pulses and Oilseeds)	2 (1+1)
5	GPBR 313	Intellectual Property Rights	1(1+0)
6	SSAC 321	Problematic Soils and their Management	2(1+1)
7	ENTO 331	Pests of Field crops and Stored Grain and their Management	3 (2+1)
8	AENG 351	Protected Cultivation and Post-harvest technologies	2 (1+1)
9	CPHY 361	Environmental Studies and Disaster Management	2(1+1)
10	PATH 371	Diseases of Field and Horticultural Crops and their Management - I (Field Crops)	3 (2+1)
11	PATH 373	Principles of Integrated Pest and Disease Management	2(1+1)
12	ELCT305/333/342/362/382	Elective Course	3 credit
TOTAL			22 (13+9) + 3 Credit***

VI Semester

S. No	Course No	Course Title	Credits
1	AGRO 303	Rainfed Agriculture and Watershed Management	2(1+1)
2	AGRO 304	Principles of Organic Farming	2(1+1)
3	SMCA 301	Agriculture Informatics	2(1+1)
4	GPBR 312	Crop Improvement-II (Fibre, Sugar, Starches, Narcotics, Vegetables, Fruits and Flowers)	2(1+1)
5	GPBR 314	Principles of Seed Technology	3 (2+1)
6	ENTO 332	Pest of Horticultural Crops and their Management and Beneficial insects	3 (2+1)
7	AECO 341	Farm Management, Production and Resource Economics	2(1+1)
8	PATH 372	Diseases of Field and Horticultural Crops and their Management - II (Horticultural Crops)	2(1+1)
9	HORT 381	Post-harvest Management and Value Addition of Fruits and Vegetables	2(1+1)
10	AEXT 391	Communication Skills and Personality Development	2(1+1)
11	ELCT 306/315/334/383	Elective Course	3 credit
*Remedial **Non gradial *** Elective Courses		**TOTAL**	*22 (12+10)+ 3 Credit****

VII Semester

S. No	Course No	Course Title	Credits
1	RAWE	Rural Agricutural Work Experience (RAWE) and Agro Industrial Attachment (AIA)	
2		Crop Production	5 (0+5)
3		Crop Protection	4 (0+4)
4		Rural Economics	3 (0+3)
5		Extension Programme	4 (0+4)
6		Research Station / KVK /DAATT Centre activities and attachment to Agro based industries	4 (0+4)
		TOTAL	*20(0+20)*

VIII Semester

S. No	Course No	Course Title	Credits
1	AELP	Experiential Learining Programme (ELP)	20 (0+20)
TOTAL			20(0+20)

Elective Courses

S. No	Course No	Course Title	Credits
1	ELCT 222	Soil, Plant, Water and Seed Testing	3(1+2)
2	ELCT 272	Food Safety Issues	3(2+1)
3	ELCT 283	Hi-tech. Horticulture	3(2+1)
4	ELCT 305	Agricultural Waste Management	3(2+1)
5	ELCT 306	Weed Management	3(2+1)
6	ELCT 315	Commercial Plant Breeding	3(1+2)
7	ELCT 333	Biopesticides and Biofertilizers	3(2+1)
8	ELCT 334	Agrochemicals	3(2+1)
9	ELCT 342	Agribusiness Management	3(2+1)
10	ELCT 362	Micro propagation Technologies	3(1+2)
11	ELCT 382	Landscaping	3(2+1)
12	ELCT 383	Protected Cultivation	3(2+1)
TOTAL			20(0+20)

Detailed syllabus and lecture out lines for first and second semester courses of first year beginning 2021-22 academic year

AGRONOMY First Year

AGRO101 AGRICULTURE HERITAGE 1(1+0)

Course outlines Theory

Introduction of Indian agricultural heritage, status of farmers in society, advice by sages to kings on their duties towards farmers, soil management in ancient, medieval & pre-modern India and its relevance in modern day sustainable agriculture, heritage of crop & water management, plant growth and development & plant protection through vrikshayurveda and traditional knowledge. Heritage of medicinal plants and their relevance today, seed health in ancient & medieval history and its relevance to present day agriculture, description of Indian civilization and agriculture by travelers from China, Europe and United States, our journey in agriculture, green revolution and its impact and concerns, vision for the future.

Lectures outlines Theory

1. Introduction to Indian agricultural heritage – Definition of heritage, agriculture heritage - Need to study agriculture heritage
2. Genesis of agriculture and its chronological arrangement - Homes of evolution of agriculture and "old and new'' world - Early indigenous domestications.
3. Status of farmers in society and specific role of women in ensuring food security- Farming systems in ancient periods.
4. Status of agriculture and advice by sages to kings on their duties towards farmers- Importance of farmers - Ancient agricultural practices and scientific basis.
5. Soil management in ancient, medieval, pre- modern India - Historical background - Soil management and its relevance in pre-modern India and modern day sustainable agriculture - Use of amendments - Land management, Piercing, tillage, puddling and pre-plant submergence, mulching, fallowing.
6. Soil concept - Ancient systems of soil classification - Ancient systems of soil management - Medieval and pre modern soil management.
7. Heritage of crop and water management – Ancient and pre-historic period; Medieval period.
8. Plant growth and development- Heritage of plant protection through vrikshayurveda and traditional Knowledge
9. Plant protection in ancient India - Plant disorders – Cause, symptoms, treatment materials.
10. Traditional knowledge in crop production and water management
11. Heritage of medicinal plants and their relevance today
12. Seed health in ancient and medieval history and its relevance to present day agriculture-seed health in Hellenistic age – seed health in India - Materials recommended for seed treatments.
13. Description of Indian civilization and agriculture by travellers from China, Europe and USA.
14. Pre-historic cropping patterns.
15. Our journey in agriculture-Green revolution and its impact and concerns.

16. Vision for the future – Challenges ahead.

References

1. Choudary S.L, Sharma, G.S, and Nene, Y.L (eds). 2000. Ancient and Medieval History of Indian agriculture and its relevance to sustainable agriculture in the 21st century; Proceedings of the summer school held from 28 May to 17 June 1999. Rajasthan college of Agriculture, Udaipur 313001.
2. Nene, Y.L (Ed). 2005. Agricultural Heritage of Asia proceedings of the international conference, 6-8 December 2004, Asian-Agri history Foundation, Secunderabad- 500 009, Andhra Pradesh, India.
3. Nene, Y.L 2007. Glimpses of Agricultural heritage of India. Asian- Agri- History Foundation, 47 – ICRISAT Colony-1 Brig sayeed Road, Secunderabad -500009 A.P India 901PP ISBN-81-903963-0-7.

Course outlines Theory

Agronomy and its scope; Seeds and sowing, tillage and tilth, crop density and geometry; Crop nutrition, manures and fertilizers, nutrient use efficiency; Water resources, soil plant water relationship, crop water requirement, water use efficiency; Irrigation, scheduling criteria, methods, quality of irrigation water and water logging.

Weeds, importance, classification, crop weed competition, concepts of weed management, principles and methods; Herbicides, classification, selectivity, resistance , allelopathy; Growth and development of crops, factors affecting growth and development, plant ideotypes; Crop rotation and its principles; Adaptation and distribution of crops, crop management technologies in problematic areas; Harvesting and threshing of crops.

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements; Effect of sowing depth on germination and seedling vigour; Identification of weeds in crops, methods of herbicide and fertilizer application; Study of yield contributing characters, yield estimation, seed germination and viability test; Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement: Use of tillage implements, reversible plough, one way plough, harrow, leveler and seed drill; Study of soil moisture measuring devices, measurement of field capacity, bulk density and infiltration rate and measurement of irrigation water.

Lecture outlines Theory

1. Agriculture - Agronomy and its scope- Role of Agronomists in resource management for crop production
2. Tillage and tilth - Objectives of tillage- Characteristics of ideal seed bed- Effect of tillage on soil properties
3. Types of tillage-Factors affecting tillage and seedbed preparation-After cultivation- Puddling.
4. Concepts of tillage – Minimum tillage, zero tillage, strip tillage, conservation tillage and their advantages and limitations.
5. Seeds and sowing- Characteristics of good quality of seed, seed treatment, agronomic significance of seed purity and quality - Methods of sowing, importance of time and depth of sowing.
6. Crop density and geometry - Crop stand establishment, factors affecting optimum stand establishment.
7. Plant population – Competition, types of competition, intra and inter plant competition - Effect of plant population on growth and yield, optimum plant density and planting pattern.
8. Soil fertility and soil productivity – Soil organic matter and its importance - Loss of soil fertility and its maintenance.
9. Crop nutrition – Essential plant nutrients- Primary, secondary and micro nutrients – Nutrient uptake – Nutrient use efficiency
10. Manures and fertilizers- Types of manures and fertilizers - Factors influencing methods and time of fertilizer application - Bio-fertilizers..
11. Irrigation - Importance of Irrigation - Objectives of irrigation - Methods of irrigation and water use

efficiency

12 Crop growth and development - Factors affecting growth and development - Agronomic manipulation of crop growth and development.

13 Plant ideotypes – Concept, definition-Morphological and physiological characteristics of new plant types.

14 Cropping pattern, Cropping system (navadhanya concept) - Crop rotation – Principles of crop rotation - Mono cropping and its disadvantages – Types of cropping systems-Mixed, multiple, intercropping, relay and multistoried cropping

15 Crop adaptation and distribution in India and Andhra Pradesh - Factors influencing crop adaptation and distribution.

16 Common problems in crop production related to climate, soil, pest and disease incidence - Crop management technologies to overcome the problems identified.

17 Dryfarming, dryland farming and rainfed farming – Classification of climate – Problems of crop production in dry areas.

18 Soil moisture conservation and water harvesting measures – Watershed: Objectives and components – Watershed management

19 Weed–Definition–Importance-Harmful and beneficial effects of weeds–Aquatic weeds

20 Classification of weeds - Based on morphology, life cycle, habitat, origin, association and special features with examples

21 Propagation of weeds–Sexual–Asexual-Vegetative (Rhizomes, rootstocks, runners, stolons, suckers, offsets, tubers, bulbs, bulbils, stems and roots)

22 Weed biology- Characteristic features of weeds, weed ecology – Persistence of weeds, climatic, edaphic and biotic factors.

23 Crop weed association – Factors affecting crop weed competition- Common weeds associated with major crops like rice, maize, wheat, sorghum, pulses, groundnut, sugarcane, cotton, and tobacco

24 Crop-weed-competition - Critical period of crop weed competition – Allelopathy.

25 Methods of weed management - Prevention, control and eradication – Physical, mechanical and cultural methods - Chemical and biological methods of weed control
– Integrated weed management

26 Herbicides- Definition, advantages and limitations of herbicide usage in India.- Bioherbicides

27 Classification of herbicides based on chemical nature, time and method of application

28 Herbicidal formulations – active ingredient- Acid equivalent- Nomenclature of herbicides.

29 Adjuvants and their use in herbicide application –Types of adjuvants with examples.

30 Mode of action of herbicides - Important biochemical modes of action of herbicides (especially interfering with photosynthesis and respiration).

31 Selectivity and resistance- Selectivity of herbicides - Fundamental principles of selectivity-Differences in morphology and growth habit of plants - Differential absorption and translocation of herbicides.

32 Harvesting and threshing of crops - Maturity symptoms of major crops - Time and methods of harvesting - Threshing and winnowing, drying and post harvesting storage of grains -Harvest

index and BC ratio.

Practical

1. Visit to college farm and identification of major crops and varieties
2. Practice of primary tillage implements and puddling
3. Practice of secondary tillage implements
4. Practice of seeding equipment , inter cultivation implements
5. Seed germination and viability test - Study of sowing depth on germination and seedlingvigour
6. Identification of manures, fertilizers and green manure crops/seeds.
7. Practice of manure and fertilizer application
8. Participation in ongoing field operations
9. Participation in ongoing field operations
10. Identification of weeds in field crops and other habitats
11. Study of weed flora in different weed management practices and calculation of herbicide efficiencies (WI & WCE)
12. Herbicide label information and computation of herbicide doses
13. Study of herbicide application equipment and calibration
14. Herbicide application and precautionarymeasures
15. Study of herbicide phytotoxicity symptoms in different crops
16. Identification of maturity symptoms of different crops

References

1. Reddy, S.R. 2016. Principles of Agronomy. Kalyani Publishers,Ludhiana - 5th edition
2. Yellamanda Reddy, T. and Sankara Reddi, G.H. (2016) Principles of Agronomy. Kalyani Publishers,Ludhiana.
3. Gopal Chandra de.1989.Fundamentals of Agronomy. Oxford & IBH Publishing Co. Pvt. Ltd. , New Delhi.
4. Gupta,O.P. 2011. Modern weed management. Agrobios (India), Jodhpur.

AGRO103 INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE 2(1+1)

Course outlines Theory

Earth atmosphere, composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, long wave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking; Monsoon,

mechanism and importance in Indian agriculture; Weather hazards, drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold- wave; Agriculture and weather relations, modifications of crop microclimate, climatic normals for crop and livestock production; Weather forecasting, types of weather forecast and their uses; Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological observatory, site selection of observatory, exposure of instruments and weather data recording; Measurement of total, shortwave and long wave radiation, and its estimation using Planck's intensity law; Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS; Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis, measurement of soil temperature and computation of soil heat flux; Determination of vapor pressure and relative humidity. determination of dew point temperature; Measurement of atmospheric pressure and analysis of atmospheric conditions; Measurement of wind speed and wind direction, preparation of windrose; Measurement, tabulation and analysis of rain; Measurement of open pan evaporation and evapotranspiration, computation of PET and AET

Lecture outlines Theory

1. Introduction: The three spheres of the earth; Terminology and definitions: Meteorology, Climatology, Agrometeorology, Agroclimatology climate and weather - Scope and importance of agrometeorology.
2. Agro climatic regions of India and Agroclimatic zones of Andhra Pradesh.
3. Atmosphere -Composition of the atmosphere-Weather elements- Extent and structure of the atmosphere.
4. Solar Radiation: Nature and properties of solar radiation - Conduction – Convection - Radiation - Solar Spectrum - Distribution of solar radiation within the crop canopies- Physiological response of different bands of incident radiation - Definitions of solar constant, net radiation, albedo - Solar radiation and crops
5. Temperature: Temperature and heat, definitions- Temperature inversion- Adiabatic lapse rate - Daily and seasonal variations of temperature – Vertical profile of temperature- Energy balance of earth
6. Low air temperature and plant injury and high air temperature and plant injury- Soil temperature-

Factors affecting soil temperature-Temperature and crops.

7. Humidity: Concept of saturation- Vapour pressure- Types of humidity- Humidity and crops- Atmospheric Pressure: Definitions of pressure, atmospheric pressure, standard atmospheric pressure

8. Wind:Types of wind; Planetary winds (trade winds, westerlies, polar easterlies, cyclones and anti cyclones) periodic winds and local winds (sea and land breezes,

mountain and valley winds) Daily and seasonal variation of winds- Effect of wind on crops

9. Precipitation: Process of precipitation, types of rainfall(orographic, convectional and cyclonic)- Definition of cloud – WMO classification of clouds.

10. Forms of precipitation (solid, liquid and mixed) and condensation (dew, fog, mist, frost, cloud) - Artificial rain making- Monsoon:Indian monsoons, SW monsoon & NE monsoon.

11. Importance of monsoon in Indian agriculture- date of onset, significant features of Indian monsoon; length of growing season.

12. Weather hazards: Drought-Floods-Cyclones-Heat and cold-waves and their management.

13. Weather Forecasting: Importance-Types of weather forecast and their uses-Synoptic charts - Remote sensing-Applications of remote sensing in agriculture - Agrometeorological Advisory services in India.

14. Climate change- variability-Global processes and effects- Green house effect- Temperature changes on the earth- Precipitation changes on the earth- Changes in extreme events- Sea level raising-Tracking climate change- Impacts of climate change on agriculture- Climate neutral

15. Summary of evidence for climate change- Basic models for evaluating climate change Impacts - Specific weather related effects due to climate change.

16. Micro climate- micro climate scales – Modifications of crop microclimate - Examples of manipulation of climate-Climatic normals for crop and livestock production

Practical

1. Visit to Agrometeorological Observatory, site selection and layout plan for observatory.
2. Exposure to agrometeorological instruments and weather data recording.
3. Measurement of total, shortwave and longwave radiation and its estimation by using Planck's intensity law.
4. Measurement of albedo and sunshine duration.
5. Computation of radiation Intensity using bright sun shine hours.
6. Measurement of maximum and minimum air temperatures and interpretation of decennial temperature data.
7. Tabulation of maximum and minimum air temperatures, trend and variation analysis for climate change of the region.
8. Measurement of soil temperature and computation of soil heat flux.
9. Determination of atmospheric pressure and vapour pressure.
10. Determination of relative humidity.
11. Determination of dew point temperature- Measurement of atmospheric pressure and analysis of atmospheric conditions.
12. Measurement of wind speed and wind direction, preparation of windroses- Measurement,

tabulation and analysis of rainfall data.

13. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET- Preparation of synoptic chart and report
14. Computation of climate change and variability
15. Crop planning for climate change
16. GDD, HTU and PTU calculations and their interpretation using their efficiencies

References

1. Radha Krishna Murthy,V.2016. Principles and practices of agricultural disaster management. B.S Publications, Koti, Hyderabad.
2. Reddy, S.R.2014. Introduction to Agriculture and Agrometeorology. Kalyani Publishers, Ludhiana, Punjab.
3. Radha Krishna Murthy, V. 2002. Basic Principles of Agricultural meteorology. B.S Publications, Koti, Hyderabad.

Course outlines Theory

Introduction, definitions of basic terms related to forestry; Objectives of silviculture, forest classification, salient features of Indian forest policies; Forest regeneration, natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; Artificial regeneration, objectives, choice between natural and artificial regeneration, essential preliminary considerations. Crown classification. Tending operations, weeding, cleaning, thinning, mechanical, ordinary, crown and advance thinning; Forest mensuration, objectives, diameter measurement, instruments used in diameter measurement; Non instrumental methods of height measurement, shadow and single pole method, instrumental methods of height measurement, geometric and trigonometric principles, instruments used in height measurement, tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees; Agroforestry, definitions, importance, criteria of selection of trees in agroforestry, different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens; Cultivation practices of two important fast growing tree species of the region.

Practical

Identification of tree-species, diameter measurements using calipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees; Height measurement of standing trees by shadow method, single pole method and hypsometer; Volume measurement of logs using various formulae; Nursery lay out, seed sowing, vegetative propagation techniques; Forest plantations and their management, visits to nearby forest based industries.

Lecture outlines Theory

1. Introduction–definitions of basic terms related to forestry, Indian forest, target area, productivity
2. Influence of forest on climate, soil, floods, erosion, human health and recreation.
3. Objectives of silviculture, forest classification, salient features of Indian forest policies.
4. Forest regeneration, Naturals regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers.
5. Artificial regeneration – objectives, choice between natural and artificial regeneration, planting methods, essential preliminary considerations. Crown classification.
6. Tending operations – weeding, cleaning, thinning – mechanical, ordinary, crown and advance thinning.
7. Principles and practices of social forestry nurseries- types of nurseries - success in nursery production.
8. Afforestation in different sites - shifting sand dunes, saline soils, ravine lands, wet lands, lateritic soils, dry rocky soils, canal banks, road sides and watershed areas.
9. Village wood lots, selection of species - measures for shortage of fuel wood- Properties of fuel wood- management and advantages of energy plantations- Suitable tree species
10. Forest mensuration – objectives, diameter measurement, instruments used in diameter measurement; Non instrumental methods of height measurement - shadow and single pole method;
11. Instrumental methods of height measurement - geometric and trigonometric principles, instruments used in height measurement;

12. Tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees.
13. Major and minor forest products
14. Agroforestry – definitions, importance, criteria of selection of trees in agroforestry
15. Different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens.
16. Cultivation practices of Subabul, Eucalyptus and Casuarina tree species.

Practical

1. Identification of tree-species.
2. Diameter measurements using calipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees.
3. Height measurement of standing trees by shadow method, single pole method and hypsometer.
4. Volume measurement of logs using various formulae.
5. Biomass estimation in energyplantations
6. Nursery lay out, seed sowing,
7. Application of pre-sowing seedtreatments
8. Vegetative propagation techniques.
9. Field planting techniques
10. Forest plantations and theirmanagement.
11. Identification of important major and minor forest products
12. Visits of nearby forest based industries.
13. Visit to social nurseries of forest department
14. Visit to energy plantations and forest research centres.
15. Visits to nearby forest based industries.
16. Collection and maintenance of forest products and herbarium

References

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2. Negi, S.S.1999. Agroforestry hand book, International book distributor, DehraDun.
3. Ram Prakash and Drake Hocking.1986. Some favourite trees for fuel and fodder, International book distributor, Dehradun.
4. Singh, S.P. 2009. Tree farming-. Agrotech Publishing academy, Udaipur.
5. Singh, S.P.2010. Favourite Agroforestry trees, Agrotech Publishing academy, Udaipur.
6. Troup, T.S.1986. Silviculture of Indian trees (Vol. II & III)- International book distributor, Dehradun.

Genetics and Plant breeding GPBR111

FUNDAMENTALSOFGENETICS *3(2+1)*

Course outlines Theory

Pre-Mendelian concepts of heredity; Mendelian principles of heredity; Cell division – mitosis and meiosis; Probability and Chi-square; Dominance relationships; Gene interaction; Multiple factor hypothesis; Epistatic interactions with examples; Multiple alleles; Linkage and its estimation; Crossing over mechanisms; Chromosome mapping; Pleiotropism and Pseudoalleles; Sex determination and sex linkage; sex limited and sex influenced traits; Structural changes in chromosome; Mutation-classification, mutagenic agents and methods of inducing mutation and ClB technique. Qualitative & quantitative traits; Polygenes and continuous variations; Cytoplasmic inheritance; Gene concept: Gene structure, function and regulation (eg. Lac operon); Nature, structure & replication of genetic material; Proteinsynthesis-Transcriptionandtranslationalmechanismsofgenetic material.

Practical

Studyofmicroscope; Studyofcellstructure; Experimentsonmonohybrid, dihybrid, trihybrid, test cross and back cross; Experiments on epistatic interactions including test cross and back cross; Practice on mitotic and meiotic cell division; Experiments on probability and Chi-square test; Determination of linkage and cross over analysis (through two point test cross and three point test cross data); Study of models on DNA and RNA structure.

Lecture outlines Theory

1. PreMendelianconceptsofheredity–Earlyhistoryofheredity, inheritanceofacquired traits, preformation theory, pangenesis and germplasm theory.
2. Chromosome - Structure of chromosome, types of chromosomes based on position of centromere.
3. Cell division – Cell cycle – Mitosis - Process of mitosis - Significance.
4. Meiosis - Process - Differences between mitosis and meiosis - Significance.
5. Mendelianprinciplesofheredity–Terminology, Mendel'sexperiments-Reasons for selection of pea as experimental material- characters studied - Reasons for mendel's success.
6. Mendel's laws — Law of segregation — Law of independent assortment — Principle of dominance – Principle of unit characters – Exceptions to mendel's laws – Rediscovery of mendelian principles.
7. Probability and Chi-square – Concept of probability, predicting results of a monohybrid cross, predicting results of a dihybrid cross - Chi-square test.
8. Dominance relationships – Complete dominance, incomplete dominance, co- dominance, over dominance, pseudodomiance, lethal factors.
9. Gene interaction - Nonepistatic interaction – Interaction of factors; epistatic interactions – Complementary epistasis, dominant epistasis.
10. Recessive epistasis, duplicate dominant gene action, dominant suppression or inhibitory gene action, duplicate genes with cumulative effect.
11. Multiple alleles – Characteristics of multiple alleles - Blood groups in humans, coat colour in rabbits, self incompatibility alleles in plants - pleiotropism, penetrance and expressivity.
12. Linkage – Definition – Classification of linkage – Characteristic features of linkage – Linkage groups.

13. Detection of linkage – Estimation of linkage - Importance of test cross in linkage studies - significance in plant breeding.

14. Crossing over mechanisms - Mechanism of crossing over – Types of crossing over – Factors affecting crossing over.

15. Significance of crossing over in plant breeding - Cytological proof of crossing over in *Drosophila*.

16. Chromosome mapping - 2-point and 3-point test cross – Cytological maps and genetical maps – Coincidence and interference.

17. Sex determination – Various mechanisms of sex determination – Chromosomal sex determination, genic balance mechanism of sex determination in *Drosophila melanogaster*, male haploidy, single gene effects etc.

18. Sex linkage – White eye colour in *Drosophila*, colour blindness and haemophilia in humans - sex influenced traits – Horns in sheep, baldness in humans, sex limited - Milk production in cattle, beard in man – Pseudohermaphrodites – Gynandromorphs.

19. Qualitative and Quantitative traits, Polygenes and continuous variations - Definition - Inheritance and their differences, multiple factor hypothesis.

20. Cytoplasmic inheritance – Definition – Chloroplast inheritance (leaf variegation in *Mirabilis jalapa)* - mitochondrial inheritance (cytoplasmic male sterility in maize) - Characteristic features of cytoplasmic inheritance - Differences between chromosomal and extrachromosomal inheritance.

21. Nature and structure of genetic material - DNA and its structure -Watson and Crick's model - Function – Experiments to prove DNA as genetic material.

22. Replication of DNA - Modes of DNA replication - Semi-conservative DNA replication - Experimental proof.

23. -Types of RNA - Messenger RNA, ribosomal RNA and transfer RNA - structure of tRNA, dfferences between DNA and RNA.

24. Protein synthesis – Central dogma, tanscription and translational mechanism of genetic material - Genetic code – Properties of genetic code – Wobble hypothesis.

25. Steps in protein synthesis - Transcription and translation.

26. Gene regulation - Lac operon concept – Gene concept – Cistron – Recon – Muton.

27. Mutation - Classification - Gene mutations - Introduction - Definition - Types of mutations - Spontaneous and induced mutations - Point mutations - Characters of mutations - Xenia and metaxenia – Chimeras Types and their significance in plant breeding.

28. Methods of inducing mutations, Physical and chemical mutagens - Detection of sex linked lethals in *Drosophila* (ClB method given by Muller).

29. Molecular basis of mutations - Transitions, transversions and frame shift mutations - Importance of mutations in plant breeding.

30. Structural changes in chromosome - Breakage - fusion - bridge cycle - Deletions (deficiency) - Duplications and their significance in plant breeding.

31. Inversions - pericentric inversions and paracentric inversions - inversions as cross over suppressors.

32. Translocations - simple and reciprocal - their role in plant breeding.

Practical

1. Study of microscope.
2. Study of cell structure.
3. Practice on mitotic cell division.
4. Practice on meiotic cell division.
5. Practice on meiotic cell division.
6. Probability and Chi-square test.
7. Monohybrid and its modifications.
8. Dihybrid.
9. Trihybrid.
10. Test cross and back cross.
11. Epistatic interactions including test cross and back cross.
12. Epistatic interactions including test cross and back cross.
13. Epistatic interactions including test cross and back cross.
14. Determination of linkage and cross over analysis (through two point test cross data).
15. Determination of linkage and cross over analysis (through three point test cross data).
16. Study of models on DNA and RNA structure.

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1. Pundhan Singh. 2006. *Genetics*. Kalyani Publishers, Ludhiana.
2. Singh, B.D. 2015. *Fundamentals of Genetics*. Kalyani Publishers, Ludhiana.
3. Gupta, P.K.2007. *Genetics*. Rastogi Publications, Meerut.
4. Khanna, V.K. 2002. *Genetics Numerical Problems*. Kalyani publishers. 2nd edition.
5. Pundhan Singh. 2011. *Genetics at a Glance*. Kalyani Publishers, Ludhiana.
6. Verma, P.S. and Agarwal, P.K. 2013. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand & Company Pvt. Ltd., Kolkata.
7. Snustad , D.P. and Simmons, M.J. 2010. *Principles of Genetics*. 5th Ed. John Wiley & Sons, 111, River Street, Hoboken, NJ, U.S.A.
8. Strickberger, M.W. 2006. *Genetics*. Prentice–Hall of India Pvt. Ltd., New Delhi.

Soil Science and Agricultural Chemistry

SSAC121 *FUNDAMENTALS OF SOIL SCIENCE* *3(2+1)*

Course outlines Theory

Soil as a natural body, Pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: Soil-texture, structure, density and porosity, Soil colour, consistence and plasticity; Elementary knowledge of soil taxonomy classification and soils of India; Soil water retention, movement and availability; soil air, composition, gaseous exchange, problem and plant growth; source, amount and flow of heat in soil; soil temperature and plant growth; Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; Soil colloids - inorganic and organic; silicate clays: constitution and properties; sources of charge ion exchange, cation exchange capacity, base saturation; Soil organic matter: composition, properties and its influence on soil properties; humic substances - nature and properties; soil organisms: macro and micro organisms, their beneficial and harmful effects; Soil pollution - behaviour of pesticides and inorganic contaminants, prevention and mitigation of soil pollution.

Practical

Study of soil profile in field. Study of soil sampling tools, collection of representative soil sample, its processing and storage. Determination of soil density, moisture content and porosity. Determination of soil texture by feel and Bouyoucos Methods. Studies of capillary rise phenomenon of water in soil column and water movement in soil, Infiltration rate. Determination of soil pH and electrical conductivity. Determination of cation exchange capacity of soil. Study of soil map. Determination of soil colour. Demonstration of heat transfer in soil. Estimation of organic matter content of soil.

Lecture outlines Theory

1. Introduction - Spheres of the earth atmosphere, hydrosphere and lithosphere – Their characteristics – Origin of soil – Soil and soil components – Mineral matter, organic matter, water and air – Definition of soil and various concepts of soil – Branches of soil science.
2. Rocks – Classification of rocks based on mode of origin –Iigneous rocks, sedimentary rocks and metamorphic rocks – Classification of rocks based on silica content – Weatherability of rocks.
3. Minerals – Primary, secondary, essential and accessory minerals – Primary minerals – Quartz, feldspar, micas, pyroxenes, amphiboles and olivines – Weatherability of primary minerals.
4. Non-silicate minerals – P, Ca, Mg, S and micronutrient containing minerals–Secondary silicate minerals – Basic structural units.
5. Weathering – Types of weathering – Physical weathering of rocks – Agents of physical weathering and their role- Biological weathering – Role of flora and fauna in weathering process.
6. Chemical weathering – Solution, hydration, hydrolysis, carbonation, oxidation and reduction.
7. Parent material – Classification of parent materials based on their mode of transport by different agents- Soil formation – Soil forming factors – Classification and their role in soil formation – Catena – Definition.
8. Pedogenic processes – Eluviation, illuviation, humification, calcification, laterization, podzolisation, melanisation, salinization and alkalization.
9. Soil profile –Detailed description of a theoretical soil profile – Differences between surface soil and sub soil.

10. Soil physical properties – Soil texture – Definition – Various inorganic components in soil and their properties – Various textural classes in soil and their properties.
11. Particle size analysis – Stoke's Law – Assumptions and limitations – significance of soil texture.
12. Soil consistence – Consistence of wet and dry soils – Soil crusting – Soil plasticity – Atterberg's plastic limits – Factors affecting plastic limits – Significance of soil consistence.
13. Soil structure – Classification – Types, classes and grades of soil structure – Importance of soil structure and its management.
14. Soil density – Bulk density and particle density – Factors affecting density parameters – Importance of bulk density of soil – Soil compaction – Iits importance
    - Calculation of porosity.
15. Soil strength and its importance – Soil colour – Components – Significance of soil colour.
16. Soil water – Forces of soil water retention – pF concept – Soil moisture characteristic curves – Importance of soil water.
17. Soil water potential – Components of water potentials – Soil moisture constants – Field capacity, wilting coefficient, hygroscopic water and saturation – Available water and methods for determining soil moisture constants – Pressure plate and pressure membrane apparatus.
18. Soil water content – Soil water movement – Darcy's Law – Saturated, unsaturated and vapour flows – Infiltration, percolation and permeability – Distribution of water in profile in different soils – Soil drainage and its importance.
19. Soil temperature – Sources of heat – Heat capacity and conductivity – factors influencing soil temperature – Modification of soil thermal regimes – Measurement of soil temperature – Importance of soil temperature on crop growth – Management of soil temperature and importance.
20. Soil air – Compositions of atmospheric air and soil air – Gaseous exchange – Influence of soil air on plant growth, soil properties and nutrient availability – Measurement of oxygen diffusion rate – Measures to improve soil aeration.
21. Soil reaction, pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability.
22. Soil colloids – Definition – General properties – Shape, surface area, electrical charge, adsorption, flocculation, deflocculation, plasticity, cohesion, swelling, shrinkage, Tyndall effect and Brownian movement.
23. Secondary silicate clay minerals of different types – Kaolinite, illite, montmorillonite and chlorite – Properties – Allophones.
24. Origin of charge in organic and inorganic colloids – Negative and positive charges
    - Differences between organic and inorganic soil colloids.
25. Adsorption of ions – Types of ion exchange – Cation and anion exchange – Cation and anion exchange capacities of soil – Base saturation – Factors affecting ion exchange capacity of soils – Importance of Cation Exchange Capacity (CEC) of soils
    - Calculation of base exchange capacity and exchangeable acidity.
26. Soil biology – Biomass – Flora and fauna – Their important characteristics – Role of beneficial organisms – Organic matter decomposition, mineralization and immobilization.
27. Nitrogen fixation, denitrification, solubilization of phosphorus and biological control of plant diseases – Promotion of plant growth promoting substances – Harmful activities of soil organisms.

28. Soil organic matter – Various sources – Composition – Compounds in plant residues – Their decomposability – Humus – Definition – Synthesis of humus.
29. Soil organic matter and humus – Importance - Fractionation of soil humus – Carbon cycle – Carbon : nitrogen (C:N) ratio of commonly available organic residues – Significance of C:N ratio in soil fertility.
30. Soil classification – Early system of soil classification – Diagnostic horizons.
31. Soil taxonomy – Order, sub order, great group and family series – Nomenclature according to soil taxonomy.
32. Soil groups of India – Alluvial soils, black soils, red soils, laterite soils and coastal sands.

Practicals

1. Methods of chemical analysis, principles, techniques and calculations
2. Study of soil sampling tools, collection of representative soil sample, its Processing and storage.
3. Description of soil profile in the field.
4. Studies of capillary rise phenomenon of water in soil column and water movement in soil.
5. Determination of texture by feel method.
6. Determination of mechanical composition of soil using Bouyoucos Hydrometer.
7. Determination of bulk density and particle density of soil and porosity.
8. Determination of soil moisture content by gravimetric method.
9. Determination of infiltration rate.
10. Determination of soil strength by cone penetrometer.
11. Aggregate analysis by wet sieving method.
12. Determination of soil pH & EC of soil.
13. Determination of cation exchange capacity of soil.
14. Determination of soil colour & study of soil map.
15. Estimation of organic matter content in soil.
16. Determination of heat transfer in soils.

References

1. Indian Society of Soil Science. 2012. *Fundamentals of Soil Science*, IARI, New Delhi.
2. Das, D. K. 2015. *Introductory Soil Science*, 4th Edition, Kalyani Publishers, New Delhi
3. Sehgal, J. 2015. *A Text Book of Pedology* – Concepts and Applications, Kalyani Publishers, New Delhi.

Entomology

ENTO 131 FUNDAMENTALS OF ENTOMOLOGY I 3(2+1) (INSECT MORPHOLOGY & TAXONOMY)

Course outlines Theory

History of Entomology in India.Factors for insect's abundance. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes.Relationship of class Insecta with other classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation.Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, wing venation, modifications and wing coupling apparatus. Structure of male and female genital organs.Metamorphosis and diapause in insects.Types of larvae and pupae.Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory(Endocrine) and reproductive systems in insects.Types of reproduction in insects. Major sensory organs like simple and compound eyes and chemoreceptors.

Systematics: Taxonomy—importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto orders, basic groups of present day insects with special emphasis to orders and families of agricultural importance like Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Miridae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Lymantridae, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Apionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthridinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyzidae, Culicidae,Muscidae and Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects (Grasshopper); Dissection of male and female reproductive systems in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance.

Lecture outlines Theory

1 History of Entomology in India - Contributions of eminent entomologists - Locations and year of establishment of entomological institutions - Arthropoda – Mention of insects in scripts – Contributions of Aristotle, J.C. Fabricius, J.G. Koenig, Carolius Linnaeus, Cramer, Dury, Dr. Kerr, Rev Hope Rothney, Ronald Ross, L De Niceville, H.M Lefroy, T.B.Fletcher, E.P. Stebbing, T.V. Ramakrishna Ayyar, B.V. David, Y.Ramachandra Rao, M S Mani, S Pradhan, H.S. Pruthi, M.R.G.K. Nair and S. Pradhan; ML Roonwal, T.Kumara Swami, M R G K Nair, K.K. Nayar and N. Ananthakrishnan - Locations and year of establishment of Division of Entomology, IARI, Zoological Survey of India (ZSI), Directorate of Plant Protection, Quarantine and Storage (DPPQS), Indian Institute of Natural Resins and Gums (IINRG), National Bureau of Agricultural Insect Resources (NBAIR), National Institute of Plant Health Management (NIPHM), National Centre for Integrated Pest Management (NCIPM) and Forest Research Institute (FRI).

2 Contributory factors for abundance of insects – Major structural characters, developmental characters and protective characters (Morphological, physiological, behavioural and construction of protectedniches)ofInsectainAnimalKingdom.

3 Classification of Phylum Arthropoda up to Classes – Different Classes of Arthropoda andcomparison of characters of Class Insecta with Arachnida, Crustacea, Symphyla, Chilopoda, Diplopoda and Onychophora;

4 Structure and functions of body wall and moulting – Different layers, chemical composition, functions of body wall and cuticular appendages – Cuticular processes and cuticular invaginations – Chaetotaxy – Moulting – Apolysis, ecdysis and sclerotization.

5 Body segmentation of the insects – Head (Syncephalon) – Procephalon and gnathocephalon, types of head, sclerites and sutures of insect head - Thorax – Segments and appendages (wings and legs).

6 Abdomen – Segments, pre and post genital appendages (Furcula, cornicles, tracheal gills and pseudo ovipositor in Diptera - Propodeum, petiole and gaster in Hymenoptera) - Male and female genital organs - Epimorphic and anamorphic development in insects.

7 Antenna – Structure of typical antenna and its modifications in different insects with examples.

8 Mouthparts – Biting and chewing, sucking (Piercing and sucking, Rasping and sucking, Chewing and lapping, Sponging and Siphoning/ Simple sucking), mask and degenerate types with examples.

9 Legs – Structure of a typical insect leg and modifications of insect legs with examples,

10 Wings – Venation, margins and angles – Types of wings and wing coupling organs with examples.

11 Types of Metamorphosis and diapause – Metamorphosis- Ametamorphosis- Incomplete Metamorphosis or Direct or Simple Metamorphosis- Intermediate metamorphosis - Complete Metamorphosis or Complex or Indirect Metamorphosis- Hypermetamorphosis with examples - Diapause- Obligate and facultative diapause
– Stage of occurrence of diapause with examples.

12 Types of larva and pupa – Differences between nymph and larva - Larva- Protopod- Oligopod (Campodeiform and Scarabaeiform)- Polypod and Apodus with examples
- Pupa- Obtect- Exarate- Coarctate- Chrysalis with examples.

13 Digestive system – Alimentary canal – Structure of foregut, midgut and hindgut – histology, functions, filter chamber and peritrophic membrane – Process of digestion- Extra intestinal digestion.

14 Circulatory system – Open and closed types – Organs of circulatory system – Dorsal blood vessel (diaphragms, sinuses and accessory pulsatile organs) – Process of circulation - Types of haemocytes –Properties and functions of haemolymph.

15 Excretory system – Structure, functions and modifications of malpighian tubules ¬
- Structure and functions of other organs of excretion.

16 Respiratory system – Tracheal system – Structure of spiracle and trachea – Classification based on functional spiracles and other means of respiration.

17 Nervous system – Neuron and its types (based on structure and function) – Synapse, ganglia, central nervous system, sympathetic nervous system and peripheral nervous system.

18 Reproductive system – Structure of male and female reproductive systems – Structure and types of ovarioles and structure of follicle – Types - Special modes of reproduction in insects.

19 Secretory (endocrine) system – Structure and functions of neurosecretory organs (neuro secretory cells of brain, corpora cardiaca, corpora allata, prothoracic glands and ring gland).

20 Sense organs – Compound eyes – Structure of ommatidium – Ocelli – Dorsal ocelli and lateral ocelli - Types of images and auditory organs (auditory hairs, tympanum, Jhonston's organ and pilifer organ) – Chemoreceptors.

21 Taxonomy – Importance - History – Binomial nomenclature - Holotype, allotype and paratype – Suffixes of tribes, subfamily, family and superfamily – Law of priority – Synonyms and homonyms - Definitions of biotype - Subspecies - Species – Genus - Family and Order. Characters of Class Insecta - Economic classification of insects- Classification upto Orders – Subclasses - Apterygota and Pterygota– Names of Orders of Apterygota and Pterygota with examples - Orthopteroid, Hemipteroid and Panarpoid group of orders.

22 Orthoptera – General characters - Gryllidae, Acrididae, Tettigonidae and Gryllotalpidae – Characters with examples.

23 Dictyoptera – General characters – Blattidae and Mantidae– Characters with examples - Odonata - General characters with examples.

24 Isoptera – General characters –Termitidae –Characters with examples - Order – Thysanoptera – General characters –Thripidae –Characters with examples

25 Hemiptera – General characters - Sub order Heteroptera – Characters - Cimicidae - Miridae, Pentatomidae, Lygaeidae, Coreidae, Pyrrhocoridae - Characters with examples.

26 Hemiptera - Suborder Homoptera – Characters – Delphacidae, Cicadellidae, Aleurodidae, Aphididae, Coccidae, Pseudococcidae, Lopophidae- Characters with examples-Neuroptera–General characters-Chrysopidae-characters with examples.

27 Lepidoptera-General characters - Differences between moths and butterflies - Noctuidae, Lymantriidae and Sphingidae and Pieridae- Characters with examples.

28 Lepidoptera- General characters - Pyralidae, Crambidae, Gelechiidae, Lycaenidae, Arctiidae, Papilionidae, Saturniidae and Bombycidae - Characters with examples.

29 Coleoptera - General characters – Scarabaeidae, Coccinellidae, Chrysomelidae,- Characters with examples.

30 Coleoptera - General characters – Cerambycidae, Bruchidae, Apionidae and Curculionidae - Characters with examples.

31 Hymenoptera - General characters – Tenthredinidae, Ichneumonidae, Braconidae, Chalcididae, Trichogrammatidae, and Apidae- Characters with examples.

32 Diptera -General characters - Culicidae, Cecidomyiidae, Muscidae, Tachinidae, Agromyzidae and Tephritidae - Characters with examples.

Practical

1 Methods of collection and preservation of insects including immature stages.

2 External features of Grasshopper / Blister beetle.

3 Study of types of mouthparts – Biting and chewing, piercing and sucking, rasping and sucking, chewing and lapping, sponging and siphoning.

4 Study of different types of insect antennae and legs.

5 Study of wing venation, types of wings and wing coupling mechanisms.

6 Study of different types of insect larva and pupa.

7 Dissection of digestive system in insects (Grasshopper).

8 Dissection of female and male reproductive systems in insects (Grasshopper).

9 Study of characters of Orders - Orthoptera, Dictyoptera and their families and Odonata.

10 Study of characters of Orders - Isoptera and Thysanoptera and their families.

11 Study of characters of Orders - Hemiptera and its sub order Heteroptera and their families.

12 Study of characters of Sub Order - Homoptera and its families.

13 Study of characters of Order - Neuroptera and Lepidoptera and their families.

14 Study of characters of Order- Coleoptera and its families.

15 Study of characters of Order- Hymenoptera and its families.

16 Study of characters of Order - Diptera and its families.

References

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3. Wigglesworth, V.B 2013. *Insect Physiology*. Springer (Originally published by Chapman and Hall, London, 1974).
4. Pant, N.C. and Ghai, S. 198. *Insect Physiology and Anatomy*. ICAR, New Delhi.
5. Kapoor, V.C 2008. *Theory and Practice of Animal Taxonomy*. Oxford and IBH Publishing, New Delhi.
6. Charles A Triplehom and Norman F. 2005. Borror and De Long's *Introduction to the Study of Insects*. Johnson Thomson Brooks/Cole Publishing. U.S.A.
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8. Timbhare, D.B. 2015. *Modern Entomology,* Himalaya Publishing House.

Agricultural Economics

AECO141 *FUNDAMENTALS OF ECONOMICS* *3(3+0)*

Course outlines Theory

Economics: Economic activity and economy-Economics- Meaning, scope and subject matter, definitions, Approaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory-rationality assumption, economic laws as generalization of human behavior. Basic concepts: scarcity, choice and decision making Goods and services, wants, demand, utility, cost and price, wealth, capital, income, investment, welfare, efficiency ,equilibrium, and firm.

Demand: meaning, law of demand, demand schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, Equi-marginal utility principle. Indifference curve analysis, Consumer's equilibrium and derivation of demand curve, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity.

Production: Production process, creation of utility, factors of production, input - outputrelationship. Laws of returns. Cost: Production costs, Supply: meaning, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply and its measurement

Market structure: meaning and types of market, basic features of perfectly competitive and imperfect markets. Price determination under perfect competition; equilibrium price. Market dynamics-changes in demand and supply and prices.

Distribution theory: meaning, factor market and pricing of factors of production.
Concepts of rent, wage interest and profit.

Public Finance/Public policy: meaning importance, Public revenue and public expenditure and their importance. Sources of public revenue, Taxes: meaning, direct and indirect taxes, agricultural taxation, VAT and GST.

National income: Meaning and importance, circular flow in the economy, concepts of national income accounting and approaches to measurement, difficulties in measurement. Trends in contribution of different sectors' to GDP .Indian economy in the globalised economy.

Population: Economic importance, Malthusian population theory, technological transition and economic growth, natural and socio-economic determinants, demographic transition in India, population growth,

Money, Banking and Credit: Evolution, meaning and functions of money, classification of money, flows of money in the economy, money supply, general price index, inflation and deflation. Banking: Role in modern economy, borrowing and lending,functions of commercial and central bank, credit ; meaning , role of credit in modern economy ,credit policy.

Economic systems: Concepts of economy and its functions, important features of capitalistic, socialistic and mixed economies, elements of economic planning.

Lecture outlines Theory

1. Introduction to Economics– Economic activity and concept of economy and its functions, basic economic problems, three main economic actors-households, firms, governments as basic decision making units.
2. Economics - Meaning, definitions, its importance as a subject to science students.
3. Scope of study of economics as a science -Subject matter of economics – Traditional approach – Consumption, production, exchange, distribution and public finance/ public policy - Modern Approach – Microeconomics and macroeconomics.
4. Methods of economic investigation – Deduction and induction approaches, positive and normative analysis - Nature of economic theory - Rationality assumption, economic laws as generalization of human behavior.
5. Basic concepts: goods and services - Characteristics and classification, scarcity, choice, decision making, wants, substitutes and complements - Utility – Cardinal and ordinal approaches, forms of utility, marginal utility.
6. Cost and price, value and wealth and their characteristics, capital, income, investment, welfare, efficiency, equilibrium and firm.
7. Demand - Meaning, law of demand, demand schedule and demand curve characteristics, determinants, types of demand - Income demand, price demand, cross demand - Product demand, firm demand, market demand.
8. Market dynamics due to changes/ shifts in demand and prices - Contraction and extension, increase and decrease in demand.
9. Law of diminishing marginal utility – Statement, assumptions of law, explanation, limitations of the law - Importance and applications.
10. Law of equi-marginal utility — Meaning, assumptions, explanation of the law - Practical importance and applications, limitations.
11. Consumer's surplus – Meaning, assumptions, explanation with examples, difficulties in measuring, consumer's surplus - Importance and applications - Engels law of family expenditure.
12. Indifference curve analysis - Indifference curves - Meaning, basic assumptions, properties and their importance in economics.
13. Budget line and its properties - Consumer's equilibrium - Graphical and algebraic expressions and its importance.
14. Elasticity of demand — Meaning, elastic and inelastic demand, measurement of elasticity of demand - Types of elasticity of demand - Price elasticity, income elasticity and cross elasticity of demand.
15. Kinds of elasticity of demand - Perfectly elastic, perfectly inelastic, relatively elastic, relatively inelastic, unitary elastic demand - Factors affecting elasticity of demand, practical importance of elasticity of demand.
16. Production - Meaning of production process, creation of utility, factors of production and input - output relationship and production function — Meaning.
17. Laws of returns - Increasing, decreasing and constant laws of returns - Meaning and explanation with examples.
18. Cost - Seven production costs - Meaning and formulas, cost and output relationships - Short run and long run cost curves.

19. Supply – Meaning, definition, law of supply, supply schedule, supply curve and properties, determinants of supply - Market dynamics due to changes/ shifts in supply and prices - Increase and decrease in supply, contraction and extension of supply.

20. Elasticity of supply and its measurement - Kinds of elasticity of supply – Perfectly elastic, perfectly inelastic, relatively elastic, relatively inelastic and unitary elastic - Factors affecting elasticity of supply.

21. Markets and market structure – Meaning, classification of markets based on market structure - Competition and its meaning, basic features of perfectly competitive and imperfect competitive markets.

22&23. Characteristics of monopolistic competition, monopoly, duoploy, oligopoly, monopsony, duopsony and oligopsony with examples.

24. Price determination under perfect competition – Equilibrium analysis - Numerical and graphical explanation.

25. Distribution theory - Meaning, factor market - Concepts of rent - Meaning, types of rent - Ricardian theory of rent.

26. Wages - Meaning, nominal and real wages, working population in India - Labour participation rate, employment rate, unemployment rate - Interest- Meaning of interest and interest rate - Profit and income - Meaning, difference between income and profit.

27. Pricing of factors of production - Modern theory of distribution.

28. Public finance/ Public policy — Meaning, role and importance of public finance/Public policy - Functions of the government – Differences between public finance and private finance - Public revenue - Meaning, major and minor sources of public revenue.

29. Tax – Meaning - Classification – Direct and indirect taxes, methods of taxation - Proportional, progressive, regressive and digressive taxation, agricultural taxation - VAT and GST.

30. Canons of taxation – Adam Smith's canons of taxation – Equality, economy, certainty and convenience – Other canons of taxation.

31. Public expenditure – Meaning, need for public expenditure - Principles of public expenditure – Budget – Meaning - Balanced budget and deficit budget - Fiscal policy
- Meaning and its policy instruments.

32. National income accounting system – Meaning and importance, circular flow in the economy.

33. Concepts of national income accounting - Gross domestic product, gross national product, net national product, net domestic product - National income at factor cost, personal income, disposable income, per capita income.

34. Approaches to measurement of national income – Product method, income method, expenditure method and value added method, difficulties in measurement.

35. Trends in contribution of different sectors' to GDP - Indian economy in the globalised world economy.

36. Importance of population in the economy - Malthusian theory, escaping from the Malthusian stagnation - Innovations, technological transition and economic growth.

37. Money - Meaning, evolution of money, functions of money, the money market - Types of demand and supply of money in the economy.

38. Credit - Meaning of credit, borrowing and lending, investments and their role in the modern economy - Credit controls and credit policy.

39. Role of banking in the modern economy, functions of central bank and commercial banks, monetary policy and its instruments.

40. Inflation – Meaning, definition, deflation - Meaning, causes of inflation - Demand pull and cost push inflation.

41. Types of inflation - Comprehensive and sporadic inflation – Suppressed and repressed inflation – Creeping, walking, running and galloping inflation – Markup inflation.

42. General price index, wholesale price index, consumer price index - Rate of inflation
– Measurement.

43. Other causes of inflation – Remedial measures – Monetary and fiscal measures.

44. Economic system - Meaning, importance of study of economy in systems approach
- Types of economic systems.

45. Capitalism - Meaning and its characteristic features, socialism and its characteristic features - Mixed economies and their characteristic features.

46. Economic planning - Meaning, importance of planning in management of resources and institutions in the economy, elements of economic planning.

47 & 48. Brief history of planning system in India - Annual plans, five year plans meaning and objectives, role of planning commission of India and NITI Ayog.

Reference

1. Dewett, K.K. and Varma, J.D. 2003. *Elementary Economic Theory.* S. Chand and Co., New Delhi.
2. Dewett, K.K and Chand, A. 2009. *Modern Economic Theory.* S.Chand and Co., New Delhi
3. Paul A. Samuelson and Nordhus. 2010. *Economics.* 19th Edition, Tata-Mc Graw Hill Education, New Delhi.
4. Jhingan, M.L. 1990. *Advanced Economic Theory*. Vikas Publishing House, New Delhi
5. Koutsoyiannis. 2015. *Modern Microeconomics*. Tata Mac-Graw Hill Publishers, New Delhi
6. *The Economy* 2016, www.core-econ.org.

Agricultural Engineering

AENG151 SOIL AND WATERCONSERVATION ENGINEERING 2(1+1)

Course outlines Theory

Introduction to soil and water conservation - Causes of soil erosion - Definition and agents of soil erosion - Water erosion - Forms of water erosion - Gully classification and control measures - Soil loss estimation by Universal Soil Loss Equation - Soil loss measurement techniques - Principles of erosion control - Introduction to contouring - Strip cropping - Contour bund - Graded bund and bench terracing - Grassed water ways and their design - Water harvesting and its techniques - Wind erosion - Mechanics of wind erosion - Types of soil movement - Principles of wind erosion control and its control measures.

Introduction to irrigation - Irrigation project classification - Methods of micro- irrigation - Importance of irrigation water measurements – Volumetric area velocity - Discharge methods - Weirs – Orifice – Flumes - Types of wells - Water lifting devices - Classification of pumps – capacity – Power - Discharge calculations - Open channel hydraulics - Discharge calculations - Underground pipeline systems - Functional components of micro irrigation systems and its design like drip - Sprinkler etc. - Water harvesting - Lining of ponds – Tanks - Canals.

Practical

General status of soil conservation in India - Calculation of erosion index - Estimation of soil loss - Measurement of soil loss - Preparation of contour maps - Design of grassed waterways-Design of contour bunds - Design of graded bunds - Design of bench terracing system - Problem on wind erosion - Discharge measurements - Irrigation pumps - Different pumps and structural differences - Design of farm ponds - Lining of ponds - Irrigation tank - Water management.

Lecture outlines Theory

1. Introduction to soil and water conservation and causes of soil erosion.
2. Definition and agents of soil erosion, water erosion - Forms of water erosion - Gully classification and control measures.
3. Soil loss estimation by universal soil loss equation - Soil loss measurement techniques.
4. Principles of erosion control - Introduction to contouring, strip cropping.
5. Contour bund - Graded bund and bench terracing.
6. Grassed water ways and their design.
7. Wind erosion - Mechanics of wind erosion, types of soil movement - Principles of wind erosion control and its control measures.
8. Introduction to irrigation - Classification of irrigation projects.
9. Importance of irrigation water measurements - Volumetric, area velocity, discharge methods - Weirs, orifice, flumes.
10. Open channel hydraulics - Discharge calculations.

11&12. Types of wells - Water lifting devices - Classification of pumps, their capacity, power requirement and discharge calculations.

13. Functional components and working principle of underground pipeline systems. 14&15.

Functional components of micro irrigation systems and its design like drip, sprinkler irrigation systems etc.

16. Water harvesting techniques - Lining of ponds, tanks and canal systems.

Practical

1. Practicing survey - Principles and educating to use pacing technique for measurement.

2&3. Area calculations through chain survey - GPS demo for tracking and area measurement.

4. Estimation of soil loss and calculation of erosion index.
5. Leveling concepts and practical utility in agriculture.
6. Preparation of contour maps.
7. Concept of vegetative water ways and design of grassed water ways.
8. Construction of contour and graded bunds.
9. Wind erosion and estimation process.

10&11. Water discharge measurements lab exercises for computing discharge. 12&13. Different irrigation pumps and their constructional differences.

14. Farm pond construction and its design aspects.
15. Farm pond and canal lining and its procedures.
16. Visit to nearby farm pond.

References

1. Ghanshyam Das., 2012. *Hydrology and Soil Conservation Engineering, including Watershed Management*. Second edition, PHI Learning Private Limited, New Delhi - 110001
2. Murthy, V. V.N., 2004. *Land and Water Management Engineering*. Kalayani Publishers, New Delhi
3. Michael A.M., 2007. *Irrigation Theory and Practice*. Second edition. Vikas Publishing House Pvt. Ltd.
4. Mal, B. C. 1995. *Introduction to Soil and Water Conservation Engineering*. Kalayani Publishers, Rajinder Nagar, Ludhiana
5. Kanetakar, T.P. 1993. *Surveying and Leveling*. Pune Vidyarthi Griha, Prakashan, Pune
6. Suresh, R. 2008. *Land and Water Management.* Standard Publishers Distributors, Delhi.

Course outlines Theory

Status of farm power in India - Sources of farm power - I.C. engines - Working principles of I C engines - Comparison of two stroke and four stroke cycle engines - Study of different components of I.C. engine - I.C. engine terminology and solved problems - Familiarization with different systems of I.C. engines - Air cleaning – Cooling - Lubrication - Fuel supply and hydraulic control system of a tractor - Familiarization with power transmission system – Clutch - Gear box - Differential and final drive of a tractor - Tractor types - Cost analysis of tractor power and attached implement - Familiarization with primary and secondary tillage implements -Implements for hill agriculture - Implements for intercultural operations - Familiarization with sowing and planting equipment - Calibration of a seed drill and solved examples - Familiarization with plant protection equipment - Familiarization with harvesting and threshing equipment.

Practical

Study of different components of I.C. engine - To study air cleaning and cooling system of engine - Familiarization with clutch – Transmission - Differential and final drive of a tractor - Familiarization with lubrication and fuel supply system of engine - Familiarization with brake – Steering - Hydraulic control system of engine - Learning of tractor driving - Familiarization with operation of power tiller - Implements for hill agriculture - Familiarization with different types of primary and secondary tillage implements - Mould plough - Disc plough and disc harrow -Familiarization with seed- cum-fertilizer drills their seed metering mechanism and calibration - Planters and transplanter - Familiarization with different types of sprayers and dusters -Familiarization with different inter-cultivation equipment - Familiarization with harvesting and threshing machinery.

Lecture outlines Theory

1. Farm power – Source of different farm power, advantages and disadvantages.
2. Internal combustion engine - Different components and their functions - Working principle of four stroke and two stroke cycle engine - Comparison between diesel and petrol engine - Difference between four and two stroke engine.
3. Terminology related to engine power - IHP, BHP, FHP, DBHP, compression ratio, stroke bore ratio, piston displacement, and mechanical efficiency - Numerical problems on calculation of IHP, BHP, C.R., stroke bore ratio, piston displacement volume.
4. Fuel supply and cooling system of I.C. engine – Types, components and their functions, working principle of forced circulation cooling system.
5. Ignition and power transmission system of I.C engine – Types, components and their functions, working principle of battery ignition system.
6. Lubrication system of I.C. engine – Types, purpose, components and their functions, working principle of forced feed system - Tractors classification, types, points to be considered in selection of tractors, estimating the cost of operation of tractor power.
7. Tillage - Primary and secondary tillage - M.B. plough – Functions, constructional features, operational adjustments and maintenance.
8. Disc plough – Functions, constructional details, operational adjustments and maintenance.
9. Numerical problems on M.B. plough and disc plough.

10. Harrows – Types, functions, operation of disc harrows - Cultivators – Rigid and spring loaded tynes - Puddlers, cage wheel, rotovators - Intercultural implements
– Hoes and weeders for dry and wetland cultivation.

11. Sowing equipment - Seed cum fertilizer drills – Types, functions, types of metering mechanisms, functional components, calibration - Paddy transplanters.

12. Harvesting equipment – Sickles, self propelled reaper, alignment and registration
- Combines, functions of combines.

13. Plant protection equipment – Types of sprayers, constructional features of knapsack sprayer, hand compression sprayer, foot sprayer, rocker sprayer and power sprayer, care and maintenance of sprayers.

14. Dusters – Hand rotary and power operated dusters, care and maintenance of dusters.

15. Tractor mounted equipments for land development and soil conservation – Functions of bund former, ridger, and leveling blade.

16. Threshing equipment and principles of combine harvester.

Practical

1. Showing the difference between EC engine and constructional details of IC engine.
2. Dismantling the IC engine and explaining the functional aspects of components.
3. Air cleaning and maintenance - Engine cooling and maintenance.
4. Familiarizing with lubrication and fuel supply system of an engine.
5. Familiarizing with clutch – Gearbox - Differential and final drive along with brake stearing hydraulic control of tractor.

6&7. Tractor driving.

8. Power tiller operation.
9. Attachment of an implement by using 3 point hitch system of a tractor.
10. Familiarization with primary tillage implements like M. B. Plough, disc plough and its adjustments.
11. Study of secondary tillage implements and its constructional details -Emphasis on disc harrow, spike tooth harrow, blade harrow, rotavator, power harrow
12. Familiarization with seed metering mechanism and its calibration.
13. Study on planters and transplanters.
14. Practicing with plant protection equipment, different sprayers and dusters.
15. Familiarization with inter-cultural equipment and different types available in the market.
16. Exposure on harvesting equipment and combine harvesters.

References

1. Jagadishwar Sahay - *Elements of Agricultural Engineering*.
2. Surendra Singh. *Farm Machinery - Principles and Applications*.ICAR Publication.
3. S.C.Jain and C.R.Rai. *Farm Tractor – Maintenance and Repair*. Standard Publishers, 1705-B, Nai Sarak, Delhi – 110006
4. Ojha, T. P. and Michael, A.M. *Principles of Agricultural Engineering*. Vol. I, Jain Brothers, 16/893, East Park Road, Karol Bagh, New Delhi – 110005

CROP PHYSIOLOGY

CPHY-162 FUNDAMENTALS OF CROP PHYSIOLOGY 3(2+1)

Course outlines Theory

Introduction to crop physiology and its importance in Agriculture; Plant cell: an Overview; seed physiology: seed structures, seed development seed viability and vigour, Physiological maturity, seed germination. Physiological aspects of growth and development: Growth analysis. Diffusion and osmosis; Absorption of water, transpiration and Stomatal complex; Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients, nutrient uptake mechanisms; assimilation of mineral nutrients: nitrate, ammonium, Biological nitrogen fixation. Photosynthesis: Light and Dark reactions, C3, C4 and CAM plants; Respiration: energy balance, significance, OPPP pathway. Lipids: Biosynthesis and functions of lipids, significance in plant metabolism; Physiology of flowering; Photoperiodism, importance classification of plants based on photoperiodism, biological clock. Phytochrome, vernalization importance. Plant growth regulators: Biosynthesis, Mode of action, Physiological roles and commercial uses in agriculture. Senescence and Abscission: definition, types, changes that occur during senescence, abscission versus senescence. Post harvest physiology: dormancy, fruit ripening, physiology of cut flowers.

Practical

Solutions- Preparation, Seed vigor and viability tests, optimum conditions for seed germination, leaf area measurement, Growth analysis, Measurement of water status in plants, Measurement of water potential, Measurement of Stomatal frequency and index

photosynthetic pigments- Absorption spectrum , Leaf anatomy of C3 and C4 plants, Measurement of photosynthesis – Hill's reaction, Measurement of photosynthesis by IRGA, Effect of plant growth regulators on plant growth. Diagnosis of nutrient deficiency symptoms in crops, Yield analysis

Lecture outlines Theory

1. Introduction to Crop Physiology and its importance in Agriculture.

2 & 3. Plant cell - The endomembrane system - Plasma membrane, endoplasmic reticulum, nuclear envelope, golgi apparatus, vacuole and endosomes - Structure and functional characteristics - Plastids, mitochondria, oil bodies, peroxisomes and glyoxysomes - Structure and functions.

4 & 5. Metabolic changes during seed development - Seed viability and seed vigor - Tests of viability and vigor - Physiological maturity, harvestable maturity - Indices of physiological maturity in crops - Seed germination - Metabolic changes during seed germination.

5. Growth and Development - Definition - Growth analysis – Growth

Parameters - Definitions and mathematical formulae

7, 8 & 9. Absorption of water - Diffusion and osmosis - water potential and its components - Importance of water potential – Active and passive uptake of water – Stomatal complex – Transpiration – Water use efficiency – Water use efficiency of C3, C4 and CAM plants – Water requirement/Transpiration ratio
– Factors affecting WUE.

10 to 13. Mineral nutrition of plants – Essential mineral elements – Criteria of essentiality of mineral elements – Mengel`s classification of mineral nutrients - Nutrient uptake mechanisms - Functional roles of N, P, K, S Ca and Mg – Functional roles of Fe, Mn, Cu, Zn, B, Mo, Cl, Na, Co and Si – Deficiency symptoms of macro and micro nutrients.

14&15. Assimilation of mineral nutrients – Nitrate assimilation – Ammonium assimilation in plants – Biological nitrogen fixation – Free-living and symbiotic bacteria – Nodule formation – Nitrogenase enzyme complex.

16 to 19. Photosynthesis – Reactions of photosynthesis – Energy synthesis – Principle of light absorption by plants – Light reactions - Cyclic and non cyclic photophosphorylation – CO2 fixation – C3 and C4 pathways – Significance of C4 pathway – CAM pathway and its significance – Photorespiration and its significance – Photosynthetic efficiency of C3, C4 and CAM plants - Factors affecting photosynthesis (light, CO2 , temp and water stress) - Relationship of photosynthesis and crop productivity.

20. Respiration – Energy balance – Significance of respiration – Oxidative Pentose Phosphate Pathway (OPPP) and its significance – Growth respiration and maintenance respiration – Alternate respiration – Salt respiration – Wound respiration.

21. Lipid metabolism – Biosynthesis of fatty acids in plastids – Functions of lipids - Significance of lipids in plant metabolism.

22 & 23. Physiology of flowering – Photoperiosism and flowering – Importance of photoperiodism – Classification of plants based on photoperiodic responses – Perception of photoperiodic stimulus – Biological clock – Phytochrome – Flowering hormones – Vernalization and flowering – importance of vernalization in agriculture.

24 to 29. Plant growth regulators – Auxins – Occurrence, transport, biosynthesis, mode of action and physiological roles – Commercial uses.– Gibberellins – occurrence, transport, biosynthesis, mode of action and physiological roles – Commercial uses – Cytokinins – Occurrence, transport, biosynthesis, mode of action and physiological roles – commercial uses – ABA – Occurrence, transport, biosynthesis, mode of action and physiological roles – Commercial uses – Ethylene – Ocurrence, transport, biosynthesis, mode of action and physiological roles – Commercial uses.

30. Senescence and abscission – Definition – Classification of senescence – Physiological and biochemical changes that occur during senescence - Prevention of leaf and flower senescence – Abscission and its relationship with senescence.

31 & 32. Post harvest physiology – Dormancy – Types of dormancy – Advantages and disadvantages of dormancy - Causes of dormancy – Remedial measures for breaking seed dormancy - Fruit ripening - Climacteric and non climacteric fruits – Metabolic changes during fruit ripening - Hormonal regulation of fruit ripening – Ripening induction and ripening inhibition – Use of hormones in increasing vase life of flowers.

References

1. Taiz, L. and Zeiger, E. 2010. *Plant Physiology* 5th edition, Sinauer Associates, Sunderland, MA, USA.
2. Gardner, F.P., Pearce, R.B., and Mitchell, R.L. 1985. *Physiology of Crop Plants.* Scientific Publishers, Jodhpur.
3. Noggle, G.R. and Fritz, G.J., 1983. *Introductory Plant Physiology*. 2nd Edition. Prentice Hall Publishers, New Jersey, USA.

PLANT PATHOLOGY

PATH171 FUNDAMENTALSOFPLANTPATHOLOGY-I 3 (2+1) (PLANT PATHOGENS – AN INTRODUTION)

Course outlines Theory

Importance of plant diseases, scope and objectives of Plant Pathology. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes.

Fungi: General characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes.

Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction.

Viruses: nature, architecture, multiplication and transmission. Study of

phanerogamic plant parasites.

Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, Anguina etc.)

Practical

Microscopy, General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic plant parasites. Study of morphological features and identification of plant parasitic nematodes. Extraction of nematodes from soil.

Lecture outlines Theory

1. Introduction to Plant Pathology - Definition of Plant Pathology, Plant Pathogen, Plant Disease, Symptom, Disorder. Importance of plant diseases- Brief mention of Important epidemics of international importance – Irish Famine (1845), Bengal Famine (1942), Coffee rust (1868), Wheat Rust (1940), Southern Corn Leaf blight in USA. Epidemics of local significance - Peanut Stem Necrosis Disease (Anantapur dt), Mung bean yellow mosaic virus (AP) *etc*. Brief mention of economic importance of micro organisms. Scope and objectives of Plant Pathology.
2. Important plant pathogenic organisms with one or two examples of important plant diseases caused by them- fungi (rice blast, wheat rust), Chromista (*Pythium* damping off, late blight of potato protozoa (coffee phloem necrosis, club root of crucifers) bacteria (rice bacterial leaf blight (BLB), cotton black arm), fastidious

vascular bacteria (sugarcane ratoon stunt, citrus greening), Phytoplasma (sugarcane grassy shoot, sesamum phyllody), *Spiroplasma* (corn stunt), viruses (TMV, MYMV), viroids (potato spindle tuber viroid, coconut cadang cadang).

3. Important plant pathogenic organisms with one or two examples of important plant diseases caused by them (contd)- algae (red rust), phanerogamic plant parasites (*Cuscuta*, *Striga*, *Orabanche*, *Loranthus*), nematodes (root knot and cyst nematode). Diseases and symptoms due to

abiotic causes (khaira, cotton purple leaf, tomato blossom end rot, black heart of potato).

4. General characteristics of fungi, fungus definition. Somatic structures - types of fungal thalli - plasmodium, unicellular and filamentous. Types of fungi based on reproductive structures - eucarpic, holocarpic. Types of fungi based on their physical presence on or in the host - ectophytic and endophytic (intercellular, intracellular and vascular). Septation in fungi – Primary, adventitious, perforated and dolipore septa. Fungal tissues - plectenchyma (prosenchyma and pseudoparenchyma).

5. Modifications of mycelium (rhizomorphs, sclerotium, stroma, haustorium, rhizoids and appressorium).Ultra structure of fungal cell. Fungal nutrition - groups of fungi based on mode of nutrition - saprophytes (obligate saprophytes and facultative parasite), parasites (obligate parasites and facultative saprophytes) and symbionts (mycorrhizae and lichens).

6. Reproduction in fungi - asexual reproduction (mitospores)- fragmentation (arthrospores, oidia, chlamydospores), fission, budding (blastospores), and sporulation –Sporangium, sporangiole, merosporangium.Spores- Plano and Aplanospores. Planospores – flagellum structure, types of flagella-tinsel, whiplash, Monoflagellate, Biflagellate, Anisokont and Heterokont zoospores. Conidiophore and Conidiospores (conidia). Asexual fruiting bodies with examples.

7. Sexual reproduction – Phases in sexual reproduction, (meiospores).Methods of plasmogamy- planogametic copulation, gametangial contact, gametangial copulation, spermatization and somatogamy.Various life cycle patterns displayed by fungi – haplobiontic haploid, haplobiontic haploid (modified), haplobiontic diploid and diplobiontic life cycles with examples. Parasexual cycle. Sexual spores in fungi.

8. Taxonomy - Nomenclature, Binomial system of nomenclature, rules of nomenclature, Classification of fungi as per Kirk *et al* (2008)- Key to phylum, sub- phyla, classes, orders and families.

9. Major characteristic features of Kingdom Fungi, Chromista and Protozoa. Characteristics of Phyla Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota and Mitosporic fungi (Anamorphic fungi) in Kingdom Fungi.

10. Kingdom Fungi – Phylum Chytridiomycota, Class Chytridiomycetes - important characteristics of Order Chytridiales – Family Synchytriaceae – disease caused by *Synchytrium endobioticum* (potato wart).

11. Phylum Zygomycota – Subphylum Mucoromycotina – Order Mucorales – Family Mucoraceae, Genus *Rhizopus*, Example of disease caused by *Rhizopus arrhizus* (Head rot of sunflower). Family Choanephoraceae, Genus *Choanephora.* Example of disease caused by *Choanephora cucurbitarum* (Choenophora blight of chillies).

12 Phylum Ascomycota - important characteristics of the phylum. Different types of ascocarps. Stile structures in ascocarps. Ascospore development in *Pyronema omphaloides*. Morphology of asci. Types of asci based on structure of ascus wall, asci arrangement -fascicle, hymenium.

13. Phylum Ascomycota, subphylum Taphrinomycotina (=Archiascomycetes) – Class Taphrinomycetes – Order Taphrinales, (i) Family Taphrinaceae - diseases caused by *Taphrina deformans* (peach leaf curl) and *T. maculans* (turmeric blotch).
(ii) Family Protomycetaceae – Disease caused by *Protomyces macrospores*

(stem gall of coriander).

14. Phylum Ascomycota Subphylum Pezizomycotina – (i) Class Eurotiomycetes – Subclass

Eurotiomycetidae Order Eurotiales – Genera *Eurotium*, *Emericella* (*Aspergillus flavus* – aflatoxins), *Talaromyces* (*Penicillium italicum* – citrus blue mold). (ii) Class Leotiomycetes Order Erysiphales Family Erysiphaceae - *Erysiphe*, *Leveillula*, *Phyllactinia*, *Uncinula*, *Sphaerotheca*, *Podosphaera* and *Microsphaera* (key for genera of Erysiphaceae based on position of fungus on/in the host, conidial stages, number of asci per cleistothecium and cleistothecial appendages) – Important diseases caused by each of the genera. Order Helotiales Family Sclerotiniaceae Genus *Sclerotinia (Sclerotinia sclerotiorum* – white mold of vegetables*)*.

15. Phylum Ascomycota, Subphylum Pezizomycotina –(iii) Class Sordariomycetes, Subclass Sardariomycetidae Order Diaporthales Family Cryphonectriaceae, Genus *Cryphonectria* (chestnut blight). Subclass Hypocreomycetidae Order Hypocreales
- Family - Clavicepitaceae, Genus – *Claviceps* (ergot of sorghum and bajra).Family –Hypocreaceae – Genus – *Hypocrea* (Anamorph – *Trichoderma*,biocontrol agent).(iv) Class Dothidiomycetes Subclass – Dothidiomycetidae Order – Capnodiales – Family – Mycosphaerellaceae – Genus – *Mycosphaerella* (*M. arachidicola* (Groundnut early leaf spot), *M. personata* (Groundnut late leaf spot),

    M. pinodes (Ascochyta blight of chickpea). Order – Myriangiales – Family – Elsinoaceae – Genus – *Elsinoe (E. ampelina* – Grape anthracnose). Subclass – Pleosporomycetidae – Order – PleosporalesFamily – Venturiaceae – Genus – *Venturia* (*V. inaequalis* – Apple scab). Family– *Pleosporaceae* – Genus– *Cochliobolus (C. miyabeanus* – brown spot of rice).

16. Phylum Basidiomycota – important characteristics – Primary, Secondary and Tertiary mycelium, dolipore septum, clamp connections. Development of basidium and basidiospores,parts of basidium, dispersal of basidiospores, structure of *Agaricus bisporus* basidiocarp .

17. Phylum Basidiomycota-Subphylum 1. Pucciniomycotina -Class Pucciniomycetes Order Pucciniales -Family –Pucciniaceae- Genera *Puccinia (three rusts of wheat*,

    groundnut rust) *Uromyces* (rust of green gram and black gram). Family - Melampsoraceae - Genus *Melampsora (M. ricini* – castor rust). *Incertae sedis* (no family),*Hemileia*(*H. vastatrix* – coffee rust),Class Microbotryomycetes (Pucciniomycetous smuts)- Order -Microbotryales - Family Microbotryaceae - Genus -*Sphacelotheca* (Sorghum grain smut, loose smut and head smut of sorghum).

18. Macrocyclic, microcyclic, demicyclic rusts; Autoecious and Heteroecious rusts with examples. Life cycle of *Puccinia graminis tritici* .

19. Phylum Basidiomycota – Subphylum 2. Ustilagomycotina Class Ustilaginomycetes Order Ustilaginales - *Ustilago* (loose smut of wheat, sugarcane whip smut)and*Tolyposporium*(bajra smut). Order Urocystidales-Family - Urocystidaceae-Genus *Urocystis* (Onion smut).*Class* Exobasidiomycetes Order Tilletiales -Family -Tilletiaceae - Genera *Tilletia* (wheat bunts), *Neovossia* (Karnal bunt of wheat). Order Exobasidiales –Family-Exobasidiaceae –Genus *Exobasidium* (Tea blisterblight).

20. Differences between rust and smut fungi. Differences between smuts and bunts Phylum Basidiomycota – Subphylum 3. Agaricomycotina Class Agaricomycetes - *Incertae sedis* (no sub class) Order Polyporales- Family Ganodermataceae -Genus *Ganoderma* (coconut root rot and wilt).

21. Anamorphic Fungi (Mitosporic fungi = Fungi Imperfecti) Characteristics. Saccardoan spore group system. (1)Hyphomycetous anamorphic fungi: Identification features of Genera

Alternaria (sunflower and sesamum leaf blight), *Botrytis* (castor grey mold), *Helminthosporium* (maize turcicum leaf blight), *Bipolaris* (rie brown spot), *Cercospora* (groundnut early leaf spot), *Phaeoisariopsis* (groundnut late leaf spot), *Fusarium*(cotton wilt), *Pyricularia* (*rice blast), Verticillium* (cotton wilt), Mycelia Sterilia – *Rhizoctonia(*rice sheath blight, dry root rot), *Sclerotium* (stem rot of groundnut).

22. Acervular Imperfect Fungi – *Colletotrichum* (sugarcane red rot), *Pestalotiopsis* (coconut grey leaf spot), *Pestalotia* (guava leaf spot), *Gloeosporium* (grape anthracnose).Pycnidial Imperfect Fungi – *Ascochyta* (chickpea blight), *Phoma* (blackleg of crucifers), *Phomopsis (brinjal fruit rot), Phyllosticta* (ginger leaf spot), *Macrophomina* (dry root rot) *Diplodia* (rose dieback), *Botryodiplodia* (cirus stem end rot) , *Septoria* (leaf spot of tomato).

23. Kingdom Chromista: Characteristics of Phylum Oomycota. Important characteristics of Class Oomycetes, Subclass- Peronosporomycetidae. Order Pythiales -Family -Pythiaceae – Genus-*Pythium* (damping off of nursery crops). Order Albuginales -Family -Albuginaceae - Genus -*Albugo* (white rust).

24. Order Peronosporales- Family -Peronosporaceae - Genus -*Phytophthora* (late blight of potato). Downy mildew fungi *Sclerospora* (green ear of bajra), *Peronospora* (blue mold of tobacco), *Peronosclerospora* (sorghum downy mildew), *Pseudoperonospora* (cucurbit downy mildew), *Plasmopara* (grape downy mildew)and *Bremia* (lettuce downy mildew) *S*porangiophore branching and sporangial characteristics of downy mildew genera.

25. Characteristics of Class Plasmodiophorea in Kingdom Protozoa. Important characteristics of Order Plasmodiophorida, Family Plasmodiophoraceae - differences in the characteristics of *Plasmodiophora* (club root of cabbage) and *Spongospora* (potato powdery scab).

26. Prokaryotes – Characteristics of phytopathogenic bacteria, Classification (2nd Edition of Bergey's Manual of Systematic Bacteriology, 2004). Identification of plant pathogenic bacteria based on morphological features. Domain Bacteria – Phyla Proteobacteria, Firmicutes and Actinobacteria Phylum Proteobacteria – Class Alphaproteobacteria- Order- Rhizobiales- Family - Rhizobiaceae -Genus - *Agrobacterium* (crown gall of stone fruits). Also *Candidatus* Liberobacter (citrus greening).

27. Class Betaproteobacteria -Order -Burkholdariales -Family -Burkholdariaceae Genus *Ralstonia* (bacterial wilt of solanaceous crops). Gammaproteobacteria - Order -Xanthomonadales -Family - Xanthomonadaceae -Genera -*Xanthomonas* (BLB, BLS, citrus canker), *Xylella* (Pierce's disease of grapes). Order Pseudomonadales -Family -Pseudomonadaceae -Genus -*Pseudomonas* (wild fire of tobacco). Order *Enterobacteriales*-Family- *Enterobacteriaceae*-Genera-*Erwinia* (Apple fire blight), *Pectobacterium* (Soft rot of vegetables).

28. Phylum Firmicutes. -Class Bacilli -Order -Bacillus -Family -Bacillaceae -Genus - *Bacillus* (Class Mollicutes Order Entomoplasmatales -Family -Spiroplasmataceae -Genus *Spiroplasma* (Corn stunt). Order –Acholeplasmatales- Family - Acholeplasmataceae - Genus -*Candidatus* Phytoplasma (Sesamum phyllody, Brinjal little leaf). Phylum Actinobacteria -Class - Actinobacteria -Order -Actinomycetales -Family -Microbacteriaceae -Genus -*Clavibacter* (Wheat yellow ear rot/tundu, sugarcane ratoon stunt).Family Streptomycetaceae Genus *Streptomyces* (Potato scab).

29. Viruses and viroids - important characteristics of plant viruses and viroids - multiplication - classification of viruses based on nucleic acid (single stranded (ss) RNA, double stranded (ds) RNA, ssDNA and dsDNA). Taxonomy based on ICTV (2005). Important plant viral diseases - Tobacco

Mosaic Virus (TMV) and Rice Tungro Virus (RTV).

30. Methods of transmission of plant viruses with examples of vector transmitted virus diseases. Examples of important viroid diseases - potato spindle tuber viroid and coconut cadang cadang. Study of phanerogamic plant parasites with suitable examples – *Cuscuta*, *Orabanche*, *Striga*, *Loranthus*.

31. **Nematodes-**Economic importance in agriculture - General characters of plant parasitic nematodes – classification.

32. **Nematodes-** symptoms and nature of damage caused by plant nematodes (*Heterodera*, *Meloidogyne*, *Anguina*, *Ditylenchus*, *Tylenchorhynchus*, *Aphelenchoides* etc.).

Practical

1. Microscopy - study of the parts of microscope.
2. Study of vegetative structures of fungi and their modifications.
3. Study of reproductive (sexual and asexual) structures of fungi.
4. Study of Zygomycetous fungus – *Rhizopus,Choanephora.*
5. Study of downy mildew fungi – *Sclerospora*, *Peronosclerospora*, *Pseudoperonospora, Peronospora, Plasmopara* and *Bremia*. Study of *Pythium*, *Phytophthora* and *Albugo.*
6. Study of powdery mildew fungi – *Oidium, Oidiopsis, Ovulariopsis.*
7. Study of ascocarps of *Erysiphe, Phyllactinia*, *Uncinula*, *Podosphaera* and *Microsphaera..*
8. Study of rust fungi – *Puccinia* (different stages), *Uromyces, Hemileia*and *Melampsora*.
9. Study of smut fungi – *Sphacelotheca*, *Ustilago* and *Tolyposporium*. Study of *Ganoderma* and *Agaricus.*
10. Study of acervulous imperfect fungi – *Colletotrichum* and *Pestalotiopsis.* Study of pycnidial imperfect fungi – *Septoria.*
11. Study of imperfect fungi – *Aspergillus*, *Penicillium* and *Pyricularia*, *Helminthosporium*, *Alternaria.*
12. Study of imperfect fungi – *Cercospora* and *Phaeoisariopsis*, *Fusarium*, *Rhizoctonia* and *Sclerotium.*
13. Isolation of phytopathogenic bacteria (locally available diseased plant material) and study of colony characteristics.
14. Demonstration of mechanical transmission of plant viruses.
15. Extraction of plant parasitic nematodes from soil.
16. Study of morphological features and identification of plant parasitic nematodes.

References: For Fungi:

1. Dube, H. C. 2013. *An Introduction to Fungi.4th (Edition).*Scientific Publishers, Jodhpur, India. (major text book)
2. Webster, J. 1989. *Introduction to fungi*. Cambridge Univ. Press (for life cycles of Fungi)
3. Dasgupta, M. K. 1987. *Principles of Plant Pathology*. Allied Publ. Pvt Ltd. p985. (for rust life cycles)

4. Students are also advised to refer Introductory Mycology by Alexopoulus, Mims and Blackwell (4th Edition) for Fungi.
5. For Bacteria, Viruses, Viroids, Phanerogamic Plant Parasites, Nematodes
6. Agrios, G. N. 2006. *Plant Pathology*. Elsevier Publishers, New Delhi.

HORTICULTURE

HORT181 FUNDAMENTALS OF HORTICULTURE 2(1+1)

Course outlines Theory

Horticulture-Its definition and branches, Importance and scope of horticulture, Horticultural and botanical classification, Climate and soil for horticultural crops, Plant propagation-methods (sexual & asexual), propagating structures; separation, division, grafting, budding, layering), High density planting; Use of rootstocks; Orchard establishment; (Principles & Layout) Principles and methods of training and pruning, Juvenility and flower bud differentiation; Unfruitfulness; pollination, pollinizers and pollinators; fertilization and parthenocarpy; Vegetable gardens & ornamental garden types and parts; Lawn making, Use of plant bio-regulators in horticulture, Irrigation methods in horticulture crops, Fertilizers application-methods.

Practical

Identification of garden tools, Identification of horticultural crops, Preparation of seed bed/nursery bed, Practice of sexual and asexual methods of propagation, Layout and planting of orchard plants, Training and pruning of fruit trees, Transplanting and care of vegetable seedlings, Making of herbaceous and shrubbery borders, Preparation of potting mixture, potting and repotting, Fertilizer application in different crops, Visits to commercial nurseries/orchard.

Lecture outlines Theory

1. Horticulture – Definition - Divisions of horticulture with suitable examples.
2. Scope and importance of horticulture - Importance of horticulture in terms of income, employment generation, industry, religious, aesthetic, food & nutritive value and export.
3. Horticultural classification based on soil, climate and botanical classification.
4. Climate and soil for horticultural crops - Influence of environmental factors on horticultural crop production – Temperature, humidity, wind, rainfall and solar radiation – Influence of soil factors – Soil type, pH, EC.
5. Propagating structures- Plant propagation- Methods - Sexual and asexual – Propagation by cuttings – Definition of cutting – Stem cuttings – Leaf cuttings – Root cuttings.
6. Propagation by Layering - Types of layering (tip, simple, compound, mound, trench, air layering) - Natural modifications of layering (runners, suckers, stolon, offset)- Propagation by separation - Bulbs, corms; division (rhizome, stem tuber, tuberous roots).
7. Grafting, budding - Rootstock and scion selection – Grafting methods – Attached scion methods of grafting, simple or approach grafting, detached scion methods

of grafting (side grafting - Veneer grafting, apical grafting - epicotyl grafting, double, soft wood grafting, cleft grafting, tongue grafting, whip grafting) - Graft incompatibility – Types – Translocated and localized incompatibility; Budding – Methods of budding – T-budding, inverted T-budding, patch budding and ring budding - Top working.

8. Principles of orchard establishment – Points to be kept in mind while selecting site for the establishment of orchards - Principles and steps in orchard establishment - Layout of orchards – Systems of planting - Square, rectangle, quincunx, hexagonal and contour systems of planting-their merits and demerits.
9. Principles and methods of training and pruning - Definition of training, objectives and training,

principles and methods of training of fruit crops - Open centre, closed centre and modified leader systems their merits and demerits - Definition of pruning, objectives of pruning, principles and methods of pruning of fruit crops.

10. Juvenility and flower bud differentiation – Methods for shortening juvenility - Application of growth regulators (Gibberellins, Auxins, cytokinins, Abscissic acid, Ethylene), environmental methods (photoperiod, temperature) - Cultivation techniques (grafting, pruning, girdling, irrigation, nutrition) - Bearing habits of fruit trees.
11. Unfruitfulness, factors (physiological, phylogenical, management, parasitical, climatological) pollination - Self and Cross pollination, pollinizers and pollinators
    - Fertilization and parthenocarpy – Types.
12. Types of vegetables Gardens – Kitchen Garden, market garden, truck garden, vegetable forcing, garden for processing, seed production garden and floating garden. Ornamental garden types – Formal – Informal – Wild Garden – Parts/ features of an ornamental garden.
13. Lawn making – Selection of Grass – Bermuda grass – Korean grass – Poa grass – Fescue grass – Kentucky blue grass - Grasses for shady areas – Site Selection – Soil
    - Preparation of soil – Drainage – Digging – Manuring and grading – Methods of planting – Sowing of seeds – Dibbling – Turfing – Maintenance of lawn – Mowing

– Rolling – Sweeping –Scraping – Raking – Weeding – Irrigation – Top dressing with compost and fertilizers - Diseases and other problems – Fairy ring – Pale Yellow Laws.

14. Use of plant bio-regulators (PBR) in horticulture – Introduction – Applications of PBR in fruit crops.
15. Irrigation methods in horticulture crops - Different methods followed in horticultural crops (check basin, furrow, ring basin, basin, flood, pitcher, funnel, drip and sprinkler).
16. Fertilizer application- Different methods of application to horticultural crops- Broad casting, top dressing, localized placement, contact placement Band placement, row placement, pellet, foliar application, starter solution, fertigation.

Practical

1. Identification of garden tools.
2. Identification of horticultural crops.
3. Layout of different planting systems.
4. Layout of kitchen garden.
5. Preparation of nursery bed (raised and flat beds) and sowing of seeds.
6. Practice of different asexual methods by divisions.
7. Practice of different asexual methods by cuttings.
8. Practice of different asexual methods by grafting.
9. Practice of different asexual methods by budding.
10. Practice of different asexual methods by layering.
11. Training and pruning of fruit trees.
12. Transplanting and care of vegetable seedlings.
13. Making of herbaceous and shrubbery borders.
14. Preparation of potting mixture, potting and repotting.

15. Fertilizer application in different crops.
16. Visits to commercial nurseries/orchard.

References

1. Chadha, K.L. 2001. *Handbook of Horticulture*. ICAR, New Delhi.
2. Jitendra Singh, 2012. *Basic Horticulture*. Kalyani Publishers. New Delhi.
3. Randhawa, G.S. and Mukhopadhyaya, A. 1994. *Floriculture in India*. Allied Publishers Pvt. Ltd., New Delhi
4. Kumar, N. 1997. *Introduction to Horticulture*. Rajyalakshmi Publications, Nagorcoil, Tamilnadu.

HORT182 PRODUCTION TECHNOLOGY OF FRUITS AND PLANTATION CROPS 2 (1+1)

Course outlines Theory

Importance and scope of fruit and plantation crop industry in India; Production technologies for the cultivation of major fruits-Mango, Banana, Citrus, Grape, Guava & Litchi, Papaya, Apple, Pear, Peach , Minor fruits- Pineapple, Pomegranate, Jackfruit, Strawberry, Nut crops (Almond & Walnut), Plantation crops-Coconut, Arecanut, Cashew, Tea, Coffee & Rubber.

Practical

Seed propagation, Scarification and stratification of seeds, Propagation methods for fruit and plantation crops including Micro-propagation, Description and identification of fruit, Preparation of plant bio regulators and their uses, Pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchard.

Lecture outlines Theory

1. Importance and scope of fruit crops - High density planting - Canopy management - Use of rootstocks in fruit crops.
2. Production technologies of Mango - Botanical name - Family – Origin – Introduction - Varieties – Climate – Soil- Propagation - Planting - Manuring- Irrigation – Inter Cultivation – Harvesting – Yield – Pests - Stem borer - Nut weevil -Fruit fly - Leaf webber - Diseases - Powdery mildew - Anthracnose - Sooty mould - Mango malformation - Physiological disorders-Fruit drop-Alternate bearing- Spongy tissue.
3. Production technology of Banana - Botanical name- Family – Origin - Importance- Varieties – Climate – Soil - Propagation- Planting – Manuring - Irrigation – Inter Cultivation practices – Harvesting – Yield – Pests - Rhizome weevil - Pseudo Stem weevil- diseases - Sigatoka leaf spot - Panama wilt - Rhizome rot - Bunchy top.
4. Production technology of Citrus - Botanical name – Family - Origin- Introduction - Varieties – Climate – Soil - Propagation - Planting - Manuring - Irrigation – Inter Cultivation – Harvesting – Yield – Pests -Butter fly - Fruit sucking moth - Citrus leaf miner - Diseases – Gummosis – Canker - Tristeza - Physiological disorders - Fruit drop – Granulation.
5. Production technology of Grape- Botanical name- Family- Origin- Introduction - Varieties – Climate – Soil - Propagation- Planting- Manuring- Irrigation – Inter Cultivation – Harvesting – Yield – Pests-Flea beetles – Mealy bug - Stem girdler Diseases- Powdery mildew - Downy Mildew – Anthracnose - Physiological disorders- Pink berries.
6. Production technology of Guava and Litchi - Botanical name- Family- Origin- Introduction - Varieties – Climate – Soil- Propagation - Planting- Manuring- Irrigation – Inter Cultivation – Harvesting – Yield – Pests of Guava - Tea mosquito bug - Mealybug - Diseases of Guava – Wilt.
7. Production technology of Papaya - Botanical name - Family- Origin- Introduction- Varieties – Climate – Soil – Propagation – Planting – Manuring - Irrigation – Inter Cultivation – Harvesting – Yield – Pests - Nematode**s** - diseases - Powdery mildew - Foot rot – Mosaic.
8. Production technology of Apple, Pear, Peach - Botanical name – Family – Origin – Importance – Varieties – Climate – Soil – Propagation - Planting- Manuring- Irrigation – Inter Cultivation – Harvesting – Yield – Pests of Apple - Wooly aphid, Codling moth - Pests of Peach - Fruit Fly -

Diseases of Apple- Scab - Powdery mildew- Physiological disorder in apple - Bitterpit - Diseases of Pear- Fruit spot - Diseases of Peach- Leaf curl.

9. Production technology of Minor fruits- Pineapple, Pomegranate - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield - Pests of pineapple- Mealy bug -Pests of pomegranate- Butterfly -Fruit sucking moth - Diseases of pineapple - Leaf and fruit rot - Diseases of pomegranate - Anthracnose and bacterial leaf spot - Physiological disorders of pomegranate - Fruit cracking.

10. Production technology of Jackfruit, Strawberry, Nut crops (Almond & Walnut) - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield – Pests of Jackfruit - Spittle bug - Fruit borer – Diseases of Jackfruit - Rhizopus rot - Die back.

11. Plantation crops- Scope and Importance - Coconut – Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield – Processing – Pests of Coconut - Black headed caterpillar - Rhinoceros beetle - Red palm weevil diseases of Coconut – Ganoderma - Tatipaka - Drey blight.

12. Production technology of Arecanut - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – harvesting – Yield – Processing - Pests of Arecanut - Mite - Spindle bug Diseases of Arecanut - Mahali (Fruit rot)- Foot rot.

13. Production technology of Cashew - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield – Processing - Pests of Cashewnut - Stem borer - Tea mosquito bug - Diseases of Cashewnut - Die back or Pink disease – Anthracnose.

14. Production technology of Tea - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield - Processing- Pests of Tea - Tea mosquito bug- Red spider mite - Diseases of Tea - Algal leaf spot- Blister blight.

15. Production technology of Coffee - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield - Processing- Pests of Coffee -White borer - Red borer and Green scales – Diseases of Coffee - Rust- Die back -Berry blotch.

16. Production technology of Rubber - Botanical name- Family- Origin- Importance- Varieties – Climate – Soil- Propagation- Planting- Manuring- Irrigation – Inter cultivation – Harvesting – Yield - Processing- Pests of Rubber - Scale insect - Mealy bug and mite - Diseases of Rubber - Birds eye spot - Pink disease.

Practical

1. Seed propagation-Scarification and stratification of seeds.
2. Propagation methods for fruit crops.
3. Propagation methods for plantation crops.
4. Micro-propagation.
5. Description and identification of fruit crops.

6. Preparation of plant bio regulators and their uses.
7. Pests and diseases of Mango, Banana, Citrus.
8. Pests and diseases of Grape, Papaya, guava.
9. Pests and diseases of Apple, Pear, Peach.
10. Pests and diseases of Pineapple, Pomegranate, Jackfruit.
11. Pests and diseases of Coconut, Arecanut.
12. Pests and diseases of Cashew, Rubber.
13. Pests and diseases of Coffee and Tea.
14. Physiological disorders of fruit crops – Mango, Citrus, Grape.
15. Physiological disorders of the plantation crops.
16. Visit to commercial plantations/ fruit orchards.

References

1. Bose, T.K. and Mitra, S.K. 1990. *Fruits – Tropical and Sub-tropical*. Naya Prakashan, Calcutta.
2. Chattopadhya, P. K. Year. *Text Book on Pomology (Fundamentals of Fruit Growing)*. Kalyani Publishers, Ludhiana.
3. Bijendra Singh. 2012. *Horticulture at a Glance*. Kalyani Publishers, Ludhiana
4. Parthasarathy, V. A., P.K.Chattopadhyay and Bose, T.K. 2006. *Plantation Crops*. Vol I and II. Parthasankar basu Naya Udyog, Kolkata.
5. Kumar, N., Abdul Khader, J.B.M, Rangaswamy, P. and Irulappan, I. 2004. *Introduction to Spices, Plantation crops, Medicinal and Aromatic Crops*. Oxford and IBH publishing Co, New Delhi.

AGRICULTURAL EXTENSION

AEXT190 *HUMAN VALUES AND ETHICS** *1(1+0)*

Course outlines Theory

Universal human aspirations: Happiness and prosperity; Human values and ethics: Concept, definition, significance and sources; Fundamental values: Right conduct, peace, truth, love and non-violence; Principles and Philosophy. Self Exploration. Self Awareness. Self Satisfaction. Decision Making. Motivation. Sensitivity. Success. Selfless Service. Case Study of Ethical Lives. Positive Spirit. Body, Mind and Soul. Attachment and Detachment. Spirituality Quotient. Examination.

Ethics: professional, environmental, ICT; Sensitization towards others particularly senior citizens, developmentally challenged and gender.

Spirituality, positive attitude and scientific temper; Team work and volunteering; Rights and responsibilities; Road safety; Human relations and family harmony; Modern challenges and value conflict: Sensitization against drug abuse and other social evils; Developing personal code of conduct (SWOT Analysis); Management of anger and stress.

Lecture outlines Theory

1. Universal human aspirations, happiness and prosperity
2. Human values and ethics - Concept, definition, significance and sources - Fundamental values - Right conduct, peace, truth, love and non-violence.
3. Principles and philosophy – Self exploration, self awareness, self satisfaction, decision making, motivation, sensitivity, success, selfless service.
4. Case study of ethical lives.
5. Positive spirit, body, mind and soul - Attachment and detachment.
6. Spirituality and spirituality quotient.
7. Examinations.
8. Ethics - Professional, environmental, ICT - Sensitization towards others particularly senior citizens, developmentally challenged and gender.
9. Positive attitude and scientific temper.
10. Team work and volunteering.
11. Rights and responsibilities.
12. Road safety.
13. Human relations and family harmony, modern challenges and value conflict.
14. Sensitization against drug abuse and other social evils.
15. Developing personal code of conduct (SWOT/SWOC/SNAC Analysis).
16. Management of anger and stress.

References

1. Gaur RR, Sanga lR and Bagaria GP. 2011. *A Foundation Course in Human Values and Professional Ethics*. Excel Books.
2. Mathur SS. 2010. *Education for Values, Environment and Human Rights*. RSA International.
3. Sharma RA. 2011. *Human Values and Education – Axiology, Inculcation and Research*. R.

Lall Book Depot.
4. Sharma RP and Sharma M. 2011. *Value Education and Professional Ethics*. Kanishka Publishers.
5. Srivastava S. 2011. *Human Values and Professional Ethics*. S K Kataria and Sons.
6. Srivastava S. 2011. *Environmental Science*. S K Kataria & Sons.
7. Tripathi A.N. 2009. *Human Values*. New Age International (P) Ltd Publishers.
8. R.S. Nagarajan. *Text Book on Professional Ethics & Human Values.*
9. D.R. Kiran. *Professional Ethics & Human Values*
10. Veerendra Kumar. *Human Values and Professional Ethics*.
11. M.Govindarajan. *Engineering Ethics*.

AEXT191 RURAL SOCIOLOGY AND EDUCATIONAL PSYCHOLOGY 2 (1+1)

Course outlines Theory

Sociology and Rural Sociology: Meaning, definition, scope, its significance in agriculture extension, Importance of Rural Sociology in Agricultural Extension and their Interrelationship. Indian Rural Society - Characteristics, Differences and Relationship between Rural and Urban Society, Social Group(s) – Meaning, Definition, Classification, Factors to be considered in formation of groups; Role of Social Groups in Agricultural Extension - Social Stratification – Meaning, Definition, Bases and Forms of Social Stratification, Characteristics and Differences between Class System and Caste System. Different Cultural Concepts viz., Culture, Tradition, Customs, Folkways, Mores, Taboos, Ritual: Definition, Meaning, Concept and Examples and their Role in Extension Education. Social Values: Meaning, Definition and Types; Social Control - Meaning, Definition, Need of social control and means of social control; and Attitudes - Types and their Role in Agricultural Extension. Social Institution – Types – Family, Education, Religious, Economic (Co - Operative Society) & Political (Panchayat). Characteristics, Functions and their importance / role in Agricultural Extension. Social Change - Meaning, definition, Nature of Social change, Dimensions of social change and factors of social change & Development: Psychology and Educational Psychology - Meaning, Definition, Scope and its Importance in Agricultural Extension. Behavior: Cognitive, affective, psychomotor domain, Intelligence - Meaning, Types, Factors and Importance in Agricultural Extension.

Perception, Emotions, Frustration - Meaning, Types, Factors and Importance in Agricultural Extension, Motivation - Meaning, Types of Motives, Theories of Motivation and Importance of Motivation in Agricultural Extension. Personality - Meaning, Definition, Types, Factors influencing Personality and Importance in Agricultural Extension. Teaching, Learning, Learning Experience, Learning Situation - Meaning and Definition, Elements of Learning Situation and its Characteristics. Principles of Learning, their implications in Teaching and Steps in Extension Teaching.

Practical

Visit to Village to study the Characteristics of Rural Society and rural stratification; Social Groups, Village Institutions – School / Co - Operative Society / Gram Panchayat; Social Organizations - Youth Club / Milk Co - Operative Centre / Water User Association; Visit to a Village to list out the Folkways, Mores, Taboos, Ritual, Customs, Tradition, Culture, Etiquette, Social Values, Simulated Exercises for Positive and Negative Emotions of Farmers in a Village. Administering Psychological Tests to assess Personality Types of Human Beings. Experiment: 1. Eysenk personality inventory; 2.Edward's personality inventory. Types of Intelligence and Frustrations among Farmers, Creating a Learning Situation under Village Conditions - Organizing a Extension Talk for Farmers in the Village / Conduct of a Method Demonstration in Village Situation

Lecture outlines Theory

1. Sociology and Rural Sociology - Meaning, definition, scope, its significance in Agricultural Extension - Importance of Rural Sociology in Agricultural Extension and their interrelationship.
2. Indian rural society - Characteristics, differences and relationship between rural and urban society.
3. Social group(s) – Meaning, definition, classification, factors to be considered in formation of groups - Role of social groups in Agricultural Extension.
4. Social Stratification – Meaning, definition, bases and forms of social stratification, characteristics and differences between class system and caste system.

5. Different cultural concepts - Culture, tradition, customs, folkways, mores, taboos, ritual - Definition, meaning, concept and examples and their role in Agricultural Extension.
6. Social values - Meaning, definition and types; social control - Meaning, definition, need of social control and means of social control and attitudes - Types and their role in Agricultural Extension.
7. Social institution – Types – Family, education, religious, economic (Co-operative society) & political (Panchayat) - Characteristics, functions and their importance/ role in Agricultural Extension.
8. Social change - Meaning, definition, nature of social change, dimensions of social change and factors of social change & development.
9. Psychology and educational psychology - Meaning, definition, scope and its importance in Agricultural Extension – Behavior - Cognitive, affective and psychomotor domains.
10. Intelligence - Meaning, types, factors and importance in Agricultural Extension.
11. Perception - Meaning, types, factors and importance in Agricultural Extension.
12. Emotions and frustration - Meaning, types, factors and importance in Agricultural Extension.
13. Personality - Meaning, definition, types, factors influencing personality and importance in Agricultural Extension.
14. Motivation - Meaning, types of motives, theories of motivation and importance of motivation in Agricultural Extension.
15. Teaching, learning, learning experience, learning situation - Meaning and definition, elements of learning situation and its characteristics.
16. Principles of learning, their implications in teaching and steps in extension teaching.

Practical

1. Visit to village to study the characteristics of rural society and rural stratification.
2. Visit to village to study the social groups.
3. Visit to village to study the village institution –School
4. Visit to village to study the village institution – Co operative society/ Bank.
5. Visit to village to study the village institution – Gram Panchayat.
6. Visit to village to study the social organization - Youth Club/ Rytu Mitra group.
7. Visit to village to study the social organization - Milk Co-operative centre/ Dairy unit.
8. Visit to village to study the social organization - Water User Association/ Self Help Group.

9&10 Visit to a village to list out the customs - Folkways, mores, taboos, rituals and social values - Simulated exercises on perception of students.

11. Simulated exercises for positive and negative emotions of students.
12. Nature of learners behavior in motivation.
13. &14. Administering psychological tests to assess personality types of human beings. Experiment: 1. Eysenk personality inventoryAdministering psychological tests to assess personality types of human beings. 2. Edward's personality inventory.
15. To study the types of intelligence among students.

16. Creating a learning situation under village conditions with a selected technology.

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1. Adivi Reddy, A. 2006. *Extension Education*. Sree Lakshmi Press, Bapatla
2. Chitamber, J. B. 1997. *Introductory Rural Sociology*. Wiley Eastern Limited, New Delhi
3. Daivadeenam, P. 2006. *Educational Psychology in Agriculture*. Agrotech Publishing Academy, Udaipur
4. Mangal, S. K. 2000. *Educational Psychology*. Prakash Brothers, Ludhiana.
5. Ray, G. L. 2006. *Extension Communication and Management*. Naya Prokash/ Kalyani Publishers, Ludhiana
6. VidyaBhushan and Sach Dev. D. R. 1998. *An Introduction to Rural Sociology*. Kitab Mahal Agencies Allahabad.

Bio Chemistry and Bio Technology

BICM101 FUNDAMENTALS OF BIOCHEMISTRY AND BIOTECHNOLOGY 3(2+1) PLANT

Course outlines Theory

Importance of Biochemistry - Properties of Water, pH and Buffer – Carbohydrate, Importance and classification - Structures of Monosaccharides - Reducing and oxidizing properties of Monosaccharides -Mutarotation, Structure of Disaccharides and Polysaccharides – Lipid, Importance and classification -Structures and properties of fatty acids - Storage lipids and membrane lipids – Proteins, Importance of proteins and classification, Structures - titration and zwitterions nature of amino acids - Structural organization of proteins – Enzymes, General properties and classification - Mechanism of action - Michaelis & Menten and Line Weaver Burk equation & plots - Introduction to allosteric enzymes - Nucleic acids - Importance and classification - Structure of Nucleotides, A, B & Z DNA – RNA, Types and Secondary & Tertiary structure - Metabolism of carbohydrates - Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain - Metabolism of lipids - Beta oxidation, Biosynthesis of fatty acids.

Concepts and applications of plant biotechnology - Scope, organ culture, embryo culture, cell suspension culture, callus culture, anther culture, pollen culture and ovule culture and their applications - Micro-propagation methods; organogenesis and embryogenesis - Synthetic seeds and their significance - Embryo rescue and its significance - Somatic hybridization and cybrids - Somaclonal variation and its use in crop improvement - Cryo-preservation - Introduction to recombinant DNA methods - Physical (Gene gun method), Chemical (PEG mediated) and Agrobacterium mediated gene transfer methods - Transgenics and its importance in crop improvement - PCR techniques and its applications - RFLP, RAPD, SSR - Marker Assisted Breeding in crop improvement - Biotechnology regulations.

Practical

Preparation of solution, pH & buffers - Qualitative tests of carbohydrates and amino acids - Quantitative estimation of glucose/ proteins - Titration methods for estimation of amino acids/lipids - Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides - Sterilization techniques. Composition of various tissue culture media and preparation of stock solutions for MS nutrient medium - Callus induction from various explants - Micro-propagation, hardening and acclimatization - Demonstration on isolation of DNA - Demonstration of gel electrophoresis techniques and DNA finger printing.

Lecture outlines

1 Introduction – Historical aspects of Biochemistry– Scope, impact and importance of Biochemistry in plant sciences -Properties of water – PH – Buffers.

2 Carbohydrates–Classification - Structures – Monosacharides – Structural aspects – mutarotation - Reducing and oxidizing properties.

3 Oligosaccharides and polysaccharides-Funtions of carbohydrates

4 Lipids – Fatty acids – Structures and properties – Functions of lipids

5 Lipids - Classification – Storage lipids and membrane lipids – Saponification, hydrogenation, Iodine number and Acidvalue.

6 Amino acids – Structures - Classification – Zwitterions –Titration

7 Peptides – Oligopeptides – Cyclic and acyclic peptides – Malformin, Glutathione, Gramicidin – Functions of peptides.

8 Proteins –Importance - Classification - Properties of proteins –Isoelectric P^{H} – Denaturation - Protein sequencing –Edman degradation method

9 Proteins – Structural organization – Primary, secondary, tertiary and quaternary structures and forces involved in stabilizing proteins

10 Enzymes – Characteristics of enzymes – Chemical nature, speed, specificity, active site - activation energy – Mechanism of enzyme action.

11 Classification of enzymes - Isoenzymes – Multienzyme complex – Allosteric enzymes and coenzymes.

12 Measurement of enzyme activity – Factors effecting enzyme activity – Enzyme Inhibition – MM & LB plots

13 Nucleic acids – Functions – Structures of nitrogen bases – Nucleosides – Nucleotides in RNA andDNA.

14 Various types of DNA and RNA – Secondary structure of B-DNA and t-RNA.

15 Metabolism – Anabolism and Catabolism – Stages of respiration – Overall metabolic view of carbohydrates, proteins and lipids.

16 Metabolism of carbohydrates – Glycolysis – Aerobic and anaerobic.

17 Tricarboxylic Acid (TCA) cycle—Glyoxalate cycle – Electron transport chain 18

Metabolism of lipids –Biosynthesis of fatty acids and tri acyl glycerol

19 Catabolism of lipids □□ □ □ □ oxidation of fatty acids in brief and □ oxidation in detail.

20 Protein Biosynthesis and post translational modifications

21 Secondary metabolites – Terpenoids – Alkaloids - Phenolics – Importance

22 Biotechnology – Major – Concepts and importance – Applications of plant biotechnology.

23 Introduction to plant tissue culture – History – Scientists - Terminology – Steps in general tissue culture – Types of sterilization and nutrient media – Types of cultures - Organ cultures, cell suspension culture, callus culture, pollen culture and their applications.

24 Micropropagation – Procedure techniques – Organogenesis and embryogenesis - Problems – Advantages –Limitations.

25 Anther culture – embryo culture – Ovule culture – Somatic embryogenesis - Synthetic seeds and its applications.

26 Protoplast isolation and fusion – Somatic hybridization – Cybrids – Somaclonal variations and applications in crop improvement – Cryo preservation

27 Recombinant DNA methods - Introduction to genetic engineering – Definitions – Gene cloning - Vectors.

28 & 29 Gene transfer methods – Indirect methods (Agrobacterium) and direct methods (physical-gene gun method; chemical-PEG mediated and other methods) with case studies / examples.

30 Transgenic plants – Present status - Applications in crop improvement – Limitations –

biotechnology regulations.

31 Polymerase chain reaction (PCR) –Procedure and applications.

32 Markers - Morphological, biochemical and molecular markers – RFLP, RAPD and SSR – Marker assisted selection for crop improvement.

Practical

1 Preparation of solutions, p^H and buffers.

2 Qualitative tests for carbohydrates.

3 Qualitative tests amino acids.

4 Estimation of amylose inrice.

5 Estimation of reducing sugar/Total soluble sugars.

6 Estimation of proteins by Lowrys method.

7 Extraction of oil from oil seeds by soxhlet apparatus.

8 Effect of P^H, temperature and substrate concentration on enzyme action.

9 Paper chromatography / TLC demonstration for seperation of amino acids. 10 Sterilization techniques.

11 Composition of various tissues culture media and preparation of stock solutions for MS nutrient medium.

12 Callus induction from various explants.

13 Micropropagation – Hardening and acclimatization.

14 Demonstration of isolation of DNA and of gel electrophoresis technique. 15 Demonstration of PCR Technique.

16 Demonstration of DNA finger printing –RAPD and Restriction digestion.

References:

1. David L. Nelson, Michael M.Cox; W.H. Freeman.Lehninger *Principles of Biochemistry*, 6th Edition
2. *Biochemistry,* Dr.U.Satyanarayana, Dr.U. Chakrapani, Books and Allied(P) Ltd, Kolkata
3. *Biochemistry,* S.N.Gupta, Rastogi Publications, First Edition, 2011
4. *Introduction to Plant Biotechnology* by HS Chawla (3rd Edition), Oxford & IBH Publishing Co. Pvt Ltd., New Delhi
5.
6.
7.

Hippocrates-Louis Pasteur- Robert Koch - Pure Culture Methods- Joseph Lister- Robert Koch- Beijerinck-Winogradsky- Francois Appert- Schroder and Von Dush- John Tyndall.

1. Protection against infection-Contributions of Edward Jenner- F. Loeffler- Behirng- Kitasasto- Louis

Pasteur - Applied aspects of Microbiology- Agricultural microbiology-Industrial microbiology-Food Microbiology - Medical microbiology
– Water Microbiology - Geochemical Microbiology- Pollution microbiology – Air microbiology – Exo-Microbiology - Microbial biotechnology.

2. Morphological types of Bacteria , Bacteria cell Structure- External and internal cell structures-Differences between Prokaryotes and Eukaryotes.
3. Microbial Nutrition- Autotrophy - Chemoautotrophy- Photoautotrophy
4. Heterotrophy – Metabolic pathways-Glycolysis-HMP-ED-TCA cycle.
5. Growth of Microorganisms - Cell Division - Growth cycle of bacteria [Lag phase, Log phase, Stationary and Death phase]- Generation time- Growth rate- Growth yield- Synchronous - Diauxic growth.
6. Bacterial genetics- Genetic recombination- Transformation- Conjugation- Transduction-Plasmids- Transposon.
7. Role of microbes in fertility of soils and plant growth - Rhizosphere- Rhizoplane- Phyllosphere-Phylloplane - Microflora- Carbon cycle- Carbon dioxide fixation.
8. Nitrogen cycle - Mineralisation- Immobilisation- Nitrification- Denitrification- Nitrogen Fixation - Phosphorus cycle, phosphorus solubilisation – Oxidation – Reduction - Sulphur cycle-Oxidation and reduction.
9. Biological nitrogen fixation - Symbiotic- Associative- Asymbiotic- Nitrogen fixation In *Azolla* - *Blue green algae* - Actinorhizal symbiosis - *Frankia*, Phosphate solubilizing microorganisms - *Bacillus* - *Pseudomonas*- *Mycorrhiza* for Phosphorous uptake.
10. PGPR Organisms - *Bacillus* – *Pseudomonas* – *Azotobacter* – *Azospirillum* - *Rhizobium*
-Microbes in human welfare.

11. Types of fermentations - Batch - Batch fed- Continuous - Solid State Fermentations, Common microbial fermentations-Alcohol- Lactic acid- Butyric acid- Formic acid
- Butanediol- Propionic Acid- Mixed Acid - Fermentation technology- Alcoholic beverages production.

12. Biofertilizers (Bacterial-Cyanobacterial-Fungal) production technology- Silage Production Technology.
13. Biopesticides- Viruses (*Nucleo polyhedrosis virus* - *Granular viruses*) – Bacteria (*Bacillus thuringiensis, Bacillus papilliae*) - fungi (*Beauveria* - *Verticillium*) - Protozoa (*Malameba locustae*- *Mattesia Spp*)-Mode of action.
14. Biofuel Production- Biodegradation - Biogas, Biomanures and Composting Technologies.

Practical

1. Introduction to microbiology laboratory and its equipments.
2. Microscope- Parts, principles of microscopy, resolving power and numerical aperture.
3. Micrometry-Measurement of size of microorganisms.
4. Methods of sterilization.
5. Bacterial staining procedures-Simple staining - Gram's staining and Endospore staining.

6. Nutritional media and their preparations.

7&8. Enumeration of microbial population in soil- Bacteria, fungi and actinomycetes.

9 Methods of isolation, purification and maintenance of microbial cultures. 10 Isolation of *Rhizobium* from legume root nodule.

11 Isolation of *Azotobacter*.

12 Isolation of phosphate solubilising bacteria/Phosphate solubilizing fungi PSB/ PSF.

13 Isolation of *Azospirillum* from roots.

14 Staining and microscopic examination of biofertilizer organisms.

15 Isolation *of VAM* from soil by wet sieving and decantation technique.

16 Determination of *VAM* root colonization by staining the infected roots.

References

1. *Microbiology*. Pelczar, J.r., M.J.E.C.S.Chan and Krieg, N.R. (5th Ed.) 2015. McGraw Hill Publishers, New York.
2. *Microbiology*. Prescott, L.M., Harley, J.P. and Klein, D.A. (9th Ed.) 2014. McGraw Hill Publishers, New York.
3. *Brock Biology of Microorganisms*. Madigan, M., Martinko, J.M and Parker, J. (14Ed.) 2015. Prentice hall of India Pvt Ltd., New Delhi.
4. *Soil Microbiology*: Subba Rao, N.S. (4th Ed.) 2014. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
5. *Microbiology A Laboratory Manual:* James, C and Natile, S. (10th Ed.) 2014. Pearson India Education Services Pvt. Ltd., South Asia.
6. *Experiments in Microbiology, Plant Pathology and Biotechnology*. Aneja, K.R.2011. New Age International (P) Ltd., Publishers, New Delh

Agricultural Microbiology

AMBE101 *AGRICULTURAL MICROBIOLOGY* *2(1+1)*

Course outlines Theory

Introduction- Scope of microbiology &brief history of microbiology. Microbial world- Prokaryotic and eukaryotic microbes and their differences, Bacteria- Detailed cell structure of bacteria, Microbial Nutrition- Autotrophy-chemoautotrophy, photo autotrophy, heterotrophy.Growth-Phases in bacterial growth, synchronous and diauxic Growth. Bacterial genetics- Genetic recombination- transformation, conjugation and transduction, plasmids, transposon. Role of microbes in soil fertility and crop production: Carbon cycle. Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. *Azolla*, blue green algae, Actinorrhizal symbiosis- *Frankia*. Phosphorus solubilizing microrganisms and *mycorrhiza*. Rhizosphere and phyllosphere. PGPRmicroorganisms. Microbes in human welfare, Types of Fermentation and Fermentation technology, Biofertilizers and silage production technology, Biopesticides-Mode of action, types of biopesticides, Biofuel production and biodegradation-Gobar gas and composting technology.

Practical

Introduction to microbiology laboratory and its equipments, Microscope- Parts, principles of microscopy, resolving power and numerical aperture, Micrometry- Measurement of size of microorganisms, Methods of sterilization, Bacterial Staining procedures-Simple staining, Gram's staining and Endospore staining, Nutritional media and their preparations, Enumeration of microbial population in soil- bacteria, fungi and actinomycetes. Methods of isolation, purification and maintenance of microbial cultures.Isolation of *Rhizobium* from legume root nodule. Isolation of *Azotobacter*. Isolation of Phosphate solubilisingbacteria/Phosphate solubilizing fungi. PSB/PSF. Isolation of *Azospirillum* from roots.Staining and microscopic examination of biofertilizer organisms. Isolation *of VAM* from soil by wet sieving and decantation Technique. Determination of *VAM* root colonization by staining the infected roots.

Lecture outlines Theory

15. Introduction- Definition- The hidden world of microbiology- How microbes evolved on earth- General classification of microbes-Microorganisms and principlesofmicrobiology- Scopeofmicrobiology.BriefHistory of microbiology

- Spontaneous generation theory- Contributions of Antony Van Leeuwenhoek- Francesco Redi- Lazzaro Spallanzani- Franz Schulze- Schroder and Von Dusch- Louis Pasteur- John Tyndall.

16. Role of microbes in fermentation-Contributions of Cagnaird Latour-Theodor Schwann, F.Kutzing- Louis Pasteur - Germ theory of disease - Contribution of

Hippocrates-Louis Pasteur- Robert Koch - Pure Culture Methods- Joseph Lister- Robert Koch- Beijerinck-Winogradsky- Francois Appert- Schroder and Von Dush- John Tyndall.

17. Protection against infection-Contributions of Edward Jenner- F. Loeffler- Behirng- Kitasasto- Louis Pasteur - Applied aspects of Microbiology- Agricultural microbiology-Industrial microbiology-Food Microbiology - Medical microbiology

– Water Microbiology - Geochemical Microbiology- Pollution microbiology – Air microbiology – Exo-Microbiology - Microbialbiotechnology.

18. Morphological types of Bacteria , Bacteria cell Structure- External and internal cell structures- Differences between Prokaryotes and Eukaryotes.

19. Microbial Nutrition- Autotrophy - Chemoautotrophy- Photoautotrophy

20. Heterotrophy – Metabolic pathways-Glycolysis-HMP-ED-TCA cycle.

21. Growth of Microorganisms - Cell Division - Growth cycle of bacteria [Lag phase, Log phase, Stationary and Death phase]- Generation time- Growth rate- Growth yield- Synchronous - Diauxic growth.

22. Bacterial genetics- Genetic recombination- Transformation- Conjugation- Transduction- Plasmids- Transposon.

23. Role of microbes in fertility of soils and plant growth - Rhizosphere- Rhizoplane- Phyllosphere- Phylloplane - Microflora- Carbon cycle- Carbon dioxide fixation.

24. Nitrogen cycle - Mineralisation- Immobilisation- Nitrification- Denitrification- Nitrogen Fixation - Phosphorus cycle, phosphorus solubilisation – Oxidation – Reduction - Sulphur cycle-Oxidation and reduction.

25. Biological nitrogen fixation - Symbiotic- Associative- Asymbiotic- Nitrogen fixation In *Azolla* - *Blue green algae* - Actinorhizal symbiosis - *Frankia*, Phosphate solubilizing microorganisms - *Bacillus* - *Pseudomonas*- *Mycorrhiza* for Phosphorous uptake.

26. PGPR Organisms - *Bacillus* – *Pseudomonas* – *Azotobacter* – *Azospirillum* - *Rhizobium*
-Microbes in human welfare.

27. Types of fermentations - Batch - Batch fed- Continuous - Solid State Fermentations, Common microbial fermentations-Alcohol- Lactic acid- Butyric acid- Formic acid
- Butanediol- Propionic Acid- Mixed Acid - Fermentation technology- Alcoholic beverages production.

28. Biofertilizers (Bacterial-Cyanobacterial-Fungal) production technology- Silage Production Technology.

29. Biopesticides- Viruses (*Nucleo polyhedrosis virus* - *Granular viruses*) – Bacteria (*Bacillus thuringiensis, Bacillus papilliae*) - fungi (*Beauveria* - *Verticillium*) - Protozoa (*Malameba locustae*- *Mattesia Spp*)-Mode of action.

30. Biofuel Production- Biodegradation - Biogas, Biomanures and Composting Technologies.

Practical

7. Introduction to microbiology laboratory and its equipments.
8. Microscope- Parts, principles of microscopy, resolving power and numerical aperture.
9. Micrometry-Measurement of size of microorganisms.
10. Methods of sterilization.
11. Bacterial staining procedures-Simple staining - Gram's staining and Endospore staining.
12. Nutritional media and their preparations.

7&8. Enumeration of microbial population in soil- Bacteria, fungi and actinomycetes.

9 Methods of isolation, purification and maintenance of microbial cultures. 10 Isolation of *Rhizobium* from legume root nodule.

17 Isolation of *Azotobacter*.

18 Isolation of phosphate solubilising bacteria/Phosphate solubilizing fungi PSB/ PSF.

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20 Staining and microscopic examination of biofertilizer organisms.

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8. *Microbiology*. Prescott, L.M., Harley, J.P. and Klein, D.A. (9th Ed.) 2014. McGraw Hill Publishers, New York.
9. *Brock Biology of Microorganisms*.Madigan, M.,Martinko, J.M and Parker, J. (14Ed.) 2015. Prentice hall of India Pvt Ltd., New Delhi.
10. *Soil Microbiology*: Subba Rao, N.S. (4th Ed.) 2014. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
11. *Microbiology A Laboratory Manual:* James, C and Natile, S. (10th Ed.) 2014. Pearson India Education Services Pvt. Ltd., South Asia.
12. *Experiments in Microbiology, Plant Pathology and Biotechnology*. Aneja, K.R.2011. New Age International (P) Ltd., Publishers, New Delh

Statistics and Mathematics

SMCA101 *ELEMENTARYMATHEMATICS* *2(1+1)*

Course outlines Theory & Practical

Matrices and Determinants : Definition of matrices- Addition- Subtraction- Multiplication- Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation. Cramer's rule and simple problems based on it.

Differential Calculus: Definition of function- limit and continuity (Simple problems). Differentiation of x^n, e^x- sin x and cos x by first principle - Derivatives of sum- difference product and quotient of two functions. Differentiation of functions of functions (Simple problems based on it) - Logarithmic differentiation (Simple problems based on it). Differentiation by substitution (Simple Problems) - Differentiation of Inverse Trigonometric functions - Equations of Tangent - Normal of given curve at given point. (Simple Problems used on it) - Maxima and Minima (Simple problems).

Integral Calculus : Integration of functions - Integration of Product of two functions- integration by substitution method - Definite Integral (Simple problems based on it) - Area under simple well-known curves (simple problems based on it).

Straight lines : Distance formula - section formula change of axes (only origin changed), Equation of lines (Slope-intercept, Slope–point, Two point, Intercept, Normal & General forms) - Point of inter section of two straight lines - Angles between two straight lines - Angle of bisectors between two lines - Area of triangles and quadrilateral.

Circle : Standard and General Equation of circle - Equation of circle passing through three given points - Equation of circle whose diameters is line joining two points - Tangent and Normal to a given circle at given point (Simple problems) - Condition of tangency of a line to circle.

Parabola : General and standard equations of parabola - Vertex, focus, equation of directrix, length of lotus rectum - Equation of tangent and normal to a given point (simple problems) -Conditions of tangency of line $y = mx + c$ to $y^2 = 4ax$.

Ellipse : Standard form of the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ - Focus - directrix, vertex of the ellipse in both cases (a>b, b>a) - Equation of tangent - normal at given points to a given ellipse (Simple problems).

Lecture outline Theory

1 Definition of matrices, order of a matrix - Type of matrices- Addition- Subtraction - Multiplication - Transpose of matrix - Minor.

2 Define Co-factor of matrix - A Inverse matrix up to 3rd order - Definition of determinants and properties of determinants up to 3rd order and their evaluation- Cramer's rule and simple problems based on it.

3 Definition of function - Limit and continuity with Simple problems.

4 Differentiation of x^n - e^x - sin x and cos x by first principle - Derivatives of sum- Difference product and quotient of two functions - Differentiation of functions of functions (Simple problems based on it).

5 Logarithmic differentiation (simple problems based on it) - Differentiation by substitution simple problems) - Differentiation of inverse trigonometric functions - Equations of tangent - Normal of given curve at given point.

6 Define Maxima and Minima with simple problems.

7 Integration of functions - Integration of product of two functions - Integration by substitution method.

8 Definite Integral (simple problems based on it) - Area under simple well-known curves (simple problems based on it).

9 Introduction to Co-ordinate geometry and give distance formula - Section formula with examples.

10 Define straight line and write different types of straight line forms with examples. Solve the angles between two straight lines - Area of triangle and quadrilateral.

11 Definition of standard and general equation of circle - Equation of circle passing through three given points.

12 Tangent and normal to a given circle at given point (simple problems) - Condition of tangency of a line to circle.

13 Definition of general and standards equations of parabola - Vertex - Focus - Equation of directrix - Length of lotus rectum.

14 Equation of tangent and normal to a given point (simple problems) - Conditions of tangency of line $y = mx + c$ to $y^2 = 4ax$.

15 Define standard form of the ellipse. Focus – Directrix - Vertex of the ellipse in both cases ($a>b$, $b>a$).

16 Equation of tangent - Normal at given points to a given ellipse with problems.

Practical

1 Problems on Addition-Subtraction-Multiplication - Transpose of matrix 3rd order.

2 Problems on minor - Co-factor of matrix - Inverse of matrix up to 3rd order.

3 Cramer's rule and simple problems based on it and problems on determinants.

4 Function limit and continuity with simple problems.

5 Problems on differentiation of x^n - e^x - sin x and cos x by first principle.

6 Derivatives of sum - difference product and quotient of two functions - Differentiation of functions of functions - Simple problems based on it.

7 Logarithmic - Inverse - Trigonometric functions- Functions of functions - Equations of tangent - Normal of given curve at given point - Simple problems.

8 Problems on integration of functions - Integration of product of two functions - Integration by substitution method.

9 Integral (simple problems based on it) - Area under simple well-known curves (simple problems based on it).

10 Problems on different types of straight line forms.

11 Problems on angles between two straight lines - Area of triangle and quadrilateral. 12 Problems on equation of circle passing through three given points.

13 Problems on parabola – Vertex – Focus - equation of directrix - Length of lotus rectum.

14 Problems on equation of tangent and normal to a given point - Conditions of tangency of line $y = mx + c$ to $y^2 = 4ax$

15 Problems on standard form of the ellipse - Focus – Directrix - Vertex of the ellipse in both cases (a>b, b>a).

16 Equation of tangent - Normal at given points to a given ellipse - Simple problems.

References

1. MVSL DN Raju and Dr. K.V. Ramana – *Engineering Mathematics-1*
2. MVSL DN Raju and Dr. K.V. Ramana – *Engineering Mathematics-2*
3. *Text Book for A.P Intermediate Mathematics* – Paper (IA & IIB).
4. MVSL DN Raju and K.V. Ramana - *Agrcultural Mathematics.*

SMCA 102 IT WORKSHOP 1(0+1)

Course Objectives:

1. Understand various features of operating systems along with hardware and software trouble shooting processes.

2. Understand the terminology, features and usage of internet, word processor, spread sheet, presentation and data storage tools

Course Outcomes: After completion of the course, student will be able to:

1. Identify the components of Personal Computer (PC) System.
2. Disassemble and assemble the components of Personal Computer.
3. Troubleshoot trivial hardware and software related problems.
4. Use word processor, spread sheet, presentation and data storage tools.
5. Install Operating Systems such as Windows and Linux on personal computers

Week 1 :

Task 1: Identify the peripherals of a computer, components in a System Cabinet and its functions. Draw the block diagram of the computer mother board along with the configuration of each peripheral and submit to your instructor.

Week 2 :

Task 2 : Every student should disassemble and **assemble the PC back to working condition.** Lab instructors should verify the work and follow it up with a Viva. Also students need to go through the video which shows the process of assembling a PC. A video would be given as part of the course content.

Week 3:

Task 3 : Every student should individually install Operating System on the personal computer. Lab instructor should verify the installation and follow it up with a Viva.

Week 4:

Task 4: Every student should configure dual boot system. Lab instructors should verify the installation and follow it up with a Viva

Week 5 :

Task 5: **Orientation & Connectivity Boot Camp :** Students should get connected to their Local Area Network and access the Internet. In the process they configure the TCP/IP setting. Finally students should demonstrate, to the instructor, how to access the websites and email.

Week 6:

Task 6: Search Engines & Netiquette: Students should know what search engines are and how to use the search engines. A few topics would be given to the students for which they need to search on Google. This should be demonstrated to the instructors by the student.

Week 7 and Week 8:

Task 7: Features of Word Processor Tool: Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track changes.

Task 8: Creating a Newsletter: Features: Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes, Paragraphs and Mail Merge.

Week 9 and Week 10:

Task 9: Features of Spread sheet Tool: Creating a Scheduler - Features:- Gridlines, Format Cells, Summation, auto fill, Formatting Text

Task 10: Calculating GPA : Cell Referencing, Formulae in spread sheet – average, std. deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function, lookup, Sorting, Conditional formatting.

Week 11 and Week 12:

Task 11: Features of Presentation tool: Students will work on basic power point utilities and tools which help them to create power point presentation.

Task 12: Presentation Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Hyperlinks, Inserting – Images, Clip Art, Audio, Video, Objects, Tables and Charts Lines and Arrows

Week 13:

Document preparation using LaTex

Week 14 and Week 15:

Review of Previous tasks

Note: Document, Spread Sheet and Presentation Tools, are from Libre Office suite

REFERENCES:

1. Comdex Information Technology course tool kit Vikas Gupta, WILEY Dream tech

2. The Complete Computer upgrade and repair book,3rd edition Cheryl A Schmidt, WILEY Dreamtech

3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education.

4. PC Hardware and A+Handbook – Kate J. Chase PHI (Microsoft)

5. IT Essentials PC Hardware and Software Companion Guide Third Edition by David Anfinson and Ken Quamme. – CISCO Press, Pearson Education.

6. IT Essentials PC Hardware and Software Labs and Study Guide Third Edition by Patrick Regan – CISCO Press, Pearson Education.

ENGLISH

ENGL101 COMPREHENSION AND COMMUNICATION SKILLS 2(1+1)
IN ENGLISH

Lecture outlines Theory

1. War minus shooting – A lesson from the text book "The Sporting Spirit"` by George Orwell - Comprehension pertaining to the textual grammar - Fill in the blanks, matching and vocabulary.
2. War Minus Shooting – A lesson from the text book, "The Sporting Spirit" by George Orwell - Comprehension pertaining to the textual grammar - Fill in the blanks, matching and vocabulary.
3. Synonyms- List of synonyms - Choose the synonyms - Exercises - Practice and implementation.
4. Antonyms – Fill in the blanks - Choose the correct antonyms - Exercises Practice and implementation.
5. Verbal ability – A list of words often confused and misused - Practice and implementation.
6. A Dilemma – A lesson from the text book, "Layman looks at Science" by Raymond

- B. Fosdick - Comprehension pertaining to the textual Grammar - Fill in the blanks, matching, vocabulary and reading comprehension.

7. A Dilemma – A Layman looks at Science - Reading comprehension and answering the questions.
8. Homonynms - Homonyms are distinct words with quite different meanings using the words in two ways - More words at a glance and exercises related to GRE and TO EFL.
9. Homophones – A list of homophones - Fill in the blanks, underline the correct word and exercises related to GRE and TOEFL.
10. You and Your English – A lesson from the text book,"A Spoken English and Broken English" by G. B. Shaw – Answering the questions related to the text - Fill in the blanks, matching and vocabulary and reading comprehension.
11. You and Your English – Reading comprehension and answering the questions.
12. Functional Grammar – Tenses - Active voice and passive voice - Degrees of comparison and types of sentences - Direct and indirect speech and agreement of verb with subject functional grammar – Articles – Prepositions - Parts of speech and agreement verb with subject - Glossary.
13. Business correspondence - Principles of letter – Writing - Courtesy and consideration - Directness and conciseness, avoid – Verbosity and participia endings - Clarity and precision - Negative and roundabout - Structure and layout

of letters - Planning a letter quotations, orders, tenders, sales letters, claim and adjustment letters, job application letters - Social correspondence – Personal correspondence and *curriculum vitae*.

14. The style - Importance of professional writing - Choice of words and phrases, clichés - Jargons - Foreign words and phrases.
15. Precise writing- Summarizing – The essential features of a good precise – Important points while making a precise - Some don't - Make a precise of the following paragraph and suggest suitable title - Figurative language – Figurative language associated with literature and with poetry - The figures of speech usually used in writing and conversation.
16. Interviews – The screening interview- The informational interview- The directive style - The

meandering style - The stress interview - The behavioural interview - The audition - The tag team interview - The meal time interview - The follow–up interview - Fermi interview - Preparing for the interview - Body language and interview - Types of interview questions - Idiomatic language.

Practical

1. Effective listening – Developing listening skills – Honing listening skills.
2. Listening to short talks and lectures from the cassettes of EFL University.
3. Spoken english — Vowels — Consonants - Monophthongs, diphthongs, triphthongs.
4. Stress – Intonation - Phonetic transcription.
5. Seminars – Conferences - Preparation and demonstration.
6. Oral presentation by students - Articulation and delivery – Evaluation sheet for oral presentation.
7. Communication skills – Verbal communication - Written communication.
8. Telephonic conversation.
9. Reading skills - Skimming, scanning - Extensive reading - Intensive reading and examples.
10. Meeting - Purpose, procedure, participation, physical arrangements.
11. Presentation of reports by using power point and L.C.D.
12. Interviews – Mock interviews .
13. Debate and Group discussion.
14. Using a dictionary effectively.
15. Vocabulary.
16. Pronunciation practice.

References

1. Balasubramanian, T. 1989. *A Text Book of Phonetics for Indian Student*, Orient Longman, New Delhi.
2. Balasubramanyam, M. 1985. *Business Communication.* Vani Education Books, New Delhi.
3. Jean Naterop, B. and Rod Revell. 1977. *Telephoning in English*. Cambridge University Press, Cambridge.
4. Krishna Mohan and Meera Banerjee. 1990. *Developing Communication Skills*. Mc Millan India Ltd. New Delhi.
5. Krishanswamy, N and Sriraman, T. 1985. *Current English for Colleges*. Mc Millan India Ltd., Madras.
6. Narayanaswamy V R. 1979. *Strengthen Your Writing.* Orient Longman, New Delhi.
7. Sharma R C and Krishna Mohan. 1978. *Business Correspondence.* Tata Mc Graw Hill Publishing Company, New Delhi.

Physical Education

COCA 100 NSS/NCC/PHYSICAL EDUCATION & YOGA PRACTICES 2(0+2)

Course outlines

Introduction and basic components of NSS, NSS programmes and activities, Understanding youth, Community mobilization, Social harmony and national integration, Volunteerism and shramdan, Citizenship, constitution and human rights, Family and society, Importance and role of youth leadership, Life competencies, Youth development programmes, Health, hygiene and sanitation, Youth health, lifestyle, HIV AIDS and first aid, Youth and yoga , Vocational skill development, Issues related environment, Disaster management, Entrepreneurship development, Formulation of production oriented project, Documentation and data reporting, Resource mobilization, Additional life skills, Activities directed by the Central and State Government

Lecture outlines

1 Introduction and basic components of NSS – Orientation - History, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health

2 NSS programmes and activities - Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary

3 Understanding youth - Definition, profile, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

4 Community mobilization -Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilisation involving youth-adult partnership

5 Social harmony and national integration - Indian history and culture, role of youth in nation building, conflict resolution and peace-building

6 Volunteerism and shramdan - Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism

7 Citizenship, constitution and human rights - Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information

8 Family and society - Concept of family, community (PRIs and other community based organisations) and society

9 Importance and role of youth leadership - Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership

10 Life competencies - Definition and importance of life competencies, problem- solving and decision-making, inter personal communication

11 Youth development programmes - Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth- led organstions

12 Health, hygiene and sanitation - Definition needs and scope of health education;

13 role of food, nutrition, safe drinking water, water born diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive

health

14 Youth health, lifestyle, HIV AIDS and first aid - Healthy lifestyles, HIV AIDS, drugs and substance

abuse, home nursing and first aid

15 Youth and yoga - History, philosophy, concept, myths and misconceptions about

16 yoga; yogatraditionsanditsimpacts, yogaasatoolforhealthylifestyle, preventive
and curative method

17 Vocational skill development - To enhance the employment potential and to set

18 up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list

19 Issues related environment - Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management

20 Disaster management - Introduction and classification of disaster, rehabilitation

21 and management after disaster; role of NSS volunteers in disaster management.

22 Entrepreneurship development - Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution

23 Formulation of production oriented project - Planning, implementation, management and impact assessment of project

24 Documentation and data reporting - Collection and analysis of data, documentation and dissemination of project reports

25 Youth and crime - Sociological and psychological factors influencing youth crime,

cyber-crime, pear mentoring in preventing crime and awareness for juvenile
justice

27 Civil/self defence - Civil defence services, aims and objectives of civil defence;

28 Needs and training of self defence

29 Resource mobilisation - Writing a project proposal of self-fund units (SFUs) and its 30
establishments

31 Additional life skills - Positive thinking, self-confidence and esteem, setting life

32 goals and working to achieve them, management of stress including time
Management.

Sd

(P NARAYANA REDDY)

Item 8

Presentation of the minutes of the BoS in AI, including course structure and syllabi, for BSc Programs of the School of Sciences to be offered from the academic year 2021-22

Anurag University
Ghatkesar, Hyderabad, Telangana 500 088
www.anurag.edu.in

Department of Artificial Intelligence

Minutes of the Board of Studies (BoS) Meeting in Artificial Intelligence held on Saturday, 26th June 2021 at 11:00 Am in Online Mode

Members Present:

1. Prof S Sameen Fatima, Head, Dept of AI&Registrar, AU, Chairperson
2. Dr G Vishnu Murthy, Dean Engineering, AU, Member
3. Dr Ananta Lakshmi, Professor and Head, Dept of English, AU, Member
4. Dr VempatiSrinivasa Rao, Professor and Head, Dept of Maths, AU, Member
5. Dr P Radha Krishna, Professor, NlT, Warangal, Member
6. Dr MV Krishna Murthy,Managing Director, United Online Software Development, Hyderabad, Member
7. Mr Bala Prasad Peddigari, Principal Consultant, Tata Consultancy Services Limited, Hyderabad, Member
8. Mr Samir Goswami, Director (MIS), DDUGKY Division, NIRDPR, Member
9. Dr P V Sudha, Professor and Head, Dept of CSE, UCE, OU, Member
10. Dr Salman A Moiz, Professor, SCIS,UoH, Member
11. Dr TilottamaGoswami, Professor,Dept of AI, AU, Member
12. Dr Pardeep Kumar, Asst.Professor, Dept of AI, AU, Member
13. Mr M Hari Prasad, Asst.Professor, Dept of AI, AU, Member

Members Absent:

1. Mr Ramakrishna Lingireddy, Vice President, Capgemini, Hyderabad, Member
2. Dr Sumohana S Channappayya, Associate Professor, IIT Hyderabad, Member
3. Dr VijayaKumari Gunta, Professor, JNTUH, Member
4. MrMalladiHarikrishna, Associate Architect, Kore.ai, Hyderabad, Alumni,Member

The Chairperson welcomed all the members and gave a brief introduction of the new courses being introduced at Anurag University in the Faculty of Science. The agenda of the meeting included the course structure for the following courses, which were presented and taken up for discussion:

1. BSc (Maths, Statistics, AI)
2. BSc (Maths, Statistics, Data Science)
3. BSc Hons (Maths, Statistics, AI)
4. BSc Hons (Maths, Statistics, Data Science)

The members expressed that the Course Structure was well thought of. However, a few suggestions were made:

a. The Skill Enhancement Course (SEC) "Linux Programming" maybe replaced with a course on "Fundamentals of Computing" Information Technology, Programming

Constructs, Database, Networks and Operating Systems. This is needed for students coming from non-computer background.

b. Few members felt Data Structures course can be offered with C instead of Python, some opined that Data Structures course may not be needed. However it was left to the Chairperson to take a decision on that.
c. Rename BSc (Maths, Statistics, AI) to BS (Maths, Statistics, AI), BSc (Maths, Statistics, Data Science) to BS (Maths, Statistics, Data Science).
d. Make BSc a 4 Year Program and allow the students to take normal degree after 3 years as per new education policy.
e. Database course should incorporate structured and unstructured data as AI and Data Science require working with both kinds of data.
f. Two Mini Projects are not required in 2nd Year, one is sufficient; instead of that two separate database courses can be offered namely "Structured Databases" and "Unstructured databases". Also cover "Graph Databases" in "Unstructured Databases" course.
g. Linear Algebra cannot be an elective; it should be made a core course and taught in the early semesters, instead of III yr I semester. The Chairperson for Maths was assigned this task
h. Replace Deep Learning with Machine Learning in III Yr I semester.
i. Add Data Storytelling as an English Course. The Chairperson for English was assigned this task

Based on the above suggestions and keeping in view Anurag University's requirements/constraints, it was resolved that the Chairperson be authorized to modify the course structure and syllabus for the following programs:

1. BSc (Maths, Statistics, AI)
2. BSc (Maths, Statistics, Data Science)
3. BSc Hons (Maths, Statistics, AI)
4. BSc Hons (Maths, Statistics, Data Science)

The members authorized the Chairperson to give the panel of examiners and evaluators.

The meeting ended with the chairperson thanking all the esteemed Board of Studies members.

Chairperson, Board of Studies in Artificial Intelligence
Department of Artificial Intelligence
Anurag University, Hyderabad

Course Structure

BSc

(Maths, Statistics, AI)

I, II & III Year

BSc
(Maths, Statistics, AI)
I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	2
2	LC-E1	English for Empowerment	3	0	0	3
3	LC-E2	English Language Skills lab	0	0	2	1
4	CC-M1	Differential and Integral Calculus	4	1	0	5
5	CC-S1	Descriptive Statistics and Probability	4	0	0	4
6	CC-AI1	Python for Problem Solving	4	0	0	4
7		Descriptive Statistics and Probability Lab	0	0	2	1
8		Python for Problem Solving Lab	0	0	2	1
Total (4L + 1T + 3P)						**21**

BSc
(Maths, Statistics, AI)
I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	2
2	LC-E3	The Power of Data Storytelling	3	0	0	3
3	LC-E4	Art of Articulation Lab	0	0	2	1
4	CC-M2	Differential Equations	4	1	0	5
5	CC-S2	Probability Distributions	4	0	0	4
6	CC-AI2	Data Structures in Python	4	0	0	4
7		Probability Distributions Lab	0	0	2	1
8		Data Structures in Python Lab	0	0	2	1
Total (5L + 1 T + 3P)						**21**

BSc
(Maths, Statistics, AI)
II Year I Semester

S.No.	Code	CourseName	Hoursperweek			Credits
			L	T	P	
1	SEC-1	Foundations of Computing	2	0	0	2
2	SEC-2	Logical Reasoning and Quantitative Analysis(LRQA)	1	1	0	2
3	CC-M3	Real Analysis	4	1	0	5
4	CC-S3	Statistical Methods and Estimation	4	0	0	4
5	CC-AI3	Artificial Intelligence	4	0	0	4
6		Statistical Methods and Estimation Lab	0	0	2	1
7		Artificial Intelligence Lab	0	0	2	1
TOTAL (5L + 2T + 2P)						**19**

BSc
(Maths, Statistics, AI)
II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	SEC-3	R Programming	2	0	0	2
2	SEC-4	Mini Project	0	1	2	2
3	CC-M4	Algebra	4	1	0	5
4	CC-S4	Statistical Inference	4	0	0	4
5	CC-AI4	Machine Learning	4	0	0	4
		Statistical Inference Lab	0	0	2	1
		Machine Learning Lab	0	0	2	1
TOTAL (4L + 2T + 2P + 1 Project)						**19**

BSc
(Maths, Statistics, AI)
III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	GE	Entrepreneurship / Business Communication / Music	4	0	0	4
2	LC-SF1	Second Language / Foreign Language	4	0	0	4
3	EC-M1	1.LinearAlgebra 2. Analytical Solid Geometry 3. Mathematical Modelling	4	1	0	5
4	EC-S1	1.Applied Statistics–I 2. Analytic Statistics-I 3. Actuarial Statistics-I	4	0	0	4
5	EC-AI1	1. Deep Learning 1. Database Systems 2. Image Processing 3. Data Preparation Techniques	4	0	0	4
6		EC-S1 Lab	0	0	2	1
7		EC-AI1 Lab	0	0	2	1
		Project(initiated in the summer)				
Total (5L + 1T + 2P)						**23**

BSc
(Maths, Statistics, AI)
III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	LC-SF2	Second Language / Foreign Language	4	0	0	4
2	EC-M2	1. Numerical Analysis 2. Integral Transforms 3. Number Theory, Logic & Sets	4	1	0	5
3	EC-S2	1. Applied Statistics–II 2. Analytic Statistics-II 3. Actuarial Statistics-II	4	0	0	4
4	EC-AI2	1. Natural Language Processing 2. Big Data 3. Information Retrieval Systems	4	0	0	4
5		EC-S2 Lab	0	0	2	1
6		EC-AI2 Lab	0	0	2	1
7	PROJ	Project	0	0	12	6
Total						**25**

Summary of Courses with Credits for BSc (Maths, Statistics, AI)

S.No.	CourseType	No of Courses	Credits Per Course	Credits
1	**AbilityEnhancement Courses (AECC)** (Gender Sensitization, Environment Studies)	2	2	4
2	**Skill Enhancement Courses (SEC)** (Foundations of Computing, R Programming, LRQA, Mini Project)	4	2	8
3	**Language Courses(LC)**			
	1.English	2	4 (3L +2P)	8
	2.Second Language / Foreign Language	2	4	8
4	**Core Courses(CC)**			
	1.Maths(M)	4	5 (4L+1T)	20
	2.Statistics (S)	4	5 (4L+2P)	20
	3.AI(AI)	4	5(4L+2P)	20
5	**Elective Course(EC)**			
	1.Maths(M)	2	5 (4L+1T)	10
	2.Statistics (S)	2	5 (4L+2P)	10
	3.AI(AI)	2	5(4L+2P)	10
6	**Generic Electives(GE)** (Entrepreneurship, Business Communication, Music)	1	4	4
7	**Project (PROJ)**	1	6(12P)	6
		30		**128**

Course Structure

BSc

(Maths, Statistics, Data Science)

I, II & III Year

BSc
(Maths, Statistics, Data Science)
I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	2
2	LC-E1	English for Empowerment	3	0	0	3
3	LC-E2	English Language Skills lab	0	0	2	1
4	CC-M1	Differential and Integral Calculus	4	1	0	5
5	CC-S1	Descriptive Statistics and Probability	4	0	0	4
6	CC-DS1	Python for Problem Solving	4	0	0	4
7		Descriptive Statistics and Probability Lab	0	0	2	1
8		Python for Problem Solving Lab	0	0	2	1
Total(5L+1T+3P)						**21**

BSc
(Maths, Statistics, Data Science)
I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	2
2	LC-E3	The Power of Data Storytelling	3	0	0	3
3	LC-E4	Art of Articulation Lab	0	0	2	1
4	CC-M2	Differential Equations	4	1	0	5
5	CC-S2	Probability Distributions	4	0	0	4
6	CC-DS2	Data Structures in Python	4	0	0	4
7		Probability Distributions Lab	0	0	2	1
8		Data Structures in Python Lab	0	0	2	1
Total(5L+1T+3P)						**21**

BSc
(Maths, Statistics, Data Science)
II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	SEC-1	Foundations of Computing	2	0	0	2
2	SEC-2	Logical Reasoning and Quantitative Analysis(LRQA)	1	1	0	2
3	CC-M3	Real Analysis	4	1	0	5
4	CC-S3	Statistical Methods and Estimation	4	0	0	4
5	CC-DS3	Data Preparation Techniques	4	0	0	4
6		Statistical Methods and Estimation Lab	0	0	2	1
7		Data Preparation Techniques Lab	0	0	2	1
TOTAL(5L+2T+2P)						**19**

BSc
(Maths, Statistics, Data Science)
II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	SEC-3	R Programming	2	0	0	2
2	SEC-4	Mini Project	0	1	2	2
3	CC-M4	Algebra	4	1	0	5
4	CC-S4	Statistical Inference	4	0	0	4
5	CC-DS4	Data Science	4	0	0	4
6		Statistical Inference Lab	0	0	2	1
7		Data Science Lab	0	0	2	1
TOTAL(4L+2T+2P+1Project)						**19**

BSc
(Maths, Statistics, Data Science)
III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	GE	Entrepreneurship / Business Communication / Music	4	0	0	4
2	LC-SF1	Second Language / Foreign Language	4	0	0	4
3	EC-M1	1. LinearAlgebra 2. Analytical Solid Geometry 3. Mathematical Modelling	4	1	0	5
4	EC-S1	1. Applied Statistics–I 2. Analytic Statistics-I 3. Actuarial Statistics-I	4	0	0	4
5	EC-DS1	2. Deep Learning 3. Database Systems 4. Image Processing 5. Artificial Intelligence	4	0	0	4
6		EC-S1 Lab	0	0	2	1
7		EC-DS1 Lab	0	0	2	1
		Project(initiated in the summer)				
Total(5L+1T+2P)						**23**

BSc
(Maths, Statistics, Data Science)
III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	LC-SF2	Second Language / Foreign Language	4	0	0	4
2	EC-M2	4. Numerical Analysis 5. Integral Transforms 6. Number Theory, Logic & Sets	4	1	0	5
3	EC-S2	3. Applied Statistics–II 4. Analytic Statistics-II 3. Actuarial Statistics-II	4	0	0	4
4	EC-DS2	4. Natural Language Processing 5. Big Data 6. Information Retrieval Systems	4	0	0	4
5	PROJ	Project	0	0	12	6
6		EC-S2 Lab	0	0	2	1
7		EC-DS2 Lab	0	0	2	1
Total(4L+1T+2P+1 Project)						**25**

Summary of Courses with Credits for BSc (Maths, Statistics, Data Science)

S.No.	CourseType	No of Courses	Credits Per Course	Credits
1	**AbilityEnhancement Courses (AECC)** (GenderSensitization, Environment Studies)	2	2	4
2	**Skill Enhancement Courses (SEC)** (Foundations of Computing, R Programming, LRQA, Mini Project)	4	2	8
3	**Language Courses(LC)**			
	1.English	2	4 (3L+2P)	8
	2.Second Language / Foreign Language	2	4	8
4	**Core Courses(CC)**			
	1.Maths(M)	4	5 (4L+1T)	20
	2.Statistics (S)	4	5 (4L+2P)	20
	3.DataScience(DS)	4	5(4L+2P)	20
5	**Elective Course(EC)**			
	1.Maths(M)	2	5 (4L+1T)	10
	2.Statistics (S)	2	5 (4L+2P)	10
	3.DataScience(DS)	2	5(4L+2P)	10
6	**Generic Electives(GE)** (Entrepreneurship, BusinessCommunication,Music)	1	4	4
7	**Project (PROJ)**	1	6(12P)	6
		30		**128**

Course Structure

BSc Hons

(Maths, Statistics, AI)

I, II & III Year

BSc Hons
(Maths, Statistics, AI)
I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	2
2	LC-E1	English for Empowerment	3	0	0	3
3	LC-E2	English Language Skills lab	0	0	2	1
4	SEC-1	Foundations of Computing	2	0	0	2
5	CC-M1	Differential and Integral Calculus	4	1	0	5
6	CC-S1	Descriptive Statistics and Probability	4	0	0	4
7	CC-AI1	Python for Problem Solving	4	0	0	4
8		Descriptive Statistics and Probability Lab	0	0	2	1
9		Python for Problem Solving Lab	0	0	2	1
Total (6L + 1T + 3P)						**23**

BSc Hons
(Maths, Statistics, AI)
I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	2
2	LC-E3	The Power of Data Storytelling	3	0	0	3
3	LC-E4	Art of Articulation Lab	0	0	2	1
4	SEC-2	R Programming	2	0	0	2
5	CC-M2	Differential Equations	4	1	0	5
6	CC-S2	Probability Distributions	4	0	0	4
7	CC-AI2	Data Structures in Python	4	0	0	4
8		Probability Distributions Lab	0	0	2	1
9		Data Structures in Python Lab	0	0	2	1
Total (6L+1T+3P)						**23**

BSc Hons
(Maths, Statistics, AI)
II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	MPT-1	Mini Project with Technical Report	0	2	4	4
2	SEC-3	Logical Reasoning and Quantitative Analysis(LRQA)	1	1	0	2
3	CC-AI3	Structured Databases	3	0	0	3
4	CC-M3	Real Analysis	4	1	0	5
5	CC-S3	Statistical Methods and Estimation	4	0	0	4
6	CC-AI4	Fundamentals of Artificial Intelligence	4	0	0	4
7		Structured Databases Lab	0	0	2	1
8		Statistical Methods and Estimation Lab	0	0	2	1
9		Fundamentals of Artificial Intelligence Lab	0	0	2	1
TOTAL(5L+3T+3P+1project)						**25**

BSc Hons
(Maths, Statistics, AI)
II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	**T**	**P**	
1	CC-AI5	Unstructured Databases	3	1	0	4
2	SEC-4	Mobile Application Development	2	0	0	2
3	CC-AI6	Web Programming	3	0	0	3
4	CC-M4	Algebra	4	1	0	5
5	CC-S4	Statistical Inference	4	0	0	4
6	CC-AI7	Machine Learning	4	0	0	4
7		Web Programming & Mobile Application Development Lab	0	0	2	1
8		Statistical Inference Lab	0	0	2	1
9		Machine Learning & Unstructured Databases Lab	0	0	2	1
TOTAL (6L+2T+3P)						**25**

BSc Hons
(Maths, Statistics, AI)
III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	GE	Entrepreneurship / Business Communication / Music	4	0	0	4
2	LC-SF1	Second Language / Foreign Language	4	0	0	4
3	EC-M1	1. LinearAlgebra 2. Analytical Solid Geometry 3. Mathematical Modeling	4	1	0	5
4	EC-S1	1. Applied Statistics–I 2. Analytic Statistics-I 3. Actuarial Statistics-I	4	0	0	4
5	EC-AI1	7. Deep Learning 8. Data Preparation Techniques 9. Image Processing	4	0	0	4
6		EC-S1 Lab	0	0	2	1
7		EC-AI1 Lab	0	0	2	1
8		Project(initiated in the summer)				
Total(5L+1T+2P)						**23**

BSc Hons
(Maths, Statistics, AI)
III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	LC-SF2	Second Language / Foreign Language	4	0	0	4
2	EC-M2	7. Numerical Analysis 8. Integral Transforms 9. Number Theory, Logic & Sets	4	1	0	5
3	EC-S2	5. Applied Statistics–II 6. Analytic Statistics-II 3. Actuarial Statistics-II	4	0	0	4
4	EC-AI2	1. Natural Language Processing 2. Big Data 3. Information Retrieval Systems	4	0	0	4
5		EC-S2 Lab	0	0	2	1
6		EC-AI2 Lab	0	0	2	1
7	PROJ	Project	0	0	12	6
Total(4L+1T+2P+1Proj)						**25**

Summary of Courses with Credits for BSc Hons (Maths, Statistics, Data Science)

S.No.	CourseType	No of Courses	Credits Per Course	Credits
1	**AbilityEnhancement Courses (AECC)** (Gender Sensitization, Environment Studies)	2	2	4
2	**Skill Enhancement Courses (SEC)** (Foundations of Computing, R Programming, LRQA, Mobile Application Development)	4	2	8
3	**Language Courses(LC)**			
	1.English	2	4 (3L + 2P)	8
	2.Second Language / Foreign Language	2	4	8
4	**Core Courses(CC)**			
	1.Maths(M)	4	5 (4L+1T)	20
	2.Statistics (S)	4	5 (4L+2P)	20
	3.AI(AI)	7	4*4credits(4L)+1*4(3L+1T) +2*3credits(3L)+6*1(2P)	32
5	**Elective Course(EC)**			
	1.Maths(M)	2	5 (4L+1T)	10
	2.Statistics (S)	2	5 (4L+2P)	10
	3.AI(AI)	2	5(4L+2P)	10
6	**Generic Electives(GE)** (Entrepreneurship, Business Communication, Music)	1	4	4
7	**Mini Project with Technical Report (MPT)**	1	4(2T+4P)	4
8	**Project (PROJ)**	1	6(12P)	6
		34		**144**

CourseStructure

BSc Hons

(Maths, Statistics, Data Science)

I, II & III Year

BSc Hons
(Maths, Statistics, Data Science)
I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	2
2	LC-E1	English for Empowerment	3	0	0	3
3	LC-E2	English Language Skills lab	0	0	2	1
4	SEC-1	Foundations of Computing	2	0	0	2
5	CC-M1	Differential and Integral Calculus	4	1	0	5
6	CC-S1	Descriptive Statistics and Probability	4	0	0	4
7	CC-DS1	Python for Problem Solving	4	0	0	4
8		Descriptive Statistics and Probability Lab	0	0	2	1
9		Python for Problem Solving Lab	0	0	2	1
Total(6L+1T+3P)						**23**

BSc Hons
(Maths, Statistics, Data Science)
I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	2
2	LC-E3	The Power of Data Storytelling	3	0	0	3
3	LC-E4	Art of Articulation Lab	0	0	2	1
4	SEC-2	R Programming	2	0	0	2
5	CC-M2	Differential Equations	4	1	0	5
6	CC-S2	Probability Distributions	4	0	0	4
7	CC-DS2	Data Structures in Python	4	0	0	4
8		Probability Distributions Lab	0	0	2	1
9		Data Structures in Python Lab	0	0	2	1
Total(6L+1T+3P)						**23**

BSc Hons
(Maths, Statistics, Data Science)
II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	MPT-1	Mini Project with Technical Report	0	2	4	4
2	SEC-3	Logical Reasoning and Quantitative Analysis(LRQA)	1	1	0	2
3	CC-DS3	Structured Databases	3	0	0	3
4	CC-M3	Real Analysis	4	1	0	5
5	CC-S3	Statistical Methods and Estimation	4	0	0	4
6	CC-DS4	Data Preparation Techniques	4	0	0	4
7		Structured Databases Lab	0	0	2	1
8		Statistical Methods and Estimation Lab	0	0	2	1
9		Data Preparation Techniques Lab	0	0	2	1
Total(5L+3T+3P+1 Project)						**25**

BSc Hons
(Maths, Statistics, Data Science)
II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-DS5	Unstructured Databases	3	1	0	4
2	SEC-4	Mobile Application Development	2	0	0	2
3	CC-DS6	Web Programming	3	0	0	3
4	CC-M4	Algebra	4	1	0	5
5	CC-S4	Statistical Inference	4	0	0	4
6	CC-DS7	Data Science	4	0	0	4
7		Web Programming & Mobile Application Development Lab	0	0	2	1
8		Statistical Inference Lab	0	0	2	1
9		Data Science & Unstructured Databases Lab	0	0	2	1
Total(6L+2T+3P)						**25**

BSc Hons
(Maths, Statistics, Data Science)
III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	**T**	**P**	
1	GE	Entrepreneurship / Business Communication / Music	4	0	0	4
2	LC-SF1	Second Language / Foreign Language	4	0	0	4
3	EC-M1	1.LinearAlgebra 2. Analytical Solid Geometry 3. Mathematical Modelling	4	1	0	5
4	EC-S1	1.Applied Statistics–I 2. Analytic Statistics-I 3. Actuarial Statistics-I	4	0	0	4
5	EC-DS1	6. Deep Learning ~~7.~~ Artificial Intelligence 8. Image Processing	4	0	0	4
6		EC-S1 Lab	0	0	2	1
7		EC-DS1 Lab	0	0	2	1
		Project(initiated in the summer)				
Total(5L+1T+2P)						**23**

BSc Hons
(Maths, Statistics, Data Science)
III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	LC-SF2	Second Language / Foreign Language	4	0	0	4
2	EC-M2	10. Numerical Analysis 11. Integral Transforms 12. Number Theory, Logic & Sets	4	1	0	5
3	EC-S2	7. Applied Statistics–II 8. Analytic Statistics-II 9. Actuarial Statistics-II	4	0	0	4
4	EC-DS2	10. Natural Language Processing 11. Big Data 12. Information Retrieval Systems	4	0	0	4
5	PROJ	Project	0	0	12	6
6		EC-S2 Lab	0	0	2	1
7		EC-DS2 Lab	0	0	2	1
Total(4L+1T+2P+1 Project)						**25**

Summary of Courses with Credits for BSc Hons (Maths, Statistics, Data Science)

S.No.	CourseType	No of Courses	Credits Per Course	Credits
1	**AbilityEnhancement Courses (AECC)** (GenderSensitization, Environment Studies)	2	2	4
2	**Skill Enhancement Courses (SEC)** (Foundations of Computing, R Programming, LRQA, Mobile Application Development)	4	2	8
3	**Language Courses(LC)**			
	1.English	2	4 (3L + 2P)	8
	2.Second Language / Foreign Language	2	4	8
4	**Core Courses(CC)**			
	1.Maths(M)	4	5 (4L+1T)	20
	2.Statistics (S)	4	5 (4L+2P)	20
	3.DataScience(DS)	7	4*4credits(4L)+1*4(3L+1T) +2*3credits(3L)+6*1(2P)	32
5	**Elective Course(EC)**			
	1.Maths(M)	2	5 (4L+1T)	10
	2.Statistics (S)	2	5 (4L+2P)	10
	3.DataScience(DS)	2	5(4L+2P)	10
6	**Generic Electives(GE)** (Entrepreneurship, BusinessCommunication,Music)	1	4	4
7	**Mini Project with Technical Report (MPT)**	1	4(2T+4P)	4
8	**Project (PROJ)**	1	6(12P)	6
		34		**144**

Syllabus
for
BSc Hons (Data Science) and BSc (Data Science) I Year
and
BSc Hons (Artificial Intelligence) and BSc (Artificial Intelligence)

B.Sc./B.Sc.(Hons) AI & DS I Year - I Sem

	L	T / P / D	C
	2	0	2

GENDER SENSITIZATION

Prerequisite: None

Course Objectives:

1. To develop students sensibility with regard to issues of gender in contemporary India.
2. To provide a critical perspective on the socialization of men and women.
3. To introduce students to information about some key biological aspects of genders.
4. To expose the students to debates on the politics and economics of work.
5. To help students reflect critically on gender violence.
6. To expose students to more egalitarian interactions between men and women.

Course Outcomes: After completion of the course student will be able to:

1. Students will have developed a better understanding of important issues related to gender in contemporary India.
2. Student will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from research, facts, everyday life, literature and film.
3. Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.
4. Students will acquire insight into the gendered division of labor and its relation to politics and economics.
5. Men and women students and professionals will be better equipped to work and live together as equals.
6. Students will develop a sense of appreciation of women in all walks of life.
7. Through providing accounts of studies and movements as well as the new laws that provide protection and relief to women, the textbook will empower students to understand and respond to gender violence.

UNIT-I

Understanding Gender: Gender: Why Should We Study It? (Towards a World of Equals: Unit-1) Socialization: Making Women Making Men (Towards a World of Equals: Unit-2), Introduction. Preparing for Womanhood .Growing up Male. First lesions in Caste. Different Masculinities .Just Relationships: Being Together as Equals (Towards a World of Equals: Unit-12)Mary Korn and Onler. Love and Acid just do not Mix. Love Letters. Others and Fathers. Further Reading: Rosa Parks-The Brave Heart.

UNIT-II

Gender and Biology: Missing Women: Sex Selection and Its Consequences, (Towards a World of Equals: Unit-4) Declining Sex Ratio. Demographic, Consequences. Gender Spectrum: Beyond the Binary (Towards a World of Equals: Unit-lO) Two or Many? Struggles with Discrimination. Additional Reading: Our Bodies, Our Health (Towards a World of Equals: Unit-13)

UNIT-III

Gender and Labour: Housework: the Invisible Labour(Towards a World of Equals: Unit t-3)"My Mother doesn't Work." "Share the Load. “Women’s Work: Its Politics and Economics (Towards a World of Equals; Unit-7) Fact and Fiction. Unrecognized and Unaccounted work .Further Reading: Wages and Conditions of Work.

UNIT-IV

Issues of Violence: Sexual Harassment: Say No! (Towards a World of Equals: Unit-6)Sexual Harassment not Eve-Teasing- Coping with Everyday Harassment-Further Reading: "Chupulu" .Domestic Violence: Speaking Out (Towards a World of Equals: Unit-8) Is Home a Safe Place? When Women Unite (Film).Rebuilding Lives. Further Reading: New Forums for Justice. Thinking about Sexual Violence (Towards a World of Equals: Unit-ll) Blaming the Victim-"! Fought for my Life " - Further Reading: The Caste Face of Violence.

UNIT-V

Gender Studies: Knowledge: Through the Lens of Gender (Towards a World of Equals: Unit-5), Point of View. Gender and the Structure of Knowledge. Further Reading: Unacknowledged Women Artists of Telangana. Whose History? Questions for Historians and Others (Towards a World of Equals Reclaiming a Past. Writing other Histories. Further Reading: Missing Pages from Modern Telangana History. Essential Reading: All the Units in the Textbook, "Towards a World of Equals: A Bilingual Textbook on Gender" written by A. Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagarj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu.

Note: Since it is Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field.

Reference Books:

1. I .Sen, Amartya, "More than One Million Women are Missing." New York Review of Books 37.20 (20 December 1990). Print. 'We Were Making History' Life Stories of Women in the Telangana People's Struggle. New Delhi: Kali for Women, 1989.
2. Tripti Lahiri. "By the Numbers: Where Indian Women Work." Women's Studies Journal (14 November 2012) Available online at: http://blogs.wsj.com/India real time/2012/11/14/by-the-numbers-where-Indian-women-work/>
3. K. Satyanarayana and Susie Tharu (Ed.) Steel Nibs Are Sprouting: New Dalit Writing From South India, Dossier2, Telugu and Kannada http://harpercollings.eo.in/BookDetail.asp?BookCode=3732

B.Sc./B.Sc.(Hons) AI & DS I Year - I Sem	L	T / P / D	C
	3	0	3

ENGLISH FOR EMPOWERMENT

(Common to B.Sc, B.A, B.Com, BBA I Year I Sem)

Prerequisite: None

Introduction:

Keeping in view of the growing importance of the English language as a tool for global communication and empowerment of students, the syllabus of *English for Empowerment* is designed to develop linguistic, communicative and critical thinking competencies of the undergraduate students.

Learning Objectives:

The course will help the students to

1. improve their English language proficiency with an emphasis on LSRW skills, vocabulary and grammar
2. enable the students to study their academic subjects more analytically and efficiently using the theoretical and practical contents of the syllabus
3. learn important life skills and human values by exposing them to a variety of content-rich texts

Course Outcomes:

The students will be able to

1. acquire proficiency in listening comprehension, reading, speaking and writing
2. use grammatical concepts and vocabulary efficiently for general and academic purposes
3. analyse the themes of all textual lessons from different perspectives
4. explain how to contextualize the use of language for different purposes
5. compose different kinds of writing: Formal Letters, Official Reports, CV and Emails etc.

UNIT-1

Humour: R.K. Narayan's Astrologer's Day

Word formation: Prefixes, suffixes and compounds - Parts of Speech: Nouns and pronouns - Articles - Listening for sounds - Listening for stress and intonation - Greeting, taking leave and introducing oneself and others - Sentence structures

UNIT-II

Inspiration: A.P.J. Abdul Kalam's Building a New State

Homonyms -Synonyms and antonyms - Commonly confused words – Finite & Non-finite verbs forms - Question tags - Listening for main points and subpoints - Making polite conversations Paragraphs - Expansion of proverbs - Note making

UNIT-III

Sustainable Development: C.V. Raman's Water: The Elixir of Life

One-word substitutes - Tenses - Listening for the theme and gist - Giving -Agreeing and Disagreeing - Official letters - Curriculum Vitae – Covering letters

UNIT-IV

Relationships: Abburi Chaya Devi's The Woodrose

Phrasal verbs -Idioms - Subject-verb agreement - Active and passive voice - Prepositions - Listening for specific details and information – Speaking on the telephones - Official reports – Business reports – Information transfer

UNIT-V

Science and Humanism: Progress: St. John Ervine's Progress

Collocations - Technical vocabulary - Common vocabulary errors - Conditional sentences - Conjunctions - Common errors in grammar - Listening for opinions and attitude - Presentations - Group discussions - Emails - Essays

Textbook:

Using English: *A Coursebook for Undergraduate Learners* by Board of Editors published by Orient Black Swan

References:

1. ***Contemporary English Grammar*** *–Structures and Composition.by* Green, David. McMillan India. 2014 (Print)
2. ***Practical English Usage*** by Michael Swan. OUP. 1995.
3. ***Remedial English Grammar*** by F.T. Wood. Macmillan.2007
4. **Business Communication** by Meenakshi Raman and Prakash Singh, Oxford, 2012.
5. ***Business Communication*** by R K Madhukar.Vikas Publishing House Private Limited, New Delhi, 2009
6. ***Essentials of Business Communication*** by Rajendra Pal and J.S. Korlahhi. Sultan Chand and Sons, New Delhi, 2008.

B.Sc./B.Sc.(Hons) AI & DS I Year - I Sem	L	T / P / D	C
	0	2	1

ESSENTIAL LANGUAGE SKILLS LAB

(Common to B.Sc, B.A, B.Com, BBA I Year I Sem)

Prerequisite: None
Introduction:

The English Language Lab aims to develop perfection in pronunciation and to articulate the speech sounds accurately. The Lab focuses on reducing MTI and improvises the awareness of different accents in a global context.

Learning Objectives:

The students will be able to

1. facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
2. bring about a consistent accent and intelligibility in students' pronunciation of English
3. sensitize students to the nuances of English speech sounds, word accent, intonation and rhythm

Course Outcomes:

After the completion of the course, the students will be able to

1. analyze the importance of speech sounds and listening comprehension
2. acquire neutralization of accent for intelligibility
3. recognize syllables and Consonant Clusters.
4. develop speaking skills with clarity and confidence which in turn enhances their employability skills
5. understand the emphasis on Pronunciation of English Language in the global world

Exercise-I

Introduction to Phonetics - Speech Sounds

Vowels and Consonants-Listening Comprehension

Common Indian Variants in Pronunciation – Differences between British and American Pronunciation

Exercise-II

Pronunciation, Common Errors in Pronunciation, Neutralization of Mother Tongue Influence

Listening Skill- Its importance – Purpose- Process- Types- Barriers- Effective Listening

Exercise-III

Syllables -Consonant Clusters

Sentence Stress -Weak Forms and Strong Forms

Exercise-IV

Word accent and Stress Shifts

Past Tense Marker and Plural Marker

Exercise-V

Intonation, Stress and Rhythm

Data Interpretation

Minimum Requirement of infra structural facilities for ELS Lab:

The Computer Assisted Language Lab for 60 students with 60 systems, one master console, LAN facility and English language software for self- study by learners.

System Requirement (Hardware component):

Computer network with Lan with minimum 60 multimedia systems with the following specifications:

i) P -IV Processor

a) Speed – 2.8 GHZ

b) RAM – 512 MB Minimum

c) Hard Disk – 80 GB

ii) Headphones of High quality

References:

1. **A Handbook for English Language Laboratories** bySuresh Kumar, E. &Sreehari, P. 2009,New Delhi: Foundation
2. **Speaking English Effectively** 2nd Edition by Krishna Mohan and N. P. Singh, 2011. Macmillan Publishers India Ltd. Delhi.
3. **Spoken English: A Manual of Speech and Phonetics** by R. K. Bansal & J. B. Harrison. 2013. Orient Blackswan. Hyderabad.
4. **English Pronunciation in Use** by Hewings, M. 2009. Advanced. Cambridge: CUP
5. **A textbook of English Phonetics for Indian Students** by T. Balasubramanian (Macmillan)
6. **Lab Manual:** A Manual entitled "**English Language Communication Skills (ELCS) Lab Manual- cum- Work Book**", published by Cengage Learning India Pvt. Ltd, New Delhi. 2013

B.Sc.(Hons) AI & DS I Year - I Sem

	L	T / P / D	C
	2	0	2

FOUNDATIONS OF COMPUTING
(B.Sc Hons AI & DS)

Prerequisite: None

Course Objectives:

- To introduce Foundation of Computer Science for beginners in computing field.

Course Outcomes:

On completion of the course, students will be able to:

- Able to Perform operations of data.
- Able to describe a simple Computer.
- Able to List Layers in Computer Networks.
- Able to List Components of Operating Systems.

UNIT–I

Introduction: Turing Model, Von Neumann Model, Computer Components, History.

Number Systems: Positional Number Systems and Non Positional Number Systems.

Data Storage: Data Types, Storing Numbers, Storing Text, Storing, Storing Audio, Storing Images, Storing Videos.

UNIT–II

Operations on Data: Logic Operations, Shift Operations, Arithmetic Operations.

Computer Organization: Central Processing Unit, Main Memory, Input/Output Subsystem, Subsystem interconnection, Program Execution, A Simple Computer.

UNIT- III

Computer Networks and Internet: Introduction, Application Layer, Transport Layer, Network Layer, Data-Link Layer, Physical Layer, Transmission Media.

Operating Systems: Introduction, Evolution, Components

UNIT –IV

Algorithm: Definition, Algorithmic Representation, Algorithms and Sub algorithms.

Programming Languages: Evolution, Translation, Programming Paradigm.

Software Engineering: The Software Lifecycle, Analysis Phase, Design Phase, Implementation Phase, Testing Phase, Documentation.

UNIT –V

File Structure: Sequential Files, Indexed Files, Hashed Files, Directories, Text vs Binary.

Databases: Database Architecture, Database Models, Relational Database Model, Database Design.

Text Books:

Behrouz Forouzan, *Foundation of Computer Science*, 4th Edition, Cengage, 2018.

B.Sc./B.Sc.(Hons) AI & DS I Year - I Sem

	L	T / P / D	C
	4	1	5

DIFFERENTIAL AND INTEGRAL CALCULUS

Prerequisite: None

Objective: The course is aimed at exposing the students to some basic notions in differential calculus.
Outcome: By the time students complete the course they realize wide ranging applications of the subject.

UNIT-I

Partial Differentiation: Introduction - Functions of two variables - Neighborhood of a point (a, b) - Continuity of a Function of two variables, Continuity at a point - Limit of a Function of two variables - Partial Derivatives - Geometrical representation of a Function of two Variables - Homogeneous Functions.

UNIT-II

Theorem on Total Differentials - Composite Functions - Differentiation of Composite Functions- Implicit Functions - Equality of fxy(a, b) and fyz(a, b) - Taylor's theorem for a function of two Variables - Maxima and Minima of functions of two variables – Lagrange's Method of undetermined multipliers.

UNIT-III

Curvature and Evolutes: Introduction - Definition of Curvature - Radius of Curvature - Length of Arc as a Function, Derivative of arc - Radius of Curvature - Cartesian Equations - Newtonian Method - Centre of Curvature - Chord of Curvature. Evolutes: Evolutes and Involutes - Properties of the evolute.

UNIT-IV

Envelopes: One Parameter Family of Curves - Consider the family of straight lines - Definition - Determination of Envelope. Lengths of Plane Curves: Introduction - Expression for the lengths of curves $y = f(x)$ - Expressions for the length of arcs $x = f(y)$; $x = f(t)$, $y = \phi(t)$; $r = f(\theta)$

UNIT-V

Volumes and Surfaces of Revolution: Introduction - Expression for the volume obtained by revolving about either axis - Expression for the volume obtained by revolving about any line - Area of the surface of the frustum of a cone - Expression for the surface of revolution - Pappus Theorems - Surface of revolution.

Text Books:

1. Shanti Narayan, P.K. Mittal Differential Calculus, S.CHAND, NEW DELHI
2. Shanti Narayan Integral Calculus, S.CHAND, NEW DELHI

Reference Books:

1. William Anthony Granville, Percey F Smith and William Raymond Longley; Elements of the differential and integral calculus
2. Joseph Edwards , Differential calculus for beginners
3. Smith and Minton, Calculus
4. Elis Pine, How to Enjoy Calculus
5. Hari Kishan, Differential Calculus

B.Sc./B.Sc.(Hons) AI & DS I Year - I Sem	L	T / P / D	C
	4	0	4

DESCRIPTIVE STATISTICS AND PROBABILITY

Prerequisite: None
Course objectives:

1. To calculate summary of statistical data.
2. To understand the uncertain occurrence situations with logical manner.
3. To get knowledge on Discrete and Continuous random variables and their probability functions.
4. To learn concept of Chebyshev's and Cauchy-Schwartz's inequalities.
5. To learn how to generate different types of generating function, like mgf. cf, pgf, etc...

Course Outcomes: After completion of the course student will be able to:

1. Analyze statistical data using measures of central tendency, dispersion and also skewness and kurtosis.
2. Use the basic probability rules, including additive and multiplicative laws, independent and mutually exclusive events.
3. Calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables.
4. Use Chebyshev's and Cauchy-Schwartz's inequalities in real problems.
5. Understand moment generating function (m.g.f), characteristic function (c.f), cumulant generating function (c.g.f), probability generating function (p.g.f) and statements of their properties.

UNIT-I

Descriptive Statistics: Concept of primary and secondary data, Classification of data, Measures of central tendency (Arithmetic mean, median, mode, geometric mean and harmonic mean) with simple applications, Absolute and relative measures of dispersion (range, quartile deviation, mean deviation, standard deviation and variance) with simple applications. Importance of moments, central and non-central moments, their inter-relationships, Sheppard's correction for moments for grouped data, Measures of skewness based on quartiles and moments, kurtosis based on moments with real life examples.

UNIT-II

Probability: Basic concepts of probability, deterministic and random experiments, trial, outcome, sample space, event, operations of events, mutually exclusive and exhaustive events, equally likely and favourable events with examples, Mathematical, Statistical and Axiomatic definitions of probability, their merits and demerits. Properties of probability based on axiomatic definition. Conditional probability and independence of events, Addition and multiplication theorems for 'n' events, Boole's inequality and Bayes' theorem, Problems on probability using counting methods and theorems.

UNIT-III

Random Variables: Definition of random variable, discrete and continuous random variables, functions of random variables, probability mass function and probability density function with illustrations. Distribution function and its properties, Transformation of one-dimensional random variable (simple 1-1 functions only). Notion of bivariate random variable, bivariate distribution, statements of its properties, Joint, marginal and conditional distributions, Independence of random variables.

UNIT-IV

Mathematical Expectation: Mathematical expectation of a function of a random variable, Raw and central moments, covariance using mathematical expectation with examples, Addition and multiplication theorems of expectation. Chebyshev's and Cauchy-Schwartz's inequalities and their applications.

UNIT-V

Generating functions: Definitions of moment generating function (m.g.f), characteristic function (c.f), cumulant generating function (c.g.f), probability generating function (p.g.f) and statements of their properties with applications.

Text Books:

1. Fundamentals of Statistics, (Vol-I) - Goon A M, Gupta M K, Das Gupta B, The World Press (Pvt) Ltd., Kolkata.
2. Fundamentals of Mathematical Statistics - V. K. Kapoor and S. C. Gupta, Sultan Chand & Sons, New Delhi.

Reference Books:

1. Sanjay Arora and Bansilal: New Mathematical Statistics, Satya Prakashan , New Delhi.
2. William Feller: Introduction to Probability theory and its applications, (Vol-I), Wiley.
3. Levine, Stephen, Krehbiel, Berenson: Statistics for Managers using Microsoft Excel
4. (4th edition), Pearson Publication.

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DESCRIPTIVE STATISTICS AND PROBABILITY - LAB

Part - 1 (Using Calculator)

1. Graphical presentation of data (Histogram, frequency polygon, Ogives) and its interpretation.
2. Diagrammatic presentation of data (Bar and Pie).
3. Computation of central tendency and dispersion measures for ungrouped and grouped data.
4. Computation of non-central and central moments – Sheppard's corrections for grouped data.
5. Computation of coefficients of Skewness - Karl Pearson's, Bowley's, β_1 and Kurtosis – β_2 and their interpretation.

Part - 2 (Using MS-Excel)

1. Basics of Excel - Data entry, editing and saving, establishing and copying formulae, Built in Functions - copy and paste, Find and Replace, Sorting.
2. Basics of Excel - Built in Functions - Filtering, Conditional formatting and creating Hyperlinks, Exporting to MS word document
3. Data visualization through diagrams.
4. Computation of central tendency and dispersion measures, Coefficient of Variation for ungrouped and grouped data.
5. Computation of Coefficients of Skewness, Kurtosis using MS-Excel and interpretation.

Note : Training shall be on establishing formulae in Excel cells and deriving the results.

The Excel output shall be exported to MS Word for writing inferences.

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PYTHON FOR PROBLEM SOLVING

Prerequisite: None

Objectives

The main objective is to teach Computational thinking using Python.

- To know the basics of problem solving using a programming language
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.

Outcomes:

On completion of the course, students will be able to:

1. Develop solutions to solve simple computational problems using Python
2. Write functions in Python for a certain task
3. Understand and write programs using lists, tuples, and dictionaries.
4. Read and write data from/to files in Python Programs

UNIT-I

Introduction to Computing and Problem Solving, Computational Model – elementary concepts, General Process of Software Development, Programming languages, Interpreters and Python, Compilers,

UNIT-II

Computing with Python – interactive and script mode, Mathematical Operations, Programs, Data Definitions, Simple Python programs, General Structure of Python program. Program Structures, Algorithms, Algorithm Notation – Flowcharts and Pseudo-code

UNIT-III

Selection Structure using Conditional Expressions, Multi-level Selection using if-elif statements, Repetition Structure using while-loop, repeat-until loop, for-loop

UNIT-IV

Functions, Modular Decomposition, Categories of Functions, Function Definition and Calling the Function, Parameters, Built-in Mathematical Functions

UNIT-V

File handling, types of files, opening and closing text files, reading and writing to and from files, case study.

Text Book:

1. Jose M Garrido, Introduction to Computational Models with Python, CRC Press, 2016

Reference Book:

1. Problem Solving with Flowcharts and a Little Flavor of Programming with Python, Achla Agarwal, Krishna Agarwal , Laura Goadrich, Mark Goadrich, 2010

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PYTHON PROGRAMMING LAB

Prerequisite: None

Course Objectives:

1. Understand the string operation and sequences used in Python Programming Languages.
2. Know the classes and objects in Python Programming Language.
3. Use the reusability concepts in Python Programming Language.
4. Use Exception Handling mechanism in Python Programming Language.

Course Outcomes: After completion of the course student will be able to:

1. Develop programs on data types, operators and expressions
2. Apply the data structures in real time scenarios
3. Write the programs on strings and functions
4. Implement programs on class and related issues.
5. Use of python exception handling and packages.

Week-1:

Installation and Environment set up of Python & Programs on Data types

Week-2:

Programs on Standard I/O, Operators and Expressions

Week-3:

Programs on Functions

Week-4

Programs on different argument types

Week-6:

Programs on Strings and string operations

Week-7:

Programs on Regular Expressions.

Week-8:

Programs on class & object, static and instance method implementation

Week-9:

Programs on Inheritance and Polymorphism

Week-10:

Programs on Abstract classes and interfaces

Week-11:

Programs on Exception Handling

Weekl2:

Demonstration of Numpy package

Demonstration of Pandas package

Week-13:

Demonstration of matplotlib package

Week-15:

Demonstration of Tkinter package

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ENVIRONMENTAL STUDIES

Prerequisite: None

Course Objectives:

1. To introduce the knowledge about Environment.
2. To introduce students to the concepts of pollution, Biodiversity
3. To develop an awareness about global Environmental problems.
4. To learn to protect environment and awareness on legal issues
5. To learn about importance of sustainable development and role of IT in environment.

Course Outcomes: After completion of the course student will be able to:

1. Understand fundamental physical and biological principles that govern natural processes.
2. Understand fundamental concepts from the social sciences and humanities underlying environmental thought and governance.
3. Integrate and apply perspectives from across the natural sciences, social sciences, and the humanities in the context of complex environmental problems.
4. Communicate integrated perspectives on complex environmental problems in the form of written and oral argument to both professional and lay audiences.
5. Design and conduct independent research that contributes to environmental thought and/or problem solving.

UNIT-I

Multidisciplinary nature of Environmental Studies: Definition, Scope and Importance— Need for Public Awareness. Ecosystems: Concept of an ecosystem — Classification, structure and function of different ecosystems - Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological pyramids. Biodiversity and its conservation: Introduction - Definition: genetic, species and ecosystem diversity. - Bio-geographical classification of India - Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man- wildlife conflicts. ICUN categories of biodiversity and RED DATA book - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT-II

Natural Resources: Renewable and non-renewable — Natural resources and associated problems: Forest resources — Use and over — exploitation, deforestation,— Timber extraction, mining, dams and other effects on forest and tribal people: Water resources — Use and over utilization of surface and ground water — Floods, drought, conflicts over water, dams — benefits and problems — Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. - Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources: Equitable use of resources for sustainable lifestyles.

UNIT-III

Environmental Pollution: Definition, Cause, effects and control measures of different kinds of pollution (Air, Water, Soil, Marine, Noise, Thermal, Nuclear, e —Waste). Carbon Capture & Sequestration — different storage sources, major disadvantages, environmental effectsSocial Issues and the Environment: From Unsustainable to Sustainable development - Urban problems related to energy -Water conservation, rain water harvesting, and watershed management. -Climate change, global warming, ozone layer depletion, nuclear accidents and holocaust.

UNIT-IV

Waste management technology: Solid waste Management: Causes, effects and control measures of urban and industrial wastes. - Role of an individual in prevention of pollution, Disaster management: floods, earthquake, cyclone and landslides. Waste water and sewage treatment technology: primary, secondary and tertiary treatments. Bioremediation, Phyto-remediation, ZLD (zero liquid discharge), membrane technology. Application of GIS and GPS system in environmental science. Environmental policy, Rules and regulations. EIA (Environmental Impact Assessment) & EMP (ENVIRONMENTAL Management Plan) — Environment Protection Act. - Air (Prevention and Control of Pollution) Act. -Water (Prevention and control of Pollution) Act - Wildlife Protection Act —Forest Conservation Act.-Public awareness. Global environmental problems and global efforts.

UNIT- V

Towards sustainable future: concept of sustainable development, threats of sustainability, population and its explosion, over exploitation of resources, strategies for achieving sustainable development. Environmental education, Conservation of resources. Urban sprawl, sustainable cities and sustainable communities, human health. Role of IT in environment, environmental ethics, concept of green building, Basic principles of Green engineering, clean development mechanism (CDM), Low carbon life cycle, Polluters-pay principle.

Text Books:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha, University Press Private Limited, Reprinted in 2005.
2. Environmental Studies: From Crisis to Cure by R.Rajagopa1an, Oxford University Press, 2“ Edition, 2005

Reference Books:

1. Environmental Science: Towards a Sustainable Future by Richard T.Wright. PHL Learning Private Ltd .New Delhi, 2008
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P.Ela. PHI Learning Pvt. Ltd. 4" Edition, 2008

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THE POWER OF DATA STORYTELLING

(Common to B.Sc, B.A, B.Com, BBA I Year II Sem)

Introduction:

This course will cover the fundamentals of effective data-driven storytelling. Story telling can put a human perspective on the increasingly complex and rapidly changing world of the digital era. Students will learn how to interpret and analyse the data and will learn to articulate the stories with data sets and communicate data findings in visual, oral, and written contexts.

Objectives:

The students will be able to

1. develop the skills necessary to be effective data storytellers.
2. locate relevant datasets, extract insights from that data and present their findings in myriad formats.
3. learn how to interpret data and to present it in different formatsto different audiences.

Course outcomes:

After the completion of the course, the students will be able to

1) identify the stories within datasets and extract insights from that data.
2) explain the importance of communication skills and competencies for individuals who serve as data storytellers.
3) act as a data-driven visual storyteller for optimal presentation of trends, patterns, and insights.
4) make effective client presentations of their work using infographic visualizations.
5) learn tools and concepts which can be put to immediate use to transform data into stories.

Unit-I

Introduction

We are all storytellers- Stories Bring Data to Life- The Essence of Data Storytelling

Unit-II

Dynamics of Data Storytelling

Getting to the Core- Planning is Everything- The Quick Fix- Application of Story elements

Unit-III

Crafting the Data Story

The Psychology of Storytelling- The narrative Techniques - Making Good stories Great! – Writer to Storyteller

Unit-IV

Data Visualization

Use Visuals to Advantage: Data Presentation Skills- Infographics Visualizations

Unit-V

Anatomy of Data Story

Rudiments of Grammar - Parts of Speech - Concord Rules - Academic and Technical Vocabulary - Data Interpretation - Case Studies

Textbook:

Vora , Sejal (2019).*The Power of Data Storytelling*, Sage Publications India pvt Ltd.

References:

1. Dykes, Brent (2020). *Effective Data Storytelling*: New Jersey, Wiley.
2. Knaflic, Cole Nussbaumer (2015).*Storytelling with Data: A Data Visualization Guide for Business Professionals*,https://www.amazon.com/Storytelling-Data-Visualization-Business-Professionals/dp/1119002257/
3. Morrow, Jordon (2021), *Be Data Literate- The Data Literacy Skills Everyone Needs to Succeed*, UK: Kogan Page Ltd.
4. Taylor, Scott (2021). *Telling your Data Story: Data storytelling for Time Management*, New Jersey: Technics Publications LLC.
5. https://www.amazon.com/Tableau-Your-Data-Analysis-Software/dp/1119001196/

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ART OF ARTICULATION LAB

(Common to B.Sc, B.A, B.Com, BBA I year II Sem)

Introduction:

The lab will provide students a platform to develop English language skills, communication skills and to practice the art of storytelling. This lab course will create the platform for data analysis and interpretation.

Learning Objectives:

The students will be able to

1) emphasize the need of English in the corporate world.
2) train the students in the art of conversation and storytelling.
3) interpret and narrate the data effectively

Course Outcomes:

After the completion of the course, the students will be able to

1) speak with eloquence and fluency.
2) develop imagination by introducing new ideas into their world.
3) apply information strategies and skills learned to a new situation or context.
4) transform data visualizations into appealing, impactful data stories.
5) **present brand identity and values** to a wider public with the help of narrative techniques.

Exercise-I

Introduction to Articulation - Articulation skills - Styles of Communication

Exercise -II

Information transfer- Data Analysis - Data Interpretation - Practices

Exercise -III

Storytelling - Narrative Styles - Figures of Speech - Data Storytelling - Practices

Exercise -IV

Visualization of Data - Voice Modulation - Presentations (Individual and Team) - Non Verbal cues in Storytelling

Exercise -V

Corporate Storytelling Techniques - Audience Analysis - Articulation in different media

References:

1. Rubie, Peter *The Elements of Story Telling- How to write compelling Fiction.* John Wiley & Sons, Inc. *1996.*
2. Choy, Esther.K, *Let the story do the Work – The Art of Storytelling for Business Success.* AMACOM, 2017.
3. Fleming, Carol.A. *It's the way you say it: Becoming Articulate, Well spoken.* Berrett-Koehler Publishers, 2013.
4. Toogood, Granville.N. *The Articulate Executive: Learn to Look, Act and sound like a Leader.* McGraw-Hill Education, 1997.
5. Fexeus, Henrik. *The Art of Reading Minds: Understand others to Get What you want.* Yellow Kite, 2015.

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R PROGRAMMING
(B.Sc Hons AI & DS)

Pre-requisites: None

Course Objectives:

1. To Give an exposure to basics of R programming elements
2. To apply various operators on data frames and lists. .
3. To understand the need of iterative programming and apply R vectorized looping functions

Course outcomes: Students will be able to:

1. Demonstrate basic programming constructs in R
2. Demonstrate vector and matrix operations
3. Apply various operators on data frames and list
4. Demonstrate iterative programming using various R functions
5. Apply appropriate visualization techniques

UNIT-I

Basics of R: Introduction, R-Environment Setup, Programming with R, Basic Data Types, Vectors: Creating and Naming Vectors, Vector Arithmetic, Vector Sub setting, Matrices: Creating and Naming Matrices, Matrix Sub setting, Arrays, Class.

UNIT-II

Factors and Data Frames: Introduction to Factors: Factor Levels, Summarizing a Factor, Ordered Factors, Comparing Ordered Factors, Introduction to Data Frame, Subsetting of Data Frames, Extending Data Frames, Sorting Data Frames

UNIT-III

Lists: Introduction, Creating a List: Creating a Named List, Accessing List Elements, Manipulating List Elements, Merging Lists, Converting Lists to Vectors, Conditionals and Control Flow: Relational Operators, Relational Operators and Vectors, Logical Operators, Logical Operators and Vectors, Conditional Statements.

UNIT IV

Iterative Programming in R: Introduction, While Loop, For Loop, Looping Over List. Functions in R: Introduction, Writing a Function in R, Nested Functions, Function Scoping, Recursion, Loading an R Package, Mathematical Functions in R, Cumulative Sums and Products, Calculus in R, Input and Output Operations.

UNIT V

Apply Family in R : Introduction, Using Apply in R, Using Lapply in R, Using Sapply, Using Tapply in R: Split Function, Using Mapply in R, Charts and Graphs : Introduction, Pie Chart: Chart Legend, 3D Pie Chart, Bar Chart, Box Plot, Histogram, Line Graph: Multiple Lines in Line Graph, Scatter Plot.

Text Book:

1) K G Srinivas ,G M Siddesh "Statistical programming in R", Oxford Publications.

Reference Books:

1) Mark Gardener, Beginning R: The Statistical Programming Language, Wrox
2) Y. Anchang Zhao: R and Data Mining: Examples and Case Studies . Elsevier in December 2012
3) Avril Coghlan : A Little Book of R For Time Series

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DIFFERENTIAL EQUATIONS

Prerequisite: None

Objective: The main aim of this course is to introduce the students to the techniques of solving differential equations and to train to apply their skills in solving some of the problems of engineering and science.

Outcome: After learning the course the students will be equipped with the various tools to solve few types differential equations that arise in several branches of science.

UNIT- I

Differential Equations of first order and first degree: Introduction - Equations in which Variables are Separable - Homogeneous Differential Equations - Differential Equations Reducible to Homogeneous Form - Linear Differential Equations - Differential Equations Reducible to Linear Form - Exact differential equations - Integrating Factors - Change in variables - Total Differential Equations - Simultaneous Total Differential Equations - Equations of the form $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$

UNIT- II

Differential Equations first order but not of first degree: Equations Solvable for p - Equations Solvable for y - Equations Solvable for x - Equations that do not contain x (or y)- Equations Homogeneous in x and y - Equations of the First Degree in x and y - Clairaut's equation. Applications of First Order Differential Equations : Growth and Decay - Dynamics of Tumour Growth - Radioactivity and Carbon Dating - Compound Interest - Orthogonal Trajectories

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UNIT- III

Higher order Linear Differential Equations: Solution of homogeneous linear differential equations with constant coefficients - Solution of non-homogeneous differential equations $P(D)y = Q(x)$ with constant coefficients by means of polynomial operators when $Q(x) = be^{ax}$, $b \sin ax/b \cos ax$, bx^k, $V e^{ax}$, Method of undetermined coefficients.

UNIT- IV

Method of variation of parameters - Linear differential equations with non constant coefficients - The Cauchy - Euler Equation - Legendre's Linear Equations - Miscellaneous Differential Equations.

UNIT- V

Partial Differential Equations: Introduction and Formation of partial differential equation by elimination of arbitrary constants and arbitrary functions, solutions of first order linear (Lagrange's) equation and nonlinear (Standard types) equations, Charpit's Method.

Text Book:

1. Zafar Ahsan, Differential Equations and Their Applications

Reference Books:

1. Frank Ayres Jr, Theory and Problems of Differential Equations.
2. Ford, L.R ; Differential Equations.
3. Daniel Murray, Differential Equations.
4. S. Balachandra Rao, Differential Equations with Applications and Programs.
5. Stuart P Hastings, J Bryce McLead; Classical Methods in Ordinary Differential Equations.

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PROBABILITY DISTRIBUTIONS

Prerequisite: None
Course objectives:

1. To understand the difference between a discrete and continuous probability distribution and the Binomial distribution (discrete) and calculate probabilities of discrete outcomes.
2. To learn the concept of Negative binomial, Geometric distributions and their real life applications.
3. To understand the Rectangular and Exponential distributions.
4. To understand the Normal distribution and properties and its importance.
5. To learn basic concepts of Beta distribution and Gamma distribution and also their properties.

Course outcomes: After completion of the course student will be able to:

1. Understand the most common discrete and continuous probability distributions and their real life applications.
2. Apply Negative binomial and Geometric distributions in real life problems.
3. Implement applications of Rectangular and Exponential distributions in various fields.
4. Compute areas of probabilities under Normal distribution.
5. Explore knowledge on Beta distribution and Gamma distributions and their interrelationships.

UNIT-I

Discrete distributions – I : Uniform and Bernoulli distributions : definitions, mean, variance and simple examples. Definition and derivation of probability mass functions of Binomial distribution, Poisson distribution, properties of these distributions: median, mode, m.g.f, c.g.f., p.g.f., c.f., and moments up to fourth order, reproductive property (wherever exists) and their real life applications. Poisson approximation to Binomial distribution.

UNIT-II

Discrete distributions – II: Negative binomial, Geometric distributions: Definitions and real life applications, properties of these distributions: m.g.f, c.g.f., p.g.f., c.f. and moments up to fourth order, reproductive property (wherever exists), lack of memory property for Geometric distribution. Poisson approximation to Negative binomial distribution.

Hyper-geometric distribution: definition, real life applications, derivation of probability function, mean, variance. Binomial approximation to Hyper-geometric distribution.

UNIT-III

Continuous distributions – I : Rectangular, Exponential- definition, properties: m.g.f., c.g.f., c.f. and moments up to fourth order, reproductive property (wherever exists) and their real life applications.

UNIT-IV

Continuous distributions – II : Normal distributions – definition, properties such as m.g.f., c.g.f., c.f. and moments up to fourth order, reproductive property, wherever exists and their real life applications. Normal distribution as a limiting case of Binomial and Poisson distributions.

UNIT-V

Continuous distributions – III : Gamma distributions - definition, properties reproductive property (wherever exists) and their real life applications. Beta distribution of two kinds: Definitions, mean and variance. Cauchy distribution (definition & c.f. only)

Text Books:

1. Fundamentals of Statistics, (Vol-I) - Goon A M, Gupta M K, Das Gupta B, The World Press (Pvt) Ltd., Kolkata.
2. Fundamentals of Mathematical Statistics - V. K. Kapoor and S. C. Gupta, Sultan Chand & Sons, New Delhi.

Reference Books:

1. Sanjay Arora and Bansilal: New Mathematical Statistics, Satya Prakashan , New Delhi.
2. William Feller: Introduction to Probability theory and its applications, (Vol-I), Wiley.
3. Hogg,Tanis, Rao: Probability and Statistical Inference, (7th edition), Pearson.
4. Levine, Stephen, Krehbiel, Berenson: Statistics for Managers using Microsoft Excel (4th edition), Pearson Publication.

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PROBABILITY DISTRIBUTIONS - LAB

Part - 1 (Using Calculator)

1. Fitting of Binomial distribution-Direct method.
2. Fitting of Binomial distribution-Recurrence relation Method.
3. Fitting of Poisson distribution-Direct method
4. Fitting of Poisson distribution-Recurrence relation Method.
5. Fitting of Negative Binomial distribution.
6. Fitting of Geometric distribution.
7. Fitting of Exponential distribution.
8. Fitting of Normal distribution-Areas method.
9. Fitting of Normal distribution - Ordinates method.

Part - 2 (Using MS-Excel)

1. Fitting of Binomial distribution-Direct method.
2. Fitting of Poisson distribution-Direct method.
3. Fitting of Exponential distribution
4. Fitting of Normal distribution-Areas method.

Note : Training shall be on establishing formulae in Excel cells and deriving the results.

The Excel output shall be exported to MS Word for writing inferences

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DATA STRUCTURES IN PYTHON

Prerequisite: Python for Problem Solving

Course Objectives:

- To introduce Linked List, Strings in Python.
- To introduce Object Orientation Concept.
- To solve various problem using Object Oriented Programming.
- To implement Linked Lists and Recusion.

Course Outcomes:

After completion of the course student will be able to:

- Able to use List, String, Tuples and Dictionaries in Python.
- Able to Describe class and objects.
- Able to solve various Problems using OOPs.
- Able to Implements Linked Lists and Recursion using Python.

UNIT–I

Python Lists, Strings, and Other Data Sequences: Lists-Indexing Lists, Slicing Operations, iterating over List with a loop, Creating List using a loop, Passing List to Function, Additional Operations on Lists; Temperature Conversion Problem, List Comprehensions, Lists of Lists, Tuples, Dictionaries, Strings, Applications Using List- Linear Search, Binary Search.

UNIT–II

Object Orientation: Object in the Problem Domain, Defining Classes, Describing Objects, Interaction between two Objects, Design with classes- Encapsulation, Data Hiding.

UNIT- III

Object-Oriented Programs: Definition of Classes, Class Definition in Python- Data Definition and Methods in class definition; Creating and Manipulating Objects, Scope of Variables, Class Hierarchy with Inheritance, Defining Classes with inheritance, Overloading and Overriding Methods.

UNIT –IV

Linked Lists: Nodes and Linked Lists - Nodes, Definition Class for Linked Lists, Creating and Manipulating a Linked List; Linked Lists with two ends, Double Linked Lists, Stacks, and Queues.

UNIT –V

Recursion: Recursive Approach to Problem Solving, Recursive Definition of Functions- Factorial Problem, Sum of Squares, Reversing a Linked List; Analyzing Recusion.
Graph: Introduction, Shortest Path Problem.

Text Books:

1. José M. Garrido, *INTRODUCTION TO Computational Models with Python,* CRC Press, 2016.

Reference Books:

A. Achla Agarwal, Krishna Agarwal, Laura Goadrich, Mark Goadrich, *Problem Solving with Flowcharts and a Little Flavor of Programming with Python*, 2010.
B. Michael T. Goodrich, Roberto Tamassia, David M. Mount, *Data Structures and Algorithms Python* John Wiley & Sons, 2013.

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DATA STRUCTURES IN PYTHON LAB

Objective

The main objective of this laboratory is to implement different Data structures. The students will be expected to write Python programs to demonstrate

- Different list representations
- Stacks, Queues and Hash table
- Trees and Graphs
- Searches and Sorting

1. Program to implement list using an Array
2. Program to implement
   a. Single Linked List
   b. Circular Lined List
   c. Doubly Linked List
3. Program to implement
   a. Stack operations using Arrays
   b. Stack operations using linked list
4. Program to implement
   a. Queue operations using Arrays
   b. Queue operations using linked list
5. Program to implement Binary Search Tree operations and traversals
   a. Insert() b. delete() c. search() d. Inorder e. Preorder f. Postorder
6. Program to implement Prim's algorithms
7. Program to implement
   a. Linear Search b. Binary Search

Item 9

Presentation of the course structure of programs to be offered by the School of Liberal Arts, from the academic year 2020-21

B.A. Hons (Economics)

I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	2
2	LC-E1	Professional English-I	3	0	0	3
3	LC-S1	Second Language	3	0	0	3
4	CC-1	Introduction to Micro Economics	5	1	0	6
5	CC-2	Mathematical methods for economics I	5	1	0	6
6	GE1	Introduction to Computers (C Language /MS-Excel)	2	1	2	4
Total						**24**

I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	2
2	LC-E2	Professional English-II	0	0	3	3
3	LC-S2	Second Language	3	0	0	3
4	CC-3	Introduction to Macro Economics	5	1	0	6
5	CC-4	Mathematical Methods for Economics II	5	1	0	6
6	GE2	Introduction to Python Programming	2	1	2	4
Total						**24**

II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Intermediate Micro Economics -I	5	1	0	6
2	CC-6	Intermediate Macro Economics I	5	1	0	6
3	CC-7	Statistical methods for Economics	5	1	0	6
4	GE3	Economic History of India	2	1	2	4
5	SEC1	Introduction to R	4	0	0	4
TOTAL						**26**

II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-8	Intermediate Micro Economics - II	5	1	0	6
2	CC-9	Intermediate Macro Economics - II	5	1	0	6
3	CC-10	Econometrics	5	1	0	6
4	GE4	Introduction to Research Methodology	4	0	0	4
5	SEC2	Introduction to SAS	4	0	0	4
TOTAL						**26**

III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-11	Indian Economy I	5	1	0	6
2	CC-12	Development Economics I	5	1	0	6
3	DSE-1	International Trade	4	1	0	6
4	DSE -2	Public Economics	4	1	0	6
Total						**24**

III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-13	Indian Economy II	5	1	0	6
2	CC -14	Development Economics II	5	1	0	6
3	DSE -3	Environmental Economics	4	1	0	6
4	DSE -4	Project Work/ Thesis / Dissertation	-	-	-	6
Total						**24**

Summary of Courses with Credits

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** (Communication Skills &Gender Sensitization, Environment Studies)	2	2 courses of 2 credits	4
2	**Skill Enhancement Courses (SEC)** Computer Laboratory or Practice	4	4 courses of 2 credits	8
3	**Language Courses (LC)** 1. English 2. Second Language / FL	 2 2	 2 Courses of 4credits 2 courses of 4 credits	 8 8
4	**Core Courses (CC)** 14 papers	14	 14 papers of 6 credits*	 84
5	**Discipline Specific Elective Course (DSE)** 4 papers	4	4 papers of 6 Credits	24
6	**Generic Electives (GE)** (Entrepreneurship, Business Communication, Music)	4	4 papers of 4 Credits	16
7	**Project (PROJ)**	1	GRADE	
		33		**148**

B.A. (Economics)

I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	4
2	LC-E1	Professional English-I	3	0	0	3
3	LC-S1	Second Language	3	0	0	3
4	DSC-1	Introduction to Micro Economics	5	1	0	6
5	DSC-2	Mathematical Methods for Economics I	5	1	0	6
Total						**22**

I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	4
2	LC-E2	Professional English-II	0	0	3	3
3	LC-S2	Second Language	3	0	0	3
4	DSC-3	Introduction to Macro Economics	5	1	0	6
5	DSC-4	Mathematical Methods for Economics II	5	1	0	6
Total						**22**

II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	DSC-5	Intermediate Micro Economics I	5	1	0	6
2	DSC-6	Intermediate Macro Economics I	5	1	0	6
3	SEC 1	Introduction to Computers (C Language /MS-Excel)	4	0	0	4
4	GE1	Statistical Methods for Economics	5	1	0	6
TOTAL						**22**

II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	DSC-7	Intermediate Micro Economics II	5	1	0	6
2	DSC -8	Intermediate Macro Economics II	5	1	0	6
3	SEC 2	Entrepreneur Skills	4	0	0	4
4	GE-2	Econometrics	5	1	0	6
TOTAL						**22**

III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	DSE-1	International Trade	5	1	0	6
2	DSE -2	Public Economics	5	1	0	6
3	SEC - 3	Introduction to Python Programming	4	0	0	4
4	GE -3	Economic History of India	5	1	0	6
Total						**22**

III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	DSE -3	Economic Growth and Development	5	1	0	6
2	DSE-4	Indian Economy	5	1	0	6
3	SEC -4	Introduction to R	4	0	0	4
4	GE -4	Global Political Economy	5	1	0	6
Total						**22**

Summary of Courses with Credits

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** (Communication Skills &Gender Sensitization, Environment Studies)	2	2 courses of 4 credits	8
2	**Skill Enhancement Courses (SEC)** Computer Laboratory or Practice	4	4 courses of 4 credits	16
3	**Language Courses (LC)** 1. English 2. Second Language / FL	 2 2	 2 Courses of 3credits 2 courses of 3 credits	 6 6
4	**Core Courses (CC)** 8 papers	14	 8 papers of 6 credits*	 48
5	**Discipline Specific Elective Course (DSE)** 4 papers	 4	 4 papers of 6 Credits	 24
6	**Generic Electives (GE)** (Entrepreneurship, Business Communication, Music)	4	4 papers of 6 Credits	24
		32		**132**

B.A. Hons (Business Economics)

I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	2
2	LC-E1	Professional English-I	3	0	0	3
3	LC-S1	Second Language	3	0	0	3
4	CC-1	Micro Economics and Applications - I	5	1	0	6
5	CC-2	Accounting for Managers	5	1	0	6
6	GE1	Introduction to Computers (C Language /MS-Excel)	2	1	2	4
Total						**24**

I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	2
2	LC-E2	Professional English-II	0	0	3	3
3	LC-S2	Second Language	3	0	0	3
4	CC-3	Micro Economics and Applications - II	5	1	0	6
5	CC-4	Mathematics for Business Economics	5	1	0	6
6	GE2	Introduction to Python Programming	2	1	2	4
Total						**24**

II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Macro Economics and Applications -I	5	1	0	6
2	CC-6	Statistics for Business Economics	5	1	0	6
3	CC-7	Corporate Finance	5	1	0	6
4	GE3	Introduction to R	2	1	2	4
5	SEC1	Entrepreneur Skills	4	0	0	4
TOTAL						**26**

II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-8	Macro Economics and Applications - II	5	1	0	6
2	CC-9	Basic Econometrics	5	1	0	6
3	CC-10	Marketing Management	5	1	0	6
4	GE4	Introduction to SAS	4	0	0	4
5	SEC2	Introduction to Research Methodology	4	0	0	4
TOTAL						**26**

III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-11	Quantitative Techniques for Management	5	1	0	6
2	CC-12	Organization Behaviour	5	1	0	6
3	DSE-1	Indian Financial Markets and Services	4	1	0	6
4	DSE -2	Economic Growth and Development	4	1	0	6
Total						**24**

III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-13	International Economics	5	1	0	6
2	CC -14	Legal Aspects of Business	5	1	0	6
3	DSE -3	Industrial Economics	4	1	0	6
4	DSE -4	Investment and Risk Management Project Work/ Thesis / Dissertation in lieu of one of the elective core discipline papers.	-	-	-	6
Total						**24**

Summary of Courses with Credits

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** (Communication Skills &Gender Sensitization, Environment Studies)	2	2 courses of 2 credits	4
2	**Skill Enhancement Courses (SEC)** Computer Laboratory or Practice	4	2 courses of 4 credits	8
3	**Language Courses (LC)** 1. English 2. Second Language / FL	 2 2	 2 Courses of 3credits 2 courses of 3 credits	 6 6
4	**Core Courses (CC)** 14 papers	14	14 papers of 6 credits*	84
5	**Discipline Specific Elective Course (DSE)** 4 papers	4	4 papers of 6 Credits	24
6	**Generic Electives (GE)** (Entrepreneurship, Business Communication, Music)	4	4 papers of 4 Credits	16
		33		**148**

B.A. (Business Economics)

I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	4
2	LC-E1	Professional English-I	3	0	0	3
3	LC-S1	Second Language	3	0	0	3
4	DSC-1	Micro Economics and Applications I	5	1	0	6
5	DSC-2	Accounting for Managers	5	1	0	6
Total						**22**

I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	4
2	LC-E2	Professional English-II	0	0	3	3
3	LC-S2	Second Language	3	0	0	3
4	DSC-3	Micro Economics and Applications II	5	1	0	6
5	DSC-4	Mathematics for Business Economics	5	1	0	6
Total						**22**

II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	DSC-5	Quantitative Techniques for Management	5	1	0	6
2	DSC-6	Organization Behaviour	5	1	0	6
3	SEC 1	Entrepreneur Skills	4	0	0	4
4	GE1	Introduction to Computers (C Language / MS-Excel)	5	1	0	6
TOTAL						**22**

II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	DSC-7	International Economics	5	1	0	6
2	DSC -8	Legal Aspects of Business	5	1	0	6
3	SEC 2	Introduction to Research Methodology	4	0	0	4
4	GE-2	Introduction to Python Programming	5	1	0	6
TOTAL						**22**

III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	DSE-1	Indian Financial Markets and Services	5	1	0	6
2	DSE -2	Economic Growth and Development	5	1	0	6
3	SEC - 3	Introduction to R	4	0	0	4
4	GE -3	Economic History of India	5	1	0	6
Total						**22**

III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	DSE -3	Industrial Economics	5	1	0	6
2	DSE-4	Investment and Risk Management	5	1	0	6
3	SEC -4	Introduction to SAS	4	0	0	4
4	GE -4	Global Political Economy	5	1	0	6
Total						**22**

Summary of Courses with Credits

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** (Communication Skills &Gender Sensitization, Environment Studies)	2	2 courses of 4 credits	8
2	**Skill Enhancement Courses (SEC)** Computer Laboratory or Practice	4	4 courses of 4 credits	16
3	**Language Courses (LC)** 1. English 2. Second Language / FL	 2 2	 2 Courses of 3credits 2 courses of 3 credits	 6 6
4	**Core Courses (CC)** 8 papers	14	8 papers of 6 credits*	48
5	**Discipline Specific Elective Course (DSE)** 4 papers	4	4 papers of 6 Credits	24
6	**Generic Electives (GE)** (Entrepreneurship, Business Communication, Music)	4	4 papers of 6 Credits	24
		32		**132**

B.A. Hons (Multi Media & Mass Communication)

I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	0
2	LC-E1	Professional English-I	3	0	0	3
3	LC-S1	Second Language	3	0	0	3
4	CC-1	Communication Media & Society	5	1	0	6
5	CC-2	Introduction to journalism	5	1	0	6
6	GE1	Advertisement Media	2	1	2	2
Total						**20**

I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	0
2	LC-E2	Professional English-II	0	0	3	3
3	LC-S2	Second Language	3	0	0	3
4	CC-3	Communication Research	5	1	0	6
5	CC-4	Print Media Production	5	1	0	6
6	GE2	Social Media	2	1	2	2
Total						**20**

II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Exploring Cinema	5	1	0	6
2	CC-6	Graphic Designing & Visual Images	5	1	0	6
3	CC-7	Television Journalism	5	1	0	6
4	AECC	Theater & Communication	2	1	2	4
5	GE3	Public Service Broadcasting	4	0	0	2
TOTAL						**24**

II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-8	Development Communication	5	1	0	6
2	CC-9	Camera & Editing for TV	5	1	0	6
3	CC-10	Reporting & Anchoring	5	1	0	6
4	AECC	Communication & Disaster Management	4	0	0	4
5	GE4	Media Moments in History	4	0	0	2
TOTAL						**24**

III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-11	Global Politics & Media	5	1	0	6
2	CC-12	Documentary	5	1	0	6
3	DSE-1	Radio Production	4	1	0	6
4	DSE -2	Photography	4	1	0	6
5		Computer Animation / Mini Project				6
Total						**30**

III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-13	Communication & the Plastic Arts	5	1	0	6
2	CC -14	Integrated Marketing Communication	5	1	0	6
3	DSE -3	Communication for special needs	4	1	0	6
4	DSE -4	Fashion Communication	-	-	-	6
5		Project Work				6
Total						**30**

Summary of Courses with Credits

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** (Communication Skills &Gender Sensitization, Environment Studies)	2 2	2 courses of 4 credits	8
2	**Skill Enhancement Courses (SEC)** Computer Laboratory or Practice	2	2 Courses of 6credits	12
3	**Language Courses (LC)** 1. English 2. Second Language / FL	 2 2	 2 Courses of 3credits 2 courses of 3 credits	 6 6
4	**Core Courses (CC)** 14 papers	14	14 papers of 6 credits*	84
5	**Discipline Specific Elective Course (DSE)** 4 papers	4	4 papers of 6 Credits	24
6	**Generic Electives (GE)** (Entrepreneurship, Business Communication, Music)	4	4 papers of 2 Credits	8
		32		**148**

B.Com. Honors (Computers)

I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	2
2	LC-E1	Professional English-I	3	0	0	3
3	LC-S1	Second Language	3	0	0	3
4	CC-1	Financial Accounting - I	5	1	0	6
5	CC-2	Business Economics	5	1	0	6
6	GE1	Introduction to Computers (C Language /MS-Excel)	2	1	2	4
Total						**24**

I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	2
2	LC-E2	Professional English-II	0	0	3	3
3	LC-S2	Second Language	3	0	0	3
4	CC-3	Financial Accounting -II	5	1	0	6
5	CC-4	Business organization and Management	5	1	0	6
6	GE2	Management Information System	2	1	2	4
Total						**24**

II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Banking and Insurance	5	1	0	6
2	CC-6	Business Law and Ethics	5	1	0	6
3	CC-7	Advanced Accounting	5	1	0	6
4	GE3	Tally ERP	2	1	2	4
5	SEC1	Introduction to Python	2	1	2	4
TOTAL						**26**

II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-8	Income Tax Law and Practice	5	1	0	6
2	CC-9	Corporate Accounting	5	1	0	6
3	CC-10	Business Mathematics	5	1	0	6
4	GE4	E Commerce	4	0	0	4
5	SEC2	Tableau	2	1	2	4
TOTAL						**26**

III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	**T**	**P**	
1	CC-11	Corporate Taxation	5	1	0	6
2	CC-12	Forensic Accounting and Auditing	5	1	0	6
3	DSE-1	SQL	4	1	2	6
4	DSE -2	RDBMS	4	1	2	6
Total						24

III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	**T**	**P**	
1	CC-13	Corporate Governance	5	1	0	6
2	CC -14	Cost and Management Accounting	5	1	0	6
3	DSE -3	Business Analytics	4	1	2	6
4	DSE -4	Web Technologies Project Work/ Thesis / Dissertation in lieu of one of the elective core discipline papers.	4	1	2	6
Total						**24**

Summary of Courses with Credits

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** (Communication Skills & Gender Sensitization, Environment Studies)	2	2 courses of 2 credits	4
2	**Skill Enhancement Courses (SEC)** a) Problem Solving and Decision-Making Skills b) Fundamentals of Budget c) Competency Building d) Introduction to R e) Digital Marketing f) Leadership and Team Building g) Entrepreneurship h) Business Statistics	2	2 courses of 4 credits	8
3	**Language Courses (LC)**			
	1. English	2	2 Courses of 3credits	6
	2. Second Language / FL	2	2 courses of 3 credits	6
4	**Core Courses (CC)** 14 papers	14	14 papers of 6 credits	84
5	**Discipline Specific Elective Course (DSE)** 4 papers	4	4 papers of 6 credits	24
6	**Generic Electives (GE)** a) Principles of marketing b) Business Environment c) Research Methodology d) Project Management e) Financial Management f) Human Resource Management g) Goods and Services Tax h) Computers in Accounting	4	4 papers of 4 Credits	16
		30		**148**

B.Com. Hons (Banking and Financial Services)

I Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-1	Gender Sensitization	2	0	0	2
2	LC-E1	Professional English-I	3	0	0	3
3	LC-S1	Second Language	3	0	0	3
4	CC-1	Financial Accounting - I	5	1	0	6
5	CC-2	Business Economics	5	1	0	6
6	GE1	Opt any one from: a. Introduction to Computers (C Language /MS-Excel) b. Principles of marketing	2	1	2	4
Total						**24**

I Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	AECC-2	Environmental Studies	2	0	0	2
2	LC-E2	Professional English-II	0	0	3	3
3	LC-S2	Second Language	3	0	0	3
4	CC-3	Financial Accounting -II	5	1	0	6
5	CC-4	Business organization and Management	5	1	0	6
6	GE2	Opt any one from: a. Business Environment b. Research Methodology	2	1	2	4
Total						**24**

II Year I Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-5	Banking and Insurance	5	1	0	6
2	CC-6	Business Law and Ethics	5	1	0	6
3	CC-7	Advanced Accounting	5	1	0	6
4	GE3	Opt any one from: a) Project Management b) Tally ERP	2	1	2	4
5	SEC1	Opt any one from: a. Problem Solving and Decision-Making Skills b. Fundamentals of Budget c. Competency Building d. E Commerce	4	0	0	4
Total						**26**

II Year II Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-8	Income Tax Law and Practice	5	1	0	6
2	CC-9	Corporate Accounting	5	1	0	6
3	CC-10	Business Mathematics	5	1	0	6
4	GE4	Opt any one from: a) Goods and Services Tax b) Computers in Accounting	4	0	0	4
5	SEC2	Opt any one from: a. Digital Marketing b. Leadership and Team Building c. Entrepreneurship d. Business Statistics	4	0	0	4
Total						**26**

III Year I Semester

S. No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-11	Corporate Taxation	5	1	0	6
2	CC-12	Forensic Accounting and Auditing	5	1	0	6
3	DSE-1	Principles and Practices of Banking	4	1	0	6
4	DSE -2	Indian Financial Systems	4	1	0	6
Total						**24**

III Year II Semester

S.No.	Code	Course Name	Hours per week			Credits
			L	T	P	
1	CC-13	Corporate Governance	5	1	0	6
2	CC -14	Cost and Management Accounting	5	1	0	6
3	DSE -3	Technology in Banking	4	1	0	6
4	DSE -4	Financial instruments and markets / Project Work/ Thesis / Dissertation in lieu of one of the elective core discipline paper	-	-	-	6
Total						**24**

Summary of Courses with Credits

S.No.	Course Type	No of Courses	Credits Per Course	Credits
1	**Ability Enhancement Courses (AECC)** (Communication Skills &Gender Sensitization, Environment Studies)	2	2 courses of 2 credits	4
2	**Skill Enhancement Courses (SEC)**	2	2 courses of 4 credits	8
3	**Language Courses (LC)**			
	1. English	2	2 Courses of 3credits	6
	2. Second Language / FL	2	2 courses of 3 credits	6
4	**Core Courses (CC)** 14 papers	14	14 papers of 6 credits	84
5	**Discipline Specific Elective Course (DSE)** 4 papers	4	4 papers of 6 Credits	24
6	**Generic Electives (GE)**	4	4 papers of 4 Credits	16
		30		**148**

Item 10

Presentation of the Amendments to the PhD Rules & Regulations by Dean, R&D

Amendments to AU-Ph.D. Rules and Regulations

Note from Dean Research and Development: to place the following Amendments of the Ph.D. Rules and Regulations of Anurag University before the Academic Council for approval.

Amendment 1:

The pattern of examination of Pre-Ph.D. Course work

a) Research Methodology/ Research Paper Writing Process (RPWP) (100 Marks-4-credits): Common to all the candidates admitted for the Ph.D. program. The research scholar shall secure a minimum of 50% marks to pass this course. The scholar needs to present two seminars on the approved research papers before DRC. Each seminar is evaluated for 100 marks (50 marks for presentation and 50 marks for technical writing of the seminar content). The DRC will evaluate the student based on the average marks of two seminar presentations.

b) **The pattern of Pre-Ph.D. examination of the two courses related to specialization** (**100 marks each- with 4-credits each**): Each Pre-Ph.D. course contains five units. The question paper contains two questions from each unit in the form of A or B. The scholar needs to write one of them. Each question carries 20 marks. The research scholar shall secure a minimum of 50% marks in each course to pass the Pre-Ph.D. examination. Two evaluations will be made for every Pre-Ph.D. course, and if the difference of marks in the two evaluations is more than 15%, it will be sent for the third evaluation, and the average of the nearest two evaluations will be considered.

Amendment 2:

To give an option for research scholars admitted into the Information Technology (IT) branch to opt for a Ph.D. in Computer Science and Engineering or Information technology. The eligibility criteria for Ph.D. admission in to the both streams is same and the fields of research also same.

Amendment 3:

To include research methodology in the syllabus of Ph.D. eligibility test as per the guidelines of University Grants Commission –Notification 5th May 2016 - (Minimum Standards and Procedure for Award of M.PHIL./PH.D Degrees) – 5.4.1 “The syllabus of Entrance test shall consist of research methodology." After the Inclusion of research methodology contents, the Ph.D. eligibility test syllabus of all branches of Engineering, Pharmacy, Management, Humanities and Sciences of Anurag University is presented for approval. (The PhD. Eligibility test syllabus is enclosed)

Computer Science and Engineering, Information Technology &

CSE (Specialization in Artificial Intelligence)

Section 1: Digital Logic

Boolean algebra.Combinational and sequential circuits.Minimization.Number representations and computer arithmetic (fixed and floating point).

Section 2: Computer Organization and Architecture

Machine instructions and addressing modes.ALU, data-path and control unit.Instruction pipelining, pipeline hazards. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

Section 3: Programming and Data Structures

Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

Section 4: Algorithms

Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide and conquer. Graph traversals, minimum spanning trees, shortest paths

Section 5: Theory of Computation

Regular expressions and finite automata.Context-free grammars and push-down automata. Regular and contex- free languages, pumping lemma. Turing machines and undecidability.

Section 6: Compiler Design

Lexical analysis, parsing, syntax-directed translation.Runtime environments.Intermediate code generation. Local optimisation, Data flow analyses: constant propagation, liveness analysis, common subexpression elimination.

Section 7: Operating System

System calls, processes, threads, inter process communication, concurrency and synchronization. Deadlock.CPU and I/O scheduling.Memory management and virtual memory. File systems.

Section 8: Databases

ER- model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

Section 9: Computer Networks

Concept of layering: OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit-switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; Fragmentation and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Email.

Section 10: Research Methodology

Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem; data collection, analysis, interpretation, Effective literature studies, approaches, analysis, Plagiarism, Research ethics.
Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

Note: Due weightage should be given for all units of the syllabus

Chemical Engineering

Section 1: Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non- reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis.

First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Section 2: Fluid Mechanics and Mechanical Operations

Fluid statics, surface tension, Newtonian and non-Newtonian fluids, transport properties, shell-balances including differential form of Bernoulli equation and energy balance, equation of continuity, equation of motion, equation of mechanical energy, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, velocity profiles, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.

Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Section 3: Heat Transfer

Equation of energy, steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations; design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

Section 4: Mass Transfer

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts; design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption, membrane separations(micro- filtration, ultra-filtration, nano-filtration and reverse osmosis).

Section 5: Chemical Reaction Engineering

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, kinetics of enzyme reactions (Michaelis-Menten and Monod models), non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis; rate and performance equations for catalyst deactivation

Section 6: Instrumentation and Process Control

Measurement of process variables; sensors and transducers; P&ID equipment symbols; process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; transducer dynamics; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Section 7: Plant Design and Economics

Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, optimization in process design and sizing of chemical engineering equipments such as heat exchangers and multistage contactors.

Section 8: Chemical Technology

Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry), fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

Section 9: Research Methodology

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Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

Note: Due weightage should be given for all units of the syllabus

Civil Engineering

Section 1: Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; Internalforcesinstructures;Frictionsanditsapplications;Centreofmass;FreeVibrationsofundamped SDOF system. Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses. Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis. Construction Materials and Management: Construction Materials: Structural Steel – Composition, material properties and behaviour; Concrete - Constituents, mix design, short- term and long-term properties. Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation. Concrete Structures: Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete beams.
Steel Structures: Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Concept of plastic analysis - beams and frames.

Section 2: Geotechnical Engineering

Soil Mechanics: Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One- dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand; Stress paths. Foundation Engineering: Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Stress distribution in soils–
Boussinesq'stheory;Pressurebulbs,Shallowfoundations–Terzaghi'sandMeyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – dynamic and static formulae,Axialloadcapacityofpilesinsandsandclays,pileloadtest,pileunderlateralloading, pile group efficiency, negative skin friction.

Section 3: Water Resources Engineering

FluidMechanics:Propertiesoffluids,fluidstatics;Continuity,momentumandenergyequations and their applications; Potential flow, Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift anddrag.
Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensionalanalysisandhydraulicsimilitude;ChannelHydraulics-Energy-depthrelationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles. Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's Law. Irrigation: Types of

irrigation systems and methods; Crop water requirements - Duty, delta, evapo-transpiration; Gravity Damsand Spillways; Linedandunlinedcanals, Designofweirson permeable foundation; cross drainage structures.

Section 4: Environmental Engineering

Water and Waste Water Quality and Treatment: Basics of water quality standards – Physical,chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment. Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications. Air Pollution: Types of pollutants, their sources and impacts, air pollution control, air quality standards, Air quality Index and limits. Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

Section 5: Transportation Engineering

Transportation Infrastructure: Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments. Geometric design of railway Track – Speed and Cant. Concept of airport runway length, calculations and corrections; taxiway and exit taxiwaydesign. Highway Pavements: Highway materials - desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes

Traffic Engineering: Traffic studies on flow and speed, peak hour factor, accident study, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Traffic signs; Signal design by Webster's method;

Section 6: Geomatics Engineering

Principlesofsurveying;Errorsandtheiradjustment;Maps-scale,coordinatesystem;Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and verticalcurves. Photogrammetry and Remote Sensing - Scale, flying height; Basics of remote sensing and GIS.

Section 7: Research Methodology

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Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

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Electronics and communication Engineering

Section 1: Networks, Signals and Systems

Circuit analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Sinusoidal steady state analysis: phasors, complex power, maximum power transfer. Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform.

Linear 2-port network parameters, wye-delta transformation.

Continuous-time signals: Fourier series and Fourier transform, sampling theorem and applications. Discrete-time signals: DTFT, DFT, z-transform, discrete-time processing of continuous-time signals. LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

Section 2: Electronic Devices

Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors. Carrier transport: diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations. P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

Section 3: Analog Circuits

Diode circuits: clipping, clamping and rectifiers. BJT and MOSFET amplifiers: biasing, ac coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers. Op-amp circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

Section 4: Digital Circuits

Number representations: binary, integer and floating-point- numbers.

Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders.

Sequential circuits: latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay. Data converters: sample and hold circuits, ADCs and DACs. Semiconductor memories: ROM, SRAM, DRAM.

Computer organization: Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

Section 5: Control Systems

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Section 6: Communications

Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems.

Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers.

Information theory: entropy, mutual information and channel capacity theorem.

Digital communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER. Fundamentals of error correction, Hamming codes, CRC.

Section 7: Electromagnetics

Maxwell's equations: differential and integral forms and their interpretation, boundary conditions,wave equation, Poynting vector. Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth. Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, Sparameters, Smith chart. Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

Section 8: Research Methodology

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Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

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Electrical and Electronic Engineering

Section-1: Electric circuits

Network elements: ideal voltage and current sources, dependent sources, R, L, C, M elements; Network solution methods: KCL, KVL, Node and Mesh analysis; Network Theorems: Thevenin's, Norton's, Superposition and Maximum Power Transfer theorem; Transient response of dc and ac networks, sinusoidal steady-state analysis, resonance, two port networks, balanced three phase circuits, star-delta transformation, complex power and power factor in ac circuits.

Section-2: Electromagnetic Fields

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

Section-3: Signals and Systems

Representation of continuous and discrete time signals, shifting and scaling properties, linear time invariant and causal systems, Fourier series representation of continuous and discrete time periodic signals, sampling theorem, Applications of Fourier Transform for continuous and discrete time signals, Laplace Transform and Z transform.

Section-4: Electrical Machines

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three-phase transformers: connections, vector groups, parallel operation; Auto-transformer, Electromechanical energy conversion principles; DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, speed control of dc motors; Three-phase induction machines: principle of operation, types, performance, torque-speed characteristics, no-load and blocked-rotor tests, equivalent circuit, starting and speed control; Operating principle of single-phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance and characteristics, regulation and parallel operation of generators, starting of synchronous motors; Types of losses and efficiency calculations of electric machines

Section-5: Power Systems

Basic concepts of electrical power generation, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss- Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential, directional and distance protection; Circuit breakers, System stability concepts, Equal area criterion, Economic Load Dispatch (with and without considering transmission losses).

Section-6: Control Systems

Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Stability analysis using Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, Solution of state equations of LTI systems, R.M.S. value, average value calculation for any general periodic waveform.

Section-7: Electrical and Electronic Measurements

Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

Section-8: Analog and Digital Electronics

Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers: characteristics and applications; single stage active filters, Sallen Key, Butterworth, VCOs and timers, combinatorial and sequential logic circuits, multiplexers, demultiplexers, Schmitt triggers, sample and hold circuits, A/D and D/A converters.

Section-9: Power Electronics

Static V-I characteristics and firing/gating circuits for Thyristor, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of uncontrolled rectifiers; Voltage and Current commutated Thyristor based converters; Bidirectional ac to dc voltage source converters; Magnitude and Phase of line current harmonics for uncontrolled and thyristor based converters; Power factor and Distortion Factor of ac to dc converters; Single-phase and three-phase voltage and current source inverters, sinusoidal pulse width modulation.

Section 10: Research Methodology

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Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

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Mechanical Engineering

Section 1: Applied Mechanics and Design

Engineering Mechanics: Free-body diagrams and equilibrium; friction and its applications including rolling friction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc.; trusses and frames; virtual work; kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations; Lagrange’s equation.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr’s circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; concept of shear centre; deflection of beams; torsion of circular shafts; Euler’s theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S- N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Section 2: Fluid Mechanics and Thermal Sciences

Fluid Mechanics: Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; control- volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli’s equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressible fluid flow.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air- conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton- wheel, Francis and Kaplan turbines; steam and gas turbines

Section 3: Materials, Manufacturing and Industrial Engineering

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress- strain diagrams for engineering materials.
Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding. Machining and Machine Tool Operations: Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non- traditional machining processes; principles of work holding, jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming. Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly; concepts of coordinate-measuring machine (CMM). Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools; additive manufacturing. Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning; lean manufacturing. Inventory Control: Deterministic models; safety stock inventory control systems. Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Section 4: Research Methodology

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Mathematics

Section-1: Calculus: Functions of two or more variables, continuity, directional derivatives, partial derivatives, total derivative, maxima and minima, saddle point, method of Lagrange's multipliers; Double and Triple integrals and their applications to area, volume and surface area; Vector Calculus: gradient, divergence and curl, Line integrals and Surface integrals, Green's theorem, Stokes' theorem, and Gauss divergence theorem.

Section 2: Linear Algebra: Finite dimensional vector spaces over real or complex fields; Linear transformations and their matrix representations, rank and nullity; systems of linear equations, characteristic polynomial, eigenvalues and eigenvectors, diagonalization, minimal polynomial, Cayley-Hamilton Theorem, Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process, symmetric, skew-symmetric, Hermitian, skew-Hermitian, normal, orthogonal and unitary matrices; diagonalization by a unitary matrix, Jordan canonical form; bilinear and quadratic forms.

Section 3: Real Analysis: Metric spaces, connectedness, compactness, completeness; Sequences and series of functions, uniform convergence, Ascoli-Arzela theorem;Weierstrass approximation theorem; contraction mapping principle, Power series; Differentiation of functions of several variables, Inverse and Implicit function theorems; Lebesgue measure on the real line, measurable functions; Lebesgue integral, Fatou's lemma, monotone convergence theorem, dominated convergence theorem.

Section 4: Complex Analysis: Functions of a complex variable: continuity, differentiability, analytic functions, harmonic functions; Complex integration: Cauchy's integral theorem and formula; Liouville's theorem, maximum modulus principle, Morera's theorem; zeros and singularities; Power series, radius of convergence, Taylor's series and Laurent's series; Residue theorem and applications for evaluating real integrals; Rouche's theorem, Argument principle, Schwarz lemma; Conformal mappings, Mobius transformations.

Section 5: Ordinary Differential equations: First order ordinary differential equations, existence and uniqueness theorems for initial value problems, linear ordinary differential equations of higher order with constant coefficients; Second order linear ordinary differential equations with variable coefficients; Cauchy-Euler equation, method of Laplace transforms for solving ordinary differential equations, series solutions (power series, Frobenius method); Legendre and Bessel functions and their orthogonal properties; Systems of linear first order ordinary differential equations, Sturm's oscillation and separation theorems, Sturm-Liouville eigenvalue problems, Planar autonomous systems of ordinary differential equations: Stability of stationary points for linear systems with constant coefficients, Linearized stability, Lyapunov functions.

Section 5: Algebra: Groups, subgroups, normal subgroups, quotient groups, homomorphisms, automorphisms; cyclic groups, permutation groups, Group action**,** Sylow's theorems and their applications; Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domains, Principle ideal domains, Euclidean domains, polynomial rings, Eisenstein's irreducibility criterion; Fields, finite fields, field extensions, algebraic extensions, algebraically closed fields.

Section 6: Functional Analysis: Normed linear spaces, Banach spaces, Hahn-Banach theorem, open mapping and closed graph theorems, principle of uniform boundedness; Inner-product spaces, Hilbert spaces, orthonormal bases, projection theorem, Riesz representation theorem, spectral theorem for compact self-adjoint operators.

Section 7: Numerical Analysis: Systems of linear equations: Direct methods (Gaussian elimination, LU decomposition, Cholesky factorization), Iterative methods (Gauss-Seidel and Jacobi) and their convergence for diagonally dominant coefficient matrices; Numerical solutions of nonlinear equations: bisection method, secant method, Newton-Raphson method, fixed point iteration; Interpolation: Lagrange and Newton forms of interpolating polynomial, Error in polynomial interpolation of a function; Numerical differentiation and error, Numerical integration: Trapezoidal and Simpson rules, Newton-Cotes integration formulas, composite rules, mathematical errors involved in numerical integration formulae; Numerical solution of initial value problems for ordinary differential equations: Methods of Euler, Runge - Kutta method of order 2.

Section 8: Partial Differential Equations: Method of characteristics for first order linear and quasilinear partial differential equations; Second order partial differential equations in two independent variables: classification and canonical forms, method of separation of variables for Laplace equation in Cartesian and polar coordinates, heat and wave equations in one space variable; Wave equation: Cauchy problem and d'Alembert formula, domains of dependence and influence, non-homogeneous wave equation; Heat equation: Cauchy problem; Laplace and Fourier transform methods.

Section 9: Topology: Basic concepts of topology, bases, subbases, subspace topology, order topology, product topology, quotient topology, metric topology, connectedness, compactness, countability and separation axioms, Urysohn’s Lemma.

Section 10: Linear Programming: Linear programming models, convex sets, extreme points;Basic feasible solution, graphical method, simplex method, two phase methods, revised simplex method ; Infeasible and unbounded linear programming models, alternate optima; Duality theory, weak duality and strong duality; Balanced and unbalanced transportation problems, Initial basic feasible solution of balanced transportation problems (least cost method, north-west corner rule, Vogel’s approximation method); Optimal solution, modified distribution method; Solving assignment problems, Hungarian method.

Section 11: Research Methodology: Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem; data collection, analysis, interpretation, Effective literature studies, approaches, analysis, Plagiarism, Research ethics.
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Physics

Section 1: Mathematical Methods of Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Green’s function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson’s rule, Solution of first order differential equation using RungeKutta method. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

Section 2: Classical Mechanics

Newton’s laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamicsmoment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity. Lorentz transformations, relativistic kinematics and mass–energy equivalence.

Section 3: Electromagnetic Theory

Electrostatics: Gauss’s law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel’s law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

Section 4: Quantum Mechanics

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Timeindependent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.

Section 5: Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law.

Section 6: Solid state devices and experimental mothods

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors.

Least squares fitting, Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors).

Section 7: Atomic & Molecular Physics

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

Section 8: Condensed Matter Physics

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Dielectric and Magnetic Properties of Materials

Section 9: Nuclear and Particle Physics

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semiempirical mass formula, liquid drop model. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance.

Section 10: Research Methodology

Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem; data collection, analysis, interpretation, Effective literature studies, approaches, analysis, Plagiarism, Research ethics.
Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

Note: Due weightage should be given for all units of the syllabus

Chemistry

Section 1: Physical Chemistry

1. Basic principles and applications of quantum mechanics – hydrogen atom, angularmomentum.
2. Variational and perturbationalmethods.
3. Basics of atomic structure, electronic configuration, shapes of orbitals, hydrogen atomspectra.
4. Theoretical treatment of atomic structures and chemicalbonding.
5. Chemical applications of grouptheory.
6. Basic principles and application of spectroscopy – rotational, vibrational, electronic, Raman, ESR,NMR.
7. Chemicalthermodynamics.
8. Phase equilibria.
9. Statisticalthermodynamics.
10. Chemicalequilibria.
11. Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Hückel theory.
12. Chemical kinetics – empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms, experimentaltechniques for fast reactions.
13. Concepts of catalysis.
14. Polymer chemistry. Molecular weights and their determinations. Kinetics of chainpolymerization.
15. Solids - structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magneticproperties
16. Collids and surfacephenomena.
17. Data analysis.

Section 2: Inorganic Chemistry

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules.
3. Concepts of acids and bases.
4. Chemistry of the main group elements and their compounds. Allotropy, synthesis, bonding and structure.
5. Chemistry of transition elements and coordination compounds – bonding theories, spectral and magnetic properties, reactionmechanisms.
6. Inner transition elements – spectral and magnetic properties, analytical applications.
7. Organometallic compounds - synthesis, bonding and structure, andreactivity. Organometallics in homogenouscatalysis.
8. Cages and metalclusters.
9. Analytical chemistry- separation techniques. Spectroscopic electro- and thermoanalyticalmethods.
10. Bioinorganic chemistry – photosystems, porphyrines, metalloenzymes, oxygen transport, electron- transfer reactions, nitrogen fixation.
11. Physical characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-, NQR, MS, electron spectroscopy and microscopictechniques.
12. Nuclear chemistry – nuclear reactions, fission and fusion, radio-analytical techniques and activationanalysis.

Section 3: Organic Chemistry

1. IUPAC nomenclature of organiccompounds.
2. Principles of stereochemistry, conformational analysis, isomerism andchirality.
3. Reactive intermediates and organic reactionmechanisms.
4. Concepts ofaromaticity.
5. Pericyclicreactions.
6. Namedreactions.
7. Transformations andrearrangements.
8. Principles and applications of organic photochemistry. Free radicalreactions.
9. Reactions involving nucleophotic carbonintermediates.
10. Oxidation and reduction of functional groups.
11. Common reagents (organic, inorganic and organometallic) in organicsynthesis.
12. Chemistry of natural products such as steroids, alkaloids, terpenes, peptides, carbohydrates, nucleic acids andlipids.
13. Selective organic transformations – chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity. Protectinggroups.
14. Chemistry of aromatic and aliphatic heterocycliccompounds.
15. Physical characterisation of organic compounds by IR, UV-, MS, andNMR.

Section 4: Interdisciplinary topics

1. Chemistry in Nano science andtechnology.
2. Medicinal chemistry.
3. Supramolecularchemistry
4. Environmentalchemistry
5. Catalysis and green chemistry.

Section 5: Research Methodology

Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem; data collection, analysis, interpretation, Effective literature studies, approaches, analysis, Plagiarism, Research ethics.
Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

Note: Due weightage should be given for all units of the syllabus

English

History of English Literature:
Chaucer – Victorian Age
Poetry – Canterbury Tales , Paradise Lost I & IX
Drama – Hamlet, Dr.Faustus
Novel – Jane Austen's Pride & Prejudice, Charles Dickens' David Copperfield

Modern Indian Fiction:
GirishKarnad'sHayavadana, Salman Rushdie's Midnight Children, AravindAdiga's The White Tiger

Literary Theory & Criticism

English Language Teaching:
LSRW Skills
Received Pronunciation: Vowels , Consonants, Syllable Structure & Stress
Communicative Language Teaching
English for Academic Purposes
English for Specific Purposes

Language Testing and Assessment

Research Methods and Materials in English
Types of Literary Research
Literature Review: Necessity, Methods and Utilization
Data Collection & Documentation Skills

Research Methodology

Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem; data collection, analysis, interpretation, Effective literature studies, approaches, analysis, Plagiarism, Research ethics.
Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

Note : Due weightage should be given for all units of the syllabus

Management

Section 1:

Management – Concept, Process, Theories and Approaches, Management Roles and Skills

Functions – Planning, Organizing, Staffing, Coordinating and Controlling.Communication – Types, Process and Barriers.
Decision Making – Concept, Process, Techniques and Tools

Organisation Structure and Design – Types, Authority, Responsibility, Centralisation, Decentralisation and Span ofControl

Managerial Economics – Concept & Importance

Demand analysis – Utility Analysis, Indifference Curve, Elasticity& Forecasting
Market Structures – Market Classification & Price Determination
National Income – Concept, Types and Measurement Inflation – Concept, Types and Measurement Business Ethics & CSR
Ethical Issues & Dilemma Corporate Governance Value Based Organization

Section 2:

OrganisationalBehaviour – Significance & Theories

Individual Behaviour – Personality, Perception, Values, Attitude, Learning and Motivation

Group Behaviour – Team Building, Leadership, Group Dynamics Interpersonal Behaviour& Transactional Analysis
Organizational Culture & Climate

Work Force Diversity & Cross Culture OrganisationalBehaviour
Emotions and Stress Management
Organisational Justice and Whistle Blowing

Human Resource Management – Concept, Perspectives, Influences and Recent Trends

Human Resource Planning, Recruitment and Selection, Induction, Training and Development
Job Analysis, Job Evaluation and Compensation Management

Section 3:

Strategic Role of Human Resource Management Competency Mapping & Balanced Scoreboard Career Planning and Development
Performance Management andAppraisal

Organization Development, Change & OD Interventions Talent Management & SkillDevelopment Employee Engagement & Work Life Balance
Industrial Relations: Disputes & Grievance Management, Labour Welfare and Social Security

Trade Union & Collective Bargaining
International Human Resource Management – HR Challenge of International Business
Geen HRM

Section 4:

Accounting Principles and Standards, Preparation of Financial Statements

Financial Statement Analysis – Ratio Analysis, Funds Flow and Cash Flow Analysis, DuPont Analysis

Preparation of Cost Sheet, Marginal Costing, Cost Volume Profit Analysis Standard Costing & Variance Analysis
Financial Management, Concept & Functions

Capital Structure – Theories, Cost of Capital, Sources and Finance Budgeting and Budgetary Control, Types and Process, Zero base Budgeting
Leverages – Operating, Financial and Combined Leverages, EBIT–EPS Analysis, Financial Breakeven Point & Indifference Level.

Section 5:

Value & Returns – Time Preference for Money, Valuation of Bonds and Shares, Risk and Returns;

Capital Budgeting – Nature of Investment, Evaluation, Comparison of Methods; Risk and Uncertainly Analysis

Dividend – Theories and Determination

Mergers and Acquisition – Corporate Restructuring, Value Creation, Merger Negotiations, Leveraged Buyouts, Takeover

Portfolio Management – CAPM, APT
Derivatives – Options, Option Payoffs, Option Pricing, Forward Contracts & Future Contracts

Working Capital Management – Determinants, Cash, Inventory, Receivables and Payables Management, Factoring

International Financial Management, Foreign exchange market

Section 6:

Strategic Management – Concept, Process, Decision & Types
Strategic Analysis – External Analysis, PEST, Porter’s Approach to industry analysis, Internal Analysis – Resource Based Approach, Value Chain Analysis

Strategy Formulation – SWOT Analysis, Corporate Strategy – Growth, Stability, Retrenchment, Integration and Diversification, Business Portfolio Analysis - BCG, GE Business Model, Ansoff's Product Market Growth Matrix

Strategy Implementation – Challenges of Change, Developing Programs Mckinsey 7s Framework

Marketing – Concept, Orientation, Trends and Tasks, Customer Value and Satisfaction

Market Segmentation, Positioning and Targeting

Product and Pricing Decision – Product Mix, Product Life Cycle, New Product development, Pricing – Types and Strategies

Place and promotion decision – Marketing channels and value networks, VMS, IMC, Advertising and Sales promotion

Section 7:

Consumer and Industrial Buying Behaviour: Theories and Models of Consumer Behaviour

Brand Management – Role of Brands, Brand Equity, Equity Models, Developing a Branding Strategy; Brand Name Decisions, Brand Extensions andLoyalty

Logistics and Supply Chain Management, Drivers, Value creation, Supply Chain Design, Designing and Managing Sales Force, Personal Selling

Service Marketing – Managing Service Quality and Brands, Marketing Strategies of Service Firms

Customer Relationship Marketing – Relationship Building, Strategies, Values and Process

Retail Marketing – Recent Trends in India, Types of Retail Outlets.

Emerging Trends in Marketing – Concept of e-Marketing, Direct Marketing, Digital Marketing and GreenMarketing

International Marketing – Entry Mode Decisions, Planning Marketing Mix for International Markets

Section 8:

Statistics for Management: Concept, Measures Of Central Tendency and Dispersion, Probability Distribution – Binominal, Poison, Normal and Exponential

Data Collection & Questionnaire Design
Sampling – Concept, Process and Techniques
Hypothesis Testing – Procedure; T, Z, F, Chi-square tests

Correlation and Regression Analysis
Operations Management – Role and Scope

Facility Location and Layout – Site Selection and Analysis, Layout – Design and Process

Enterprise Resource Planning – ERP Modules, ERP implementation
Scheduling; Loading, Sequencing and Monitoring
Quality Management and Statistical Quality Control, Quality Circles, Total Quality Management – KAIZEN, Benchmarking, Six Sigma; ISO 9000 Series Standards

Operation Research – Transportation, Queuing Decision Theory, PERT / CPM

Section 9:

International Business – Managing Business in Globalization Era; Theories of International Trade; Balance of payment

Foreign Direct Investment – Benefits and Costs

Multilateral regulation of Trade and Investment under WTO
International Trade Procedures and Documentation; EXIM Policies
Role of International Financial Institutions – IMF and World Bank
Information Technology – Use of Computers in Management Applications; MIS, DSS

Artificial Intelligence and Big Data

Data Warehousing, Data Mining and Knowledge Management – Concepts
Managing Technological Change

Section 10:

Entrepreneurship Development – Concept, Types, Theories and Process, Developing Entrepreneurial Competencies

Intrapreneurship – Concept and Process

Women Entrepreneurship and Rural Entrepreneurship

Innovations in Business – Types of Innovations, Creating and Identifying Opportunities, Screening of Business Ideas

Business Plan and Feasibility Analysis – Concept and Process of Technical, Market and Financial Analysis

Micro and Small Scale Industries in India; Role of Government in Promoting SSI

Sickness in Small Industries – Reasons and Rehabilitation

Institutional Finance to Small Industries – Financial Institutions, Commercial Banks, Cooperative Banks, Micro Finance.

Section 11: Research Methodology

Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem; data collection, analysis, interpretation, Effective literature studies, approaches, analysis, Plagiarism, Research ethics. Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

Note: Due weightage should be given for all units of the syllabus

Pharmacy

(Same as GPAT syllabus)

Section 1: Pharmaceutics

Intermolecular forces & their impact on the state of the matter. Various physical properties of matter, dipole moment, dielectric constant, Van Der Waal's equation & critical phenomenon, liquefaction of gases, aerosols.
States of mater, Physical properties of drug molecules, pH, buffers and isotonic solution, Solubility phenomena, Surface tension, Interfacial phenomenon, Rheology, Micromeretics & powder flow, Diffusion and dissolution, Colloids, Complexation and protein Binding, Dispersion systems, Development, manufacturing standards Q.C. limits, Labeling as per the pharmacopoeal requirements. Formulation and evaluation of tablets, capsules, parenterals, liquid dosage forms and cosmetics like lipstick, shampoo, creams, nail preparations and dentifrices. Biopharmaceutical classification of drugs. Method of preparation, evaluation and application of Novel drug delivery systems like liposomes, ethosomes, neosomes, nanoparticles, microemulsions, nanoemulsions. Drug absorption, distribution, metabolism and elimination. Compartment model- Definition and Scope. Pharmacokinetics of drug absorption- Zero order and First order absorption rate constant. Determination of pharmacokinetic parameters. Bioavailability and bioequivalence: Measures of bioavailability, C-max, T-max, and Area under the Curve (AUC);
Review of regulatory requirements for conducting bioequivalent studies.

Section 2: Pharmaceutical Analysis

Fundamental principles, Basic instrumentation and pharmaceutical applications of flame Photometry, Flourimetry, UV-Visible, Mass Spectroscopy, Infrared spectroscopy, NMR spectroscopy, HPLC, HPTLC, Gel chromatography, Electrophoresis and Ion-pair chromatography. Introductory principle, instrumentation and application of LC-MS and GC-MS. Theory, methods and applications of enzyme and radioimmunoassay techniques, Differential scanning calorimetry (DSC), X-ray diffractometry (XRD), Validation and Calibration.

Section 3:Pharmaceutical Jurisprudence

Drugs and cosmetics Act and rules with respect to manufacture, sales and storage.

Pharmacy Act. Pharmaceutical ethics.

Section 4:Pharmaceutical Chemistry

Basic introduction to organic chemistry related to synthesis and reaction mechanism of the main organic functional groups such as Alkanes, Alkenes, Alkynes, Aliphatic hydroxyl compounds, Alkyl halides, Aldehydes & Ketones and Carboxylic acids. Stereochemistry, substitution reactions, elimination reactions, addition reactions, rearrangement reactions.
Introduction to drug design; Bioisosterosim, QSAR, Molecular modeling, Physico chemical aspects of Drug molecules and biological actions, Drug-receptor interactions.

A detailed study of the following classes with respect to drug nomenclature, classification, physicochemical properties, mode of action [MOA], structure-activity relationships, synthesis, drug metabolism, therapeutic uses & side effects.

General anesthetics, Local anesthetics, Coagulants, Anticoagulants & Plasma expanders, Purgatives, laxatives & anti-diarrhoeal agents, Antimalarials, Antiamoebic agents, Anthelmintic agents, Antibacterial, Antifungal agents, Antiviral agents, Anti-cancer agents, Antihistamines, Hypoglycemic agents, Sedative-hypnotics, Antiepileptic agents, Neuroleptics, Anti-anxiety drugs, Antibiotics, Anti-malarial, Steroids, Narcotic analgesics, Analgesic and anti-inflammatory agents, Adrenergic drugs, Cholinergic agents, Drugs used in neuromuscular disorders & Parkinson's disease, Hypertensive, anti-hypertensive, & anti-anginal agents.

Metabolism of carbohydrate, lipids and proteins and nucleic acid metabolism.

Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids, Biological oxidation.

Section 5: Pharmacology

General Pharmacology; Detailed pharmacology including classification, mechanism of action, adverse effects and therapeutic uses of following classes

Neurohumoral transmission in the C.N.S with special emphasis on Pharmacology of various neurotransmitters, Protein and peptide as drugs, Parasympathomimetics, Parasympatholytics, Sympathomimetics, Sympatholytics, Ganglionic stimulants and blockers, Neuromuscular blocking agents, Peripheral skeletal muscle relaxants, Local anesthetic agents, General anesthetics, Sedatives, hypnotics, Centrally acting muscle relaxants, Antipsychotics, Antidepressants, Anti-anxiety agents, Anti-epileptic drugs, Anti-parkinsonism drugs, Narcotic analgesics, Anti-hypertensive drugs, Anti-anginal agents, Anti-arrhythmic drugs, Anti-hyperlipidemic drugs, Oral hypoglycemic agents, Anticoagulants and haemostatic agents, Fibrinolytics and antiplatelet drugs, Diuretics and anti-diuretics, Anti-asthmatic drugs, Anti-tussives and expectorants, Respiratory stimulants, Thyroid hormones and antithyroid drugs, Antibiotics, Antifungal, Anti-protozoal, Anti-viral, Anti-cancer, Anti-tuberculosis drugs, Antacids, antiulcer drugs, Laxatives and antidiarrheal drugs, Emetics and anti-emetic, Anti-inflammatory and anti-gout drugs. Immunostimulants and immunosuppressants and Principles of toxicology.

Section 6: Pharmacognosy

Introduction to Alkaloids, Glycosides, Tannins, Resins, Volatile oils and Flavonoids; Biosynthetic pathways, Extraction & Isolation techniques, Adulteration & evaluation of crude drugs, Quality control of herbal drugs as per WHO guidelines, Traditional herbal drugs, Natural pestisides. Alternative systems of medicines, Ayurvedic formulations.

Section 7: Pharmacognostic study of the following drugs

Digitalis, Strophanthus, Squill, Aloe, Rhubarb, Senna, Quassia, Dioscorea, Glycyrrhiza, Ginseng, Gentian, Withania, belladonna, Hyoscymous, stramonium, Cinchona, Opium, Nuxvomica, Ergot, Rauwolfia, Vinca, Kurchi, Ephedra, Vasaca, Solanum xanthocarpum, Pale catechu, Black catechu, Guggul, Black pepper, Mentha, Coriander, Cardamom, Cinnamon, Orange peel, Lemongrass, Citronella, Cumin, Caraway, Dill, Clove, Fennel, Nutmeg, Sandalwood, Benzoin, Colophony, Asafoetida, Ginger, Turmeric and Podophyllum.

Section 8:Research Methodology

Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem; data collection, analysis, interpretation, Effective literature studies, approaches, analysis, Plagiarism, Research ethics.
Effective technical writing: how to write a report, Research Proposal writing, Format of research proposal,\presentation and assessment by a review committee.

Note: Due weightage should be given for all units of the syllabus

Item 11

Approval of the Academic Regulations for B.Sc. / B.Com. / BA / BBA Programs with effect from the academic year 2021-22

Academic Regulations for B.Sc / B.Sc (Honors) / B.Com / B.Com (Honors) / BA / BA (Honors) / BBA Programs with effect from the Academic Year 2021-22

1. Distribution and Weightage of Marks

1.1 The performance of a student in a semester shall be evaluated course-wise for a maximum of 100 marks in each theory and practical course. In addition, industry-oriented mini-project, seminar, comprehensive viva-voce and project work shall be evaluated for 100 marks each.

1.2 The distribution of marks for Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE) along with the minimum pass percentage shall be as follows:

Course	Continuous Internal Evaluation (CIE)	Semester End Examination (SEE)	*Min. Pass Percentage in (SEE)	*Min. Pass Percentage in (CIE+SEE)
Theory	40	60	35	40
Laboratory / Practicals	50	50	35	40
Mini-Project	0	100	40	40
Project Work	50	50	35	40

*A relaxation of 4 marks shall be given to physically challenged students in SEE or (CIE+ SEE).

2 Theory Courses:

Continuous Internal Evaluation (CIE):

The CIE for Theory Courses has the following three components, comprising of 40 marks:

a) Midterm examination:

There shall be two midterm examinations of 20 marks each. The average of the two examinations shall be taken as the marks secured by each candidate. Each midterm examination shall be conducted for the duration of 90 minutes and the question paper consists of Part-A (Short Answers) for 5 marks and Part-B (Long Answers) for 15 marks. Part-B shall contain 5 questions of which a student have to answer 3 questions; each question carries 5 marks.

The First midterm examination shall be conducted for 2.5 units of syllabus at the end of 8 weeks of instruction and Second midterm examination shall be conducted for remaining 2.5

units at the end of 16 weeks of instruction.

In case any student has missed one of the two examinations, or wants to improve in one of the examinations, an optional third midterm examination will be conducted. This optional third midterm examination will be conducted during the preparation cum external practical examinations period subject to the following conditions:

i. Interested students have to register for the third mid examination by paying the prescribed registration fee.

ii. Third midterm examination covers entire semester syllabus carrying 20 marks

b) Quizzes:

There shall be a total of five quizzes of 10 marks each. The quiz is to be conducted at the end of each of the five units of instruction. The average of the five quizzes shall be taken as the final marks secured by each candidate.

c) Assignment / Seminars / Projects / Group Activities:

The faculty will evaluate the students for 10 marks by conducting any of the following in two phases covering at least two units in each phase : Assignments / Seminars / Projects / Group Activities. This should be completed before the conduct of the second midterm examination.

Semester End Examinations (SEE):

a) The semester end examination will be conducted for 60 marks. The question paper will consist of two parts viz., i) Part-A for 20 marks, ii) Part –B for 40marks.

b) Part-A is compulsory, which consists of ten questions (numbered from 1 to 10), two questions from each unit carrying 2 marks each.

c) Part-B consists of five questions (numbered from 11 to 15), each question drawn from a separate unit of the syllabus and having an "either" "or" choice (that means there will be two questions from each unit and the student shall have to answer any one of them).

3. Practical Courses

For practicals, there shall be CIE during a semester for 50 marks and SEE for 50 marks. Out of the 50 marks for CIE the breakup shall be as follows:

a. Throughout the semester the student will be evaluated as follows:

i. Preparation for Lab – 10 marks

ii. Observation – 10 marks

iii. Completion of Experiment – 5 marks

iv. Record – 5 marks

b. Before the end of instruction a Skill Test will be conducted for 20 marks

The practical semester end examination shall be conducted with an internal / external examiner along with the lab faculty. The examiner shall be appointed by the Dean of the concerned school.

4 Mini-Project

The Mini project shall be submitted in report-form and should be presented before the committee, which shall be evaluated as SEE for 100 marks. The committee consists of Head of the Department, Supervisor and a senior faculty member. There shall be no CIE marks for Mini-project.

5 Project Work

Out of a total of 100 marks for the project work, 50 marks shall be for CIE and 50 marks for the SEE. The CIE shall be based on two seminars given by each student on the topic of his/her project. The SEE (viva-voce) shall be conducted by a committee consisting of (i) External examiner appointed by Dean (Examinations) on the recommendation of Chairperson, BoS, (ii) Head of the department, (iii) Supervisor of the project and (iv) a Senior faculty member of the department. The evaluation of project work shall be conducted at the end of the III Year II Semester.

5.1 If there is a complaint in awarding the CIE marks, the University shall nominate a committee to look into the matter.

5.2 Candidates shall be permitted to apply for recounting / revaluation of SEE theory scripts within the stipulated period with a payment of prescribed fee.

5.3 Recounting: The totaling of the marks awarded shall be verified in the answer script and corrected if there is any mistake.

5.4 Revaluation

a) The answer scripts of the candidate who applied for revaluation are evaluated by two subject experts independently other than the original evaluator.

b) If the difference of marks between these two valuations is 15% or more, it will be sent for third valuation to another subject expert.

c) Nearest of two valuations out of three in the descending order, will be considered and the average of these two will be taken as the final marks obtained.

d) If the difference of the final marks after revaluation is 15% or more of original marks, then the revaluation marks are considered for declaring the result.

e) If the revaluation marks are less than the original marks, the original marks are retained and there is no change in the result.

5.5 Challenge Valuation:

The candidates who have applied for revaluation and are not satisfied with the result are only eligible to apply for challenge valuation by paying the prescribed fee in the form of DD payable to the Registrar, AU.

a) On receipt of the DD, a photocopy of the answer booklet shall be given to the student.

b) The paper will be evaluated in the presence of the student by a senior faculty member appointed by the University.

c) If there is any change in the marks >= 15% of the maximum marks, the new marks will be awarded to the student. Otherwise, there will be no change in original secured marks.

d) If the change in marks (equal or above 15% of the maximum marks) occur, the amount paid towards challenge valuation will be refunded. Otherwise, the student will forfeit the total amount which he/she has paid.

6 Attendance Requirements

6.1 A student is eligible to write the Semester end examinations only if he/ she acquire a minimum of 75% attendance in aggregate of all courses.

6.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted on medical grounds after submission of required certificate from a medical doctor as approved by the Academic Council.

6.3 A stipulated fee shall be payable towards condonation of shortage of attendance.

6.4 Shortage of attendance below 65% in aggregate shall not be condoned.

6.5 However, in respect of women candidates who seek condonation of attendance due to pregnancy, the Vice-Chancellor may condone the deficiency in attendance to the extent of 15% (as against 10% condonation for others) on medical grounds subject to submission of medical certificate to this effect. Such condonation shall not be availed twice during the program of study.

6.6 Students whose shortage of attendance is not condoned are not eligible to write semester end examinations of that semester. Such students are detained and their registration for examination stands cancelled.

6.7 A student detained due to shortage of attendance in a semester may seek re- admission into that semester, as and when offered, within four weeks from the date of commencement of class work with the academic regulations of the batch into which he/she gets re-admitted.

6.8 A student will be promoted to the next semester if he/she satisfies the attendance requirement of the present semester and shall not be eligible for readmission into the same semester.

6.9 For all mandatory, non-credit courses offered in a semester, a student shall be declared successful or 'passed', if he/she secures >=75% attendance in such a course. A 'satisfactory participation certificate' for that mandatory course will be issued and no marks or letter grade shall be allotted.

6.10 Attendance of N.S.S / N.C.C Camps or Inter collegiate or Inter University or Inter State or International matches or debates or such other Inter University activities as approved by the authorities, will be taken into consideration while calculating the attendance.

(i) Such leave should be availed with prior permission and not be availed more than twice during the program of study.

(ii) Without any prior permission, such leave shall be treated as absence.

(iii) While calculating the attendance, the no. of classes not attended in each course should be deleted in the denominator.

7 Promotion Rules:

The Rules of promotion are as follows:

Promotion	**From I Yr. to II Yr.**	**From II Yr. to III Yr.**
Condition to be fulfilled	50% of the total credits up to I Yr. II Sem.	60% of the total credits up to II Yr. I Sem.

7.1 A student shall register and put up required attendance in all courses and earn all the credits for the award of degree.

7.2 When a student is detained due to shortage of attendance in any semester, no grade allotments or SGPA/CGPA calculations will be given for that entire semester in which he/she is detained.

7.3 When a student is detained due to lack of credits in any year, he may be readmitted after fulfillment of the academic requirements, with the academic regulations of the batch into which he/she gets readmitted.

7.4 For readmitted candidates, if there are any professional electives / open electives, the same may also be re-registered if offered. However, if those electives are not offered in later semesters, then alternate electives may be chosen from the set of elective courses offered under that category.

8. Supplementary Examinations

9.1 A student who is eligible to appear for the semester end examinations in a course, but is absent / failed in that examination, may write the exam in that course during supplementary examinations. In such cases, CIE assessed earlier for that course will be carried over and added to the marks to be obtained in the supplementary examinations for evaluating his/her performance in that course.

9.2 Supplementary examination(s) in the failed courses shall be conducted as per schedule given by the University. If the concerned course is not available in the new regulation, the student shall have to appear for the examinations with the syllabus of equivalent course(s) prevailing for the regular students in that academic year. The equivalent course will be established by the concerned Head / Chairperson, BoS. However, if no such similar course is offered in the current regulation, the supplementary examination(s) shall be conducted with the same syllabus which is studied during regular course of study with extra fee as specified by the University from time to time.

10 Grade Points

10.1 Marks will be awarded to indicate the performance of each student in each theory courses or lab / practical / seminar / project / mini-project etc., based on the percentage of marks obtained in both CIE and SEE taken together along with a letter grade.

10.2 A 10 point absolute grading system using the following letter grades and corresponding percentage of marks shall be followed as given below:

Letter Grade		Grade Points	% of Marks Secured (M) (Class Intervals)
O	Outstanding	10	$M \geq 90$

A+	Excellent	9	80≤ M <90
A	Very Good	8	70≤ M <80
B+	Good	7	60≤ M <70
B	Average	6	50≤ M <60
C	Pass	5	40≤ M <50
F	Fail	0	M < 40
Ab	Absent	0	--

10.3 A student obtaining 'F' grade in any subject shall be considered as 'failed' and will be required to reappear as 'supplementary candidate' in the SEE, as and when conducted. In such cases, CIE in those subject(s) will remain same as those the student obtained earlier.

10.4 A letter grade does not imply any specific percentage of marks.

10.5 In general, a student shall not be permitted to repeat any course(s) only for the sake of 'grade improvement' or 'SGPA/CGPA improvement'.

10.6 A student earns grade point (GP) in each course, on the basis of the letter grade obtained by him in that course (excluding mandatory non-credit courses). Then the corresponding 'credit points' (CP) are computed by multiplying the grade point with credits for that particular course.

Credit Points (CP) = Grade Point (GP) x Credits (for a course)

10.7 After successful completion of the course only, the students get GP ≥ 5 ('C' grade or above).

10.8 SGPA/CGPA at the end of each semester shall be awarded only if he/she has passed all the courses up to the end of that semester.

12 Passing Standards

12.1 A student shall be declared successful or 'passed' in a Semester, only when he/she gets a SGPA ≥ 5.00 (at the end of that particular Semester); and a student shall be declared successful or 'passed' in the entire UG Program, only when he/she gets a CGPA ≥ 5.00;subject to the condition that he secures a GP ≥ 5 (C Grade or above) in every registered course in each semester.

12.2 A student shall be declared successful or 'passed' in any non-credit course, if he/she secures a 'satisfactory participation certificate' for that mandatory course.

12.3 After the completion of each semester, a grade card or grade sheet (or transcript) shall be issued to all the registered students of that semester, indicating the letter grades and credits earned. It will show the details of the courses registered (course code, title, no. of credits etc.), grade earned, credits earned, SGPA and CGPA.

13 Vertical Progression

It shall also be necessary to lay down uniform minimum standards for SGPA and CGPA together with the minimum number of credits to be earned in a semester for the vertical progression of students. This shall be used in facilitating the mobility of students from one institute to another and also in avoiding any confusion among the students. At the end of each semester the minimum standard for SGPA = 5.0 and CGPA=5.0. However, failure to secure a minimum CGPA = 5.0 at the end of any semester for the first time, shall attract a warning before approval to continue in the following semester.

14 Eligibility for Award of B.Sc / B.Sc (Honors) / B.Com / B.Com (Honors) / BA / BA (Honors) / BBA:

A student shall be eligible for award of the B.Sc / B.Sc (Honors) / B.Com / B.Com (Honors) / BA / BA (Honors) / BBA degree if he / she fulfill all the following conditions:

14.1 He / she should have registered and successfully completed all the components prescribed in the program of study to which he / she is admitted by securing all the credits.

14.2 He / she have obtained CGPA greater than or equal to 5.0 (minimum requirements for pass)

14.3 He / she has no dues to the Institute, Hostels, Libraries, NCC/NSS etc.

14.4 No disciplinary action is pending against him/her.

14.5 Those who fail to fulfill the above academic requirements, shall forfeit their admission.

15 Award of Class

15.1 A student who registers for all the specified courses as listed in the program and secures the required number of credits (with CGPA ≥ 5.0), within five academic years from the date of commencement of the first academic year, shall be declared to have 'qualified' for the award of the degree.

15.2 A student who qualifies for the award of the degree as listed in item 15.1 shall be placed in the following classes:

CGPA	Class	Condition
CGPA ≥ 8.00	First Class with Distinction	• Should have passed all the courses in ‘first appearance’ in a semester examination and should complete the program in 4 years of time. • Should not have been detained or prevented from writing the semester end examinations in any semester due to shortage of attendance or any other reason.
6.50 ≤ CGPA < 8.00	First Class	• The Students who secure CGPA ≥ 8.00, but not fulfilling the conditions for “First Class with Distinction” shall be awarded ‘First Class’ only.
5.50 ≤ CGPA < 6.50	Second Class	
5.0 ≤ CGPA < 5.50	Pass Class	

15.3 The CGPA can be converted to equivalent percentage of marks by using the following formula:

Percentage (%) of marks = (CGPA - 0.5) X 10

16 Withholding of Results

If the student has not paid the dues, if any, to the University or if any case of disciplinary action is pending against him/her, the result will be withheld, and he/she will not be allowed into the next semester. In such cases the matter will be referred to the Academic Council for final decision.

17 Transitory Regulations

17.1 Discontinued, detained, or failed candidates are eligible for readmission as and when next offered as per the university admission procedure.

17.2 Students on transfer shall complete the prescribed courses of the concerned program not covered earlier should take the remaining program along with others.

17.3 There shall be no branch transfers after the cutoff date of admissions.

18 Transcripts

After successful completion of the total program of study, a transcript containing performance of all academic years/semesters will be issued as a final record. Duplicate transcripts will also be issued if required after the payment of requisite fee.

19 Convocation

19.1 The University shall conduct convocation ceremony to confer the degree(s).

19.2 The University shall institute Prizes and Awards to meritorious students during convocation.

20 Termination from the program

The admission of a student to the program may be terminated in the following circumstances:

20.1 The student fails to satisfy the requirements of the program within the maximum period stipulated for that program.

20.2 The student fails to satisfy the norms of discipline specified by the university from time to time.

21 Amendments

The regulations hereunder are subject to amendments as may be made by Academic Council from time to time. Any or all such amendments will be effective from such date and to such batches of candidates (including those already undergoing the program).

Item 12

Any other matter with the permission of the Chair