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**Course Structure of**

**M.Tech**

**Computer Science and Engineering**

**M.Tech(CSE)**

**Department of Computer Science and Engineering**

**ANURAG UNIVERSITY**

Hyderabad, Medchal (Dist),

Telangana– 500 088

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**ANURAG UNIVERSITY**

**School of Engineering**

**DEPARTMENT of COMPUTER SCIENCE & ENGINEERING (CSE)**

**COURSE STRUCTUREof M.Tech(CSE)**

**R21 REGULATIONS**

**M.TECH (CSE) I YEAR I SEM (1st Semester)6T+ 2L+1 Audit Course**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sno** | **Course Code** | **Course title** | **L** | **T** | **P** | **Credits** |
| 1 | A310201 | Advanced Data structures | 3 | 0 | 0 | 3 |
| 2 | A310202 | Python Programming | 3 | 0 | 0 | 3 |
| 3 | A310203  A310204  A310205  A310206 | 1.Information Security  2. Artificial Intelligence  3. Computer Networks  4. Digital Image Processing | 3 | 1 | 0 | 4 |
| 4 | A310207  A310208  A310209  A310210 | 1Web Technologies  2.Data Mining  3.Operating Systems  4. Cloud Computing | 3 | 0 | 0 | 3 |
| 5 | A310211  A310212  A310213  A310214 | 1.Cyber Security  2. Software Engineering  3.Object Oriented Programming (Java)  4.Machine Learning | 3 | 0 | 0 | 3 |
| 6 | A3100001 | Research Methodology | 2 | 0 | 0 | 2 |
| 7 | A310221 | Advanced Data structures Lab | 0 | 0 | 3 | 1.5 |
| 8 | A310222 | Python Programming Lab | 0 | 0 | 3 | 1.5 |
| 9 |  | Audit Course | 2 | 0 | 0 | 0 |
|  |  | **Total** | **19** | **0** | **6** | **21** |

**M.Tech (CSE) I YEAR II SEM (2nd Semester)5T+ 1L+ 1 seminar**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sno** | **Category** | **Course title** | **L** | **T** | **P** | **credits** |
| 1 | A320201 | Big Data Analytics | 3 | 1 | 0 | 4 |
| 2 | A320202 | Data science | 3 | 1 | 0 | 4 |
| 3 | A320203  A320204  A320205  A320206 | 1.Block Chain Technology  2.Advanced Data Base Management Systems  3. Principles of Internet of Things  4. Deep Learning | 3 | 0 | 0 | 3 |
| 4 | A320207  A320208  A320209  A320210 | 1. Natural Language Processing 2. Predictive Analytics with R 3. Mobile Applications & Development 4. Human Computer Interaction | 3 | 0 | 0 | 3 |
| 5 | A320211  A320212  A320213  A320214 | 1. English for Professionals 2. Entrepreneurship Development 3. Technical and Business Communication Skills 4. Project Management | 3 | 0 | 0 | 3 |
| 6 | A320221 | Data Science Lab | 0 | 0 | 4 | 2 |
| 7 |  | Seminar | 0 | 0 | 4 | 2 |
|  |  | **Total** | **15** | **2** | **8** | **21** |

**M.Tech (CSE) II YEAR I SEM(3rd Semester)Project Phase I**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sno | Category | Course title | L | T | P | Credits |
| 1 |  | Project Review I | 0 | 0 | 24 | 12 |
|  |  | **Total** | **0** | **0** | **24** | **12** |

**M.Tech (CSE) II YEAR II SEM (4th Semester)Project Phase II**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sno | Category | Course title | L | T | P | Credits |
| 1 |  | Project Review II | 0 | 0 | 28 | 14 |
|  |  | **Total** | **0** | **0** | **28** | **14** |

**ANURAG UNIVERSITY**

**SCHOOL OF ENGINEERING**

**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)**

**M.Tech (CSE)**

**R21 REGULATIONS**

**M .TECH(CSE) I YEAR I SEM**

**I Year M.Tech(CSE)- I Sem**  **L T / P / D C**

**3 0 3**

**ADVANCED DATA STRUCTURES**

**(PCC)**

**Prerequisites:**Data Structures and Java Programming.

**Course Objectives:**

1. Understand various static and dynamic representations of data structures.
2. Know the basic concepts of Hashing.
3. To introduce various techniques for representation of the data in the real world.
4. To be familiar with Graph representations and traversals.
5. Compute the complexity of various algorithms

**Course Outcomes:**

1. Design and implement the mechanism of stacks, general tree data structures with their

applications.

1. Outline the concepts of hashing, collision and its resolution methods using hash Function.
2. Implement various algorithms on graph data structures.
3. Implementation of various advance concepts of binary trees  with real time applications.
4. Determine and analyse the complexity of given Algorithms

**UNIT I:**

Algorithms, Performance analysis- time complexity and space complexity, Asymptotic Notation-Big Oh, Omega and Theta notations, Complexity Analysis Examples. Data structures-Linear and non-linear data structures, ADT concept, Linear List ADT, Array representation, Linked representation, Vector representation, singly linked lists -insertion, deletion, search operations, doubly linked lists-insertion, deletion operations, circular lists. Representation of single, two dimensional arrays.

**UNIT II:**

Stack and Queue ADTs, array and linked list representations, infix to postfix conversion using stack, implementation of recursion, Circular queue-insertion and deletion, array and linked list representations , implementation using Heaps, Insertion into a Max Heap, Deletion from a Max Heap, java.util package-ArrayList, LinkedList, Vector classes, Stacks and Queues in java.util, Iterators in java.util.

**UNIT III:**

Searching–Linear and binary search methods, Hashing-Hash functions, Collision Resolution methods-Open Addressing, Chaining, Hashing in java.util-HashMap, HashSet, Hashtable.

Sorting –Bubble sort, Insertion sort, Quick sort, Merge sort, Heap sort, Radix sort, comparison of sorting methods.

**UNIT IV:**

Trees- Ordinary and Binary trees terminology, Properties of Binary trees, Binary tree ADT, representations, recursive and non recursive traversals, Java code for traversals, threaded binary trees.

Graphs- Graphs terminology, Graph ADT, representations, graph traversals/search methods-DFS and BFS, Java code for graph traversals, Applications of Graphs-Minimum cost spanning tree using Kruskal’s algorithm, Dijkstra’s algorithm for Single Source Shortest Path Problem.

**UNIT V:**

Search trees- Binary search tree-Binary search tree ADT ,insertion, deletion and searching operations, Balanced search trees, AVL trees-Definition and examples only, Red Black trees – Definition and examples only, B-Trees-definition, insertion and searching operations, Trees in java.util-TreeSet, TreeMap Classes, Tries(examples only ), Pattern matching-KMP algorithm.

**TEXT BOOKS:**

1.Data structures, Algorithms and Applications in Java, S.Sahni, Universities Press.

2.Data structures and Algorithms in Java, Adam Drozdek, 3rd edition, Cengage learning.

3 Data structures and Algorithm Analysis in Java, M. A. Weiss, 2nd edition, Addison-Wesley (Pearson Education).

**REFERENCE BOOKS:**

1.Java for Programmers, Deitel and Deitel, Pearson education.

2Data structures and Algorithms in Java, R.Lafore, Pearson education.

3java: The Complete Reference, 8th edition, Herbert Schildt, TMH.

4Data structures and Algorithms in Java, M. T. Goodrich, R. Tomassia, 3rd edition, Wiley India Edition

5.Data structures and the Java Collection Frame work, W. J. Collins, Mc Graw Hill.

6.Classic Data structures in Java, T.Budd, Addison-Wesley (Pearson Education).

7. www.tutorialspoint.com/[Data Structures Algorithms](https://www.tutorialspoint.com/data_structures_algorithms/stack_algorithm.htm)

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

**PYTHON PROGRAMMING**

**(PCC)**

**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, . . . )

1. understand the difference between expressions and Statements.
2. utilize high-level data types such as lists and dictionaries, understand the difference between mutable and immutable types.
3. write a simple class and access methods and attributes,
4. 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 builtin functions, modules, 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.

1. 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&#39;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&#39;Relly

3. Python Programming using problem solving approach, Reema Thareja, Oxford Higher

Education.

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**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 1 4

**INFORMATION SECURITY**

**(PEC-I)**

**Course Objectives:**

1. Describe the encryption and decryption Algorithms
2. Illustrate basics of application of cryptography which are one of the key technologies to implement security functions.
3. Describe the importance of security in the real world through Applications
4. Interpret various types of Intruders and Viruses.
5. Explore Various network security applications, IPSec, Firewall, IDS, Web security, Email security, and Malicious software etc.

**Course Outcomes:**

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/

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 1 4

**ARTIFICIAL INTELLIGENCE**

**(PEC-I)**

**Pre-requisite:** Programming Knowledge, Computer Organization

I Year B.Tech. AI - I Sem L T / P / D C   3 0 3

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**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 versusWeak AI, Heuristics, Identifying Problems Suitable for AI, Applications and Methods, EarlyHistoryofAI, Recent HistoryofAIto thePresent, AIIn 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 BlindSearch Algorithms **Informed Search:** Introduction, Heuristics, Informed Search Algorithms–Finding Any Solution, The Best-First Search, The Beam Search,Additional Metrics for SearchAlgorithms,Informed Search–FindingAn OptimalSolution,

**UNIT III: Search Using Games:** Introduction,Game Trees and Minimax Evaluation, MinimaxWith Alpha-Beta Pruning, Variations and Improvements To Minimax, Games of Chance and theExpectiminimaxAlgorithm

**UNITIV:LogicinArtificialIntelligence:**Introduction,LogicandRepresentation,PropositionalLogic, Predicate Logic – Introduction, Several Other Logics, Uncertainty and Probability**Knowledge Representation:** Introduction, Graphical Sketches and the Human Window,GraphsandtheBridgesofKönigsbergProblem,SearchTrees,RepresentationalChoices,ProductionSystems,Object Orientation, Frames,SemanticNetworks

**UNIT V: Production Systems:** Introduction, Background, Production Systems and InferenceMethods,Production Systems and Cellular Automata, Stochastic Processes and Markov Chains,BasicFeatures and Examples of Expert Systems

# Text Books:

1. StephenLucci,DannyKopec.ArtificialIntelligenceinthe21stCentury.ALivingIntroduction.MercuryLearningandInformation.2ndEdition.2016

# Reference Books:

1. Russell,Norvig:ArtificialIntelligence,AModernApproach,PearsonEducation,SecondEdition. 2004
2. Rich,Knight,Nair:ArtificialIntelligence,TataMcGrawHill,ThirdEdition2009
3. SarojKaushik.ArtificialIntelligence.CengageLearning.2011

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 1 4

**COMPUTER NETWORKS**

**(PEC-I)**

**Prerequisites:** C Programming Language and Data Structures.

Course Objectives:

1.Elaborate on the fundamental concepts of computer networks and network models.

2.Know about the error and flow control mechanisms in the data link layer.

3.Explore the knowledge of various routing algorithms.

4.Describe the transport layer functionalities.

5.Illustrate different application layer functionalities.

**Course Outcomes:**

1. Illustrate the functionalities of various network models and Data link Layer.

2.  Analyze error and flow control mechanisms in the data link layer

   3. Examine various Routing Protocols.

   4. Compare various congestion control mechanisms to improve the QoS of networking.

   5.Identify the suitable Application layer protocols for specific applications.

**UNIT - I:**

**Network Models**: Layered Tasks, OSI model, Layers in the OSI model, TCP/IP protocol Suite, Addressing.

**Data Link Control**: Error detection and Correction- Introduction, Hamming Distance, CRC, Checksum.

**UNIT - II:**

**Data Link Layer**:  Framing, Flow and Error Control, Noiseless Channels, Noisy Channels, HDLC.

**Multiple Access**: Random Access, Controlled Access, Channelization.

**UNIT- III:**

**Network Layer:** IPV4, IPV6, Transition from IPv4 to IPv6,Delivery, Forwarding and Routing, **Routing protocols:** Distance Vector Routing, Link State Routing, Path Vector Routing

**UNIT- IV:**

**Transport Layer:** Process-to-Process delivery, TCP, UDP, Congestion Control, Quality of Service, Techniques to improve QoS.

**UNIT-V:**

**Application Layer:** Domain Name Space, Distribution of Name Space, DNS in Internet, Resolution, Domain Name Space (DNS) Messages, Electronic mail, File Transfer Protocol.

**Text Books:**

1) Behrouz A Forouzan ,Data Communications and Networking,4th  Edition, McGraw-Hill.

**Reference Books:**

1) Andrew S. Tanenbaum, Computer Networks, Third Edition.

2) William Stallings, Data Communications, Eight Edition. Pearson Publishers.

3) <http://highered.mheducation.com/sites/0072967757/student_view0/index.html>

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 1 4

**DIGITAL IMAGE PROCESSING**

**(PEC-I)**

**Prerequisites:Mathematics**

**Course Objectives:**

1. Comprehend fundamental aspects of digital image processing
2. Understand the image noise models and enhancement methods
3. Evaluate the image segmentation methodologies
4. Understand the colour image processing techniques
5. Understand image morphological operations

**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-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**

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.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

**WEB TECHNOLOGIES**

**(PEC-II)**

**Pre-requisites:** Basics of Object Oriented programming, Java

**Course Objectives:**

1. To provide knowledge on web architecture, web services.
2. Client side scripting technologies to focus on the development of web-based information systems and web services.
3. To provide skills to design interactive and dynamic web sites.
4. To provide knowledge for implementing web applications with database connection

**Course Outcomes:**

Studentwill be able to:

1. Design static web pages and provide client side authentication.(L6)
2. Prepare Static Web pages With Validations.(L6)
3. Develop new tag sets using XML mechanism.(L5)
4. Design and develop web applications using JSP and MVC architecture.(L6)
5. Understand database connectivity and retrieving data using client/server database.(L2)

**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, 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.

**ANURAG UNIVERSITY**

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**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

**DATA MINING**

**(PEC-II)**

**Prerequisites:** Basic Statistics Knowledge, Data Structures& Algorithms and Database management system

**Course Objectives:**

1. To gain a foundational understanding of data mining and preprocessing techniques.
2. To understand the frequent patterns and association mining.
3. To understand and use of basic classification and prediction algorithms for real world problems.
4. To understand and use of clustering algorithms for real world problems.
5. To consistently apply knowledge concerning current data mining research and how this may contribute to the effective design and implementation of data mining applications.

**Course Outcomes:**

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

1. Describe what Data Mining is and apply preprocessing techniques in different datasets.
2. Apply Association and classification knowledge to different data sets
3. Apply basic classification & predictive algorithms in real world problems
4. Apply the clustering Techniques for different data sets
5. Explore recent trends in data mining such as web mining, spatial-temporal mining

**UNIT I:**

**Introductionto Data Mining**: Fundamentals of data mining, Data Mining Functionalities,  
Data Mining Task Primitives, Major issues in Data Mining. **Data Preprocessing**: Needs for Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction.

**UNIT II:**

**Mining Frequent Patterns, Associations, and Correlations:** Basic Concepts, Efficient and Scalable Frequent Itemset Mining Methods, Mining Various Kinds of Association Rules, From Association Mining to Correlation Analysis, Constraint-Based Association Mining.

**UNIT III:**

**Classification and Prediction:** Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Rule-Based Classification, Support Vector Machines, kNN. **Prediction:** Regressions, Accuracy and Error Measures, Evaluating the Accuracy of a Classifier or Predictor, Ensemble Methods—Increasing the Accuracy, Model Selection.

**UNIT IV:**

**Cluster Analysis**: Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning Methods-K-means, PAM, Hierarchical Methods-BIRCH, Density-Based Methods-DBSCAN, Outlier Detection.

**UNIT V:**

**Applications and Trends in Data Mining:** Data Mining Applications, Data Mining System Products and Research Prototypes, Data Mining System Products and Research Prototypes, Trends in Data Mining (web mining, spatial-temporal mining).

**Text Book:**

1.Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Second Edition, Elsevier, 2007.

**Reference Books:**

1. Alex Berson and Stephen J. Smith, Data Warehousing, Data Mining & OLAP, Tata McGraw Hill, Tenth Reprint, 2007.
2. Arun K. Pujari, Data Mining Techniques,2nd Edition, Universities press.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

**OPERATING SYSTEMS**

**(PEC-II)**

**Prerequisites :** Computer Organization, Data Structures

**Course Objectives:**

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 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, 3rd Edition, PHI, 2008.

3. Behrouz A. Forouzan, Richard F. Gilberg, Unix and shell programming, cengage

Learning 2009.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

**CLOUD COMPUTING**

**(PEC-II)**

**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.
4. To understand various services in cloud applications
5. 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:

1. Compare and contrast various cloud architectures. (L4)
2. Learn & Implement Virtualization .(L3)
3. Analyze and design storage mechanisms. (L4)
4. Apply security mechanism for the Cloud.(L3)
5. 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:**

1. [Ivanka Menken](http://www.amazon.com/Ivanka-Menken/e/B002BOBZ8Y/ref=ntt_athr_dp_pel_1)Ivanka Menken (Author)
2. ›[Visit Amazon's Ivanka Menken Page](http://www.amazon.com/Ivanka-Menken/e/B002BOBZ8Y/ref=ntt_athr_dp_pel_pop_1)
3. Find all the books, read about the author, and more.
4. See [search results](http://www.amazon.com/s/ref=ntt_athr_dp_sr_pop_1?_encoding=UTF8&sort=relevancerank&search-alias=books&field-author=Ivanka%20Menken) for this author
5. Are you an author? [Learn about Author Central](http://authorcentral.amazon.com/gp/landing/ref=ntt_atc_dp_pel_1)
6. , Gerard Blokdijk ,Cloud Computing Virtualization Specialist Complete Certification Kit - Study Guide Book, 2009.Gerard Blokdijk (Author)›[Visit Amazon's Gerard Blokdijk Page](http://www.amazon.com/Gerard-Blokdijk/e/B002BLL870/ref=ntt_athr_dp_pel_pop_2)Find all the books, read about the author, and more.See [search results](http://www.amazon.com/s/ref=ntt_athr_dp_sr_pop_2?_encoding=UTF8&sort=relevancerank&search-alias=books&field-author=Gerard%20Blokdijk) for this author Are you an author? [Learn about Author Central](http://authorcentral.amazon.com/gp/landing/ref=ntt_atc_dp_pel_2)
7. 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

### Tom Clark, Storage Virtualization: Technologies for Simplifying Data Storage and Management, Addison-Wesley, 2005

### 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

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

### CYBERSECURITY

### (PEC-III)

**Course Objectives:**

1. Analyze the importance of cyber Security and discuss major issues concerning cyber security

2. Identify different cyber security vulnerabilities

3. Apply tools for cyber security safeguard

4. Interpret various malwares and implement different tools

5. Discuss the importance of cyber forensics.

**Course Outcomes:**

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

1. Analyze the role of cyber security and its challenges
2. Summarize various security vulnerabilities in Internet
3. Identify different tools to safeguard the network
4. Discuss various malwares and tools to analyze them
5. Interpret the role of cyber forensics in cyber secuirty

**UNIT I**

**Foundations of Cyber Security Concepts:**Essential Terminologies, CIA, Risks, Breaches, Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning).Open Source/ Free/ Trial Tools: nmap, zenmap, PortScanners, Network scanners.

**UNIT II**

**Cyber Security Vulnerabilities:**Internet Security, Cloud Computing &Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness.

**UNIT III**

**Cyber Security Safeguards**- Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment.Open Source/ Free/ Trial Tools: WinAudit, Zap proxy (OWASP), burp suite, DVWA kit .

**UNIT IV**

**Malware Analysis:** Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware’s,Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management,Task Management, Windows Registry/ services another configuration), Malware Analysis. Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, Anti Phishing.

**UNIT V**

**Introduction to Cyber Forensics**, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of Crime Sense, Image Capturing and its importance, Partial Volume Image, Web Attack

Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations.

**Text Books:**

1. Gupta Sarika, “Information and Cyber Security”, Khanna Publishing House, Delhi.

2. Atul Kahate, “Cryptography and Network Security”, McGraw Hill.

**Reference Books:**

1. William Stallings, “Cryptography and Network Security”, Pearson Education/PHI, 2006.

2. V.K. Jain, “Cryptography and Network Security”, Khanna Publishing House.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

**SOFTWARE ENGINEERING**

### (PEC-III)

**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:**

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

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.

**Reference Links:**

1.<https://nptel.ac.in/courses/106/105/106105182/>

2.<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>

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

**OBJECT ORIENTED PROGRAMMING (JAVA)**

### (PEC-III)

**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

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

3 0 3

### MACHINE LEARNING

### (PEC-III)

**Course Objectives:**

1. To understand the need for machine learning for various problem solving
2. To study the various supervised  and unsupervised learning algorithms in machine learning
3. To understand the latest trends in machine learning
4. To design appropriate machine learning algorithms for problem solving

**Course Outcomes**:

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

1. Describes Fundamental concepts of machine learning and its applications, and the setup for the practical knowledge (L2)
2. Analyzing Supervised Learning Methods to achieve the accuracy on the training data.(L4)
3. Apply  Unsupervised Learning algorithms  to various grouping problems(L3)
4. Usage of Ensemble learning  for better prediction. (L5)
5. Analyze the problem of unwanted increase in dimension to fixate granularity in Data.(L4)

**UNIT I:**

**Introduction to Machine Learning:**What is Machine Learning, Why Machine Learning, Types of Machine Learning Systems, Challenges of Machine Learning Why Python, Essential libraries and Tools, A first Application –Classifying Iris Species.

**UNIT II:**

**Supervised Learning :**Classification and Regression, Generalization over fitting and under fitting, Supervised Machine  Learning Algorithms, Sample Datasets, k-Nearest Neighbors, Linear Models, Naive Bayes Classifiers, Decision Trees, Kernelized Support Vector Machines, Uncertainty Estimates from Classifiers

**UNIT III:**

**Unsupervised Learning and Preprocessing:**Types of Unsupervised Learning, Challenges in Unsupervised Learning, Preprocessing and Scaling, clustering, k-Means Clustering, Agglomerative Clustering, Comparing and evaluating the clustering algorithms.

**UNIT IV:**

**Ensemble Learning and Random forest**:Voting Classifiers, Bagging and pasting, Random Patches and Random subspaces, Random Forest, Boosting-Ada Boost and Gradient Boost

**UNIT V:**

**Dimensionality Reduction:**The curse of Dimensionality, main approaches to Dimensionality r reduction, PCA, Kernel PCA

**Reinforcement Learning -** Learning to Optimize Rewards, Introduction to OpenAI Gym, Markov Decision Processes

**Text Books:**

### Introduction to Machine Learning with Python by Andreas C. Müller, Sarah GuidoOctober 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)

**M.Tech (CSE)**

**I Year M.Tech (CSE) I Sem**  L T / P / D C

2 0 2

**RESEARCH METHODOLOGY**

**(PCC)**

**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

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**  L T / P / D C

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**ADVANCED DATA STRUCTURES LAB**

**(PCC LAB)**

1. Write Java programs that use both recursive and non-recursive functions for implementing the following searching methods:

a) Linear search b) Binary search

2. Write Java programs to implement the following using arrays and linked lists

* 1. List ADT

3. Write Java programs to implement the following using an array.

a) Stack ADT b) Queue ADT

4. Write a Java program that reads an infix expression and converts the expression to postfix form. (Use stack ADT).

5. Write a Java program to implement circular queue ADT using an array.

6. Write Java programs to implement the following using a singly linked list.

a) Stack ADT b) Queue ADT

7. Write Java programs to implement the deque (double ended queue) ADT using

a) Array b) Singly linked list c) Doubly linked list.

8. Write a Java program to implement priority queue ADT.

9. Write a Java program to perform the following operations:

* + 1. Construct a binary search tree of elements.
    2. Search for a key element in the above binary search tree.
  1. Delete an element from the above binary search tree.

10. Write a Java program to implement all the functions of a dictionary (ADT) using Hashing.

11. Write a Java program to implement Dijkstra’s algorithm for Single source shortest1 path problem.

12. Write Java programs for the implementation of bfs and dfs for a given graph.

13. Write Java programs for implementing the following sorting methods:

a) Bubble sort d) Merge sort g) Binary tree sort

b) Insertion sort e) Heap sort

c) Quick sort f) Radix sort

14. Write a Java program to perform the following operations: a) Insertion into a B-tree b) Searching in a B-tree

15. Write a Java program that implements Kruskal’s algorithm to generate minimum cost spanning tree.

16. Write a Java program that implements KMP algorithm for pattern matching.

**(Note: Use packages like java.io, java.util, etc)**

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**                                             L     T / P /D   C

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**PYTHON PROGRAMMING LAB**

**(PCC 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 onControl 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 overloding

Week-9:

Programs 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

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**                                             L     T / P /D   C

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**ENGLISH FOR RESEARCH PAPER WRITING**

**(Audit Course )**

**Course objectives:**

Students will be able to:

1. Understand that how to improve your writing skills and level ofreadability
2. Learn about what to write in eachsection
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-timesubmission

**UNIT I**

Planning and Preparation, Word Order, Breaking up long sentences, StructuringParagraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

**UNIT II**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising,

Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction. Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

**UNIT III**

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 whenwriting a Review of the Literature.

**UNIT IV**

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 theConclusions

**UNIT V**

Useful phrases, how to ensure paper is as good as it could possibly be the first- timesubmission

**Suggested Studies:**

* 1. Goldbort R (2006) Writing for Science, Yale University Press (available on GoogleBooks)
  2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge UniversityPress
  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 Dordrecht Heidelberg London,2011

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- I Sem**                                           L     T / P /D   C

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**VALUE EDUCATION**

**(Audit Course )**

##### **Course Objectives**

Students will be able to

1. Understand value of education and self-development
2. Imbibe good values instudents
3. Let the should know about the importance ofcharacter

**UNIT I**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision ofhumanism.Moral and non- moral valuation. Standards andprinciples. Valuejudgements

**UNIT II**

Importance of cultivation ofvalues. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness,Cleanliness. Honesty, Humanity. Power of faith, NationalUnity. Patriotism. Love for nature,Discipline

**UNIT III**

Personality and Behaviour Development - Soul and Scientific attitude. Positive Thinking. Integrity anddiscipline. Punctuality, Love andKindness. Avoid faultThinking. Free from anger, Dignity oflabour. Universal brotherhood and religioustolerance. Truefriendship.

**UNIT IV**

Happiness Vs suffering, love fortruth.Aware of self-destructivehabits.Association andCooperation. Doing best for savingnature Character and Competence –Holy books vs Blind faith. Self-management and Goodhealth.

**UNIT-V**

Science of reincarnation. Equality, Nonviolence, Humility, Role ofWomen. All religions and samemessage.Mind your Mind,Self-control.Honesty, Studyingeffectively

***Suggested reading***

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, NewDelhi

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

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**BIG DATA ANALYTICS**

### (PCC)

**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.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 1 4

### DATA SCIENCE

**(PCC)**

**CourseObjectives:**

1. Togainafoundationalunderstandingofdatascience.
2. Tounderstandthedataexplorationanalysis indatascience.
3. Tounderstandandusebasicmachinelearningalgorithmsforpredictivemodeling.
4. TounderstandandusethevariousgraphicsinRandTableaufordatavisualization.
5. Tounderstandtheethicaland privacyissuesindatascience.

## **CourseOutcomes:**

1. DescribewhatDataScienceis and theskillsets neededto beadatascientist.
2. Explainthesignificanceofexploratorydataanalysis(EDA)indatascience.
3. Applybasicmachine learningalgorithmsforpredictivemodeling.
4. Learntopersuadeeffectivevisualizationofgivendata.
5. Reasonaroundethicalandprivacyissuesindatascienceconductandapplyethicalpractices.

## **UNIT I:**

**IntroductionToData Science**: What is Data Science, Big Data and Data Science hype – and getting past the hype,Whynow?–Datafication,Currentlandscapeofperspectives,Skillsetsneeded,StatisticalInference,Populationsandsamples,Statisticalmodeling,probabilitydistributions,fittingamodel,Introductionto R.

## **UNIT II:**

**ExploratoryDataAnalysisAndTheDataScienceProcess:**Basictools(plots,graphsandsummarystatistics)ofEDA,PhilosophyofEDA,TheDataScienceProcess, CaseStudy.

## **UNITIII:**

**BasicMachineLearningAlgorithms:**LinearRegression,k-NearestNeighbors(k-NN),k-means,Motivatingapplication:FilteringSpam, Why Linear Regression and k-NN are poor choices for Filtering Spam, Naive Bayes andwhyitworksfor Filtering Spam.

**UNIT IV:**

**DataVisualization:**Basicprinciples,ideasandtoolsfordatavisualization,Examplesofinspiring(industry)projects,IntroductiontoTableau. Creatingownvisualizationofacomplex dataset.

**UNIT V:**

**DataScienceAndEthicalIssues:**Discussionsonprivacy,security,ethics,AlookbackatDataScience,Next-generationdatascientists.

## **TextBooks:**

1. CathyO’NeilandRachelSchutt.DoingDataScience,Straight TalkFrom The Frontline.O’Reilly.2014.
2. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to KnowaboutDataMining andData-analyticThinking. ISBN 1449361323. 2013.

## **ReferenceBooks:**

1. TrevorHastie,RobertTibshiraniandJerome Friedman.ElementsofStatisticalLearning,SecondEdition. ISBN0387952845. 2009.
2. Jiawei Han, Micheline Kamber and Jian Pei. Data Mining: Concepts and Techniques,ThirdEdition. ISBN0123814790. 2011.
3. ChrisEaton,DirkDeRoos,TomDeutsch,GeorgeLapis,PaulZikopoulos,“Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”,McGrawHillPublishing, 2012.
4. <https://docs.google.com/file/d/0B6iefdnF22XQeVZDSkxjZ0Z5VUE/edit?pli=1>

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

### BLOCK CHAIN TECHNOLOGY

### (PEC-IV)

**Prerequisites:** Object Oriented Programming Through Java, 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:**

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 Books:**

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

**Reference Books**

1. Blockchain Technology:Chandramouli Subramanian,Asha A George,Abhilash K A and Meena Karthikeyan,Published by University Press
2. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos Blockchain by Melanie Swa, O’Reilly
3. Philipp Hacker, Ioannis Lianos (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>

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

**ADVANCED DATABASE MANGEMENT SYSTEMS**

**(PEC-IV)**

**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 DatabaseIntroduction 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)

4. <https://www.pdfdrive.com/fundamentals-of-database-systems-pdf-e51477130.html>

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

**PRINCIPLES OF INTERNET OF THINGS**

### (PEC-IV)

**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:

1. Summarize the concepts of Internet of Things (L2)
2. Interpret Domain specific Internet of Things Applications (L2)
3. Develop programs for interfacing using Raspberry Pi (L6)
4. Design basic IoT applications using Arduino (L6)
5. 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.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

### 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. h[ttp://faculty.neu.edu.cn/yury/AAI/Textbook/Deep%20Learning%20with%20Python.pdf](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

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

**NATURAL LANGUAGE PROCESSING**

**(PEC-V)**

**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

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

### PREDICTIVE ANALYTICS WITH R

**(PEC-V)**

**Prerequisites** : Basics of Statistics, Machine Learning andBasic 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

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 : 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 & Other References**

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

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

**MOBILE APPLICATIONS AND DEVELOPMENT**

**(PEC-V)**

**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**:

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, 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.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

**HUMAN COMPUTER INTERACTION**

**(PEC-V)**

**Prerequisites:Web -Technologies**

**Course Objectives**

1. Identify and formulate characteristics and components of graphical user interface.
2. Analyze various design paradigms for human computer interaction.
3. Design & implement human computer interaction using various design techniques.
4. Support Design rules to use HCI in the software process.

**Course Outcomes:**

**1:** Ability to identify the importance of user interfaces

**2:** Ability to Design interfaces as per the business requirements

**3:** Ability to apply latest technologies in developing interfaces.

**4:** Ability to explain software tools, methods and procedures for interface development

**UNIT - I**

**Introduction** : Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design.

**The graphical user interface** – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface. [T1]

**UNIT – II**

**Design process** – Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions. [T1 & R1]

**UNIT – III**

**Screen Designing** : Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design. [T1 & R1]

**UNIT – IV**

**Windows** – New and Navigation schemes selection of window, selection of devices based and screen based controls.

**Components** – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors. [T1]

**UNIT - V**

**Software tools** – Specification methods, interface – Building Tools.

**Interaction Devices** – Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers. [T2 & R1]

**Text Books:**

1. The essential guide to user interface design, Wilbert O Galitz, Wiley DreamaTech.
2. Designing the user interface. 3rd Edition Ben Shneidermann , Pearson Education Asia.

**References:**

1. Human – Computer Interaction. Alan Dix, Janet Fincay, GreGoryd, Abowd, Russell Bealg, Pearson.
2. Interaction Design Prece, Rogers, Sharps. Wiley Dreamtech,

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

**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 professionalpursuits

**Course Outcomes:**

On successful completion of this course, students will be able to

1. Analyzethe 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:**

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.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

**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.

1. Stuart Read, Effectual Entrepreneurship, Routledge, 2013.
2. Robert Hisrich et al, Entrepreneurship, 6e, TMH, 2012.
3. Nandan H, Fundamentals of Entrepreneurship, PHI, 2013
4. Shejwalkar, Entrepreneurship Development, Everest, 2011
5. Khanka, Entrepreneurship Development, S.Chand, 2012

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

3 0 3

**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.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

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 itsPhases, 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, achievingCross- 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, Typesof 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**

1. Enzo Frigenti, Project Management, Kogan, 2015
2. R. Panneerselvam & P. Senthil Kumar, Project Management, PHI, 2015
3. Thomas M. Cappels, Financially Focused Project Management, SPD, 2008.

**ANURAG UNIVERSITY**

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING (CSE)

**M.Tech(CSE)**

**I Year M.Tech(CSE)- II Sem**  L T / P / D C

0 4 2

**DATA SCIENCE LAB**

**(PCC LAB)**

**Prerequisites:** Basics of Python Programing, Basics of R programming and Statistics and probability

**Course Objectives:**

* To acquire in-depth understanding of the data analysis, machine learning and other advanced data science techniques.
* To empower students with tools and techniques for handling, managing, analyzing and interpreting data.
* To strengthen the analytical and problem solving skill through developing real time applications.
* To gain practical experience in programming tools for data sciences and machine learning.

**Course outcomes**

* Understand data science concepts and various use cases in different industries [ L2 ]
* Apply statistics and probability for data science. [ L3 ]
* Develop R and Python Code for Data Science solutions [L6]
* Create powerful business dashboards with Tableau [L6]

**Programming Languages/Tools:**

* R
* Tableau
* Python

**List of Experiments:**

Week 1: Introduction to Data Science with using Python / Revisiting of Jupiter/Installation of Libraries.

Week 2: Apply accessing and importing and exporting data using Python.

Week 3: Apply data preprocessing: Data manipulation and data cleaning using Python.

Week 4: Apply Machine Learning - Linear regression using Python.

Week 5: Apply Machine Learning - Logistic Regression using Python.

Week 6: Introduction to R tool for data analytics science / Revisiting of Installing R Libraries.

Week 8: Exploratory Data Analysis and apply statistics analysis and visualization using R

Week 9: Apply K-means clustering (supervised Learning) on given datasets using R.

Week 10: Apply K-NN (unsupervised learning) on given datasets using R.

Week 11: Data Visualization using tableau **/** Installation of Tableau / Introduction to Tableau interface.

Week 12: to Week 14: Create and connect to data/Visual analytics/mapping/creating dashboards and stories.