PROGRAM STRUCTURE
AND
DETAILED SYLLABUS

R20 REGULATIONS

M.Tech (MACHINE DESIGN)

FOR
MASTER OF TECHNOLOGY TWO YEAR POST GRADUATE COURSE
(Applicable for the batches admitted from 2020-2021)

ANURAG UNIVERSITY

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Academic Regulations for M.Tech.(Regular) with effect from the Academic Year 2020-21.

1. Eligibility for Admissions

1. Admission to the M.Tech. program shall be made subject to eligibility, qualification and specialization as prescribed by the Anurag University (AU) from time to time.
2. Admissions shall be made on the basis of merit / rank obtained by the candidates at the qualifying Entrance Test conducted by the University or on the basis of any other order of merit as approved by the University, subject to reservations as prescribed by the Telangana State Private Universities Act (Establishment and Regulations) No.11 of2018.

2. Courses of Study

The following specializations are offered for the M.Tech program of study:

1. Computer Science and Engineering
2. Electrical Power Systems
3. Embedded Systems
4. Machine Design
5. Power Electronics and Electrical Drives
6. Structural Engineering
7. VLSI System Design

3. Course Registration

3.1 Every student is required to be present and register online at the commencement of each semester on the day fixed for and notified in the academic calendar. The students will choose the courses for registration in consultation with the Faculty Advisor. The students may also consult the Head of the Department / Dean of the School.

3.2 The registration will be organized departmentally under the supervision of the Head of the Department in coordination with Faculty Advisor.

3.3 A student, who does not register on the day announced, may be permitted to register, in consideration of any compelling reason, within the first week. Similarly, a student may be permitted to change the registration for a course within the first week only in consultation with respective faculty advisor. No late registration/change of registration shall be permitted after the first week from the scheduled date.

3.4 Only those students will be permitted to register who have: (a) cleared all University and Hostel dues of the previous semesters (b) paid all required fees for the current semester, and (c) not been debarred from registering for a specified period on disciplinary action or any other ground.

3.5 A candidate shall be given one chance to re-register and attend the classes for a maximum of two courses, if the CIE marks secured by a candidate are less than 50% and failed in those subjects but fulfilled the attendance requirement. A candidate must re-register for failed courses within four weeks of commencement of the class work and secure the required minimum attendance to appear for SEE. In the event of the student taking this chance, his CIE marks and SEE marks obtained in the previous attempt stand cancelled.

3.6 Dropping of courses: Within four weeks after the commencement of the semester, the student may, in consultation with the faculty advisor, drop one or more courses. The dropped courses shall be registered in the subsequent semesters as and when it is offered.

4. Attendance

4.1 Attendance in all classes (lectures/tutorials, laboratories etc.) is compulsory. A student will not be permitted to appear in the semester end examination on grounds of unsatisfactory attendance. Minimum required attendance in each theory / laboratory course is 75% (including the days of attendance in sports, games, and NCC and NSS activities) for appearing in the semester end examination. Students are advised to monitor the status of their attendance in the online system from time to time. Absence without obtaining sanction of leave will be considered as an act of indiscipline.

4.2 Condonation of shortage of attendance in each course up to 10% (65% and above and below 75%) in each semester shall be granted on genuine medical grounds and valid reasons on representation by the candidate with supporting documentary evidence.

4.3 Shortage of attendance below 65% in each course shall not be condoned.

4.4 Students whose shortage of attendance is not condoned in any course are not eligible to appear for their semester end examination of that course and their registration shall stand cancelled.

4.5 However, in respect of women candidates who seek condonation of attendance due to pregnancy, the Vice-Chancellor may condone the deficiency in attendance to

the extent of 15% (as against 10% condonation for others) on medical grounds subject to submission of medical certificate to this effect. Such condonation shall be availed only twice during the program of study.

4.6 A prescribed fee shall be payable towards condonation of shortage of attendance.

4.7 A candidate shall get minimum required attendance at least in three (3) theory courses in the present semester to get promoted to the next semester.

4.8 Promotion Rules:

4.8.1 A student shall be promoted from I Year to II Year only if he/she fulfills the academic requirements of securing 50% of average credits up to I Year II Semester, from all the examinations, whether or not the candidate takes the examinations.

4.8.2 A student shall register and put up required attendance in all 88 credits and earn all 88 credits for the award of degree.

4.8.3 Students, who fail to earn 88 credits as indicated in the course structure within four academic years from the year of their admission, shall forfeit their admission.

4.9 When a student is detained due to shortage of attendance in any semester, no grade allotments or SGPA/CGPA calculations will be done for that entire semester in which he/she got detained.

4.10 When a student is detained due to lack of credits in any year, he / she may be readmitted after fulfillment of the academic requirements, with the academic regulations of the batch into which he / she gets readmitted.

4.11 For readmitted candidates, if there are any professional electives / open electives, the same may also be re-registered if offered. However, if those electives are not offered in later semesters, then alternate electives may be chosen from the set of elective courses offered under that category.

5. Assessment of Academic Performance

5.1 The performance of a student in a semester shall be evaluated course-wise for a maximum of 100 marks in each theory and practical course. In addition, Seminars, Comprehensive Viva-Voce, Technical Paper writing, Project Work Reviews and Project Work shall be evaluated for 100 marks each. The distribution of marks for Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE) along with the minimum pass percentage shall be as follows:

Course	Continuous Internal Evaluation (CIE)	Semester End Examination (SEE)	Minimum Requirements to	academic Pass a Course
			*Minimum Pass Percentage (SEE)	*Minimum Pass Percentage (CIE+SEE)
Theory	40	60	40	50
Laboratory / Practicals	50	50	40	50
Seminars	100	0	-	50
Comprehensive Viva-Voce	-	100	50	**50**
Technical Paper Writing	100	-	-	50
Project Reviews	100	-	-	50

*Provided a relaxation of 10% of maximum marks shall be given to physically challenged students.

5.2 Each theory course in a semester is evaluated for 100 marks, with the following weightages:

5.2.1 Continuous Internal Evaluation(CIE)

The CIE for Theory Courses has the following three components, comprising of 40 marks:

a. Midterm Examinations for 20marks

b. Quizzes for 10marks

c. Assignment / Seminars / Projects / Group Activities for10 marks

d. Mid-term Examinations

There shall be two midterm examinations of 20 marks each. The average of the two examinations shall be taken as the marks secured by each candidate. Each midterm examination shall be conducted for the duration of 90 minutes and the question paper consists of Part-A (Short Answers for 5 marks) consists of 5 questions carrying 1 mark each, and Part-B (Long Answers for 15 marks) containing 5 questions of which student has to answer 3 questions; each question carrying 5 marks.

The First midterm examination shall be conducted for 2.5 units of syllabus at the end of 8 weeks of instruction and Second midterm examination shall be conducted for remaining 2.5 units at the end of 16 weeks of instruction.

In case any student has missed one of the two examinations, or wants to improve in one of the examinations, an optional third midterm examination will be conducted. This optional third midterm examination will be conducted during the preparation cum external practical examinations period subject to the following conditions:

1. Interested students have to register for the third mid examination by paying the prescribed registration fee.

2. Third midterm examination covers entire semester syllabus carrying 20marks

a. Quizzes:

There shall be a total of five quizzes of 10 marks each. The quiz is to be conducted at the end of each of the five units of instruction. The average of the five quizzes shall be taken as the final marks secured by each candidate.

5.2.2 Assignment / Seminars / Projects / Group Activities:

The faculty will evaluate the students for 10 marks by conducting any of the following in two phases covering at least two units in each phase: Assignments / Seminars / Projects / Group Activities. This should be completed before the conduct of second mid-term examination.

5.2.3 Semester End Examination

a. The semester end examination will be conducted for 60 marks. The question paper will consist of two parts viz.,i) Part-A for 20marks, ii) Part –B for 40 marks.

b. Part-A is compulsory, which consists of ten questions (numbered from 1 to 10), two questions from each unit carrying 2 marks each.

c. Part-B consists of five questions (numbered from 11 to 15) shall be set by covering one question (may contain sub-questions) from each unit of the syllabus carrying 8 marks each. For each question there will be an"either""or"choice (that means there will be two questions from each unit and the student shall have to answer any one of them).

5.3 Each laboratory course in a semester is evaluated for 100 marks, with the following weightages:

a. Throughout the semester the student will be evaluated for 50 marks under CIE as follows**:**

i. Preparation for Lab – 10 marks.
ii. Observation – 10 marks.
iii. Completion of Experiment – 5 marks.
iv. Record –5 marks.
v. Skill Test – 20 Marks

Before the end of instruction a Skill Test will be conducted for 20 marks. The practical SEE shall be conducted for 50 marks with an examiner along with the lab faculty. The examiner shall be appointed by the Dean (Examinations) of the University.

5.4 There shall be two seminar presentations during I Year I Semester and I Year II Semester. For each Seminar there will be only internal evaluation of 100 marks. Students shall present a seminar before the faculty members assigned for the purpose.

5.5 There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce is intended to assess the students' understanding of various courses he has studied during the program. Comprehensive viva-voce will

be taken by the faculty members assigned for the purpose.

5.6 There shall be a Technical Paper Writing that covers concepts of abstract, introduction, material and methods, conclusion, references, acknowledgement etc. The report shall be presented as a printed document for evaluation. Evaluation shall done by the faculty member assigned for the purpose

5.7 There shall be a project work review I and II in 2nd Year first and second semester respectively. For the Project work Reviews there is an internal marks of 100, the evaluation should be done by the Project Review Committee (PRC) for 50 marks and Supervisor will evaluate for 50 marks.

5.8 A candidate shall be given one chance to re-register for the courses if the internal marks secured by a candidate is less than 50% and failed in that course for maximum of two times. In the event of the student taking another chance, his / her CIE and SEE marks obtained in the previous attempt stands cancelled.

5.9 If there is a complaint in awarding the CIE marks, the University shall nominate a committee to look into the matter.

5.10 Candidates shall be permitted to apply for recounting/revaluation of SEE theory-scripts within the stipulated period with payment of prescribed fee.

5.11 Recounting: The totaling of the marks awarded shall be verified in the answer script and corrected if there is any mistake.

5.12 Revaluation

a) The answer scripts of the candidate who applied for revaluation are evaluated by two subject experts independently other than the original evaluator.

b) If the difference of marks between these two valuations is 15% or more, it will be sent for third valuation to another subject expert.

c) Nearest of two valuations out of three will be considered and the average of these two will be taken as the final marks obtained.

d) If the difference of the final marks and original marks after revaluation is 15% or more of maximum marks, then the revaluation marks are considered for declaring the result.

e) If the revaluation marks are less than the original marks, the original marks are retained and there is no change in the result.

5.13 Challenge Valuation:

The candidates who have applied for revaluation and are not satisfied with the result are only eligible to apply for challenge valuation by paying the prescribed fee in the form of DD payable to the Registrar, AU.

a) On receipt of the DD, a photocopy of the answer booklet shall be given to the student.

b) The paper will be evaluated in the presence of the student by a senior faculty member appointed by the University.

c) If there is any change in the marks >= 15% of the maximum marks, the new marks will be awarded to the student. Otherwise, there will be no change in original secured marks.

d) If the change in marks (equal or above 15% of the maximum marks) occurs, the amount paid towards challenge valuation will be refunded.Otherwise, the student will forfeit the total amount which he/she has paid.

6. The Grading System

6.1 As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and Corresponding percentage of marks shall be followed:

% of Marks Secured (Class Intervals)	Letter Grade (as per UGC Guidelines)	Grade Points
90% and above (≥ 90%, ≤ 100%)	O (Outstanding)	10
Below 90% but not less than 80% (≥ 80%, < 90%)	**A**$^{+}$(Excellent)	9
Below 80% but not less than 70% (≥ 70%, < 80%)	**A** (Very Good)	8
Below 70% but not less than 60% (≥ 60%, < 70%)	**B**$^{+}$(Good)	7
Below 60% but not less than 50% (≥ 50%, < 60%)	**B** (Above Average)	6
Below 50% (< 50%)	F (Fail)	0
Absent	Ab	0

6.2 In general, a student shall not be permitted to repeat any course(s) only for the sake of 'Grade Improvement' or 'SGPA/ CGPA improvement'.

6.3 The 'Credit Points' (CP) for a course, is computed by multiplying the Grade Point with Credits for that particular course.

Credit Points (CP) = Grade Point (GP) x Credits

6.4 The Student passes the course only when he/she gets GP ⍰6 (B Grade or above).

6.5 The Semester Grade Point Average (SGPA) is calculated as follows

$$SGPA = \frac{\{\sum_{i=1}^{N} C_i G_i\}}{\{\sum_{i=1}^{N} C_i\}}$$

where 'i' is the course indicator index (takes into account all courses in a semester), 'N' is the no. of courses registered for the Semester (as specifically required and listed under the Course Structure of the parent Department), C is the no. of Credits allotted to the ith course, and G represents the Grade Points (GP) corresponding to the Letter Grade awarded for that course.

6.6 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all semesters considered for registration. The CGPA is calculated as follows:

$$CGPA = \frac{\{\sum_{j=1}^{M} C_j G_j\}}{\{\sum_{j=1}^{M} C_j\}}$$

Where 'M' is the total no. of courses (as specifically required and listed under the course Structure of the parent Department) the Student has registered from the 1st Semester onwards up to and inclusive of the Semester S (obviously M > N), 'j' is the course indicator index (takes into account all courses from 1 to S Semesters), C is the no. of credits allotted to the j^{th} course, and G represents the Grade Points (GP) corresponding to the Letter Grade awarded for that j^{th} course. After registration and completion of I Year I Semester however, the SGPA of that semester itself may be taken as the CGPA, as there are no cumulative effects.

6.7 For CGPA and SGPA calculations performance in failed courses (securing F Grade) will also be taken into account, and the Credits of such courses will also be included in the multiplications and summations.

7. Passing Standards

7.1 A student shall be declared successful or 'passed' in a Semester, only when he/she gets a SGPA ≥ 6.00 (at the end of that particular Semester); and a student shall be declared successful or 'passed' in the entire UGP, only when he/she gets a CGPA ≥ 6.00; subject to the condition that he/she secures a GP ≥ 6 (B Grade or above) in every registered course in each Semester.

7.2 After the completion of each semester, a grade card or grade sheet (or transcript) shall be issued to all the registered students of that semester, indicating the letter grades and credits earned. It will show the details of the courses registered (course code, title, No. of credits, grade earned etc.), credits earned, SGPA and CGPA.

8. Evaluation of Project/Dissertation Work

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

8.1 A Project Review Committee (PRC) shall be constituted with Head of the Department as Chairman, Project Supervisor and two senior faculty members.

8.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the courses, both theory and practical.

8.3 After satisfying 8.2, a candidate has to submit, in consultation with his Project Supervisor, the title, objective and plan of action of his project work to the PRC for approval. Only after obtaining the approval of the PRC the student can initiate the Project work.

8.4 If a candidate wishes to change his supervisor or topic of the project, he/she can do so with the approval of the PRC. However, the PRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

8.5 A candidate shall submit his project status report in two stages at least with a gap of 3 months between them.

8.6 The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of all theory and practical courses with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Head of the Department and make an oral presentation before the PRC.

8.7 Three copies of the Project Thesis certified by the supervisor shall be submitted to the University.

8.8 After approval from the PRC, a soft copy of the thesis should be submitted for PLAGIARISM check and the plagiarism report should be submitted to the examination branch and be included in the final thesis. The thesis will be accepted for submission, if the similarity index is less than 30%. If the similarity index has more than the required percentage, the student is advised to modify accordingly and re-submit the soft copy of the thesis after one month. The maximum number of re-submissions of thesis after plagiarism check is limited to TWO. The candidate has to register for the project work and work for two semesters. After two attempts, the admission is liable to be cancelled.

8.9 For Project Evaluation (Viva Voce) in II Year II Sem. there is an external mark of 100 and the same evaluated by the External examiner appointed by the Institution. The candidate has to secure minimum of 50% marks in Project Evaluation (Viva-Voce) examination.

8.10 If he/she fails to fulfill the condition as specified in 8.9, he/she shall reappear for the Viva-Voce examination only after three months. In the reappeared examination also, fails to fulfill the above said condition, he/she will not be eligible for the award of the degree.

8.11 The thesis shall be adjudicated by one examiner appointed by the Dean-Examinations from the list of panel of examiners approved by the Vice- Chancellor. For this, Chairman, Board of Studies of the respective departments shall submit a panel of 3 examiners, who are eminent in that field with the help of the concerned guide and senior faculty of the department.

8.12 If the report of the examiner is unfavorable, the candidate shall revise and resubmit the Thesis. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected.

8.13 If the report of the examiner is favorable, Project Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis.

8.14 The Head of the Department shall coordinate and make arrangements for the conduct of Project Viva-Voce examination.

9 Award of Degree and Class

9.1 A Student who registers for all the specified courses as listed in the Course Structure, satisfies all the Course Requirements, and passes the examinations prescribed in the entire PG Program (PGP), and secures the required number of Credits 88 (with CGPA ≥ 6.0), shall be declared to have 'QUALIFIED' for the award of the M.Tech Degree in the chosen Branch of Engineering and Technology with specialization as he/she admitted.

9.2 Award of Class

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M.Tech Degree, he/she shall be placed in one of the following three classes based on the CGPA:

CGPA	Class	Condition
≥8.00	First Class with Distinction	• Should have passed all the courses in 'first appearance' in a semester examinations and should complete the program in 2 years of time. • Should not have been detained or prevented from writing the end semester examinations in any semester due to shortage of attendance or any other reason.
≥6.75 - <8.00	First Class	• The Students who secure CGPA □□□□□□, but not fulfilling above conditions for "First Class with Distinction" shall be awarded "First Class"
≥ 6.00 -< 6.75	Second class	

9.3 A student with final CGPA (at the end of the PGP) < 6.00 will not be eligible for the Award of Degree.

10 Withholding of Results

If the student has not paid the dues, if any, to the institution or if any case of indiscipline is pending against him/her, the result of the student will be withheld and he/she will not be allowed into the next semester. His/her degree will be withheld in such cases.

11 Transitory Regulations

11.1 Discontinued, detained or failed candidates are eligible for readmission / re-registration as and when offered next as per the University admission procedure.

11.2 The candidate who fails in any course has to complete the same course / equivalent course in the maximum stipulated time as per the Regulations in vogue.

12 Convocation

12.1 The University shall conduct convocation to confer the degree(s).

12.2 The University shall institute Prizes and Awards to meritorious students during convocation.

13 Amendments

The regulations hereunder are subject to amendments as may be made by Academic Council from time to time. Any or all such amendments will be effective from such date and to such batches of candidates (including those already undergoing the program).

ANNEXURE – I: Disciplinary Action against Students – Provisions

A. Student's behavior and discipline will be assessed and will receive the same attention as the academic work. Discipline includes the observance of good conduct and orderly behavior by the students of the University;

B. All students pursuing a Program at the University shall observe code of conduct and maintain discipline and must consider it as a duty to behave decently at all places;

C. Every student shall always carry the Identity card issued by the university. Every student shall have to produce or surrender the identity card, as and when required by the proctorial staff, teaching and library staff and the officials of the university. The loss of the identity card, whenever it occurs, shall immediately be reported in writing to the Registrar.

D. Any violation of the code of conduct or breach of any rules and regulations of the university is construed as an act of indiscipline and shall make him/her liable for disciplinary action;

E. The following acts are treated as gross indiscipline;

   a) Disobeying the teacher/officials or misbehaving in the class;
   b) Quarrelling or fighting in the University campus, hostels amongst themselves, indulging in any activity which amounts to ragging or Harassment of other students;
   c) Quarrelling or fighting with a University employee(s) or any other public utility functionaries in the campus;
   d) Indecent behavior in the University campus or outside causing inconvenience to others;
   e) Visiting socially unacceptable websites, smoking or consuming liquor or banned substances like drugs etc. ;
   f) Damage to the University property;
   g) Indulging in acts of theft, forgery, stealing and misappropriating;
   h) Any other activity that defames the University;
      i. Use of mobile in the class/academic area.
      ii. irregularity in attending classes, persistent idleness, negligence or indifference towards the work assigned;
      iii. Any other conduct which is considered to be unbecoming of a student.

F. Rules for Students Conduct & Behavior in Campus and Outside;

G. The rules and regulations, academic calendar shall be provided to all the students

H. In general, Dean, Student Affairs will deal with the welfare and discipline of all students in the campus including Hostel and also outside the campus and will ensure maintenance of good conduct. He/ She will be assisted by other members of faculty/ staff/ wardens as nominated;

I. Conduct and Behavior:

a) Students should attend all their classes and strictly observe class timings. They should likewise carry out other out-door and extracurricular duties assigned to them. Their attendance and leave is governed by the regulations pertaining to them;

b) Students must give their undivided attention to their academic work and must be respectful to their teachers and supervisors;

c) Students must conduct themselves with due decorum in the classes, laboratories, Library etc. and move in an orderly and disciplined manner in the campus;

d) Students should not indulge in abusive behavior/ violence of any kind with fellow students, teaching faculty and employees of the University within or outside the University. Violence by any student or group of students will lead to severe disciplinary action;

e) No meeting of the students other than those organized under the aegis of the various recognized students' activities shall be called without the prior permission in writing from the Dean, Student Affairs;

f) Neither meetings/functions within the University campus shall be organized nor any outsider address the students without the prior permission in writing from the Registrar;

g) No students shall use unfair means at any of the examinations and tests or attempt or threaten the staff to get undue advantage;

h) Students must pay all fees and other dues on specified dates. If they do not do so, they render themselves liable to penalties as in force from time to time;

i) Students must take good care of all University property. Any damage to University property shall be viewed as indiscipline. Such student(s), in addition to facing the disciplinary action, shall have to replace the damaged property and make good the losses caused due to their action. Students must use the furniture and fittings with due care and must not deface buildings, roads, furniture and fittings etc. in any manner;

j) Students must handle the laboratory equipment, instruments and machinery with great care. Any damage or breakage of such equipment etc., due to improper use are negligent handling will have to be made good by the students concerned;

k) Ragging in any form is unlawful and strictly prohibited. If a student found ragging shall be punished as per the Anti-Ragging Act;

l) The University shall have a zero-tolerance policy towards Ragging and shall lay down strict guidelines on the same as per policies of the UGC in vogue and in compliance to directions of Hon'ble Supreme Court;

m) Mobile cellular phone may be carried by the students. However, they shall be kept in silent mode during the classes. Violation will lead to confiscation of the mobile phone;

n) All the students are required to observe the decorum in the dress code as prescribed by the University. Students not adhering to the prescribed dress code may be denied entry to the University campus;

o) Smoking, consumption/possession of liquor, intoxicants, drugs, cigarettes, hookah etc., inside or outside the Campus is strictly prohibited. Any violation will invoke severe penalty including rustication from the Hostel/ University.

J. Policy to prevent Sexual Harassment:

a) The University shall be committed to treating every employee and student with dignity and respect. It shall seek to create a work environment that is free from sexual harassment of any kind, whether verbal, physical or visual;

b) A policy shall be prescribed by the University to provide guidelines for prompt redressal of complaints related to sexual harassment which should be in full compliance with "The Sexual Harassment of Women at Workplace (Prevention, Prohibition & Redressal)" Act, 2013;

c) All references / complaints and redressal mechanism pertaining to any matter will be handled within the ambit of the said Act and the Rules framed thereunder. The policy so prescribed shall be communicated to all employees and students.

K. Grievance and Redressal Mechanisms:

The University shall constitute various Grievance and Redressal committees and its guidelines as specified by the statutory authorities of the University.

ANNEXURE – II: Malpractices Rules

S.No	Nature of Malpractice Improper conduct during examinations	Punishment
	***If the candidate*:**	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he/she is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he/she will be handed over to the police and a case is registered against him/her.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate disappearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The hall ticket of the candidate is to be cancelled.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all Semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he/she will be handed over to the police and a case is registered

		against him/her.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination. Takes away answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all SEEs. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks	Cancellation of the performance in that subject.
6	Refuses to obey the orders of the Chief Superintendent / Assistant Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty inside or outside the examination hall or causing any injury to himself / herself or to any others or threatens whether by words, either spoken or written or by signs or by visible representation, assaults the officer in-charge, or any person on duty in or outside the examination hall or any others, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	They shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case will be registered against them.

7.	Leaves the exam hall taking away answer script or intentionally tears the script or any part-thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work & shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all Semester examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits these at.
9.	Who is not a candidate for the particular examination or any person not connected with the University indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the University will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Found copying,on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the malpractice committee for further action on suitable punishment as per rules.	

ANNEXURE –III: Definitions

In these Regulations, unless the context otherwise requires:

a. Academic Year: Two consecutive (one odd + one even) semesters constitute one academic year

b. Choice Based Credit System (CBCS): The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses)

c. Course: Usually referred to, as a 'course' is a component of a program. All courses neednot carry the same weightage. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/tutorials/laboratory work/field work/outreach activities/ project work/vocational training/viva/seminars/term papers/assignments/ presentations/self- study etc., or a combination of some of these

d. Credit Based Semester System (CBSS): Under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students

e. Credit: A unit by which the course work is measured. It determines the numberof hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week

f. Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale

g. Credit Point: It is the product of grade point and number of credits for a course

h. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters i.e., O, A+, A, B+, B, C and F

i. Semester Grade Point Average (SGPA): It is a measure of academic performance in a semester. It is the ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places

j. Cumulative Grade Point Average (CGPA): It is a measure of overall cumulative performance of a student. The CGPA is the ratio of total credit points secured by a student in all semesters and the sum of the total credits. It shall be expressed up to two decimal places

k. Program: An academic program of the University

l. Semester: Each semester shall consist of 16 weeks of instruction.

m. Transcript or Grade Card or Certificate: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display

the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester

n. Types of courses: The courses in a program may be of three kinds: Core, Elective and Foundation

o. Core course: This is the course which is to be compulsorily studied by a student as a core requirement of a program in a branch of study

p. Elective course: This is the course to be chosen from a pool of courses. Elective course may be (a) Supportive to the branch of study (b) Providing an expanded scope (c) Enabling an exposure to some other branch/domain (d) Nurturing student's proficiency/skill

q. Foundation course:This course may be of two kinds, compulsory foundation and elective foundation

r. Compulsory Foundation courses: These are the courses based upon the content that leads to knowledge enhancement. They are mandatory for all disciplines

s. Elective Foundation courses: These are value-based and are aimed at man-making education

t. The academic regulations should be read as a whole for the purpose of any interpretation.

u. In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chancellor is final.

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DEPARTMENT OF MECHANICAL ENGINEERING

M. Tech (Machine Design)

I YEAR I SEMESTER

CODE	Category	Course Title	L	T	P	C
A31014	PC-1	Engineering Noise Control	4	0	0	4
A31015	PC-2	Mechanical Behavior of Engineering Materials	4	0	0	4
A31016	PC-3	Advanced Mechanics of Solids	4	0	0	4
A31017 A31018 A31019	PE-I	1. Design Optimization 2. Vibration Analysis of Mechanical Systems 3. Tribology in Design	3	0	0	3
A31020 A31021 A31022	PE-II	1. Advanced Mechanics of Composite Materials 2. Design for Manufacturing & Assembly 3. Design of Pressure Vessels and Piping	3	0	0	3
A31023 A31024	OE-I	1. Computational Methods in engineering 2. Database Management System	3	0	0	3
A31207	Laboratory I	Kinematics & Dynamics Lab	0	0	3	2
A31208	Seminar I	Seminar-I	0	0	3	2
Total			**21**	**0**	**6**	**25**

I YEAR II SEMESTER

CODE	Category	Course Title	L	T	P	C
A32010	PC-4	Research Methodology and IPR	4	0	0	4
A32011	PC-5	Advanced Finite Element Analysis	4	0	0	4
A32012	PC-6	Analysis & Synthesis of Mechanisms	4	0	0	4
A32013 A32014 A32015	PE-III	1. Industrial Robotics 2. Product Design & Development 3. Experimental Stress Analysis	3	0	0	3
A32016 A32017 A32018	PE-IV	1. Design and Analysis of Experiments 2. Theory of Elasticity and Plasticity 3. Vehicle Dynamics	3	0	0	3
A32019 A32020	OE-II	1. Advanced Optimization Techniques and Applications 2. Signal Analysis and Condition Monitoring	3	0	0	3
A32021	AUDIT COURSE	Pedagogy Studies	---	---	---	--
A32208	Laboratory II	Computer Aided Testing, Analysis & Modeling Lab	0	0	3	2
A32209	Seminar II	Seminar-II	0	0	3	2
Total			**21**	**0**	**6**	**25**

II YEAR I SEMESTER

CODE	Course Title	L	T	P	C
A33204	Technical Paper Writing	0	3	0	2
A33205	Comprehensive Viva-Voce	0	0	0	4
A33206	Project work Review I	0	0	22	8
Total		**0**	**3**	**22**	**14**

II YEAR II SEMESTER

CODE	Course Title	L	T	P	C
A34203	Project work Review II	0	0	24	8
A34204	Project Evaluation (Viva-Voce)	0	0	0	16
Total		**0**	**0**	**24**	**24**

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	ENGINEERING NOISE CONTROL						**PC-1**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Basics of vibration and acoustics, physics and mathematics.	4	0	-	0	30	70	4

Course Objectives:

1. To identify the effects of noise and the approach to its control.
2. To study the sound propagation outdoors and indoors.
3. To identify the sound radiation from vibrating structures and evaluations.
4. To solve the measurement techniques for absorption.
5. To study the design of different devices.

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

1. Able to draw Plotting in Octave and understanding the Background Mathematics.
2. Understand the frequency and noise of different sound propagation systems.
3. Understand the radiation from the vibrating bodies under different conditions.
4. Able to apply various techniques for absorption and radiation concept.
5. Able to design different devices and understanding to control noise from devices.

UNIT-I: Units of Noise Measurement: Overview of decibels for sound pressure, intensity and power levels; combining sound pressures (incoherent and coherent); basic frequency analysis including one-third octave bands; A-weighting and other measures of sound.

Characterization of Noise Sources: Physical nature of noise sources, idealizations; acoustical efficiency; frequency spectrum; parametric dependencies including operational speed;

directivity; estimation of source sound power (including engines, fans etc). Summary of sound power measurement methods (ISO 3745, ISO 3744, ISO 3741, ISO 9614).

UNIT-II: Sound Propagation outdoors and Indoors: Point source and line source; geometric spreading; ground effects; meteorological effects; noise barriers; sound in rooms, reverberant field. Principles of passive noise control: Effect of multiple sources and multiple paths; noise path models; control at source; airborne transmission; structure-borne transmission.

UNIT-III: Sound radiation from vibrating structures (engineering approach) Definition of radiation ratio; radiation from monopole and dipole sources; radiation from bending waves in plates; corner modes, edge modes, coincidence; means of reducing radiation ratio. Transmission of airborne sound through partitions Transmission loss of a single partition, mathematical derivation for normal incidence; coincidence and the transmission loss for particular angles of incidence and for a diffuse field (qualitative); double partitions (qualitative); measurement methods for sound reduction index; machinery enclosures using Sabine formula.

UNIT-IV: Sound Absorbent Materials and Applications: Surface impedance and its relation to absorption coefficient; qualitative treatment of dissipation mechanisms; practical forms of sound absorber; measurement techniques for absorption (ISO10534, ISO354). **Vibration Control:** Force and velocity excitation, blocked force and free velocity; vibration isolation - low and high frequency models; damping treatments; effects of damping; structural modification; vibration absorbers and neutralisers.

UNIT-V: Silencer Design: Acoustic impedance; insertion loss; reactive silencers: side branches, expansion chambers; flow-generated noise; lined ducts, splitter attenuators; pressure drop; break-out noise.

Text Books:

1. F.J. Fahy (2001). Foundations of Engineering Acoustics.
2. D. A. Bies and C.H. Hansen (1996), Engineering Noise Control.

References:

1. Key Texts available in Hartley and EJ Richards Libraries.
2. F.J.Fahy and D.J. Thompson (2015). Fundamentals of Sound and Vibration.

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I M. Tech I Semester (Machine Design)

<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td><td>PC/PE/OE</td></tr>
<tr><td></td><td colspan="5">MECHANICAL BEHAVIOUR OF ENGINEERING MATERIALS</td><td>PC-2</td></tr>
<tr><td>Prerequisite</td><td colspan="4">Contact Hours Per Week</td><td>CIE</td><td>SEE</td><td>Credits</td></tr>
<tr><td rowspan="2">Metallurgy and Material Science</td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">30</td><td rowspan="2">70</td><td rowspan="2">4</td></tr>
<tr><td>4</td><td>0</td><td>-</td><td>0</td></tr>
</table>

Course Objectives:

1. To impart the knowledge of various fractures and failures in a component subjected to tensile loads.
2. To know the various loading modes and stress concentration regions.
3. To know the crack opening displacements for various modes of cracks.
4. To get the knowledge of various empirical laws and mean stress correction factors.
5. To impart the knowledge of creep rate.

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

1. Understand the energy release rates in crack propagation direction and solution for crack tip stresses.
2. Analyze the stresses in various crack propagation and factors influencing the crack propagation.
3. Determine the strain release rate in a material and can able to find out resistance to fracture against crack extension.
4. Analyze the factors influencing the fatigue life of components and different methods of counting the cycles.
5. Understand various factors influencing fatigue lives of welded joints.

UNIT-I: Introduction: Fracture behavior of metals and alloys. The ductile/brittle transition temperatures for notched and un-notched components, Ductile rupture as a failure mechanism Fracture at elevated temperature.

Definitions of types of fracture and failure, Introduction to stress intensity factor and strain energy release rate, Equivalence of energy approach and stress intensity approach.

Stress Intensity Factor and its use in Fracture Mechanics: Early concepts of stress concentrators and flaws, Ingles solution to stress round an elliptical hole-implications of results. Stress intensity factor for a crack. Westergaard‟s solution for crack tip stresses. Stresses and displacement in Cartesian and polar coordinates.

UNIT-II: Linear Elastic Fracture Mechanics (LEFM): Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, strain energy release rate, fracture energy, R. Modification for ductile materials, loading conditions. Stress intensity factor and the material parameter, the critical stress intensity factor.

UNIT-III: Elastic/Plastic Fracture Mechanics: The crack opening displacement and J-integral approaches, R-curve analysis Testing procedures, Measurement of these parameters, RAD, Fail sage and safe life design approaches, Practical applications. Advanced topics in EOFM.

UNIT-IV: Analysis of Fatigue: The empirical laws of fatigue failure. High cycle-low strain fatigue. Basquin‘s law. Goodman, Soderberg and Gerber mean stress corrections. Miner‘s law of damage summation. Low cycle fatigue, Crack growth and application of fracture mechanics to fatigue. Paris-Ergodan law. Threshold stress intensity range. Crack closure and its theories. Cycle counting methods. Development in using rain flow counting methods to recreate fatigue standard spectra. Standard spectra suitable for different applications.

UNIT-V: Fatigue of Welded Structures: Factors affecting the fatigue lives of welded joints. The codes and standards available to the designer. The use of fracture mechanics to supplement design rules. Practical examples. Introduction to creep phenomena.

Text Books:

1. Fracture Mechanics: Fundamental and Applications /Anderson T.L & Boca Raton/ CRC Press, Florida, 1998.
2. Deformation and Fracture mechanics of Engineering Materials / Richard W Hertz /Wiley

References:

1. Plasticity for structural Engineers / W.F. Chen and D.J,. Ha.
2. Engineering Fracture Mechanics/ D.R.J. Owen and A.J. Fawkes /Pincridge press, Swansea, U.K.
3. Mechanical Metallurgy / Dieter / McGraw Hill.
4. Fracture and fatigue control in structures/ S.T. Rolfe and J.M. Barsom/ Prentice Hall, Eglewood cliffs, N.J.
5. Fracture of brittle solids/ B.R. Lawn and T.R. Wilshaw/ Cambridge university press.
6. Plastic deformation of Metals/ R.W.K. Honeycombe/ 2nd edition, Edward Arnold.
7. Elements of Fracture Mechanics/Prasanth Kumar/TMH.
8. F.R.N. Nabarro, H.L. deVilliers, The Physics of Creep, Taylor and Francis, (1995).

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	ADVANCED MECHANICS OF SOLIDS						**PC-3**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Applied Mechanics, Mechanics of solids	L	T	D	P	30	70	4
	4	0	-	0			

Course Objectives:

1. To impart concepts of stress and strain analyses in a solid.
2. To study the methodologies in theory of elasticity at a basic level.
3. To acquaint with the solution of advanced bending problems.
4. To get familiar with energy methods for solving structural mechanics problems.
5. To impart concepts of contact stress and deflection of bodies.

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

1. Apply concepts of stress and strain analyses in solids.
2. Use the procedures in theory of elasticity at a basic level.
3. Solve general bending problems.
4. Apply energy methods in structural mechanics problems.
5. Understanding the analogy models developed for analyzing the non-circular bars subjected to torsion, and also analyzing the stresses developed between rolling bodies and stress in three dimensional bodies.

UNIT–I: Shear Centre: Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections.

Unsymmetrical Bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

UNIT–II: Curved Beam Theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors – Radial stress in curved beams – closed ring subjected to concentrated and uniform lads-stresses in chain links.

UNIT-III: Torsion: Torsion of a cylindrical bar of Circular cross Section; Saint-Venant's semi-inverse methods; Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hallow thin wall torsion members, Multiply connected Cross section, Thin wall torsion members with restrained ends

Axi-Symmetric Problems: Rotating Discs – Flat discs, Discs of uniform thickness, Discs of Uniform Strength, Rotating Cylinders.

UNIT-IV: Theory of Plates: Introduction; Stress resultants in a flat plate; Kinematics: Strain-Displacement relations for plates; Equilibrium equations for small displacement theory of flat plates; Stress – Strain– Temperature relation for Isotropic plates: Strain energy of a plate; Boundary conditions for plate; Solution of rectangular plate problem; Solution of circular plate problem.

Beams on Elastic Foundation: General theory; Infinite Beam subjected to Concentrated load; boundary conditions; Infinite beam subjected to a distributed lad segment; Semi-infinite beam with concentrated load near its end; Short Beams.

UNIT-V: Contact Stresses: Introduction, problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Methods of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

Text Books:

1. Advanced Mechanics of materials/Seely and Smith/ John Willey.
2. Advanced Mechanics of materials / Boresi & Sidebottom/wiely international.
3.

References:

1. Advanced strength of materials / Den Hortog J.P./Torrent.
2. Theory of Plates /Timoshenko.
3. Strength of materials / Sadhu singh/ Khanna Publishers.
4. Mechanics of Materials / Beer & Jhonson / McGraw Hill.
5. Theory of Plates & Shells / Timoshenko/ McGraw Hill/ 2nd Edition.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	DESIGN OPTIMIZATION						**PE-I**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Introductory courses in mathematics, mechanics, solid mechanics and mechanical engineering design.	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To introduce the concept of design optimization and classify optimization problems.
2. To familiarize the techniques of unconstrained minimization.
3. To elaborate on the direct and indirect methods using various mathematical functions and algorithms
4. To give exposure to optimization techniques with respect to various engineering problems.
5. To extend the knowledge of optimization techniques to degrees of freedom systems.

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

1. Understand the concept of design optimization and classify optimization problems.
2. Explain the technique of unconstrained minimization.
3. Analyze the direct and indirect methods using various mathematical functions and algorithms.
4. Apply optimization techniques to various engineering problems.
5. Relate optimization techniques to two degrees of freedom systems.

UNIT-I: General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints, classification of optimization problems. Single and multivariable optimization techniques.

UNIT-II: Technique of unconstrained minimization. Golden section, Random, Pattern and Gradient search methods, interpolation methods, equality and inequality constraints.

UNIT-III: Direct methods and indirect methods using penalty function, Lagrange multipliers, Geometric programming, stochastic programming, Genetic algorithms

UNIT-IV: Engineering applications, structural-design application axial and transverse loaded members for minimum cost, maximum weight. Design of shafts and torsion members, design optimization of springs.

UNIT-V: Dynamics applications for two-degree freedom system. Vibration absorbers. Application in mechanisms.

Text Books:

1. Engineering Optimization -Theory and Practice/ Singiresu S. Rao/ New Age.
2. Introduction to Optimum Design/Jasbir S. Arora/ Academic Press/ Everest/ 3rd Edition.

References:

1. Optimum Design of Mechanical elements/ Johnson Ray C/ Wiley, John & Sons.
2. Genetic Algorithms in search, Optimization and Machine/ Goldberg D. E. Addison/Wesley / New York.
3. Optimization for Engineering Design Algorithms and Examples/ Kalyanamoy Deb/Prentice Flail of India.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	VIBRATION ANALYSIS OF MECHANICAL SYSTEMS						**PE-I**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Strength of Materials, Machine Design	3	0	-	0	30	70	3

Course Objectives:

1. To study the behavior of single and two degree freedom systems and principal modes of undamped and damped free and forced vibrations.
2. To learn the solving solutions of multidegree freedom through different types of methods.
3. To study the equations of natural frequency for different beams
4. To learn the frequency domain vibration analysis
5. To study the Vibration Control in Structures of actuators for active control, semi active control of automotive suspension systems.

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

1. Understand the causes of vibration and types of vibration.
2. Determine the behavior of two degrees freedom systems.
3. Analyze the multi degree freedom systems.
4. Determine the methods that can be utilize for condition monitoring of various systems.
5. Understand the various special vibration measuring techniques.

UNIT-I: Single and Two Degree Freedom Systems: Response to Non Periodic Excitations: unit impulse, unit step and unit Ramp functions; response to arbitrary excitations, Principal modes-undamped and damped free and forced vibrations; undamped vibration absorbers.

UNIT-II: Multi-Degree of Freedom Systems: Introduction Modeling of Continuous systems as Multi-degree of Freedom systems, Using Newton's second law to derive equations of motion, Influence Coefficients. Potential and kinetic energy expressions in matrix form, Generalized coordinates and generalized forces, Using Lagrange's equations to derive equations of motion, Equations of motion of undamped systems in matrix form, Eigen value problem, solution of the

Eigen value problems – solution of the characteristic equation, orthogonality of normal modes, repeated Eigen values.

UNIT- III: Determination of Natural Frequencies and Mode Shapes: Introduction, Dunkerley's formula, Rayleigh's Method- Properties of Rayleigh's Quotient, Computation of the Fundamental Natural Frequency, Fundamental Frequency of Beams and Shafts. Holzer's Method-Torsional, Spring Mass Systems, Jacobi's method, Standard Eigen value Problems.

UNIT-IV: Frequency Domain Vibration Analysis: Over view, machine-train monitoring parameters-Data base development-vibration data acquisition-trending analysis-failure- node analysis-signature analysis-root cause analysis.

UNIT-V: Vibration Control in Structures: Introduction, State space representation of equations of motion, Passive control, Active control and semi active control, Free layer and constrained damping layers, piezo electric sensors and actuators for active control, semi active control of automotive suspension systems.

Text Books:

1. Mechanical Vibrations / SS Rao/ Pearson/ 2009, Ed 4.
2. Mechanical Vibrations/Groover/Nem Chand and Bros.

References:

1. Elements of Vibration Analysis by Meirovitch, TMH, 2001.
2. Mechanical Vibrations/Schaum Series/ McGraw Hill.
3. Mechanical Vibrations/Debabrata Nag/Wiley.
4. Vibration problems in Engineering / S.P. Timoshenko.
5. Mechanical Vibrations and sound engineering/ A. G. Ambekar/ PHI.
6. Theory and Practice of Mechanical Vibrations/JS Rao & K. Gupta/New Age Intl. Publishers/Revised 2nd Edition.

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I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	TRIBOLOGY IN DESIGN						**PE-I**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Fluid Mechanics, Machine Design	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To provide the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components.
2. To introduce the concept of surface engineering and its importance in tribology.
3. Understand the principles for selecting compatible materials for minimizing friction and wear in machinery.
4. To acquire and apply fundamental principles of hydrostatic lubrication
5. Understand the fundamental principles of high contact stresses (Hertz stresses) and Elasto hydrodynamic (EHD) lubrication in rolling bearings and gears.

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

1. Understand the different types of lubrications and relevant theories used in supporting elements.
2. Interpret and understand various lubricants and its properties
3. Understand and apply principles of mechanism of wear, sources of friction and lubrication systems.
4. Understand, apply and analyze the hydrostatic lubrication
5. Apply the principles of lubrication, lubrication regimes, and theories of hydrodynamic, elasto-hydrodynamic and mixed / boundary lubrication.

UNIT-I: Friction, theories of friction, Friction control, Surface texture and measurement, genesis of friction, instabilities and stick-slip motion.

UNIT-II: Wear, types of wear, theories of wear, wear prevention. Tribological properties of bearing materials and lubricants.

UNIT-III: Lubrication, Reynolds's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), Finite Bearings, Design of hydrodynamic journal bearings.

UNIT-IV: Hydrostatic, squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings.

UNIT-V: Elasto-hydrodynamic lubrication – pressure viscosity term in Reynolds's equation, Hertz' theory, Ertel-Grubin equation, lubrication of spheres, gear teeth and rolling element bearings, Air lubricated bearings, Tilting pad bearings.

Text Books:

1. Fundamentals of Fluid Film Lubrication – B. J. Hamrock, McGraw Hill International, 1994.
2. Introduction to Tribology of Bearings –B. C. Majumdar, A. H. Wheeler &co. pvt. Ltd.

References:

1. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.
2. Principles in Tribology, Edited by J. Halling, 1975.
3. D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.
4. "Fundamentals of Friction and wear of Materials" American Society of Metals.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	ADVANCED MECHANICS OF COMPOSITE MATERIALS						**PE-II**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Structure and properties of composite materials and design procedures for composite structures.	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To identify the properties of fiber and matrix materials used in commercial composites as well as some common manufacturing techniques.
2. To determine composite mechanical properties from constituent fiber and matrix material properties including longitudinal and lateral moduli, Poisson's ratio, and shear modulus.
3. To study the generalized stiffness and compliance matrix relating in-plane stresses to strains for a composite layer assuming plane stiffness.
4. To solve the classical laminated plate theory to determine extensional, coupling, and bending stiffnesses of a composite laminate. Also be able to perform this calculation using MATLAB for a composite laminate with many layers.
5. To identify the fabricate composite laminates and built-up composite structures such as I-beams, box beams, or model-scale aircraft wings using a composite manufacturing procedure.

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

1. Understanding of types, manufacturing processes, and applications of composite materials and Basic understanding of linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior.
2. Ability to analyze problems on macro and micro mechanical behavior of lamina
3. Ability to analyze problems on macro mechanical behavior of laminate
4. An ability to predict the loads and moments that cause an individual composite layer and a composite laminate to fail and to compute hygro thermal loads in composites.
5. An ability to compute the properties of a composite laminate with any stacking sequence.

UNIT–I: Basic Concepts and Characteristics: Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites. **Reinforcements:** Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

UNIT–II: Micromechanics: Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties.

Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

UNIT–III: Coordinate Transformation: Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off – axis, stiffness modulus, off – axis compliance.

Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

UNIT–IV: Strength of Unidirectional Lamina: Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects. Micros mechanical predictions of elastic constants.

UNIT–V: Analysis of Laminated Composite Plates: Introduction thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.

Text Books:

1. Mechanics of Composite Materials/ R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.

References:

1. Analysis and performance of fibre Composites/ B. D. Agarwal and L. J. Broutman/ Wiley-Interscience, New York, 1980.

2. Mechanics of Composite Materials/ Second Edition (Mechanical Engineering)/ Autar K. Kaw ,Publisher: CRC.
3. Analysis of Laminated Composite Structures/ L. R. Calcote/ Van Nostrand Rainfold, New York, 1969.
4. Advanced Mechanics of Composite Materials/ Vasiliev & Morozov /Elsevier/Second Edition.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	DESIGN FOR MANUFACTURING AND ASSEMBLY						**PE-II**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
DMM-I, DMM-II, Manufacturing Technology and Engineering Metrology	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To teach students various steps in the product development process and significance of early phases of design for economical production.
2. To teach fundamental principles of design for economical production and application of these properties in practical design problems.
3. To teach interactions among part geometry tolerances, materials and manufacturing processes.
4. To teach design of products for ease of assembly and manufacture.
5. To teach principles of robust design procedures and how to set values for various design variables so that the product sheets so that the product needs the performance requirements and remains insensitive to variations in manufacturing and use.

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

1. Given a set of functional requirement and constraints generate alternate concepts of objectively evaluate the concepts for their functionally and ease of production.
2. Map customer requirements to Engineering chracteristics,process parameters and production requirements taking into account of economical production.
3. Application of fundamental principles of design to improve the ease of production while satisfying the performance requirements.
4. Given a product design evaluate and improve the ease of manufacturing and assembly.
5. Establish a list of candidate materials for each component of design through the identification of fundamental requirements.

UNIT-I: Introduction: Design Philosophy, steps in design process, General design rules for manufacturability- basic principles of designing for economical problem- creativity in design materials- selection of materials for design developments in material technology- criteria for material selection-material selection interrelationship which process selection, process selection charts.

UNIT-II: Machining Process: Overview of various manufacturing process-general design rules for machining- Dimensional tolerance and surface roughness- Design for machining ease-Redesigning of components for machining ease with suitable examples, General design recommendations for machined parts.

Metal Casting: Approval of various casting processes, selection of casting process- general design consideration for casting- casting tolerance- use of solidification simulation in casting design-product design rules for sand casting.

UNIT-III: Metal Joining: Approval of various welding processes, Factors on design of weldments- general design guidelines pre and post treatment of welds- effects of thermal stresses in weld joints- design of brazed joints- Forging –design factor for forging- closed die forging design- general design recommendations extrusion& sheet metal work- design guide lines for extruded sections- design principles for punching, blanking, bending, deep drawing, Keeler goodman forming line diagram component design for blanking.

UNIT-IV: Assemble Advantages: Developments of the assemble process, choice of assemble method assemble advantages, social effects of automation.

Automatic Assembly Transfer Systems: Common transfer, intermittent transfer, indexing mechanisms and operator paced free- transfer machine.

UNIT-V: Design of Manual Assembly: Design for Assembly fits in the design process, general design guide lines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part geometry on handling, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of chamfer design on insertion operations, estimation of insertion time.

Text Books:

1. Assembly Automation and product design GeofferyBoothroyd:Marcel Dekker Inc (NY,1992).
2. Engineering design : Material & Processing Approach George E.Dieter: McGraw Hill Ind 2nd Ed.2000.

References:

1. Hand book of Product design Geoffery Boothroyd and Dekken,NY.1990.
2. Computer Aided Assembly London/A. Delbrainbre.
3. Product design for manufacturing and Assembly Geoffery Boothroyd.
4. Design and Manufacturing/ Surender Kumar & Goutham Sutradar /Oxford & IBH publishing Co. Pvt. Ltd. New Delhi, 1998.
5. ASM Hand book.Vol.20.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	DESIGN OF PRESSURE VESSELS AND PIPING						**PE-II**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
DMM-I, DMM-II, Fluid Mechanics	3	0	-	0	30	70	3

Course Objectives:

1. To know about the need and significance of pressure vessels.
2. To understand the different components of piping system.
3. To teach the various steps in the design of the piping system.
4. Application of fundamental principles of design to improve the ease of design of piping layout
5. To design pressure Vessels.

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

1. Determine stresses in pressure vessels.
2. Design pressure vessels using codes.
3. Design support members of pressure vessels.
4. Apply various design considerations for pressure vessels.
5. Design of pressurized fluid piping.

UNIT–I: Introduction, Materials- shapes of Vessels – stresses in cylindrical spherical and arbitrary, shaped shells. Cylindrical Vessels subjected to internal pressure, wind load bending and torque-isolation of pressure vessels – conical and tetrahedral vessels. Theory of thick cylinders; Shrink fit stresses in built up cylinders – auto freltage of thick cylinders Thermal stresses in Pressure Vessels.

UNIT–II: Theory of Rectangular Plates: Pure bending – different edge conditions. Theory circular plates: Simple support and clamped ends subjected to concentrated anduniformly distributed loads-stresses from local loads. Design of dome bends, shellconnections, flat heads and cone openings

UNIT–III: Discontinuity Stresses In Pressure Vessels: Introduction beam on an elastic foundation, infinitely long beam semi- infinite beam, cylindrical vessel under axially symmetrical loading, extent and significance of load deformations on pressure vessels, discontinuity stresses in vessels, stresses in a bimetallic joints, deformation and stresses in flanges. Pressure vessel materials and their environment : Introduction ductile material tensiletests, structure and strength of steel Leuder‘s lines determination of stress patterns fromplastic flow observations, behavior of steel beyond the yield point, effect of cold work orstrain hardening on the physical properties of pressure vessel steels fracture types in tension.

Toughness of materials, effect of neutron irradiation of steels, fatigue of metals, fatigue crackgrowth fatigue life prediction cumulative fatigue damage stress theory of failure of vesselssubject to steady state and fatigue conditions.

UNIT–IV: Introduction to Piping Design: Effects of operating conditions, including flow rate design pressure and temperature on piping design, Impact of internal and external forces on the design, piping layout, an overview of the general support classifications.

UNIT-V: Preliminary Piping Design: Concepts and developing an initial piping layout, Design principles Including fluid properties, flow rate and physical laws which influence the complete piping system layout, understand the effect of different piping system components such as tanks, vessels and pumps on the overall system.

Text Books:

1. Theory and design of modern Pressure Vessels / John F. Harvey _Van/ Nostrand Reihold Company / New York.
2. Pressure Vessel Design and Analysis / Bickell M. B. Ruizes / Macmillan Publishers.

References:

1. Process Equipment design / Beowll & Yound Ett.
2. Indian standard code for unfired Pressure vessels IS 2825.
3. Pressure Vessels Design Hand Book Henry H. Bednar PE / CB S Publishers / New Delhi.
4. Theory of plates and shells / Timoshenko & Noinosky / Dover Publications.
5. Stress in Beams, Plates and Shells / Ansel C. Ugural / CRC Press / 3rd Edition.

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I M. Tech I Semester (Machine Design)

<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td><td>PC/PE/OE</td></tr>
<tr><td></td><td colspan="5">COMPUTATIONAL METHODS IN ENGINEERING</td><td>OE-I</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4" rowspan="2">Contact Hours Per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr></tr>
<tr><td rowspan="2">Matrix algebra, numerical integration, Ordinary and partial differential equations,</td><td>L</td><td>T</td><td>D</td><td>P</td><td rowspan="2">30</td><td rowspan="2">70</td><td rowspan="2">3</td></tr>
<tr><td>3</td><td>0</td><td>-</td><td>0</td></tr>
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Course Objectives:

1. To study the solution of system of linear equations, area bounded by the curvesand evaluation of definite integrals.
2. To learn the Finite difference approximations of ordinary differential equations and optimization techniques to minimize or maximize the functions.
3. To study the Finite Difference approximations of parabolic and elliptic partial differential equations
4. To learn the Finite Difference approximations of hyperbolic partial differential equations
5. To study the least square and Regression Analysis.

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

1. a) Understanding the concepts of Matrix Determinant, Rank, Inverse to solve the system of linear equations.

   b) Apply Simpson's rules to find the area bounded by the curves.

   c) Evaluation of definite integral of a function using Gaussian quadrature.
2. a) Apply the optimization techniques to maximize/minimize the functions.

   b) Apply Finite difference techniques to solve the ordinary differential equations.
3. Apply Finite difference techniques to solve the parabolic and elliptic partial differential equations.
4. Apply Finite difference methods to solve the hyperbolic partial differential equations.

5. Able to know how to construct the linear and nonlinear curves using least square approximations and estimating the relationship between a dependent and independent variable using regression analysis.

UNIT-I: Introduction to Numerical Methods Applied To Engineering Problems: Examples, solving sets of equation–Matrix notation–Determination andinversion – Iterative methods – Relaxation methods – System of non-linear equations – computer programs. **Numerical Integration:** Newton-Cotes integration formulas – Simpson ‘s rules, Gaussian quadrature. Adaptive integration.

UNIT-II: Optimization: One dimensional unconstrained optimization, multidimensionalunconstrained optimization – direct methods and gradient search methods, constrained optimization.

Boundary Value Problems and Characteristic Value Problems: Shooting method–Solution through a set of equations – Derivative boundary conditions – Rayleigh - Ritz method – Characteristic value problems,

UNIT-III: Numerical Solutions of Partial Differential Equations: Laplace ‘s equations – Representation as a difference equation – Iterative methods for Laplace ‘s equations – poison equation – Examples – Derivative boundary conditions – Irregular and non-rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.

Parabolic partial differential equations: Explicit method–Crank-Nicolson method–Derivative boundary condition – Stability and convergence criteria – Finite element for heat flow – computer programs.

UNIT-IV: Hyperbolic Partial Differential Equations: Solving wave equation by finite differences-stability of numerical method – method of characteristics wave equation in two space dimension-computer programs.

UNIT- V: Curve Fitting and Approximation of Functions: Least square approximation fitting of non-linear curves by least squares – regression analysis – multiple linear regression, nonlinear regression – computer programs.

Text Books:

1. Numerical Methods for Engineers/ Steven C.Chapra, Raymond P.Canale/ Tata Ma-Graw Hill.

2. Applied numerical analysis / Curtis F.Gerald, partick.O.Wheatly /Addison-wesley, 1989.

References:

1. Numerical methods / Douglas J.Faires, Riched Burden / Brooks-cole publishing company, 1998 Second edition.
2. Numerical mathematics and computing/ Ward cheney& David Kincaid / Brooks-cole publishing company 1999 fourth edition.
3. Mathematical methods for physics and engineering / Riley K.F.M.P.Hobson& Bence S.J./ Cambridge university press,1999.

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I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	DATABASE MANAGEMENT SYSTEM						**OE-I**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Any programming language.	3	0	-	0	30	70	3

Course Objectives:

1. To provide a sound introduction to Database management systems, Databases and its applications.
2. To familiarize the participant to give a good formal foundation on the relational model of data.
3. To present SQL and procedural interfaces to SQL comprehensively.
4. To give an introduction to systematic database design approaches conceptual design, logical design, schema refinement and physical design.
5. To introduce the concepts of transactions and transaction are processing and the issues and techniques relating to concurrency and recovery manager.

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

1. Design Entity-Relationship Model for enterprise level databases.
2. Develop the database and provide restricted access to different users of database and formulate the Complex SQL queries.
3. Analyze various Relational Formal Query Languages and various Normal forms to carry out Schema refinement
4. Use of suitable Indices and Hashing mechanisms for real time implementation.
5. Ability to analyze various concurrency control protocols and working principles of recovery algorithms.

UNIT-I: Database System Applications, database system VS file system- view of data- data abstraction – instances and schemas – data models – the ER Model – Relational model – other models – Database languages – DDL – DML – database Access for applications programs – database users and administrator – transaction management – database system structure – storage manager – the query processor – history of database systems – database design and ER diagrams – Beyond ER design entities of ER model – concept design with the ER model – conceptual design for large enterprises.

UNIT-II: Relational Model: introduction to the relational model – integrity constraint over relations – enforcing integrity constraints – querying relational data – logical database design – introduction to views – destroying / altering tables and views.

Relational Algebra and Calculus : relational algebra – selection and projection set operations – renaming – joins – division – examples of algebra overviews – relational calculus – tuple relational calculus – domain relational calculus – expressive power of algebra and calculus.

UNIT–III: Form of basic SQL Query – examples of basic SQL Queries – introduction to nested queries – correlated nested queries set – comparison operators – Aggressive operators -Null values – comparison using null values – logical connectivity‘s – AND, OR and NOTR – impact on SQL constructs – Outer joins – disallowing NULL values – complex integrity constraints in SQL Triggers and Active Database. Schema refinement – problems caused by redundancy – decompositions – problem related to decomposition – reasoning about FDS – FIRST, SECOND, THIRD Normal forms – BCNF – Lossless join decomposition – Dependency preserving Decomposition – Schema refinement in database design – Multi valued dependencies – forth Normal Form.

UNIT-IV: Overview of Transaction Management: ACID properties – Transactions and schedules – concurrent execution of transaction – lock based concurrency control – performance locking – transaction support in SQL – Introduction to crash recovery.

Concurrency Control: Serializability and recoverability – introduction to lock management – lock conversions dealing with dead locks – specialized locking techniques concurrency without locking.

Crash Recovery: introduction to ARIES – the log – other recovery related structures – the write- Ahead Log Protocol – check pointing – recovering form a system crash – media recovery – other approaches and interaction with concurrency control.

UNIT-V: Overview of Storage and Indexing : data on external storage – File organization and indexing – cluster indexing, primary and secondary indexes – index data structures – hash based indexing tree base indexing –comparison of file organizations – indexes and performance Tuning.

Storage data: Disks and Files: the Memory Hierarchy – redundant Arrays of independent – Disks – disk space management – buffer manager – files of records – page formats – record formats.

Tree structure Indexing: introduction for tree indexes – indexed sequential access methods

(ISAM)-B+ Tress: A dynamic Index structure.

Hash based Indexing: Static Hashing – extendable hashing – Linear Hashing – Extandable vs Linear hashing.

Text Books:

1. Database Management Systems/ Raghurama Krishnan, Johannes Gehrke/ TATA McGraw hills 3rd Edition.
2. Database systems Concepts/ Silberschatz, Korth/ McGraw hill, IV Edition.

References:

1. Database Management Systems/ P.Radha Krishna/ Hi-TECH Publications 2005.
2. Introduction to Database Management Systems / C.J.Date/ Pearson Education.
3. Database Systems design, Implemantation and Management/ Rob & Coronel/ 5th Edition, Thomson.
4. Database Management Systems/ Elmasri Navrate/ Pearson Education.
5. Database Management Systems /Mathew Leon, Leon Vikas.
6. Database Systems / Connoley/ Pearson Education.

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I M. Tech I Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	KINEMATICS AND DYNAMICS LAB						**LAB**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
--	0	0	-	3	30	70	2

(A minimum of 10 experiments is to be conducted)

Experiments:

1. Determination of damped natural frequency of vibration of the vibrating system with different viscous oils.
2. Determination of steady state amplitude of a forced vibratory system.
3. Static balancing using steel balls.
4. Determination of the magnitude and orientation of the balancing mass in dynamic balancing.
5. Field balancing of the thin rotors using vibration pickups.
6. Determination of the magnitude of gyroscopic couple, angular velocity of precession and representation of vectors.
7. Determination of natural frequency of given structure using FFT analyzer.
8. Diagnosis of a machine using FFT analyzer.
9. Direct Kinematic analysis of a robot.
10. Inverse Kinematic analysis of a robot.
11. Trajectory planning of a robot in joint space scheme.
12. Palletizing operation using Robot programming.

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I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	RESEARCH METHODOLOGY AND IPR						**PC-4**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
None	L	T	D	P	30	70	4
	4	0	-	0			

Course Objectives:

1. To understand the research problem
2. To know the literature studies, plagiarism and ethics
3. To get the knowledge about technical writing
4. To analyze the nature of intellectual property rights and new developments
5. To know the patent rights

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

1. Understand research problem formulation.
2. Analyze research related information and follow research ethics
3. Understand how a technical paper can be converted into Research proposal with new ideas, concept and creativity.
4. Understand the process of patenting and development and how the funds can be granted on patents.
5. Understand that IPR protection provides an incentive to inventors for further research work in R & D, which leads to creation of new and better products for social benefits.

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"

References:

1 Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2 Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
3 Mayall , "Industrial Design", McGraw Hill, 1992.
4 Niebel , "Product Design", McGraw Hill, 1974.
5 Asimov, "Introduction to Design", Prentice Hall, 1962.
6 Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

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I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	ADVANCED FINITE ELEMENT ANALYSIS						**PC-5**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Engineering Mathematics, Strength of Materials, Heat Transfer and Vibrations.	L	T	D	P	30	70	4
	4	0	-	0			

Course Objectives:

1. To Study the basics of finite element method for displacement and stress analysis with the help of various methods.
2. To implement the basics of FEM relating stresses, strains in the Heat Transfer and Vibrations concepts.
3. To analyze a bridge between hand calculations based on strength of materials and numerical solutions for more complex geometries with loading conditions.
4. To study approximate nature of the finite element method and convergence of results are examined
5. To Design the stiffness matrix of 1D,2D and 3D stress analysis with FEM software.

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

1. Determine the approximate solutions for various elements using numerical methods.
2. Evaluate the displacements, stresses and strains of a bar, Truss element.
3. Solve the nodal displacements for two-dimensional elements.
4. Examine the Heat transfer and dynamic analysis of bars and beams.
5. Use professional-level finite element software to solve Non Linear and Linear Problems.

UNIT - I: Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description, comparison of FEM with other methods, variational approach, Glerkin's Methods. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain- displacement relations.

UNIT - II: Types of 1D elements, Displacement function, Global and local coordinate systems, Properties of stiffness matrix, Boundary conditions elimination method and penalty approach, Symmetric boundary conditions, Stress calculations Quadratic shape functions, and problems.

Analysis of Trusses: Plane Trusses and Space Truss elements and problems

UNIT - III:

Analysis of Beams: Hermite shape functions – stiffness matrix – Load vector – Problems.

2-D Problems: CST, force terms, Stiffness matrix and load vectors, boundary conditions, Problems.

UNIT- IV:

Scalar Field Problems: 1-D Heat conduction-Slabs – fins - problems. Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis.

UNIT - V:

Finite element formulation: Three dimensional problems in stress analysis. Introduction to non-linear problems, incompressible fluid, Bending of elastic plates, and Finite Element analysis software.

Text Books:

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.
2. Finite Element Methods: Basic Concepts and applications, Alavala, PHI

References:

1. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu,
2. Prentice Hall of India, 1997
3. Finite Element Method – Zienkiewicz / McGraw Hill
4. Introduction to Fininte element analysis- S. Md. Jalaludeen, Anuradha Publications, print- 2012
5. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition
6. Segerland. L.J., Applied Finite Element Analysis, Wiley Publication, 1984.
7. Reddy J.N., An Introduction to Finite Element Methods, Mc Graw Hill Company, 1984.

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I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	ANALYSIS AND SYNTHESIS OF MECHANISMS						**PE-6**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Kinematics of Machinery, Design of Machine Elements.	L	T	D	P	30	70	4
	4	0	-	0			

Course Objectives:

1. To learn how to analyze the motions of mechanisms.
2. To determine radius of curvature of polodes.
3. To have knowledge on the graphical techniques commonly used in the synthesis of mechanisms.
4. To design mechanisms through various graphicalmethods.
5. To implement analytical methods in the synthesis of mechanisms.

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

1. Analyze the plane motion mechanism based on the concepts of inflection circle.
2. Evaluate polode curvature of the given four bar mechanism and plot coupler curves.
3. Design mechanisms by using graphical methods and to plot Burmester's curve.
4. Develop new mechanisms using graphical methods by involving function generation and path generation methods.
5. Design mechanisms using analytical methods implementing various function generation and path generation methods.

UNIT – I:

Advanced Kinematics of Plane Motion- I: Introduction to plane motion. The Inflection circle,Euler – Savary Equation, Analytical and graphical determination of d_i, Bobillier's Construction, Collineation axis, Hartmann's Construction,Inflection circle for the relative motion of two moving planes, Application of the Inflection circle to kinematic analysis.

UNIT – II:

Advanced Kinematics of Plane Motion - II: Polode curvature, Hall's Equation, Polodecurvature in the four bar mechanism, coupler motion, relative motion of the output and input links, Determination of the output angular acceleration and its Rate of change, Freudenstein'scollineation –axis theorem, Carter –Hall circle, The circling – point curve for the Coupler of a four bar mechanism.

UNIT – III:

Introduction To Synthesis-Graphical Methods - I: The Four bar linkage ,Guiding a bodythrough Two distinct positions, Guiding a body through Three distinct positions, The Roto center triangle , Guiding a body through Four distinct positions, Burmester's curve.

UNIT – IV:

Introduction To Synthesis-Graphical Methods - II: Function generation- Generaldiscussion, Function generation: Relative – Roto center method, Overlay's method, Functiongeneration-Velocity – pole method, Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.

UNIT – V:

Introduction To Synthesis - Analytical Methods: Function Generation: Freudenstien'sequation, Precision point approximation, Precision – derivative approximation, Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition, Method of components, Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link, Method of components.

Text Books:

1. Kinematics and Dynamics of plane mechanisms/ Jeremy Hirschhorn/McGraw-Hill, 1962.
2. Theory of Machines and Mechanisms/ J. E Shigley and J.J .Uicker Jr./ McGraw-Hill, 1995.

References:

1. Design of machinery / Robert L Norton third edition/ McGraw-Hill 2004
2. Theory of Mechanisms and Machines/ Amitabh Ghosh and Ashok Kumar Mallik/ E. W. P. Publishers.
3. Kinematic Linkage Design/ Allen S.Hall Jr./ PHI,1964.
4. Kinematics and Dynamics of Machinery/Charles E Wilson/Pearson/3rd Edition.

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I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	INDUSTRIAL ROBOTICS						**PE-III**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Kinematics of Machinery, Dynamics of Machinery	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To classify different types of robot configurations and their anatomy.
2. To analyze the position and velocity kinematics of a robot arm.
3. To model the dynamics of a robot arm, implement in 2D.
4. To construct, program and test the operation of a robotic system to perform a specified task.
5. To classify and design different robotic work cells and their importance in industries.

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

1. Understand the evolution, classification, structures and drives for robots.
2. Summarize the kinematic arrangement of robots and its applications in the area of manufacturing sectors.
3. Solve different dynamics related problems associated with the robots.
4. Classify different types of programming methods for robots.
5. Expose the students to build a robot for any type of application.

UNIT-I:

Introduction: Automation and Robotics, Robot anatomy configuration, joint motion and notation, work volume, robot drive system, control system and dynamic performance, precision of movement.

Control System and Components: basic concept and modals controllers control system analysis, robot actuators and feedback components (sensors): Internal & External Sensors, Positions sensors, velocity sensors - Desirable features, tactile, proximity and range sensors, uses sensors in robotics, Power Transmission Systems.

UNIT-II:

Motion Analysis and Control: Manipulator kinematics, position representation Homogeneous transformation, D-H Notation, D-H Transformation Matrix, Forward & Inverse transformations, problems on planar & spatial manipulators, Differential Kinematics, Jacobian Formulation, problems, manipulator path control: Slew, Joint Interpolated & Straight line motions, trajectory planning: Joint space scheme, Cartesian space scheme, Cubic Polynomial fit without and with via point, blending.

UNIT-III:

Robot Dynamics: Lagrange – Euler & Newton - Euler formulations, problems on two link planar manipulators, configuration of robot controller.

End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.

Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

UNIT-IV:

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations. Robot Languages: Textual robot languages, Generation, Robot language structures, Elements and functions.

UNIT-V:

Robot Cell Design and Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work cell design, Work cell control, Inter locks, Error detection and Work cell **controller. Robot Applications:** Material transfer, Machine loading/unloading Processing operations, Assembly and Inspection, Future Applications.

Text Books:

1. Industrial robotics by Mikell P.Groover, McGraw Hill
2. Robotics by K.S.Fu, McGraw Hill.

Reference:

1. Introduction to Robotics Mechanics & Control by John J.Craig, Pearson
2. Robot Analysis by Lung Wen Tsai, John Wiley & Sons
3. Robot Analysis and Control by Asada H. and J. E. Slotin, Wiley, New York.

ANURAG UNIVERSITY

School of Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	PRODUCT DESIGN AND DEVELOPMENT						**PE - III**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Design of Machine Elements.	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To understand the need of Product Development, customer needs and product management.
2. To explore concept generation and selection based on customer needs.
3. To have knowledge on component standardization and integrated design process.
4. To interpretthe quality of industrial design based on customer needs.
5. To estimate the manufacturing cost and understand the basics of prototyping.

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

1. Plan the need of Industrial Product Development, customer needs and design aspects of new products.
2. Able to involve customer into the development of new products and managing requirements.
3. Able to understand the Industrial design and develop the product architecture accordingly.
4. Investigate the customer requirement and survey of problems
5. Design for manufacturing and do prototyping for new projects.

UNIT – I:

Introduction: Need for IPPD – strategic importance of product development – integration ofcustomer, designer, material supplier and process planner, Competitor and costumer – behavior analysis

Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

UNIT – II:

Concept generation and concept selection: Activity of concept generation – Structured approaches– Five step Method: clarify – Search-Externally and internally – explore systematically – reflect on the solutions and processes – Concept selection – Integral part of PDD process-methodology – benefits.

UNIT – III:

Product architecture: Implications – Product change – variety – component standardization

– Product performance – manufacturability

Industrial design: Assessing the need for industrial design, impact – design process Integrate design process – assessing the quality of industrial design.

Robust design - introduction, various steps in robust design.

UNIT – IV:

Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT – V:

Design for manufacturing: Definition – Estimation of Manufacturing cost – reducing the componentcosts and assembly costs –cost of supporting production. Minimizing System complexity.

Prototyping: Prototype basics – Principles of prototyping – planning for prototypes – Economicanalysis. Understanding and representing tasks – baseline project planning – accelerating the project execution.

Text Books:

1. Product Design and Development / Kari T. Ulrich and Steven D. Eppinger /McGraw Hill International Edns. 1999.
2. Effective Product Design and Development / Stephen Rosenthal / Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.

References:

1. Concurrent Engg/ integrated Product development / Kemnneth Crow / DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310)377-569, Workshop Book.
2. Tool Design – Integrated Methods for Successful Product Engineering / Staurt Pugh / Addison Wesley Publishing, Neyourk, NY, 1991, ISBN 0-202-41639-5.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	EXPERIMENTAL STRESS ANALYSIS						**PE- III**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Strength of Materials	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To recognize the various techniques available to measure the stress and strains using different sources.
2. To realize the working of recording instruments and data logging methods
3. To identify the crack growth by applying brittle coatings.
4. To know the principles of photo elasticity in two dimensional stress analyses
5. To acquire the knowledge of birefringent coatings.

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

1. Understand the overall concepts of stress/strain analysis by experimental means
2. Able to identify where the continuous variation of the magnitude is going to change for a particular period.
3. Analyze the crack propagation in a material and also the displacement fields can be measured by moiré methods.
4. Determine the stress distribution in a material when it is subjected to Mechanical deformation.
5. Analyze the effectiveness of coating thickness and also adequate results of stresses can be analyzed by different techniques of three dimensional photo elasticity.

UNIT I:

Introduction**,** Theory of Elasticity, Plane stress and plane strain conditions, compatibility conditions, problem using plane stress and plane strain conditions, three-dimensional stress strain relations.

Strain measurement methods: various types of strain gauges, electrical resistance strain gauges, semiconductor strain gauge circuits.

UNIT II:

Recording Instruments: Introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies, telemetry systems.

UNIT III:

Brittle Coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.

Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to moiré-fringe analysis, the displacement field approach to Moire-fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of moiré-fringes, experimental procedure and techniques.

UNIT IV:

Photo Elasticity: Photo elasticity, polariscope, plane and circularly polarized light, bright and dark filed setup, photo elasticity materials, Isochromatic fringes – Isoclinics.

UNIT V:

Three Dimensional Photo Elasticity: Introduction, locking in model deformation, materials for three dimensional photo elasticity, machining cementing and slicing three dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear-difference method in three dimensions, applications of the Frozen-stress method, the scattered-light method.

Birefringent coating: Introduction, coating stress and stains, coating sensitivity, coating materials, application of coatings, effective of coating thickness, fringe-order determinations in coatings, stress separation methods.

Text Books:

1. Theory of elasticity / Timoshenko and GoodierJr.
2. Experimental Stress analysis/ Dally and Riley, McGraw-Hill

References:

1. A treatise on Mathematical theory of elasticity / LOVE A.H./ DoverPublications
2. Photo Elasticity / Frocht/ Wiley / 3rdEdition
3. Experimental Stress Analysis / Sadhu singh / KhannaPublications

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	DESIGN AND ANALYSIS OF EXPERIMENTS						**PE - IV**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Probability and Statistics	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To study different types of formal experimental designs such as completely randomized, randomized block and factorial experimental designs.
2. To study fundamental concepts including continuous probability distributions, random sampling, hypothesis testing and analysis of variance.
3. To describe how to design experiments, carry out them and analyze the data.
4. To learn the technique of regression analysis.
5. To discuss the optimization techniques such as response surface methodology and Taguchi methods.

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

1. Make use of the basics of the Design of Experiments such as randomization, replication and blocking.
2. Familiarize with basic concepts of probability and statistics such as random variables, random sampling and hypothesis testing.
3. Understand the process of designing an experiment and choose appropriate design of experiments.
4. Understand the concepts of response surface methodology and regression analysis.
5. Apply the Taguchi method to identify significant factors that influence the process.

UNIT - I:

Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, historical perspective of experimental approaches, Steps in experimentation, principles of experimentation

UNIT - II:

Simple comparative experiments: Basic concepts of probability & statistics, comparison of two means and two variances, comparison of multiple (more than two) means and ANOVA

UNIT - III:

Experimental designs: Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays and interaction tables, modifying orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data

UNIT - IV:

Response surface methodology: Concept, linear model, steepest ascent, second order model, regression.

UNIT - V:

Taguchi's Parameter Design: Concept of robustness, noise factor, objective function & S/N ratios, inner array & outer array design, data analysis

References:

1. Montgomery DC, Design and Analysis of Experiments, 7^{th} Edition, John Wiley & Sons, NY, 2008.
2. Ross P J , Taguchi techniques for Quality Engineering, McGraw-Hill Book Company, NY, 2008

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	THEORY OF ELASTICITY AND PLASTICITY						**PE - IV**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Strength of Materials	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To impart knowledge on basic concepts of theory of elasticity and problems in rectangular and polar coordinates.
2. To impart the knowledge of stresses and strains in three dimensional bodies.
3. To know the knowledge of bending stresses induced in beams.
4. To know the yield criteria for ductile materials and to understand the plastic stress-strain relations.
5. To impart the knowledge of various methods of solving practical problems.

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

1. Understand the stress strain relations for different types of elastic body.
2. Analyze the stresses and strains for three dimensional elements.
3. Solve the problems on bending for different shaped bars.
4. Analyze the structure of metal when it is in plastic state.
5. Solve the problems by characteristic and engineering methods.

UNIT I: Elasticity: Two dimensional stress analysis - Plane stress - Plane strain - Equations of compatibility - Stress function - Boundary conditions.

Problems In Rectangular Co-ordinates -Solution by polynomials – Saint Venent's principles - Determination of displacement - Simple beam problems.

Problems In Polar Coordinates - General equations in polar coordinates – Stress distribution symmetrical about axis - Strain components in polar coordinates – Simple and symmetric problems.

UNIT II:

Analysis of Stress And Strain In Three Dimensions: Principle stresses - Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain.

General theorems: Differential equations of equilibrium and compatibility - Displacement - Uniqueness of solution - Reciprocal theorem.

UNIT III:

Bending of Prismatic Bars: Stress function - Bending of cantilever beam – Beam of rectangular cross-section - Beams of circular cross-section.

UNIT IV:

Plasticity: Plastic deformation of metals - Structure of metals - Deformation – Creep stress relaxation of deformation - Strain rate condition of constant maximum shear stress - Condition of constant strain energy - Approximate equation of plasticity.

UNIT V:

Methods of Solving Practical Problems: The characteristic method – Engineering method - Compression of metal under press - Theoretical and experimental data drawing.

Text Books:

1. Theory of Elasticity/Timoshenko S.P. and Goodier J.N./Koakusha Publishers
2. An Engineering Theory of Plasticity/E.P. Unksov/Butterworths

References:

1. Applied Elasticity/W.T. Wang/TMH
2. Theory of Plasticity for Engineers/Hoffman and Sacks/TMH
3. Theory of Elasticity and Plasticity/Sadhu Singh/ Khanna Publishers
4. Theory of Elasticity and Plasticity/Harold Malcolm Westergaard/Harvard University Press.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	VEHICLE DYNAMICS						**PE - IV**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Theory of Machines, Automobile Engineering	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To understand fundamental principles, 2D mechanisms, vehicle kinematics and dynamics
2. To understand 3D mechanisms and 3D vehicle design
3. To get knowledge of Bond graph technology
4. To know about steering mechanisms and dynamics of vehicle rollovers
5. To understand various functions involved in wheeled vehicle handling.

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

1. To understand vehicle kinematics and dynamics, 2D mechanisms and mechanics involved in vehicle terrain interaction, Fundamentals.
2. To understand 3D mechanisms and remember fundamentals of 3D vehicle design.
3. To understand suspension design and Analyze computer models and vehicle performance.
4. To analyze steering mechanisms, forces and moments involved
5. To understand vehicle handling system and Analyze torque and speeds required to skid steering a tracked vehicle.

UNIT - I: Introduction- Fundamental Principles, Vehicle tires performance, cornering characteristics,Mechanics of Vehicle Terrain interaction. Vehicle Kinematics, Fundamental principles of velocity, acceleration. Two dimensional mechanisms, Forward Vehicle Dynamics.

UNIT - II: Three dimensional Mechanisms, Multi-Body Systems Design, Introduction to 3D vehicle design.

UNIT- III: Suspension Design: Computer models using Bond Graph Technology, Drive train dynamics, vehicleperformance

UNIT– IV: Steering Mechanisms: Two and three dimensional analysis, Mechanics of Vehicle Terraininteraction. Vehicle Collations, Fundamental laws of motion, energy and momentum, Forces and Moments 2D and 3D. The Dynamics of vehicle rollovers.

UNIT- V: Wheeled Vehicle Handling – Handling control loop, vehicle transfer function, Kinematic behavior of vehicles with rigid wheels and with complaint tyres: Neutral steer point, static margin, over and under-steer. Solution with two degree of freedom in the steady state: Stability factor, characteristic and critical speeds. Tracked Vehicle Handling – Analysis of sprocket torques and speeds, required to skid steer a tracked vehicle. Extension of theory to include three degrees of freedom.

Text Books:

1. Vehicle Dynamics: Theory and Application/Reza Jazar/Springer 2008
2. Theory of Ground Vehicles/ J. Y. Wong/ John Wiley.

References:

1. Vehicle stability/ Dean Karnopp/ Dekker Mechanical Engineering
2. Modeling& Simulation of Mechatronics Systems/ Karnoop Margolis, Rosenberg,/Wiley/2007.
3. Suspension and Tyres / Giles J.G. Steering/ Illiffe Books Ltd., London.
4. Fundamental of Vehicle Dynamics/ Gillespie/ T.D, SAE USA.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	ADVANCED OPTIMIZATION TECHNIQUES AND APPLICATIONS						**OE- II**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Operations Research	L	T	D	P	30	70	3
	3	0	-	0			

Course Objectives:

1. To evaluate Numerical optimization techniques for single variable optimization problems.
2. To solve multi variable optimization problems for un constrained problems.
3. To formulate GP model and solve it using arithmetic geometric inequality theorem and to understand the applications of Dynamic Programming.
4. To make use of sensitivity analysis on LPP queuing, Simulation of inventory, queuing problems.
5. To relate stochastic programming problem for finding mean, variance of random variables, and apply Geometry cutting plane method & branch bound method for linear IPP.

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

1. Formulate appropriate optimization techniques and solve a variety of examples taken from various fields of engineering.
2. Solve various multivariable un constrained problems.
3. Formulate GP model and solve it.
4. Make sensitivity analysis to study effect of changes in parameters of LPP on the optimal solution without reworking. Simulate the system to estimate specified performance measures.
5. Apply chance constrained algorithm and solve stochastic linear programme. Solve integer programming problem by either geometry cutting plane algorithm or branch band method.

UNIT- I: Single Variable Non-Linear Unconstrained Optimition: One dimensional Optimization methods:- Uni-modal function, elimination method, Fibonacci method, golden section method, nterpolation methods- quadratic & cubic interpolation methods.

UNIT – II:

Multi Variable Non-Linear Unconstrained Optimization: Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method. Variable metric method.

UNIT – III:

Geometric Programming: Polynomials – arithmetic – geometric inequality – unconstrained G.P – constrained G.P

Dynamic Programming: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

UNIT- IV:

Linear Programming: Formulation – Sensivity analysis. Change in the constraints, cost coefficients , coefficients of the constraints, addition and deletion of variable, constraints. Simulation – Introduction – Types – Steps – application – inventory – queuing – thermal system.

UNIT- V:

Integer Programming: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

Stochastic Programming: Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, co variance, joint probability distribution – stochastic linear, dynamic programming.

Text Books:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar

References:

1. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
2. Operation Research/H.A. Taha/TMH
3. Optimization in operations research/R.L Rardin
4. Optimization Techniques/Benugundu & Chandraputla/Person Asia.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	SIGNAL ANALYSIS AND CONDITION MONITORING						**OE-II**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
--	3	0	-	0	30	70	3

Course Objectives:

1. To understand Fourier analysis, signal analysis, and analyzer types.
2. To get knowledge of stationary signals and filter analysis.
3. To understand Non stationary signals and window types.
4. To know about various analysis of bandwidths.
5. To understand about condition monitoring in real systems.

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

1. Understand Fourier analysis, bandwidths, Detectors, recorders.
2. Analyze stationary signals using various types of analysis
3. Analyze on stationary signals and scale the results
4. Understand analysis of various bandwidths
5. Understand condition monitoring in various mechanical systems.

UNIT-I: Introduction, Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution.Signal analysis: Filter response time. Detectors. Recorders. Analog analyzer types.

UNIT-II: Practical Analysis of Stationary Signals: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.

UNIT-III: Practical Analysis of Continuous Non-Stationary Signals: Choice of window type, Choice of window length, Choice of incremental step, Practical details, Scaling of the results.

UNIT-IV: Practical Analysis of Transients: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth), Analysis by repeated playback (variable bandwidth).

UNIT-V: Condition Monitoring In Real Systems: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards onvibrations.

Text Books:

1. Condition Monitoring of Mechanical Systems / Kolacat.
2. Mechanical Vibrations Practice with Basic Theory / V. Ramamurti/ Narosa Publishing House.

References:

1. Frequency Analysis /R. B. Randall.
2. Theory of Machines and Mechanisms/ Amitabh Ghosh & AK Malik/ EWP.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	COMPUTER AIDED TESTING, ANALYSIS AND MODELLING LAB						**LAB**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
--	L	T	D	P	30	70	2
	0	0	-	3			

TESTING

1. Preparation and study of the Micro Structure of ferrous metals and alloys.
2. Preparation and study of the Microstructure of nonferrous metals and alloys.
3. Effect of tempering time on the hardness of quenched carbon steels.
4. Effect of tempering temperature on the hardness of a hardened carbon steels.
5. Preparation of metallic specimens by electro polishing.
6. Study of work hardening characteristics of a pure metal.
7. Determination of carbon percentage in the given ferrous specimen.

MODELING

1. Surface modeling.
2. Solid modeling.
3. Drafting.
4. Assembling.

ANALYSIS OF STRUCTURES USING FEA PACKAGES

1. Static Analysis.
2. Modal Analysis.
3. Harmonic Analysis.
4. Spectrum Analysis.
5. Buckling Analysis.
6. Analysis of Composites.
7. Fracture mechanics.
8. Transient analysis

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						Open Electives offering to other Departments
	INDUSTRIAL SAFETY						**OE**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	0	-	0	30	70	3

Course Objectives:

1. To impart knowledge of different aspects of engineering safety.
2. To focus on tools, techniques and methodologies need for prevention of accidents.
3. To discuss advantages and applications of corrosion prevention methods.
4. To know the importance of fault tracing methods.
5. To analyze preventive and periodic maintenance of mechanical and electrical components.

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

1. Understand the basic safety terms.
2. Recognize types and applications of tools used for maintenance.
3. Learn various types of wear and corrosion and their prevention
4. Understand the concepts of fault tracing and importance.
5. Understand advantages and applications of preventive and periodic maintenance of mechanical and electrical components.

UNIT-I: Industrial Safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II: Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III: Wear and Corrosion and Their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT-IV: Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V: Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Text Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

References:

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

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DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech I Semester (Machine Design)

Course Code	Course Title						Open Electives offering to other Departments
	OPERATIONS RESEARCH						**OE**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	0	-	0	30	70	3

Course Objectives:

1. Concepts and tools to help them understand the operations research and various methods.
2. Teach students about networking, inventory, queuing models.
3. Understand the importance of project management and simulations method in industry.
4. To impart knowledge about dynamic programming and optimization techniques.
5. Teach students about mathematical models for optimization.

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

1. Solve linear programming problems by simplex method and other techniques and formulate the problems in scheduling.
2. Analyze various OR models like Game theory, Queuing, Inventory control etc and apply them for optimization.
3. Usage of Network diagrams and simulation for solving problems.
4. Application of dynamic programming in industry and basics of Optimization Techniques.
5. Formulate mathematical models for optimization problems

UNIT–I: Introduction to Operations Research –Linear Programming - Mathematical Formulation –Graphical method –Simplex method, Duality. Sequencing Models: Problem with N jobs and 2 machines –n jobs and 3 machines problem.

UNIT-II: Game Theory: Competitive games -Useful terminology -Rules for game theory -Two person zero sum game –Property of dominance -Graphic solution –Algebraic method.

Queuing Models: Poisson arrivals and Exponential service times –Single channel models and Multi-channel models. **Inventory Control:** Necessity for maintaining inventory -Inventory costs-Inventory models with deterministic demand -inventory models with probabilistic demand.

UNIT-III: Project Management: Introduction -Phases of project management-Construction of Network diagrams-Critical path method (CPM) and Project evaluation and review technique (PERT).

Simulation: Basic concepts, Advantages and disadvantages -Random number generation -Monte Carlo Simulation applied to queuing problems.

UNIT-IV: Dynamic Programming: Multistage decision process, principles of optimality, application of dynamic programming, examples.

Optimization Techniques: Introduction to optimization techniques. Non – linear programming problem: Kuhn – Tucker conditions with min cost flow and max cost flow problems.

UNIT-V: Linear Programming: Sensitivity analysis – change in the constraints, cost coefficients, coefficients of the constraints. Parametric Programming.

Geometric Programming, Flow in Networks, Elementary Graph Theory.

Text books:

1. Kanti Swarup, P K Gupta, Man Mohan, Operations Research, Sultan Chand &Sons, 2014.
2. Sharma J K -Operations Research, Pearson.

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008.
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009.
5. Pannerselvam, Operations Research: Prentice Hall of India 2010.

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I M. Tech I Semester (Machine Design)

Course Code	Course Title						Open Electives offered to other Departments
	COMPOSITE MATERIALS						**OE**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
--	3	0	-	0	30	70	3

Course Objectives:

1. To introduce the concept of composite materials and classify composite materials.
2. To familiarize the functional requirements of reinforcement and matrix .
3. To elaborate the mechanical behavior of composites.
4. To give exposure to manufacturing of composites.
5. To extend the knowledge of laminate strength and laminate failure.

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

1. Understand the concept of composite materials and classify composite materials.
2. Explain the functional requirements of reinforcement and matrix.
3. Analyze the mechanical behavior of composites.
4. Apply failure criteria to various composites.
5. Relate laminar strength to laminate strength.

UNIT–I: Introduction: Definition – Classification and characteristics of Composite materials, Advantages and application of composites, Functional requirements of reinforcement and matrix, Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT–II: Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT–III: Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of

Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–IV: Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT–V: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Text Books:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W.

ANURAG UNIVERSITY

School of Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

I M. Tech II Semester (Machine Design)

Course Code	Course Title						PC/PE/OE
	PEDAGOGY STUDIES						**Audit Course**
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
Research Methodology and Teaching Learning Methods.	L	T	D	P	0	0	0
	2	-	-	-			

Course Objectives: Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes: Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Syllabus:

Units Content Hours:

1. **Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions and Overview of methodology and Searching.
   Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.
2. **Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage:** quality assessment of included studies.
   - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
   - Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.
3. **Professional development:** alignment with classroom practices and follow-up support

- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes.

4. Research gaps and future directions:

- Research design
- Contexts

5. Model Curriculum of Engineering & Technology PG Courses [Volume-I] [46]

- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact.

Suggested Reading:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.