PRASAD V POTLURI SIDDHARTHA INSTITUTE OF TECHNOLOGY
(Autonomous)

Academic Regulations for Two Year M. Tech Programme
(PVP 22)
(w.e.f. the Academic Year 2022-23)

MACHINE DESIGN

DEPARTMENT OF MECHANICAL ENGINEERING

PRASAD V. POTLURI SIDDHARTHA INSTITUTE OF TECHNOLOGY
(Autonomous)
AICTE approved, NBA & NAAC Accredited, An ISO 9001:2015 certified Institution
Permanently Affiliated to Jawaharlal Nehru Technological University
Kakinada
Kanuru, Vijayawada -520 007, Andhra Pradesh
Phone:0866 2581699
e-mail: principal@pvpsiddhartha.ac.in
www.pvpsiddhartha.ac.in

w.e.f. A.Y 2022 – 2023

PRASAD V. POTLURI
SIDDHARTHA INSTITUTE OF TECHNOLOGY
(Autonomous)

Kanuru, Vijayawada – 520 007

Approved by AICTE, Accredited by NBA & NAAC, An ISO 9001:2008 Certified Institution
Permanent Affiliation to JNTUK, Kakinada

Academic Regulations for Two Year M. Tech Programme (PVP 22)
(w.e.f. the Academic Year 2022-23)

CONTENTS

1. INTRODUCTION

Academic Programmes of the Institute are governed by rules and regulations approved by the Academic Council, which is the highest Academic body of the Institute. These academic rules and regulations are effective from the academic year 2022-23 for students admitted into two year postgraduate programme offered by the Institute leading to Master of Technology (M.Tech) in various specializations offered by respective departments as given in Table 1.

2. PROGRAMMES OFFERED

Currently, the Institute is offering M.Tech programmes in the following disciplines:

Table 1: List of Specializations

Sl. No.	Specialization	Offering Department
1	Microwave & Communication Engineering	Electronics and Communication Engineering
2	Machine Design	Mechanical Engineering

3. DURATION OF THE PROGRAMME

The duration of the programme is two academic years consisting of four semesters. A student is permitted to complete the M.Tech programme in a stipulated time frame of 4 years from the date of admission. Otherwise they shall forfeit their seat in M.Tech programme and their admission shall stand cancelled.

4. MINIMUM INSTRUCTION DAYS

Each semester normally consists of a minimum of 90 instruction days.

5. ELIGIBILITY CRITERIA FOR ADMISSION

The eligibility criteria for admission into M.Tech programme shall be as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE) & AICTE from time to time.

6. REGISTRATION

A student shall register for courses in each semester at the beginning of every semester according to the choice provided and courses offered by the concerned department.

7. MEDIUM OF INSTRUCTION

The medium of instruction and examination is English.

8. PROGRAMME STRUCTURE

Every specialization of M.Tech programme shall have theory courses and practical courses along with Term Paper/ Mini project/ Seminar in the first and second semesters. Pedagogy training/ Industrial training shall be for a period of 4 weeks at the beginning of third semester followed by a Dissertation in third and fourth semesters.

8.1 Course Code and Course Numbering Scheme

Course Code consists of 9/ 10 characters which is specified by Regulation, department, programme, semester number, type of course, course number & elective code. The details are described in Tables 2, 3, 4 & Figure - 1.

Table 2: Third and Fourth Characters description

Characters	Name of the Department
EC	Electronics & Communication Engineering
ME	Mechanical Engineering

Table 3: Fifth and Sixth Characters description

Characters	Name of the Programme
MC	Microwave & Communication Engineering
MD	Machine Design

Table 4: Course Type description

Course Type Character	Description
T	Theory course
L	Laboratory /Practice course
TR	Pedagogy training/ Industrial training
DS-A	Dissertation Part-A
DS-B	Dissertation Part-B

For example, the annotation of the course **22MEMD1T5A is** as given in Figure-1below.

2	2	M	E	M	D	1	T	5	A
Year of Framing the Regulations		Department Code		Specialization code		Semester number	Course type	(optional) Course number	(optional) Elective code

Figure - 1: Course code description

8.2 Contact Hours and Credits

The Course Credits are broadly fixed based on the following norms.

- Theory – One Lecture period is assigned 1 credit
- Laboratory – Three periods are assigned 2 credits and two periods are assigned 1 credit
- Mini project /Term Paper/Seminar is assigned 2 credits
- Pedagogy training/Industrial training is conducted for four weeks and is assigned 2 credits
- Dissertation is assigned 16 credits
- However, some courses are prescribed with fixed number of credits depending on the complexity of the subject and relative importance.

8.3 Theory classes

Each course is prescribed with fixed number of lecture periods per week. During lecture periods, the course instructor shall deal with the concepts of the course.

8.4 Laboratory Courses

A minimum prescribed number of experiments/ programs have to be performed by the students, who shall complete these in all respects and get each experiment evaluated by course instructor concerned and certified by the Head of the Department concerned at the end of the semester.

8.5 Programme Credits

Each discipline of the M.Tech programme is designed to have a total of 74 credits and the student shall have to register for all the courses prescribed in the curriculum and secure all 74 credits for award of the degree.

9. SYLLABUS

As approved by the BOS of concerned department and ratified by Academic Council.

10. ELIGIBILITY REQUIREMENT FOR APPEARING AT SEMESTER END EXAMINATION AND CONDONATION

10.1 A candidate shall be deemed to have eligibility to write his end semester examinations if he has put in at least 75% of attendance in that semester, which is computed by totalling the number of periods of lectures, practical courses and Dissertation (as the case may be), held in that semester with the total number of periods attended by the student in all the courses put together.

10.2 Condonation of shortage in attendance may be recommended by respective Heads of Departments on genuine medical grounds, provided the student puts in at least 65% attendance as calculated above and provided the Principal is satisfied with the genuineness of the reasons and the conduct of the student.

10.3 Students, having shortage of attendance percentage less than 75 and greater than or equal to 65, shall have to pay requisite fee towards condonation.

10.4 A student who gets less than 65% attendance in that semester shall not be permitted to take the end semester examinations. His registration for those courses in that semester will be cancelled. The student shall re register for that semester and repeat those courses of that semester as and when they are offered next.

10.5 The candidate should secure a minimum of 50% aggregate marks in internal examinations conducted for theory and laboratory courses in that semester, to be eligible to write semester end examinations.

10.6 A student, who does not satisfy the attendance and/or internal marks requirement, shall have to repeat that semester.

11. EXAMINATIONS AND SCHEME OF EVALUATION

11.1 INTERNAL EXAMINATIONS:

11.1.1 Theory Courses

Each course is evaluated for 4**0** marks (a+b).

a) Two mid term examinations each for 30 marks will be conducted for 90 minutes duration in every theory course in a semester. The First mid examination will be conducted in Units 1 & 2 of the syllabus, and the second mid examination will be conducted in Units 3 & 4 of the syllabus. The mid examination marks shall be awarded by calculating the average of the marks secured in the two mid term examinations.

There shall be two questions from each unit of syllabus prescribed. Any one question from each unit has to be answered. Each question carries 15 marks.

b) Two home assignments each for 10 marks are to be conducted for each course after completion of First & Third units of Syllabus. The assignment marks shall be awarded by calculating the average of the marks secured in the two Assignments.

Students shall be informed regarding the home assignment and they have to submit the completed assignment within the prescribed period.

NOTE: A student who is absent for any Mid Term Exam or non submission of assignment, for any reason whatsoever, shall be deemed to have scored zero marks in that Exam/ Assignment.

11.1.2 Laboratory Courses:

For Laboratory courses there shall be continuous evaluation during the semester for 25 internal marks. The distribution of internal marks is given below:

Criteria	Marks
Day to Day work	10
Record	05
Internal Examination	10

11.1.3 Term Paper/ Mini Project/ Seminar:

Two internal reviews are to be conducted for Term Paper/ Mini Project/ Seminar. The distribution of internal marks is given below:

Criteria	Marks
Review -1	10
Review -2 & Viva – Voce	15

11.2 SEMESTER END EXAMINATIONS

11.2.1 Theory Courses: 60 marks

- The Semester end examinations shall be conducted for 3 hours duration at the end of the semester. The question paper shall be given in the following pattern:

Each course shall consist of four units of syllabus. There shall be two questions from each unit of syllabus prescribed. Any one question from each unit has to be answered. Each question carries 15 marks.

11.2.2 Laboratory Courses: 50 marks

- 40 marks are allotted for experiments & 10 marks are allotted for viva-voce examination.
- Each Semester-end Laboratory Examination shall be evaluated by an External Examiner along with an Internal Examiner.

11.2.3 Term Paper/ Mini Project/ Seminar:

The distribution of Semester end examination marks are given below:

Criteria	Marks
Report	30
Seminar & Viva – Voce	20

11.2.4 Pedagogy training/ Industrial training:

- Pedagogy training shall be for a period of at least 4 weeks and evaluation shall be totally internal for 75 marks based on the performance during the training.
- Industrial training shall be for a period of at least 4 weeks and a report has to be submitted by the end of the third semester. The assessment shall be carried out for 75 marks during fourth semester by an internal evaluation committee comprising Head of the Department and two faculty of the department including the project supervisor.

11.2.5 MOOCS

- MOOCS Course can be chosen either from the listed electives III or IV as the case may be, or can be chosen by the student from other sources without having a conflict with the already offered courses of the programme.
- The course will be finalized by a committee constituted at the Department level.
- A mentor has to be identified in the department who would monitor the MOOCS course work from time to time and submit interim reports to the HOD duly signed by the mentor and the student.
- The duration of the course must be within 40-60 contact hours.
- Apart from the online certification the student would be evaluated for 40 marks for internals and 60 marks for external examination.
- The MOOCS course has to be completed as per the academic calendar for the concerned semester.

11.2.6 Dissertation:

Dissertation shall be for a period of at least 40 weeks. There shall be two parts for evaluation:
Part-A: A Status report has to be submitted by the end of third semester which shall be evaluated for 50 marks by the Project Review Committee (PRC) based on the presentation made by student on the topic selected, literature survey and the progress of the work.
Part-B: The Project assessment shall be further carried out for 150 marks during fourth semester by an internal & external evaluation committee comprising Head of the Department, Project Supervisor and an External Examiner appointed by the Principal.

EVALUATION OF DISSERTATION WORK:

Every candidate shall be required to submit the dissertation after taking up a topic approved by the PRC.

a) The PRC shall be constituted with the Head of the Department as the Chairman and two senior faculty as Members along with the supervisor to oversee the proceedings of the dissertation work from allotment of topic to submission.
b) Registration of Dissertation Work: A candidate shall register for the Dissertation work in the beginning of the second year. The duration of the Dissertation work is for two semesters.
c) After satisfying point b, a candidate has to submit, in consultation with his supervisor, the title, objective and plan of action of his Dissertation to the PRC for its approval. Only after obtaining the approval of PRC the student can initiate the Dissertation work.
d) If a candidate wishes to change his supervisor or topic of the Dissertation work he can do so with the approval of the PRC. If so, his date of registration for the Dissertation work shall start from the date of change of supervisor or topic as the case may be whichever is earlier.
e) Evaluation of the Dissertation shall be done twice, one at the end of the third Semester and the other during the fourth Semester.
f) The evaluation at the end of third semester shall be carried out by PRC for 50 marks based on the presentation made by student on the topic selected, literature survey and the progress of the work. The student shall be permitted to proceed for the remaining work in fourth semester if he gets at least 25 marks. Otherwise, the student shall reappear before the PRC with improved work within four weeks.
g) The evaluation during fourth semester shall be carried out twice each for 25 marks.
h) Dissertation is said to be completed only if the work done by the student leads to publication in Peer Reviewed international journal, national journal, international conference and national conference (Preferably in IEEE, ASME, Elseiver, Springer etc proceedings) while evaluating the Dissertation.
i) The candidate shall make an oral presentation before the PRC for the approval to submit a draft copy of the Dissertation. A candidate shall be permitted to submit his Dissertation not earlier than 40 weeks from the date of registration of the Dissertation.
j) Three copies of the Dissertation certified by the supervisor shall be submitted to the Institute after approval by the PRC.
k) For the purpose of adjudication of the Dissertation, an external examiner shall be selected by the Principal from a panel of 5 examiners who are experienced in that field and proposed by the Head of the Department in consultation with the supervisor.
l) The final evaluation, i.e., viva-voce examination, for 100 marks, shall be conducted by a board consisting of the supervisor, Head of the Department and the external examiner.
m) A student is deemed to be failed, if he secures less than 50 marks in the external viva-voce examination and/or less than 100 marks from both internal and external viva-voce examination put together and shall be awarded Fail grade (F).
n) If any candidate fails or does not submit his thesis due to ill health or any other reason permitted by the head of the institution, he will be given another chance to attend for the viva-voce examination conducted separately at a later date. The expenditure for conducting the viva-voce is completely borne by the candidate. If the candidate still fails to complete the project he should reregister into the second year and has to repeat the Dissertation.

12. CONDITIONS FOR PASS AND AWARD OF CREDITS FOR A COURSE

12.1 Conditions for Pass and award of Grades & Credits:

a) A candidate shall be declared to have passed in individual theory course if he secures a minimum of 50% aggregate marks (Internal & semester end examination marks put together), subject to a minimum of 40% marks in semester end examination.

b) A candidate shall be declared to have passed in individual laboratory/project course if he/she secures a minimum of 50% aggregate marks (Internal & semester end examination marks put together), subject to a minimum of 40% marks in semester end examination.

c) The student has to pass the failed course by appearing at the supplementary examination as per the requirement for the award of degree.

d) On passing a course of a programme, the student shall earn assigned credits in that Course.

12.2 Method of Awarding Letter Grades and Grade Points for a Course:

A letter grade and grade points will be awarded to a student in each course based on his/her performance as per the grading system shown in Table - 5.

Table - 5: Grading System for M.Tech Programme

Marks Range Theory/ Laboratory (Max – 100)	Marks Range Mini Project/ Project Work or Dissertation (Max – 100)	Letter Grade	Level	Grade Point
≥ 90	≥ 90	O	Excellent	10
≥ 80 to < 90	≥ 80 to < 90	S	Very Good	9
≥ 70 to < 80	≥ 70 to < 80	A	Good	8
≥ 60 to < 70	≥ 60 to < 70	B	Fair	7
≥ 50 to < 60	≥ 50 to < 60	C	Satisfactory	6
< 50	< 50	F	Fail	0
		AB	Absent	0

12.3 Calculation of Semester Grade Points Average (SGPA)

The performance of each student at the end of the each semester is indicated in terms of SGPA. The SGPA is calculated as below:

$$\textbf{SGPA} = \frac{\sum(CR\ X\ GP)}{\sum \text{CR}}$$

Where CR= Credits of a course

GP = Grade points awarded for a course

12.4 Calculation of Cumulative Grade Point Average (CGPA) and Award of Division for Entire Programme:

The CGPA is calculated as below:

$$\textbf{CGPA} = \frac{\sum(CR\ X\ GP)}{\sum \text{CR}}$$ (for entire programme)

Where CR= Credits of a course
GP = Grade points awarded for a course

12.5 Award of Degree and 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 shall be place in one of the following four choices.

Table 6: Award of Degree and class

Class Awarded	CGPA to be secured	
First class with distinction	≥ 7.75 (Without any supplementary appearance)	From the CGPA secured form 74 credits
First class	≥ 7.75 (With any supplementary appearance) ≥ 6.75 and < 7.75 (Without any supplementary appearance)	
Second class	≥ 6.75 and < 7.75 (With any supplementary appearance) ≥ 6.0 and < 6.75 (Without any supplementary appearance)	
Pass class	≥ 6.0 and < 6.75 (With any supplementary appearance) > 5.0 and < 6.0	

The Grades secured, Grade points and Credits obtained will be shown separately in the memorandum of marks.

13. SUPPLEMENTARY EXAMINATIONS

Supplementary examinations will be conducted along with regular semester end examinations.

14. READMISSION CRITERIA

A candidate, who is detained in a semester due to lack of attendance/marks/credits, has to obtain written permission from the Principal for readmission into the same semester after duly fulfilling all the required norms stipulated by the Institute in addition to paying an administrative fee of Rs. 1000/-

15. RE-REGISTRATION

A candidate, who is unable to secure 50% marks in any course due to lack of internal marks, can re-register for that course(s) of that semester along with subsequent batches of admitted students for one attempt. However he should attend the class work and appear for the internal & external examinations of that course(s) of the semester. Attendance in the re-registered courses(s) has to be calculated separately to become eligible to write the end examination in the re-registered course(s). In the event of taking another chance, the internal marks and end examination marks obtained in the previous attempt are nullified. The re-registration courses for a student at a time should not exceed one course during course work semester and two courses during Dissertation period. An administrative fee of Rs. 2000/- per each semester has to be paid.

16. BREAK IN STUDY

Student, who discontinues the studies for reasons what so ever, can get readmitted into appropriate semester of M.Tech programme only with the prior permission of the Principal of the Institute. However the academic regulations under which he was first admitted shall continue to be applicable to him. An administrative fee of Rs. 2000/- per each year of break in study in addition to the prescribed tuition and special fee has to be paid by the candidate to condone his break in study.

17. TRANSITORY REGULATIONS

A Candidate, who is detained or discontinued in the semester, on readmission will have to continue his studies in the same academic regulations under which he was first admitted.

18. ELIGIBILITY FOR AWARD OF M.TECH DEGREE

The M.Tech Degree shall be conferred on a candidate who has satisfied the following requirement.

- A Regular student (two year programme) should register himself for 74 Credits and has to secure all 74 academic credits.

19. CONDUCT AND DISCIPLINE

- Students shall conduct themselves within and outside the premises of the Institute in a manner befitting the ethical code of the Institute.
- As per the order of Honorable Supreme Court of India and AICTE guidelines, ragging in any form is considered a criminal offence and is banned. Ragging within or outside any educational institution is prohibited. Ragging means doing an act, that causes or is likely to cause insult or annoyance or fear of apprehension or threat or intimidation or outrage of modesty or injury to a student. Any form of ragging will be severely dealt with as per AP Prohibition of Ragging Act-1997 section-4.

Table 7: Punishments for Ragging

Nature of ragging	Punishment
Teasing, embarrassing and humiliating	Imprisonment upto 6 months or fine upto Rs.1,000/- or both
Assaulting or using criminal force or criminal intimidation	Imprisonment upto 1 year or fine upto Rs.2,000/- or both
Wrongfully restraining or confining or causing hurt	Imprisonment upto 2 years or fine upto Rs.5,000/- or both

Causing grievous hurt kidnapping or raping or committing unnatural offence	Imprisonment upto 5 years and fine upto Rs.10,000/-
Causing death or abetting suicide	Imprisonment upto 10 years and fine upto Rs.50,000/-

- A student convicted of an offence under this act and punished with imprisonment for a term of more than six months shall not be admitted in any other educational institution.
- henever any student complains of ragging to the head or manager of an educational institution, such head or manager should inquire into the complaint and if the complaint in prima-facie found true, should suspend the student or students complained against.
- If the head or manager of an educational institution fails or neglects to take action in the manner specified in the Act, the person shall be deemed to have abetted the offence and shall be punished for the offence.
- If a student commits suicide due to or in consequence of ragging, the person who commits such ragging shall be deemed to have abetted such suicide.

The following acts of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures.

i. Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus.
ii. Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.

The following activities are not allowed within the campus:

- Mutilation or unauthorized possession of library books.
- Noisy and unruly behavior, disturbing studies of fellow students.
- Hacking computer systems (such as entering into other person‘s areas without prior permission, manipulation and/or damage of computer hardware and software or any other cyber crime etc.)
- Use of mobile phones in the campus.
- Plagiarism of any nature.
- Any other act of gross indiscipline as decided by the Institute from time to time.
- Commensurate with the gravity of offense, the punishment may be reprimand, fine, expulsion from the institute / hostel, debarment from an examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.
- For an offence committed in (i) a hostel, (ii) a department or in a class room and (iii)

elsewhere, the Chief Warden, the Head of the Department and the Principal, respectively, shall have the authority to reprimand or impose fine.

- Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Principal for taking appropriate action.
- Unauthorized collection of money in any form is strictly prohibited.
- Detained and break-in-study candidates are allowed into the campus for academic purposes only with permission from authorities.
- Misconduct committed by a student outside the Institute campus but having the effect of damaging, undermining & tarnishing the image & reputation of the institution will make the student concerned liable for disciplinary action commensurate with the nature and gravity of such misconduct.
- The disciplinary action committee constituted by the Principal, shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.
- Grievance redressal committee, constituted by the Principal, shall deal with all grievances pertaining to the academic / administrative and disciplinary matters.
- All the students must abide by the code and conduct rules of the Institute.

20. MALPRACTICES

The Principal shall refer the cases of malpractice by students in internal assessment tests and end semester examinations, to a malpractice enquiry committee constituted for the purpose. The committee shall follow the approved scales of punishment.

The committee consists of:

1. Heads of Department (Three)
2. Controller of Examinations
3. Deputy Controller of Examinations

Table 11: Disciplinary action for malpractices/improper conduct in examinations

	Nature of Malpractices/Improper conduct	Punishment
1 (a)	If the candidate possesses or keeps accessible, any paper, note book, programmable calculators, mobile phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in the examination hall but has not made use of (material shall include any marks on the student's body that 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)	If the candidate gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through mobile 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 will be handed over to the police and a case is registered against him.
2	If the candidate 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 is appearing.	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 Dissertation. He 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	If the candidate 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 Dissertation) 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 University 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 will be handed over to the police and a case is registered against him.
4	If the candidate smuggles in an answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the	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 Dissertation and shall not

	examination.	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 other examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	If the candidate 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	If the candidate 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 in or outside the examination hall of any injury to his person or to any of his relations 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 of his relations, or indulges in any other act of misconduct or mischief which results in damage to or destruction of property in the examination hall or any part of the Institute 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.	In case of students of the Institute, 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	If the candidate leaves the exam hall taking away answer script or intentionally tears of 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 Dissertation 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 other examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	If the candidate possesses 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 Dissertation 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.
9	If student of the Institute, who is not a candidate for the particular examination or any person not connected with the Institute indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the Institute: 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 Dissertation. He 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 Institute: Will be handed over to police and a police case will be registered against them.
10	If the candidate 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 Dissertation. He shall not be permitted for the remaining examinations of the subjects of that semester/year.
11	Copying detected 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 Dissertation of that semester/year examinations.
12	If any malpractice is detected which is not covered in the above clauses 1 to 11, shall be awarded suitable punishment.	

Note: Special squads may be formed to oversee the proper conduct of examinations.

21. WITHHOLDING OF RESULTS

If the candidate has not paid any dues to the Institute or if any case of indiscipline is pending against him, the result of the candidate shall be withheld and he will not be allowed into the next higher semester. The recommendation for the issue of the degree shall be liable to be withheld in all such cases.

22. OTHER MATTERS

22.1 The physically challenged students who have availed additional examination time and a scribe during their Intermediate/ EAMCET (AP) examinations will be given similar concessions on production of relevant proof/documents.

22.2 Students who are suffering from contagious diseases are not allowed to appear for internal or end semester examinations.

22.3 The students who have participated in coaching/tournaments held at State/ National/ International levels through University/ Indian Olympic Association during end semester external examination period will be promoted to subsequent semesters till the entire course is completed as per the guidelines of University Grants Commission Letter No. F.1-5/ 88(SPE/PES), dated 18-08-1994.

22.4 The Principal shall deal with any academic problem, which is not covered under these rules and regulations, in consultation with the Heads of the Departments in an appropriate manner and subsequently such actions shall be placed before the Academic Council for ratification. Any emergency modification of regulation, approved in the meetings of the Heads of the Departments, shall be reported to the Academic Council of the Institute for ratification.

23. GENERAL

- The Academic Council may, from time to time, revise, amend or change the regulations, schemes of examination and/or syllabus and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the Institute.
- Wherever the words ―he‖, ―him‖, ―his‖, occur in the regulations, they may include ―she‖, ―her‖, ―hers‖ also.
- The academic regulations should be read as a whole for the purpose of any interpretation.
- In case of any doubt or ambiguity in the interpretation of above rules, the decision of the principal is final.

24. INSTITUTE RULES AND REGULATIONS

- Use of Mobile phones is strictly prohibited inside the Institute academic area.
- Students should come to Institute in proper dress.
- All students should wear identity cards in the Institute premises.
- Students should be present in their respective classrooms by start time of class sharply.
- Students should not leave the Institute premises without prior permission of their respectiveHeads during Institute working hours.
- Students should maintain silence in the class rooms during working periods.
- Sitting / wandering of the students at the stair cases, corridors, cycle stands or the areas withinthe Institute premises is strictly prohibited.
- Vehicle horn inside the campus is prohibited.

Prasad V. Potluri Siddhartha Institute of Technology, Vijayawada
M.Tech (Machine Design)

PROGRAMME STRUCTURE

Semester-I							
Course code	**Course name**	**Period**	**Week**	**Internal marks**	**End Exam marks**	**Total**	**Credits**
		L	P				
22MEMD1T1	Advanced Mechanics of Solids	4	----	40	60	100	4
22MEMD1T2	Pressure Vessel Design	4	----	40	60	100	4
22MEMD1T3	Mechanical Vibrations	4	----	40	60	100	4
22MEMD1T4	Geometric Modelling	4	----	40	60	100	4
22MEMD1T5	Elective-I	4	----	40	60	100	4
22MEMD1T6	Elective-II	4	----	40	60	100	4
22MEMD1L1	Machine Dynamics Lab	----	3	25	50	75	2
22MEMD1L2	Computer Aided Modelling Lab	----	3	25	50	75	2
	Total	**24**	**6**	**290**	**460**	**750**	**28**
Semester-II							
22MEMD2T1	Mechanism Design and Synthesis	4	----	40	60	100	4
22MEMD2T2	AI and ML of Mechanical Systems	4	----	40	60	100	4
22MEMD2T3	Finite Element Methods in Engineering	4	----	40	60	100	4
22MEMD2T4	Advanced Robotics	4	----	40	60	100	4
22MEMD2T5	Elective-III	4	----	40	60	100	4
22MEMD2T6	Elective-IV/MOOCS	4	----	40	60	100	4
22MEMD2L1	Analysis Lab	----	3	25	50	75	2
22MEMD2L2	Mini Project/Term Paper	----	3	25	50	75	2
	Total	**24**	**6**	**290**	**460**	**750**	**28**
Semester-III							
	Pedagogy Training/Industrial Training	----	----	75	----	75	2
	Dissertation-Part-A	----	----	50	----	50	6
	Total	**----**	**----**	**125**	**----**	**125**	**8**
Semester-IV							
	Dissertation-Part-B	----	----	50	100	150	**10**
	Total Credits (I+II+III+IV)						**74**

Elective	Course Code	Course Name
Elective-I	22MEMD1T5A	Computational Methods
	22MEMD1T5B	Continuum Mechanics and Tensor Analysis
	22MEMD1T5C	Rapid Prototyping
	22MEMD1T5D	Computational Fluid Dynamics
Elective-II	22MEMD1T6A	Theory of Elasticity and Plasticity
	22MEMD1T6B	Mechanics of Composite Materials
	22MEMD1T6C	Design for Manufacturing
	22MEMD1T6D	Tribology
Elective-III	22MEMD2T5A	Fracture Mechanics
	22MEMD2T5B	Theory of Plates and Shells
	22MEMD2T5C	Condition Monitoring
	22MEMD2T5D	Nano Technology
Elective-IV	22MEMD2T6A	Non-destructive Testing
	22MEMD2T6B	Mechatronics
	22MEMD2T6C	Concurrent Engineering
	22MEMD2T6D	Product Design

ADVANCED MECHANICS OF SOLIDS

Course Code	22MEMD1T1	**Year**	I	**Semester**	I
Course Category	Programme core	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Mechanics of Solids
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Understand the concept of theory of elasticity equations for solving various engineering problems.	L2	1
CO2	Study the failure modes of different structural members.	L3	2
CO3	Compute the shear centre for various sections and calculate the bending stresses and deflections of beams under unsymmetrical loading.	L3	3
CO4	Determine the bending stresses in curved beams and stresses in axisymmetric rotating members.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2				2			1		2	3	2
CO 2	3	3	2				2			1		2	3	2
CO 3	3	3	2				2			1		2	3	2
CO 4	3	3	2				2			1		2	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**Theories of stress and strain**: Definition of stress at a point, stress notation, stress in arbitrary plane, stress transformation, principal stresses, strain notation, strain displacement relation, strain compatibility relations, principal strains. **Yield Criteria**: General concepts, maximum Principal Stress Criterion, Maximum Principal Strain Criterion, Strain Energy Density Criterion,	CO 1

	Maximum Shear Stress Criterion, Distortion Energy Density Criterion	
2	**Failure criteria**: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles $N > 10^6$, buckling. **Application of energy methods**: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.	CO 2
3	**Shear Center**: 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.	CO 3
4	**Curved Beam Theory**: Winkler Bach formula for circumferential stress, Limitations, Location of Neutral axis of cross section, stresses in crane hooks, closed ring subjected to concentrated load-stresses in chain links. **Axi-Symmetric Problems**: Rotating Discs, Flat discs, Discs of uniform thickness, Discs of uniform strength.	CO 4

Learning Resources

Text Book(s):

1. Advanced Mechanics of Materials, (6th Edition) by Arthur P. Boresi and Richard J. Schmidt, Wiley India (P.) Ltd, New Delhi, 2012.

References:

1. Advanced strength of materials by Den Hortog J.P., Dover Publications, 1988
2. Advanced Mechanics of Solids by L.S Srinath, Mcgraw Hill Education, 2010.
3. Mechanics of Materials (10th Edition) by B.C Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi Publications, 2015.
4. Strength of Materials (Revised Edition) by R. K. Rajput, S Chand & Pvt. Ltd., 2014.
5. Strength of Materials, (11th Edition) by Dr. Sadhu Singh, Khanna Publishers, New Delhi, 2007.

PRESSURE VESSEL DESIGN

Course Code	22MEMD1T2	**Year**	I	**Semester**	I
Course Category	Programme core	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Design of Machine Elements
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Understanding of the fundamental engineering processes and principles of pressure equipment design.	L2	1,2
CO2	Understand the suitable Pressure vessel materials and their environment.	L2	3,4
CO3	Apply vessel design codes in influencing vessel design features, stresses, materials and inspection/testing requirements.	L3	3
CO4	Design pressure vessels and various parts of vessels	L4	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	1	1			2			1		2	3	2
CO 2	3	3	1	1			2			1		2	3	2
CO 3	3	3	1	1			2			1		2	3	2
CO 4	3	3	1	1			2			1		2	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**INTRODUCTION:** Materials-shapes of Vessels-stresses in cylindrical, spherical and arbitrary, shaped shells. Cylindrical Vessels subjected to internal pressure, wind load, bending and torque-dilation of pressure vessels-conical and tetrahedral vessels.	**CO1**

	THEORY OF THICK CYLINDERS: Shrink fit stresses in built up cylinders-auto frettage of thick cylinders. Thermal stresses in Pressure Vessels.	
2	**THEORY OF RECTANGULAR PLATES:** Pure bending- different edge conditions. **THEORY OF CIRCULAR PLATES:** Simple supported and clamped ends subjected to concentrated and uniformly distributed loads-stresses from local loads. Design of dome bends, shell connections, flat heads and cone openings.	**CO1**
3	**PRESSURE VESSEL MATERIALS AND THEIR ENVIRONMENT:** Introduction, ductile material tensile tests, structure and strength of steel, Leuder's lines, determination of stress patterns from plastic flow observations, behaviour of steel beyond the yield point, effect of cold work or strain 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 crack growth, fatigue life prediction, cumulative fatigue damage, stress theory of failure of vessels subject to steady state and fatigue conditions.	**CO2, CO3**
4	**STRESS CONCENTRATIONS:** Influence of surface effects on fatigue, effect of the environment and other factors on fatigue life, thermal stress fatigue, creep and rupture of metals at elevated temperatures, hydrogen embrittlement of pressure vessel steels, brittle fracture, effect of environment on fracture toughness, fracture toughness relationships, criteria for design with defects, significance of fracture mechanics evaluations, effect of warm prestressing on the ambient temperature toughness of pressure vessel steels.	**CO2, CO4**

Learning Resources

Text Book(s):

1. Theory and design of modern Pressure Vessels by John F. Harvey, Van nostrand reihold company, New York, 1974
2. Pressure Vessel Design and Analysis by Bickell, M.B.Ruizcs, 1998.

References:

1. Process Equipment design- Beowll & Yound Ett, John Wiley & Sons Inc, 1959.
2. Indian standard code for unfired Pressure vessels IS:2825, 1969.
3. Pressure Vessel Design Hand Book, Henry H.Bednar, P.E., C.B.S.Publishers, New Delhi, 1989.

MECHANICAL VIBRATIONS

Course Code	22MEMD1T3	**Year**	I	**Semester**	I
Course Category	Programme core	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Apply the knowledge of mathematics and science to solve the free vibration problems of Single-Degree-of-Freedom Systems.	L3	1
CO2	Identify various types of forced vibration problems and develop the mathematical models, analyze, solve to find the response of Single-Degree-of-Freedom Systems subjected to harmonic excitation.	L3	2
CO3	Identify and develop the mathematical models, analyze, solve to find the free/ forced vibration response of Two-Degrees-of-Freedom Systems and continuous systems	L3	3
CO4	Apply maintenance and condition monitoring techniques to machinery and Diagnose Machinery faults.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1									3	1
CO 2	3	3	1	1									3	1
CO 3	3	3	1	1									3	1
CO 4	3	3	1	1									3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**FREE VIBRATION OF SINGLE-DEGREE-OF-FREEDOM SYSTEMS:** Importance of the Study of Vibration, Elementary Parts of Vibrating Systems,	**CO1**

	Number of Degrees of Freedom, Discrete and Continuous Systems, Classification of Vibration, Vibration Analysis Procedure, Harmonic Motion, Harmonic Analysis, Free Vibration of an Undamped Translational and Torsional Systems, Rayleigh's Energy Method, Free Vibration with Viscous Damping and Coulomb Damping**.**	
2	**HARMONICALLY EXCITED VIBRATION:** Equation of Motion, an Undamped System Under Harmonic Force, Damped System Under Harmonic Force, Damped System Under the Harmonic Motion of the Base, Damped System Under Rotating Unbalance, Transfer-Function Approach, Solutions using Laplace Transform, Frequency Transfer Functions, Representation of Frequency-Response Characteristics	**CO2**
3	**TWO-DEGREE-OF-FREEDOM SYSTEMS:** Free Vibration Analysis of an Undamped System, Coordinate Coupling and Principal Coordinates, Forced-Vibration Analysis, dynamic vibration absorber. **MULTIDEGREE-OF-FREEDOM SYSTEMS:** Influence Coefficients, Potential and Kinetic Energy Expressions, Generalized Coordinates and Generalized Forces Using Lagrange's Equations to Derive Equations of Motion, free vibration of Multi degree-of-Freedom Systems. **Continuous Systems**: Transverse Vibration of a String or Cable, Longitudinal Vibration of a Bar or Rod, Torsional Vibration of a Shaft or Rod, Lateral Vibration of Beams.	**CO3**
4	**PREDICTIVE MAINTENANCE TECHNIQUES**: Basics, maintenance philosophies, Bathtub curve, Classification of maintenance, advantages,and disadvantages of maintenance, plant machinery classifications, and recommendations. Introduction to Condition monitoring, definition, Types of condition monitoring **MACHINERY FAULT DIAGNOSIS USING VIBRATION ANALYSIS:** Unbalance, bent shaft, Eccentricity, Misalignment, looseness, Belt drive problems, gear defects, bearing defects	**CO4**

Learning Resources

Text Book(s):

1. Mechanical Vibrations (5^{th} edition) by Singiresu S. Rao, Pearson Education
2. Machinery vibration Analysis & Predictive Maintenance by Paresh Girdhar, Elsevier publishers

References:

1. Elements of Vibration Analysis (2nd edition) by Leonard Meirovitch, McGraw-Hill
2. Mechanical Fault diagnosis and condition monitoring by R. A .Collacott
3. Mechanical Vibrations: theory and applications by (1st edition) S Graham Kelly, Cengage Learning
4. Vibrations (2nd edition) by Balakumar Balachandran and Edward B. Magrab, Cengage Learning

GEOMETRIC MODELLING

Course Code	22MEMD1T4	**Year**	I	**Semester**	I
Course Category	Programme Core	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Express types of manipulation techniques, mathematical representation schemes for various entities used in geometric modeling.	L3	1
CO2	Formulate algebraic and geometric form of a cubic spline, Bezier, and B-Spline curves and their derivatives.	L3	2
CO3	Develop parametric representation of analytic and synthetic surfaces.	L3	3
CO4	Distinguish various schemes used for construction of solid models.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	3		3	2		1	1			2	3	2
CO 2	2	2	3		3	2		1	1			2	3	2
CO 3	2	2	3		3	2		1	1			2	3	2
CO 4	2	2	3		3	2		1	1			2	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**TRANSFORMATIONS IN GEOMETRIC MODELING**: Introduction, Translation, Scaling, Reflection, Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. **CUBIC SPLINES:** Definition, Explicit and implicit equations, parametric equations. Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four-point form, reparametrization, truncating and subdividing of curves.	**CO1**

2	**BEZIER CURVES**: Bezier curve definition, matrix representation of Bezier curves, Bernstein basis, equations of Bezier curves, properties, derivatives, increasing the flexibility of Bezier curves, degree elevation. **B-SPLINE CURVES**: B-Spline curve definition, properties, convex hull properties of Bspline, knot vectors, B-spline basis function, B-spline curve control, open, periodic, non-uniform B-spline curves, matrix formulation of B-spline curve, end conditions of periodic Bspline curve, equations, and derivatives.	**CO2**
3	**SURFACE MODELLING**: Introduction, Surface Models, Surface Representation. Parametric Representation of Analytic Surfaces - Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Parametric Representation of Synthetic Surfaces - Hermit Bi-cubic Surface, Bezier Surface, B-Spline Surface, Coons Surface, Gaussian curvature.	**CO3**
4	**SOLIDS IN GEOMETRIC MODELING FOR DESIGN:** Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modeling, B-rep of Solid Modelling, CSG approach of solid modelling. Popular modeling methods in CAD.	**CO4**

Learning Resources
Text Book(s): 1. Geometric Modeling (1st edition) by Micheal. E. Mortenson, McGraw Hill Publishers, First edition 2. Elements of Computer Graphics (1st edition) by Roger & Adams Tata McGraw Hill. First edition
References: 1. An Introduction to Nurbs with Historical perspective (1st edition) by David F Rogers. First edition

COMPUTATIONAL METHODS

Course Code	22MEMD1T5A	**Year**	I	**Semester**	I
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Solve the linear and non linear system of equations using numerical methods and understand the concept of numerical integration.	L3	1
CO2	Solve the boundary value and characteristic value problems and using regression analysis fit an approximation of functions.	L3	2
CO3	Find the temperature distribution in a rectangular plates using finite difference method.	L3	3
CO4	Find the temperature distribution in a rod and solve the wave equation by finite difference method.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3		1		1							1
CO 2	3	3	3		1		1							1
CO 3	3	3	3		1		1							1
CO 4	3	3	3		1		1							1

Syllabus

Unit	Contents	Mapped CO
1	**INTRODUCTION TO NUMERICAL METHODS APPLIED TO ENGINEERING PROBLEMS:** Examples, solving Sets of equations – Matrix notation – Determinants and inversion – Iterative methods –Relaxation methods – System of non-linear equations. **NUMERICAL INTEGRATION:** Newton-Cotes integration formulas –	**CO1**

	Simpson's rules, Gaussian quadrature. Adaptive integration.	
2	**BOUNDRY VALUE PROBLEMS AND CHARACTERISTIC VALUE PROBLEMS:** Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method –Characteristic value problems. **CURVE FITTING AND APPROXIMATION OF FUNCTIONS:** Least square approximation fitting of non- linear curves by least squares –regression analysis- multiple linear regression, non linear regression.	**CO2**
3	**NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS:** Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.	**CO3**
4	**PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS:** Explicit method- Crank-Nickelson method – Derivative boundary condition, Stability and convergence criteria– Finite element for heat flow. **HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS:** Solving wave equation by finite differences- stability of numerical method – method of characteristics-wave equation in two space dimensions.	**CO4**

Learning Resources
Text Book(s): 1. Numerical Methods for Engineers by Steven C.Chapra, Raymond P.Canale, Tata Mc- Graw hill. 2. Applied numerical analysis by Curtis F.Gerald, partick.O.Wheatly, Addison- wesley, 1989. 3. Numerical methods (2nd edition) by Douglas J..Faires,Riched Burden, Brooks/cole publishing , 1998.
References: **1.** Numerical mathematics and computing (4th edition) by Ward cheney & David Kincaid, Brooks/cole publishing 1999. **2.** Mathematical Methods for Physics and Engineering by Riley K.F.M.P.Hobson &Bence S.J, Cambridge University press, 1999.

CONTINUUM MECHANICS & TENSOR ANALYSIS

Course Code	22MEMD1T5B	**Year**	I	**Semester**	I
Course Category	Programme elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Understand the stress tensor and derive it for ideal, Newtonian and viscous fluids	L2	1
CO2	Explain the models of linear elasticity and, linear viscoelasticity	L2	2
CO3	Explain central terms as material volume, particle and deformation tensor	L2	3
CO4	Distinguish Eulerian and Lagrangian definition of the equations of motion	L3	4
CO5	Derive conservation laws for mass, momentum and energy on local and global form	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2			1							3	1
CO 2	3	3	2			1							3	1
CO 3	3	3	2			1							3	1
CO 4	3	3	2			1							3	1
CO5	3	3	2			1							3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**TENSOR ANALYSIS - I:** Multi linear forms, Definition of Tensor over including vector spaces, Alternating tensors, determinants, orientation, tensor products.	**CO1**

2	**TENSOR ANALYSIS – II:** Rotation of tensors, calculations of tensors, internal calculations of tensors and Integral identities, **TENSOR CALCULUS:** Tensor calculus.	**CO2**
3	**CONTINUUM MECHANICS** Eulerian and Lagrangian description of a continuous, discrete systems, continua, physical quantities and their derivatives. Rigid body motion, Relation between continuum models and real materials **CONSERVATION LAWS IN A CONTINUUM:** Mass conservation in Lagrangian and Eulerian frames, Conservation of momentum in Lagrangian and Eulerian frames.	**CO3**
4	**CONSERVATION LAWS OF ENERGY:** Conservation in angular momentum in Lagrangian form. Conservation of energy in Lagrangian and Eulerian frames. Strain and decomposition. Finite deformation, infinitesimal displacements **CONSTITUTIVE RELATIONS - I:** Material frame indifference, Elastic Materials **CONSTITUTIVE RELATIONS - II:** Viscous fluids, linear viscoelasticity	**CO4, CO5**

Learning Resources
Text Book(s): 1. Continuous mechanics by George Backus, Samizdat Press, 1997
References: 1. Mechanics of Continua by A.C. Eringan, 1962 2. Continuous Physics by A.C. Eringan Vol. 1, Academic press 17, 1967, 3. Introduction to Continuous Mechanics by B.L.N. Kennett 4. Quick introduction to Tensor analysis by R.Sharipov, 2004, Samizdat Press. 5. Non-linear continuum mech-win, SEACAS theory manuals part II by T.A. Laursen, S.W.Attaway and R.I.Zadoks

RAPID PROTOTYPING

Course Code	22MEMD1T5C	**Year**	I	**Semester**	I
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Understand the Rapid Prototyping principles and apply appropriate tools and techniques in Rapid Prototyping	L3	1
CO2	Get acquainted with the basic kinds of RP-systems understand the progress in RP-technology in the context of shortening lead-time for new production.	L3	2
CO3	Appreciate the concept of Rapid Manufacturing in terms of its potential applicability, practicability, and expedience.	L3	3
CO4	Identify, characterize and select the ideal materials for a given Rapid Prototyping system.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	2	1	2	2	1	1						2	1
CO 2	2	2	1	2	2	1	1						2	1
CO 3	2	2	1	2	2	1	1						2	1
CO 4	2	2	1	2	2	1	1						2	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**INTRODUCTION:** Prototype fundamentals – Definition, types of prototype, roles of prototype; historical development, development of RP in the primary areas – input, method, materials and applications; advantages of rapid prototyping, categorization of rapid prototyping systems liquid based, solid based, powder	**CO1**

	based. **Rapid Prototyping Process Chain**- Fundamental Automated Processes - process chain, 3D modeling, data conversion and transmission, checking and preparing, building, post processing.	
2	**LIQUID-BASED RAPID PROTOTYPING:** 3Dsystems Stereo Lithography Apparatus (SLA) - products, process, principle - photo polymers, photo polymerization, layering technology, laser and laser scanning; strength and weaknesses of the SLA, Applications. Example: INCS Prototyping and Manufacturing Services Make Japan a Model for the World Market. Cubital's Solid Ground Curing (SGC)- , products, Advantages and disadvantages, Process, Principle, Applications. Rapid Freeze Prototyping, Micro Fabrication,	**CO2**
3	**SOLID-BASED RAPID PROTOTYPING:** Stratays's Fusion Deposition Modeling (FDM) Products: FDM MC Machines, Dimension Series, Process, Principle, Strengths and Weaknesses, Applications, Example- Toyota Uses FDM for Design and Testing. Cubic Technologies Laminated Object Manufacturing (LOM) Products, Process: Pre Processing, Building, Post-Processing, System Structure, Materials; Principle, Strengths and Weaknesses, Applications. Example: National Aeronautical and Space Administration (NASA) and Boeing Rocket dyne Use of LOM to Create Hot Gas Manifold for Space Shuttle Main Engine. 3D Systems Multi-jet Modeling System (MJM)- , products, process, principles, Advantages and disadvantages, Applications. The shape deposition Manufacturing Process, Introduction, process, Advantages and disadvantages	**CO3**
4	**POWDER-BASED RAPID PROTOTYPING:** 3D Systems Selective Laser Sintering (SLS) - Products, Process - The SLS Process, materials, Principle - Sinter Bonding, Strengths and Weaknesses, Applications. Example: Los-Angeles-Based TEST A Architecture/Design Utilizes SLS for Large-Scale Models of Carbon Tower Prototype OPTOMEC's Laser Engineered Net Shaping (LENS)- , products, Principle, Advantages and disadvantages, Applications and examples.	**CO4**

Learning Resources
Text Book(s): 1. Rapid Prototyping Principles and Applications (3rd Edition) by Chee Kai Chua, Kah Fai Leong, World Scientific Publishing Co. Pt. Ltd. 2. Rapid Manufacturing An Industrial Revolution for the Digital Age by N. Hopkinson, R.J.M. Hague and P.M. Dickens Lough borough University, UK
References: 1. Rapid Manufacturing by Pham, D.T, Dimov, S.S, , Springer, 2001. 2. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing by Ian Gibsn., David W Rosen., Brent Stucker, Springer, 2010

COMPUTATIONAL FLUID DYNAMICS

Course Code	22MEMD1T5D	**Year**	I	**Semester**	I
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Fluid Mechanics
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Describe governing flow equations for a fluid dynamics problem.	L3	1
CO2	Classify the Partial Differential Equations (PDEs) and various Discretization techniques.	L3	2
CO3	Apply the basic knowledge of Computational Fluid Dynamics (CFD) to Nozzle flow problems and Incompressible flow problems.	L3	3
CO4	Apply the basic knowledge of CFD to Heat Transfer problems.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	3	3							3	3	2
CO 2	3	3	3	3	3							3	3	2
CO 3	3	3	3	3	3							3	3	2
CO 4	3	3	3	3	3							3	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**INTRODUCTION** Computational Fluid Dynamics as a Research and Design Tool, Applications of Computational Fluid Dynamics, **GOVERNING EQUATIONS OF FLUID DYNAMICS**: Introduction, Models of the Flow, Substantial Derivative, Divergence of Velocity, Continuity Equation, Momentum Equation and Energy Equation,	**CO1**

	Conservation and Non-conservation forms of Governing Flow Equations.	
2	**PARTIAL DIFFERENTIAL EQUATIONS – ITS MATHEMATICAL BEHAVIOR** Introduction, Classification of Quasi-Linear Partial Differential Equations, Eigen Value Method, Hyperbolic Equations, Parabolic Equations, Elliptic Equations. **DISCRETIZATION** Introduction, Finite Differences, Difference Equations, Explicit and Implicit Approaches, Errors and Stability Analysis, Grid Generation. **TRANSFORMATION OF GRIDS** Transformation of Equations, Metrics and Jacobians, Transformed version of Governing Flow Equations.	**CO2**
3	**CFD TECHNIQUES** Introduction, The Lax Wendroff Technique, MacCormack's Technique, The Alternation-Direction Implicit (ADI) Technique, Pressure Correction Technique. **CFD Application to Nozzle Flow** Solution to Subsonic-Supersonic Isentropic flow using MacCormack's Technique **CFD Application to Incompressible Couette Flow** Solution by using Pressure Correction method.	**CO3**
4	**NUMERICAL METHODS IN HEAT CONDUCTION** One-Dimensional Steady Heat Conduction in a plane wall and boundary conditions; Two-Dimensional Steady Heat Conduction and boundary conditions; Transient Heat Conduction in a plane wall; Two-Dimensional Transient Heat Conduction in a rectangular coordinates.	**CO4**

Learning Resources
Text Book(s): 1. John. D. Anderson, Computational fluid dynamics - Basics with applications, McGraw Hill 2. D. A. Anderson, J. C. Tannehill, and R. H. Pletcher. Computational Fluid Mechanics and Heat Transfer. NewYork: Hemisphere, 1984.
References: 1. Suhas V. Patankar, Numerical heat transfer and fluid flow, Butter-worth Publishers. 2. T. K Sengupta, Fundamentals of Computational Fluid Dynamics, University Press

THEORY OF ELASICITY AND PLASTICITY

Course Code	22MEMD1T6A	**Year**	I	**Semester**	I
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Demonstrate the application of plane stress and plane strain in a given situation.	L3	1
CO2	Understand the two dimensional problems in polar coordinate system.	L3	2
CO3	Apply stress-strain relations for linearly elastic solids, and Torsion	L3	3
CO4	Demonstrate the ability to analyze the structure using plasticity.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2				2			1		2	3	1
CO 2	3	3	2				2			1		2	3	1
CO 3	3	3	2				2			1		2	3	1
CO 4	3	3	2				2			1		2	3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**Introduction**: Elasticity – notation for forces and stresses – components of stresses – components of strain – stress strain relationship – Generalized Hooke's law. **Plane stress and plane strain analysis** – plane stress – plane strain – differential equations of equilibrium – boundary conditions – compatibility equations – stress function – boundary condition.	**CO1**
2	**Two dimensional problems in rectangular coordinates** – solution by polynomials – Saint Venant's principle – determination of displacements – bending of simple beams – application of corier eries or two dimensional	**CO2**

	problems – gravity loading. Two dimensional problems in polar coordinates – stress distribution symmetrical about an axis – pure bending of curved bars – strain components in polar coordinates – displacements for symmetrical stress distributions – simple symmetric and symmetric problems – general solution of two – dimensional problem in polar coordinates – application of general solution in polar coordinates.	
3	**Torsion of Prismatic Bars**:torsion of prismatic – bars with elliptical cross sections – other elementary solution – membrane analogy – torsion of rectangular bars – solution of torsion problems by energy method – use of soap films in solving torsion problems – hydro dynamical analogies – torsion of shafts, tubes, bars etc. **Bending of Prismatic Bars**: Stress function – bending of cantilever – circular cross section – elliptical cross section – rectangular cross section – bending problems by soap film method – displacements.	**CO3**
4	**Plasticity:** Physical Assumptions – Yield criteria – Failure theories – Applications of thick cylinder – Plastic stress strain relationship. Elasto – plastic problems in bending and torsion.	**CO4**

Learning Resources
Text Book(s): 1. Theory of Elasticity (third edition) by Timeshanko, McGrawhill Publications, 2010. 2. Theory of Plasticity (third edition) by J.Chakarbarthy, McGrawhill Publications, 2006.
References: 3. Theory of Elasticity by Y.C.Fung. 4. Theory of Elasticity by Gurucharan Singh 5. Theory of Elasticity by Sadhu Singh, Khanna Publishers, New Delhi

MECHANICS OF COMPOSITE MATERIALS

Course Code	22MEMD1T6B	**Year**	I	**Semester**	I
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Material Science and Metallurgy
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Understand the types, manufacturing processes, and applications of composite materials	L2	1
CO2	Analyze problems on macro mechanical behavior of lamina	L4	2
CO3	Analyze problems on micromechanical behavior of lamina	L4	3
CO4	Apply failure criteria and critically evaluate their behavior	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	1	1	2					1			1	3	1
CO 2	3	2	1	2					1			1	3	1
CO 3	3	2	1	2					1			1	3	1
CO 4	3	2	1	2					1			1	3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	BASIC CONCEPTS AND CHARACTERISTICS: Geometric and Physical definitions, natural and man-made composites, applications, types and classification of composites. Reinforcements: Fibers – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibers. Particulate composites, Thermoplastics, Thermosetts, Metal matrix and ceramic matrix composites. Manufacturing Methods for Composite Materials, Autoclave Molding,	**CO1**

	Filament Winding, Resin Transfer Molding.	
2	ELASTIC BEHAVIOR OF UNIDIRECTIONAL LAMINA: Stress-Strain Relations-General Anisotropic Material, Specially Orthotropic Material, Transversely Isotropic Material, Orthotropic Material Under Plane Stress, Isotropic Material, Relations Between Mathematical and Engineering Constants, Stress-Strain Relations for a Thin Lamina (Two-Dimensional), Transformation of Stress and Strain (Two-Dimensional), Transformation of Elastic Parameters (Two-Dimensional), Transformation of Stress-Strain, Relations in Terms of Engineering Constants (Two-Dimensional), Transformation Relations for Engineering Constants (Two-Dimensional), Micromechanical predictions of elastic constants STRENGTH OF UNIDIRCETIONAL LAMINA Longitudinal Tension-Failure Mechanisms and Strength, Longitudinal Compression, Transverse Tension, Transverse Compression, In-Plane Shear, Out-of-Plane Loading, General Micromechanics Approach. Macro-mechanical strength parameters, macromechanical failure theories, maximum stress theory, maximum strain theory, Tsai- hill, TsaiWu theory.	**CO2**
3	ELASTIC BEHAVIOR OF MULTIDIRECTIONAL LAMINATES: Laminates, Basic assumptions, Strain-Displacement Relations, Stress-Strain Relations of a Layer Within a Laminate, Force and Moment Resultants, General Load-Deformation Relations: Laminate Stiffness, Inversion of Load-Deformation Relations: Laminate Compliances. Symmetric Laminates: Symmetric Laminates with Isotropic Layers, Symmetric Laminates with Specially Orthotropic Layers (Symmetric Cross-ply Symmetric Angle-Ply Laminates Anti symmetric Laminates, Anti symmetric Cross-ply Laminates, Anti symmetric Angle-Ply Laminates, Balanced Laminates,	**CO3**
4	FAILURES AND LIFE PREDICTIONS: Possible modes of failure, stress analysis of first ply failure, ultimate laminate failure or analysis of last ply failure: Total- ply failure method and partial-ply failure method, inter laminar stress. FAILURE MODES: Matrix cracking, Delamination, Tensile fiber failure, Micro buckling, global instability, Common Features of Life Prediction Methodology, Damage Characterization.	**CO4**

Learning Resources
Text Book(s): 1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994. 2. Mechanics of Composite Materials by R. M. Jones, Mc Graw Hill , New York, 1975. 3. Mechanics of composite materials by Madhujit Mukhopadhyay, Universities press.
References: 1. Analysis and performance of fibre Composites by B. D. Agarwal and L. J. Broutman, Wiley Inter-science, New York, 1980. 2. Mechanics of Composite Materials (2nd Edition) by Autar K. Kaw, Publisher: CRC Taylor and Francis

DESIGN FOR MANUFACTURING

Course Code	22MEMD1T6C	**Year**	I	**Semester**	I
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Material Science and Metallurgy
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Express design principles of design for economic production and material selection, and process selection.	L3	1
CO2	State design rules for machining, dimensional tolerance and specify design recommendation for machine parts.	L3	2
CO3	Illustrate various factors to be considered in design of casting and welding.	L3	3
CO4	List out design guide lines for forging and extrusion process.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3			1	1	2				2	3	2
CO 2	3	3	3			1	1	2				2	3	2
CO 3	3	3	3			1	1	2				2	3	2
CO 4	3	3	3			1	1	2				2	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	INTRODUCTION Design philosophy-steps in design process-general design rules for manufacturability-basic principles of designing for economical production MATERIALS: Selection of materials for design-developments in material technology criteria for material selection-material selection	**CO1**

	interrelationship with process selection process selection charts.	
2	MACHINING PROCESSES: Overview of various machining processes-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.	**CO2**
3	METAL CASTING: Appraisal of various casting processes, selection of casting process,- general design considerations for casting-casting tolerance-use of solidification, simulation in casting design product design rules for sand casting. METAL JOINING: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints.	**CO3**
4	FORGING: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations. EXTRUSION & SHEET METAL WORK: Design guide lines extruded sections-design principles for punching, blanking, bending, and deep drawing-Keeler Goodman forging line diagram – component design for blanking.	**CO4**

Learning Resources
Text Book(s): 1. Design for Manufacture by Geoffrey Boothroyd. 2. Design for manufacture, John cobert, Adisson Wesley. 1995
References: 1. Product Design for Manufacturing and Assembly by Geoffrey Boothroyd, Peter Dewhurst, Winston Knight. Marcel Dekker,Inc 2. ASM Hand book Vol.20

TRIBOLOGY

Course Code	22MEMD1T6D	**Year**	I	**Semester**	I
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Material Science and Metallurgy
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Monitor the nature of surfaces and select proper lubrication system to reduce friction	L3	1
CO2	Analyze and design hydro dynamic bearings	L4	2
CO3	Analyze and design hydro static bearings and plan proper sealing	L4	3
CO4	Select the rolling element bearing for the given conditions and analyze failure of tribological components	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2									2	3	1
CO 2	3	2	2									2	3	1
CO 3	3	2	2									2	3	1
CO 4	3	2	2									2	3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	INTRODUCTION: Nature of surfaces and contact-Surface topography-friction and wear mechanisms and effect of lubricants- methods of fluid film formation. LUBRICATION: Choice of lubricants, types of oil, Grease and solid lubricants- additives- lubrication systems and their selection – selection of pump, filters, piping design- oil changing and oil conservation.	**CO1**
2	HYDRODYNAMIC BEARINGS: Fundamentals of fluid formation –	**CO2**

	Reynold's equation; Hydrodynamic journal bearings – Sommerfield number-performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings-optimum condition with largest minimum film thickness.	
3	HYDROSTATIC BEARINGS: Thrust bearings – pad coefficients- restriction-optimum film thickness journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure. SEALS: Different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals.	**CO3**
4	SELECTION OF ROLLING ELEMENT BEARINGS: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method. FAILURE OF TRIBOLOGICAL COMPONENTS: Failure analysis of plain bearings, rolling bearings, gears and seals, adhesive wear, abrasive wear, corrosion wear, surface fatigue, wear analysis using soap and Ferrography.	**CO4**

Learning Resources
Text Book(s): 1. Hydrostatic and Hybrid bearing design by Rowe W.W.& O. Dionoghue, Butterworths & Co. Publishers Ltd, 1983. 2. Mechanical Fault diagnosis and condition monitoring by Collacott R.A, Chapman and Hall, London 1977. 3. Fundamentals of fluid film lubricant by Bernard J. Hamrock, Mc Graw-Hill Co, 1994
References: 1. Tribology hand Book by Neale MJ Neumann Butter worths, 1975. 2. Standard hand book of lubrication engineers by Connor and Boyd JJO, ASLE, Mc Graw Hill Book & Co.,1968 3. Design of Machine Elements, (3ed Edition) by V.B. Bhandari, Tata McGraw Hill Publishers, New Delhi, 2010.
Data Book to be allowed in Examination: 1. Design data hand book (4th Edition), by K Mahadevan & K Balaveera Reddy, CBS Publishers, 2013. 2. Design Data Hand Book by (1st Edition) by S. Md. Jalaluddin, , Anuradha Publications, Chennai, 2009

MACHINE DYNAMICS LAB

Course Code	22MEMD1L1	**Year**	I	**Semester**	I
Course Category	Program Core	**Branch**	ME	**Course Type**	PRACTICAL
Credits	2	**L-T-P**	0-0-3	**Prerequisites**	Nil
Continuous Internal Evaluation:	25	**Semester End Evaluation:**	50	**Total Marks:**	75

Upon successful completion of the course, the student will be able to

CO	**Course Outcome**	**BTL**	**Experiments**
CO 1	Evaluate the natural frequencies in different vibrating systems and the effect of gyroscopic couple	L4	1,2,3,12
CO 2	Compute the radius of gyration & Moment of Inertia of the oscillating part in the vibration system	L4	4,5
CO 3	Test for amplitude and damping coefficient in damped and undamped vibrating systems	L4	6,7,8
CO 4	Verify the static and dynamic balancing and determination of whirling speeds of shaft	L4	9,10,11
CO5	Determination of vibrations using FFT analyser	L4	13,14,15

Contribution of Course outcomes towards the achievement of programoutcomes
& Strength of correlations (High: 3, Medium: 2, Low: 1)

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO 1	3	3	2	3						1			3	3
CO 2	3	3	2	3						1			3	3
CO 3	3	3	2	3						1			3	3
CO 4	3	3	2	3						1			3	3
CO 5	3	3	2	3						1			3	3

Course Content		
Experiment No	Contents	Mapped CO
Exp 1	Determination of Natural frequency of single mass, single helical spring system.	CO1
Exp 2	Determination of Natural frequency of the combination of springs – springs in parallel or springs in series.	CO1
Exp 3	Determination of Natural frequency of undamped torsional single rotor system.	CO1

Exp 4	Determination of radius of gyration of a given compound pendulum.	CO2
Exp 5	Determination of radius of gyration, a moment of inertia – bifilar suspension Method.	CO2
Exp 6	To find the Damping coefficient of the torsional single rotor system.	CO3
Exp 7	Determination of amplitude of vibration of a damped vibrating system.	CO3
Exp 8	Determination of amplitude of vibration of an undamped vibrating system.	CO3
Exp 9	Verify the Static balancing using a steel ball.	CO4
Exp 10	Verify the Dynamic balancing using steel balls.	CO4
Exp 11	Whirling of shafts/ determination of critical speed with Rotors.	CO4
Exp 12	Gyroscopic couple verification.	CO1
Exp 13	Determination of vibrations in machines using FFT analyzer.	CO5
Exp 14	Determination of misalignment in given machine using FFT analyzer	CO5
Exp 15	Diagnosis of unbalance in a machine using FFT analyzer.	CO5
Learning Resources		
Text Books	1. Theory of Machines, (4^{th} Edition) by S.S.Rattan ,Tata Mc.Graw Hill, New Delhi, 2014. 2. Mechanical vibrations, (4th edition) by Singiresu S. Rao Pearson education publications, Delhi, 2004.	
Reference Books	1. Theory of Machines, (5th Edition) by R.K.Bansal, Laxmi Publications(p) ltd. New Delhi, ,2010	

COMPUTER AIDED MODELLING LAB

Course Code	22MEMD1L2	**Year**	I	**Semester**	I
Course Category	Program Core	**Branch**	ME	**Course Type**	PRACTICAL
Credits	2	**L-T-P**	0-0-3	**Prerequisites**	
Continuous Internal Evaluation:	25	**Semester End Evaluation:**	50	**Total Marks:**	75

Upon successful completion of the course, the student will be able to

CO	**Course Outcome**	**BTL**	**Experiments**
CO 1	Model a part or assembly of parts using Computer-Aided Design software.	L4	2,3,4
CO 2	Use parametric modeling techniques to reflect engineering requirements.	L4	2,3,4
CO 3	Use motion and interference checking to ensure that parts will not interfere throughout their complete range of motion.	L4	3
CO 4	Communicate effectively the geometry and intent of design features.	L4	2,3,4

Contribution of Course outcomes towards the achievement of programoutcomes
& Strength of correlations (High: 3, Medium: 2, Low: 1)

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO 1	1		1		3					3			3	1
CO 2	1		1		3					3			3	1
CO 3	1		1		3					3			3	1
CO 4	1		1		3					3			3	1

Course Content		
Experiment No	Contents	Mapped CO
Exp 1	Introduction of 3D Modeling software	
Exp 2	Part modeling of following models a) Screw Jack b) Universal Joint c) Plummer Block	CO1,CO2,CO4
Exp 3	Creation of 3D assembly model of following machine elements using 3D modeling software	CO1,CO2,CO3,CO4

	a) Screw Jack b) Universal Joint c) Plummer Block	
Exp 4	Creation of drawing views of assembly models using 3D modeling software a) Screw Jack b) Universal Joint c) Plummer Block	CO1,CO2,CO4

MECHANISM DESIGN AND SYNTHESIS

Course Code	22MEMD2T1	**Year**	I	**Semester**	II
Course Category	Programme core	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Kinematics of Machinery
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Build up critical thinking and problem solving capacity of various mechanical engineering problems related to kinematics of mechanisms	L3	1
CO2	Analyze design related problems of function, path, motion generation, dimensional synthesis, Coordinate transformation, and the four bar slider crank position solution.	L4	2
CO3	Asses various concepts of two position motion, three position motion generated by analytical synthesis, precision point methods	L4	3
CO4	Velocity and acceleration analysis of, Fourbar pin jointed linkage, Coriolis acceleration, working principles of cams	L4	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2		2					1			3	1
CO 2	3	3	2		2					1			3	1
CO 3	3	3	2		2					1			3	1
CO 4	3	2	2		2					1			3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**Kinematics of Mechanisms**: Introduction – kinematics and kinetics - Mechanisms and machines- applications of kinematics- identification of need, background research, Detailed design prototyping and testing, production. **Kinematics fundamentals**: Introduction, Degrees of Freedom (DOF), types of motion, links, joints and kinematic chains, Determining Degree of Freedom in Planar Mechanisms and in Spatial Mechanisms. Mechanisms and structures.	**CO1**
2	**Graphical linkage synthesis**: Introduction synthesis, Function, path, and motion generation, Dimensional synthesis, two position synthesis, three position synthesis with specified moving pivots. Quick return mechanisms, Fourbar quick return, Straight line mechanisms designing optimum straight line Fourbar linkages. **Position Analysis**: Introduction coordinate systems position and displacement – Coordinate transformation. Translation, and rotation, Graphical position Analysis of linkages, The Fourbar slider crank position solution, Position of any point on a linkage, Transmission angles, extreme values of the transmission angle.	**CO2**
3	**Analytical linkage synthesis**: Introduction, types of kinematic synthesis, Precision points, Two position motion generation by analytical synthesis, Three position motion generation by analytical synthesis, Synthesis for a specified fixed pivot location, Center point and circle point circles, Four and five position analytical synthesis, Analytical synthesis of a path generator with prescribed timing analytical synthesis of Fourbar function generator, Precision point methods, Coupler curve equation methods, Optimization methods.	**C03**
4	**Velocity Analysis**: Introduction-definition of velocity, Graphical velocity analysis, instant centers of velocity, velocity analysis with instant centers, angular velocity ratio, Mechanical Advantage, using instant centers in linkage Design, The Fourbar inverted slider crank. **Acceleration Analysis**: Introduction definition of Acceleration Graphical Acceleration analysis, Analytical solutions for acceleration analysis, and the Fourbar pin jointed linkage the Fourbar slider-crank, Coriolis acceleration. The Fourbar inverted slider crank. **Cam Design**: Introduction cam terminology, type of follower motion, type of follower, type of cam , type of motion constraints, SVAJ Diagrams. The fundamental law of cam design, Simple Harmonic Motion (SHM), Cycloidal displacement.	**CO4**

Learning Resources

Text Book(s):

1. Kinematics and Dynamics of Machinery - RL. Norton, Tata McGraw Hill, 2009
2. Machine Design an Integrated Approach - RL. Norton, Pearson , 2004

References:

1. Mechanical Engineering Design - Shigley et al., Tat McGraw Hill, 2011
2. Mechanism Design –Arthur g Erdman Prentice hall of india,1988
3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. E.W.P.Publishers.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING OF MECHANICAL SYSTEMS

Course Code	22MEMD2T2	**Year**	I	**Semester**	II
Course Category	Programme core	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Understand the core concepts of Mechanical Systems in the context of Industry 4.0	L2	1
CO2	Apply AI concepts on Various Mechanical Systems	L3	2
CO3	Apply ML and Deep Learning concepts on Various Mechanical Systems	L3	3
CO4	To provide adequate knowledge of fuzzy logic, in solving engineering problems	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2							1		2	3	2
CO 2	3	3	2							1		2	3	2
CO 3	3	3	2							1		2	3	2
CO 4	3	3	2							1		2	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**Introduction to Mechanical Systems:** Evolution in the context of Industry 4.0, Key issues: Adaptability, Intelligence, Autonomy, Safety, Sustainability, Interoperability, Flexibility of Mechanical Systems. **Introduction of Statistics**: Descriptive statistics: Central tendency measures, Dispersion measures, data distributions, centre limit theorem, sampling, sampling methods; Inferential Statistics: Hypothesis testing, confidence level, degree of freedom, P-value, Chi-square test, ANOVA, Correlation V's	**CO1**

	Regression, Uses of Correlation and regression.	
2	**Artificial Intelligence:** Brief review of AI history, Problem formulation: Graph structure, Graph implementation, state space representation, search graph and search tree, Search Algorithms: random search, Depth-first, breadth-first search and uniform-cost search. Heuristic: Best first search, A* and AO* algorithm, generalization of search problems. Ontology; Fuzzy; Metaheuristics.	**CO2**
3	**Machine Learning:** Overview of supervised and unsupervised learning; Supervised Learning: Linear Regression, Non-linear Regression Model evaluation methods, Logistic Regression, Neural Networks; Unsupervised Learning: K-means clustering, C-means Clustering. Convolutional Neural Networks (CNN), Pooling, Padding Operations, Interpretability in CNNs, Limitations in CNN. Cases with respect to different mechanical systems.	**CO3**
4	**CLASSICAL LOGIC AND FUZZY LOGIC** Classical Predicate Logic – Tautologies, Contradictions, Equivalence, Exclusive OR and Exclusive NOR, Logical Proofs, Deductive Inferences. Fuzzy Logic, Approximate Reasoning, Fuzzy Tautologies, Contradictions, Equivalence and Logical Proofs, Other forms of the Implication Operation, Other forms of the Composition Operation	**CO4**

Learning Resources

Text Book(s):

1. Rajkumar, Dionisio De Niz ,and Mark Klein, Cyber-Physical Systems, Wesley Professional.
2. Robert Levine et al., "A Comprehensive guide to AI and Expert Systems",McGraw Hill Inc, 1986.
3. Ross, T. J. (2005), "Fuzzy logic with engineering applications," John Wiley & Sons.

References:

1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
2. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2011.
3. C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems", Springer 2007.
4. Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing", Wiley publisher, 1996.
5. Montgomery Douglas, 2017. Design of Experiments, John Wiley and Sons, Inc.
6. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing" Prentice Hall.

FINITE ELEMENT METHODS IN ENGINEERING

Course Code	22MEMD2T3	**Year**	I	**Semester**	II
Course Category	Programme core	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Strength of Materials
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Apply variational and weighted residual methods to solve differential equations.	L3	1
CO2	Analyze 1-D bar, Truss, beam and Frame problems using finite element method.	L4	2
CO3	Develop finite element formulations and solve 2-D structural problems using triangular and quadrilateral elements.	L4	3
CO4	Analyze Heat Transfer and vibration problems for frequencies and mode shapes.	L4	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	1	1			2			1		2	3	2
CO 2	3	3	1	1			2			1		2	3	2
CO 3	3	3	1	1			2			1		2	3	2
CO 4	3	3	1	1			2			1		2	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**FORMULATION TECHNIQUES**: Methodology, engineering problems and governing differential equations, variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, weighted residual methods. **FINITE ELEMENT METHOD**: Concepts of discretization, types of	**CO1**

	elements, interpolation function, node numbering scheme, assembly and boundary conditions.	
2	**ANALYSIS OF BARS**: Element shape functions, stiffness matrix, load vectors, determination of displacements, reaction, stresses, temperature effects. ANALYSIS OF TRUSSES: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects. **ANALYSIS OF BEAMS AND FRAMES**: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses.	**CO2**
3	**UNIT-III** **TWO DIMENSIONAL PROBLEMS**: Analysis of 2-D problems using constant strain triangle element, axi-symmetric formulations. **ISOPARAMETRIC FORMULATIONS**: Sub, iso and super parametric elements, four noded quadrilateral element, numerical integration – Gaussian Quadrature approach.	**CO3**
4	**FINITE ELEMENTS IN STRUCTURAL DYNAMICS**: Dynamic equations, eigen value problems, and their solution methods, simple problems. **CONVERGENCE**: Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle. **ONE DIMENSIONAL SCALAR FIELD PROBLEMS**: Heat transfer: equilibrium equations, heat conduction in plane walls, convection heat transfer in fins, finite element formulation, simple problems.	**CO4**

Learning Resources

Text Book(s):

4. SS Rao , "The Finite Element Methods in Engineering", ButterworthHeinemann,5th Edition.
5. Chandraputla, Ashok and Belegundu , "Introduction to Finite Elements in Engineering ", Prentice – Hall,2011.

References:

6. Daryl L Logan, "A first course in finite element method", Cengage Learning. 5 th Edition
7. JN Reddy, "An introduction to Finite Element Method", McGrawHill, 4th Edition.
8. Chandraputla, Ashok and Belegundu , "Introduction to Finite Elements in Engineering ", Prentice – Hall,2011.
9. C. S. Krishnamurthy, "Finite Element Analysis -Theory and Programming", Tata Mc Graw Hill,2nd Edition.

ADVANCED ROBOTICS

Course Code	22MEMD2T4	**Year**	I	**Semester**	II
Course Category	Programme core	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Engineering Mechanics
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Apply the knowledge of Mathematics and science to carry out the position and orientation analysis of robot using homogeneous transformations	L3	1
CO2	Develop the mathematical models, analyze, solve forward and inverse kinematics equations of a robot	L3	2
CO3	Develop the mathematical models for dynamic analysis and trajectory planning of a robot	L3	3
CO4	Understand the principles of Block diagram algebra in motion control systems and working principles of various types of sensors and actuators.	L2	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2			1		1				1	3	1
CO 2	3	3	2			1		1				1	3	1
CO 3	3	3	2			1		1				1	3	1
CO 4	3	3	2			1		1				1	3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**Fundamentals:** Introduction, definition of robot, classification of robots, robot components, degree of freedom, robot joints, robot coordinates, reference frames, robot characteristics, robot work space, advantages, disadvantages and applications of robots. matrix representation of a point in a	**CO1**

	space, representation of a vector in space, representation of a frame at the origin of a reference frame, representation of a frame in a reference frame, representation of a rigid body. representation of a pure translation, pure rotation about an axis, representation of combined transformations, transformations relative to the rotating frame, inverse of transformation matrices.	
2	**Robot Kinematics:** Forward and inverse kinematics of robots-forward and inverse kinematic equations for position, forward and inverse kinematic equations for orientation, forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg (D-H) representation of forward kinematic equations of robots, The inverse kinematic solution of robots Degeneracy and Dexterity, problems with D-H representation. **Differential Motions and Velocities:** Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.	**CO2**
3	**Dynamic Analysis and Forces:** Introduction, Lagrangian mechanics, Effective moments of inertia, dynamic equations for multi-degree of freedom robots-kinetic energy, potential energy, the Lagrangian, robot's equations of motion, static force analysis of robots. **Trajectory Planning:** Introduction, basics of trajectory planning, joint space trajectory planning-third order polynomial trajectory planning, fifth order polynomial trajectory planning, linear segments with Parabolic blends, linear segments with parabolic blends via points Higher order trajectories	**CO3**
4	**Motion Control Systems:** Basic components and terminology, Block Diagrams, Laplace Transform, Transfer function, Block diagram algebra, first and second order transfer functions, Pole/Zero Mapping, Steady state error, Root Locus Method, Proportional controls Proportional Plus Integral controllers, proportional plus derivative controllers, PID Controller **Robot Actuators:** characteristics of Actuating systems, comparison of actuating systems, hydraulic devices, pneumatic devices, Electric motors, servomotors, stepper motors, Advantages, Disadvantages & applications of Robot Actuators. **Robot Sensors**: Sensor characteristics, Position, Velocity and Acceleration sensors, force and pressure sensors, proximity sensors, sniff sensors, advantages, disadvantages and applications of sensors.	**CO4**

Learning Resources
Text Book(s): 1. Introduction to Robotics – Analysis, System, Applications, Saeed B. Niku, 2nd edition Wiley India Pvt. Ltd.
References: 1. Introduction to Robotics: Mechanics and Control, John J. Craig, 3rd edition, Pearson Education India

FRACTURE MECHANICS

Course Code	22MEMD2T5A	**Year**	I	**Semester**	II
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Material Science and Metallurgy
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Understand the concept of crack subsequently leading to fracture failure and further analyze the mechanical components against failure	L2	1
CO2	Predict the fracture strength of mechanical components under different fracture modes	L3	2
CO3	Apply fracture mechanics principles by determining fracture parameters using experimental methods	L3	3
CO4	Design mechanical components against fracture by determining fracture parameters for the analysis of cracks in solids	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2											2	2	2
CO 2	2	2	2									2	2	2
CO 3	2	2	2	2	2							2	2	2
CO 4	2		2	2								2	2	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	INTRODUCTION: Fracture behavior of metals and alloys, Definitions of types of fracture and failure, Introduction to stress intensity factor and strain energy release rate, Equivalence of energy approach and stress intensity	**CO1**

	approach. Brittle and Ductile Fracture, Modes of Fracture Failure, Damage Tolerance	
2	STRESS INTENSITY FACTOR AND ITS USE IN FRACTURE MECHANICS: Early concepts of stress concentrators and flaws, Ingles solution to stress round an elliptical holeimplications of results. Stress intensity factor for a crack. Westergaard's solution for crack tip stresses. Stresses and displacement in Cartesian and polar coordinates, Linear Elastic Fracture Mechanics. Different modes of crack opening.	**CO2**
3	ELASTIC/PLASTIC FRACTURE MECHANICS: Elastic/plastic fracture mechanics: The crack opening displacement and J-integral approaches, R-curve analysis Testing procedures, Measurement of these parameters, Fail safe and safe life design approaches,	**CO3**
4	FATIGUE: Importance of fatigue in engineering, Low cycle fatigue, Coffin-Manson law, Cyclic work hardening and softening. Micro structural models of crack initiation. Stage I, II and III crack growth. 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.	**CO4**

Learning Resources
Text Book(s): 1. Elements of Fracture Mechanics by Prashant Kumar, McGraw Hill Education Private Limited, New Delhi, India. 2. Mechanical Metallurgy by Dieter, McGraw Hill.
References: 1. Fracture Mechanics: Fundamental and Applications by Anderson T.L & Boca Raton, CRC Press, Florida, 1998

THEORY OF PLATES AND SHELLS

Course Code	22MEMD2T5B	**Year**	I	**Semester**	II
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Material Science and Metallurgy
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Understand the Simple bending of Plates and Different Boundary Conditions for plates	L2	1
CO2	Analyze circular plates subjected to different kinds of loads	L4	2
CO3	Understand the concept of Material Orthotropy, Structural Orthotropy and Plates on elastic foundation	L2	3
CO4	Design various types of shells structures and folded pipes.	L4	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3				2			1		2	3	1
CO 2	3	3	3				2			1		2	3	1
CO 3	3	3	3				2			1		2	3	1
CO 4	3	3	3				2			1		2	3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	Simple bending of Plates, Assumptions in thin plate theory, Different relationships, Different Boundary Conditions for plates, Plates subjected to lateral loads, Navier's method for simply supported plates, Levy's method for general plates, Example problems with different types of loading.	**CO1**
2	Circular plates subjected to Axi-symmetrical loads, concentrated load,	**CO2**

	uniformly distributed load and varying load, Annular circular plate with end moments, Rayleigh-Ritz method, Application to different problems, Finite difference method, Finite element methodology for plates.	
3	Orthotropic Plates, Bending of anisotropic plates with emphasis on orthotropic plates, Material Orthotropy, Structural Orthotropy, Plates on elastic foundation	**CO3**
4	Shells- Classification of shells - Membrane and bending theory for singly curved and doubly curved shells - Various approximations -Analysis of folded plates	**CO4**

Learning Resources
Text Book(s): 1. Theory and Analysis of Plates by Rudolph Szilard, Prentice Hall, New Jercy 1986. 2. Theory of Plates and Shells by Timoshenko S.P and Woinowsky Krieger, McGraw Hill, 1984. 3. Design and Construction of Concrete Shell Roofs by G. S. Ramaswamy, CBS Publishers. 2005.
References: 1. Theory and Analysis of Elastic Plates and Shells by J N Reddy, CRC Press, 2007. 2. Theory of Plates by K Chandra Shekhara, University Press, Hyderabad, 2001

CONDITION MONITORING

Course Code	22MEMD2T5C	Year	I	Semester	II
Course Category	Programme Elective	Branch	ME	Course Type	Theory
Credits	4	L-T-P	4-0-0	Prerequisites	Material Science and Metallurgy
Continuous Internal Evaluation:	40	Semester End Evaluation:	60	Total Marks:	100

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

CO	Statement	BTL	Units
CO1	Apply maintenance and condition monitoring techniques to machineries and industries	L2	1
CO2	Implement data acquisition and signal processing techniques to all mechanical components and plants	L3	2
CO3	Diagnose Machinery faults and apply methods to correct faults	L3	3
CO4	Predict machinery faults and using oil analysis and other NDT techniques	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2	2	2	1	1						2	3	1
CO 2	3	2	2	2	1	1						2	3	1
CO 3	3	2	2	2	1	1						2	3	1
CO 4	3	2	2	2	1	1						2	3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	PREDICTIVE MAINTENANCE TECHNIQUES: Basics, maintenance philosophies, Bath tub curve, Classification of maintenance, advantages and disadvantages of maintenance, plant machinery classifications and recommendations. CONDITION MONITORING TECHNIQUES: Introduction to Condition monitoring, definition, Types of condition monitoring, advantages and	**CO1**

	limitations of different condition monitoring techniques like wear derbies monitoring, oil monitoring, performance monitoring, vibration monitoring, thermography, corrosion monitoring.	
2	DATA ACQUISITION: Introduction, collection of vibration signal, vibration transducers, characteristics and mountings, conversion of vibrations to electrical signal. SIGNAL PROCESSING, APPLICATIONS AND REPRESENTATIONS: The Fast Fourier Transform (FFT) analysis, Time waveform analysis, Phase signal analysis, special signal processes	**CO2**
3	MACHINERY FAULT DIAGNOSIS USING VIBRATION ANALYSIS: Unbalance, bent shaft, Eccentricity, Misalignment, looseness, Belt drive problems, gear defects, bearing defects, Electrical faults, Cavitation Shaft cracks, Rotor rubs, Resonance, Hydraulic and aerodynamic forces. CORRECTING FAULTS THAT CAUSE VIBRATION: Introduction, Balancing Alignment, Resonance vibration control with dynamic absorbers.	**CO3**
4	OIL AND PRACTICAL ANALYSIS: Introduction, oil fundamentals, oil analysis sampling methods, lubricant properties, contaminants in lubricants, practical analysis techniques. OTHER PREDICTIVE MAINTENANCE TECHNIQUES: Ultrasound, Infrared thermography applications of IR thermography, ISO 2372 standards for vibrations.	**CO4**

Learning Resources
Text Book(s): 1. Machinery vibration Analysis & Predictive Maintenance by Paresh Girdhar, Elsevier publishers. 2. Mechanical Fault diagnosis and condition monitoring by R. A .Collacott.
References: 1. Vibration monitoring and diagnosis by R. A. Collacott. 2. First course on condition monitoring in the process industries, by M.J.Neale, Nov 1979, Manchester. 3. Management of Industrial Maintenance by Newman-Butterworth, March 1978. 4. Condition Monitoring Manual by National Productivity council, New Delhi

NANO TECHNOLOGY

Course Code	22MEMD2T5D	**Year**	I	**Semester**	II
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Recognize importance of nano materials	L2	1
CO2	Characterize nano materials by SEM, STM, AFM	L2	2
CO3	Describe different nano particle fabrication methods	L2	3
CO4	Identify different synthesis methods for semi conductor and metal nano particles	L2	3
CO5	List the applications of carbon nano tubes	L2	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	1	2	2	2				1			2	2	1
CO 2	3	1	2	2	2				1			2	2	1
CO 3	3	1	2	2	2				1			2	2	1
CO 4	3	1	2	2	2				1			2	2	1
CO 5	3	1	2	2	2				1			2	2	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	INTRODUCTION: Size and shape dependence of material properties at the nanoscale, Nanoscale elements in conventional technologies. NANO FABRICATION: Top-down and bottom-up nanofabrication lithography, etching, ion implantation, thin film deposition, Electron beam lithography, Soft lithography: nano imprinting and micro contact printing, Solution/plasma-phase nanofabrication, sol-gel methods, template techniques.	**CO1**
2	SELF ASSEMBLY AND SELF-ORGANIZATION: Functional coatings with self assembled monolayers of molecules and nanoparticles Langmuir-Blodgett films, layer-by-layer growth. IMAGING/CHARACTERIZATION OF NANOSTRUCTURES: General considerations for imaging, Scanning probe techniques: SEM, STM, AFM,	**CO2** 61

	NSOM.	
3	METAL AND SEMICONDUCTOR NANOPARTICLES: Synthesis, stability, control of size, Optical and electronic properties, Ultra-sensitive imaging and detection with nano particles, bioengineering applications, Catalysis. SEMICONDUCTOR AND METAL NANOWIRES: Vapor/liquid/solid growth and other synthesis techniques, Nano wire transistors and sensors.	**CO3, CO4**
4	CARBON NANOTUBES: Structure and synthesis, Electronic, vibrational, and mechanical properties, enabling faster computers using carbon nano tubes, brighter TV screens and stronger mechanical reinforcement, Mechanics at nanoscale Enhancement of mechanical properties with decreasing size, Nano electromechanical systems, Nano machines, Nano fluidics, filtration, sorting, Molecular motors.	**CO5**

Learning Resources
Text Book(s): 1. Nanoscale Science and Technology by Kelsall, Hamley, and Geoghegan, Wiley (2005) 2. Introduction to Nanoscale Science and Technology by Di Ventra, Evoy, and Heflin, Kluwer Academic Publishers (2004).
References: 1. Introduction to Nanotechnology by Poole and Owens, Wiley (2003). 2. Nanochemistry: A Chemical Approach to Nanomaterials by Ozin and Arsenault, RSC Publishing

NON-DESTRUCTIVE TESTING

Course Code	22MEMD2T6A	**Year**	I	**Semester**	II
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Explain the fundamentals of non-destructive testing and Liquid Penetration testing	L2	1
CO2	Demonstrate Magnetic Particle Testing and Ultrasonic testing methods	L2	2
CO3	Describe Acoustic Emission Testing, Thermography, and Codes, Standards, Specification and Procedures used for NDT	L2	3
CO4	Enumerate the procedures to detect different flaws in composite materials	L2	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	2		1	2	1			2			1	3	1
CO 2	3	2		1	2	1			2			1	3	1
CO 3	3	2		1	1	1			2			1	3	1
CO 4	3	2		1	2	1			2			1	3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	INTRODUCTION: Various methods, advantages, disadvantages and applications. Visual Examination: Basic principle, the eye- defects which can be detected by unaided, visual inspection, optical aids used for visual inspection- microscope, bore scope, endoscope, telescope, holography; applications. LIQUID PENETRANT TESTING: Physical principles, Procedure for Penetrant testingcleaning, penetrant application, removal of excess penetrant, application of developer, inspection and evaluation;	**CO1**

	Penetrant testing materials: penetrants, cleaners and emulsifiers, developers, special requirements, test blocks; penetrant testing methods: water washable method, post-emulsifiable method, solvent removal method; sensitivity, applications & limitations	
2	MAGNETIC PARTICLE TESTING: Principle of MPT, Magnetizing techniques- magnetization using a magnet, magnetization using an electro magnet, constant current flow method. Procedure used for testing a component: Equipment used for MPT-simple equipment, large portable equipment, stationary magnetizing equipment; sensitivity, limitations. ULTRASONIC TESTING: Basic properties of sound beam- sound waves, velocity of ultrasonic waves, acoustic impedance, behaviour of ultrasonic waves. Inspection methods: Normal incident pulse-echo inspection, normal incident through-transmission testing, angle beam pulse-echo testing, criteria for probe selection, flaw sensitivity, beam divergence, penetration and resolution.	**CO2**
3	ACOUSTIC EMISSION TESTING: Principle of AET, technique, instrumentation, sensitivity, applications. THERMOGRAPHY: Basic principles, detectors and equipment, techniques, applications. CODES, STANDARDS, SPECIFICATION AND PROCEDURES: Code, standards- international and national standards, industry standards, government and military standards, industry practices, standards; specification, procedures, Indian National standards for NDT, International standards for NDT- ISO standards for quality systems.	**CO3**
4	LIQUID CRYSTALS FOR FLAW DETECTION IN COMPOSITES: Equipment, specimen preparation procedure, results, passive tests, discussion and conclusions. DETECTION OF DAMAGE IN COMPOSITE MATERIALS BY VIBROTHERMOGRAPHY: Experimental technique, results and discussion. APPLICATION OF X-RAY TOMOGRAPHY TO THE NON-DESTRUCTIVE TESTING OF HIGH PERFORMANCE POLYMER COMPOSITES: Introduction, presentation of basic method on the medical scanner, absorption of x-rays, x-ray tomography, terminology, results achieved with the CGR – ND 8000 Scanner, conclusions.	**CO4**

Learning Resources

Text Book(s):

1. Practical Non-Destructive Testing, (2nd Edition) by Baldev Raj, T. Jayakumar, M. Thavasimuthu, Wood head Publishing Limited.
2. Non-Destructive Testing of Fibre-Reinforced Plastics Composites by J. Summerscales, Springer.
3. Damage Detection in Composite Materials by Masters JE, ASTM STP 1128.
4. Non-destructive evaluation and flaw criticality for composite materials by R. Byron Pipes, ASTM International, 197

MECHATRONICS

Course Code	22MEMD2T6B	**Year**	I	**Semester**	II
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Understand the fundamentals systems of mechatronics in a synergistic framework	L2	1
CO2	Select appropriate sensors and transducers to devise an instrumentation system for collecting information	L3	2
CO3	Design a control system for effective functioning of Mechatronics systems using digital electronics, microprocessors, microcontrollers and Programmable logic controllers	L4	3
CO4	Determine the performance of a Mechatronics system	L3	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	2	1	1				1				2	1
CO 2	3	3	2	1	1				1				2	1
CO 3	3	3	2	1	1				1				2	1
CO 4	3	3	2	1	1				1				2	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	OVERVIEW OF MECHATRONICS: History of Mechatronics, Scope and Significance of Mechatronics systems, elements of mechatronics systems, needs and benefits of mechatronics in manufacturing. CASE STUDIES: Design of pick and place robot, Barcode, Washing machine, Car engine management system, automated manufacturing system, Automatic camera, Automatic parking system, Safety devices and systems.	**CO1**
2	SENSORS: Classification of sensors basic working principles, Displacement Sensor -Linear and rotary potentiometers, LVDT and RVDT, incremental and absolute encoders. Strain gauges. Force/Torque –Load cells. Temperature –	**CO2**

	Thermocouple, Bimetallic Strips, Thermistor, RTD, Accelerometers, Velocity sensors –Tachometers, Proximity and Range sensors –Eddy current sensor, ultrasonic sensor, laser interferometer transducer, Hall Effect sensor, inductive proximity switch. Light sensors –Photodiodes, phototransistors, Flow sensors –Ultrasonic sensor, laser Doppler anemometer tactile sensors –PVDF tactile sensor, micro-switch and reed switch Piezoelectric sensors, vision sensor. ACTUATORS: Electrical Actuators: Solenoids, relays, diodes, Thyristors, Triacs, BJT, FET, DC motor, Servo motor, BLDC Motor, AC Motor, stepper motors. Hydraulic & Pneumatic devices – Power supplies, valves, cylinder sequencing. Design of Hydraulic & Pneumatic circuits. Piezoelectric actuators, Shape memory alloys.	
3	DIGITAL ELECTRONICS: Number systems, BCD codes and arithmetic, Gray codes, self-complimenting codes, Error detection and correction principles. Boolean functions using Karnaugh map, Design of combinational circuits, Design of arithmetic circuits. Design of Code converters, Encoders and decoders. SIGNAL CONDITIONING: Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Pulse width Modulation Counters, decoders. Data acquisition – Quantizing theory, Analog to digital conversion, digital to analog conversion. CONTROLLERS: Classification of control systems, Feedback, closed loop and open loop systems, Continuous and discrete processes, control modes, Two step Proportional, Derivative, Integral, PID controllers.	**CO3**
4	PLC PROGRAMMING: PLC Principles of operation PLC sizes PLC hardware components I/O section Analog I/O section Analog I/O modules, digital I/O modules CPU Processor memory module Programming. Ladder Programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output. Application on real time industrial automation systems BASIC SYSTEM MODELS & ANALYSIS: Modelling of one and two degrees of freedom Mechanical, Electrical, Fluid and thermal systems, Block diagram representations for these systems. Dynamic Responses of System: Transfer function, Modelling Dynamic systems, first order systems, second order systems.	**CO4**

Learning Resources
Text Book(s): 1. Mechatronics, (5th edition) by W. Bolton, Addison, Wesley Longman Ltd, 2010 2. Introduction to Mechatronics and Measurement systems (4thedition) by Alciatore David G & Histand Michael B, Tata McGraw Hill, 2006
References: 1. Introduction to Robotics Analysis, Systems (2nd edition), Applications by Saeed B Niku, Pearson Education India, PHI, 2003. 2. Mechatronics System Design (3rdedition) by Devdas Shetty& Richard Kolk, PWS Publishing, 2009.

CONCURRENT ENGINEERING

Course Code	22MEMD2T6C	**Year**	I	**Semester**	II
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	Statement	BTL	Units
CO1	Understand the need for adopting CE methodology to organizations.	L2	1
CO2	Understand the importance of such factors as the right corporate culture, multi-disciplinary teams and their empowerment for successful implementation	L2	2
CO3	Undertake an evaluation of the company's present communication infrastructure and recommend suitable changes to support the CE environment	L2	3
CO4	Become familiar with a range of computer based tools for modeling engineering processes and information	L2	4
CO5	Understand various factors and techniques required to optimize the product development process.	L2	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3			1	1	2				2	3	2
CO 2	3	3	3			1	1	2				2	3	2
CO 3	3	3	3			1	1	2				2	3	2
CO 4	3	3	3			1	1	2				2	3	2
CO 5	3	3	3			1	1	2				2	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	DESIGN STAGE: Life-cycle design of products - opportunity for manufacturing enterprises -modality of Concurrent Engineering Design,	**CO1**

	Automated analysis idealization control - Concurrent engineering in optimal structural design - Real time constraints checking the design process	
2	CONCEPTUAL DESIGN MECHANISM: Qualitative physical approach, an intelligent design for manufacturing system Modeling and reasoning for computer based assembly planning.	**CO2**
3	CONCEPTUAL DESIGN MECHANISM: Qualitative physical approach, an intelligent design for manufacturing system Modeling and reasoning for computer based assembly planning.	**CO3**
4	DESIGN FOR ECONOMICS: Evaluation of design for manufacturing cost, Concurrent mechanical design - decomposition in concurrent design - negotiation in concurrent engineering design studies	**CO4, CO5**

Learning Resources
Text Book(s): 1. Integrated Product Development by Anderson MM and Hein, L. Berlin, Springer Verlog, 1987 2. Design for Concurrent Engineering by Cleetus, J, Concurrent Engg. Research Centre, Morgantown, WV, 1992
References: 1. Concurrent Engineering: Automation Tools and Technology by Andrew Kusaik, John Wiley and Sons Inc., 1992 2. Concurrent Engineering Fundamentals: Integrated Product Development by Prasad, Prentice Hall, 1996 3. Successful Implementation of Concurrent Product and Process by Sammy G Sinha, John Wiley and Sons Inc, 1999

PRODUCT DESIGN

Course Code	22MEMD2T6D	**Year**	I	**Semester**	II
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

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

CO	**Statement**	**BTL**	**Units**
CO1	Apply various tools of problem solving to arrive at a fruitful design	L3	1
CO2	Analyze the factors influencing the design.	L4	2
CO3	Determine the risk and reliability aspects associated with product design.	L3	3
CO4	Select appropriate manufacturing processes to realize the product design	L3	4
CO5	Evaluate various modes of product testing	L4	4

Contribution of Course outcomes towards achievement of programme outcomes &Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3								2	2	3	1
CO 2	3	3	3								2	2	3	1
CO 3	3	3	3								2	2	3	1
CO 4	3	3	3								2	2	3	1
CO 5	3	3	3								2	2	3	1

Syllabus		
Unit	**Contents**	**Mapped CO**
1	PRODUCT DESIGN PROCESS: Design process steps, problem-solving process, creative problem solving, invention, brainstorming, morphological analysis, behavioral aspects of decision making, decision theory. MODELING AND SIMULATION: Triz, role of models in engineering design, mathematical modeling, similitude and scale models, geometric modeling on computer, finite-element analysis.	**CO1**

2	MATERIAL SELECTION: Material selection for new product design, role of processing in design, design for manufacture, design for assembly. DESIGN FOR ENVIRONMENT: Need of Design for Environment, techniques to reduce environment impact	**CO2**
3	RISK AND RELIABILITY: Risk and society, Hazard analysis, fault tree analysis. failure analysis and quality: causes of failures, failure modes, failure mode and effect analysis, FMEA procedure, Product liability, Intellectual property	**CO3**
4	PRODUCT TESTING: Thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness, accelerated testing and data analysis, accelerated factors, Weibull probability plotting, testing with censored data.	**CO4, CO5**

Learning Resources
Text Book(s): 1 Engineering Design by George E. Dieter, Mc Graw-Hill. 2. Product Design by Kevin Otto, Pearson Education, 2014.
References: 1. The Product Management Handbook by Richard S. Handscombe, Mc Graw-Hill. 2. New Product Design and development by Ulrich Eppinger, TMH. 3. Engineering Design Principles by Ken Hurst, Elseviewer. 4. Product Integrity and Reliability in Design by John W. Evans and Jillian Y. Evans, Springer

ANALYSIS LAB

Course Code	22MEMD2L1	**Year**	I	**Semester**	I
Course Category	Program Core	**Branch**	ME	**Course Type**	PRACTICAL
Credits	2	**L-T-P**	0-0-3	**Prerequisites**	Nil
Continuous Internal Evaluation:	25	**Semester End Evaluation:**	50	**Total Marks:**	75

Upon successful completion of the course, the student will be able to

CO	Course Outcome	BTL	Experiments
CO 1	Demonstrate the ability to create models for trusses, frames, plate structures, machine parts, and components using ANSYS general-purpose software	L3	1,2,3,4,5,6,7
CO 2	Use the ANSYS package to solve basic engineering analysis problems using FEA techniques	L4	1,2,3,4,5,6,7
CO 3	Model heat transfer, fracture, vibrational problems using ANSYS	L4	8,9,10,11,12,13,14
CO 4	Demonstrate the ability to evaluate and interpret FEA analysis results for design and evaluation purposes	L4	8,9,10,11,12,13,14
CO5	Develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use	L4	15,16,17,18

Contribution of Course outcomes towards the achievement of programoutcomes
& Strength of correlations (High: 3, Medium: 2, Low: 1)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	3	3				1	2			3	2
CO 2	3	3	3	3	3				1	2			3	2
CO 3	3	3	3	3	3				1	2			3	2
CO 4	3	3	3	3	3				1	2			3	2
CO 5	3	3	3	3	3				1	2			3	2

Course Content		
Experiment No	Contents	Mapped CO
Exp 1	Analysis of a Truss Structure with multipoint constrains	CO1, CO2
Exp 2	Analysis of a Slit Ring	CO1, CO2
Exp 3	Analysis of a Plate with a Circular Hole	CO1, CO2

Exp 4	Analysis of a bi-material cylindrical pressure vessel under internal pressure (Plane strain approach)	CO1, CO2
Exp 5	Analysis of an Axisymmetric Shell with Internal Pressure	CO1, CO2
Exp 6	Analysis of a Layered Composite Plate	CO1, CO2
Exp 7	Linear Buckling Analysis	CO1, CO2
Exp 8	Thermo-Mechanical Analysis	CO3, CO4
Exp 9	Fracture analysis of plate with center crack	CO3, CO4
Exp 10	Vibration of an Automobile Suspension	CO3, CO4
Exp 11	Harmonic Analysis of a Guitar String	CO3, CO4
Exp 12	Impact Loading on a Beam	CO3, CO4
Exp 13	Dynamic Analysis of a 4-bar Linkage	CO3, CO4
Exp 14	Transient Thermo-Mechanical Analysis of a Welded Joint	CO3, CO4
Exp 15	Large Deformation Analysis of a Plate	CO5
Exp 16	Plastic Deformation of an Aluminum Sphere	CO5
Exp 17	Contact Analysis of a Block Dropping on a Beam	CO5
Exp 18	Simulation of a Nano-Indentation Test	CO5

PVP22

MINI PROJECT

Course Code	22MEMD2L2	**Year**	I	**Semester**	I
Course Category	Program Core	**Branch**	ME	**Course Type**	PRACTICAL
Credits	2	**L-T-P**	0-0-3	**Prerequisites**	Nil
Continuous Internal Evaluation:	25	**Semester End Evaluation:**	50	**Total Marks:**	75

Upon successful completion of the course, the student will be able to

CO	**Course Outcome**	**BTL**
CO 1	Describe the basic functions of various departments of an industry	L2
CO 2	Identify the importance of the activity / operation of the industry to solve the industrial problems by using theoretical knowledge	L3
CO 3	Get the knowledge in the field of optimization techniques	L4

Contribution of Course outcomes towards the achievement of program outcomes & Strength of correlations (High: 3, Medium: 2, Low: 1)

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO 1	2				2	1	1	3	2	3	2	2	2	2
CO 2	2	3	3	2	2	1	1				2	3	2	2
CO 3				3	2					3	2	1	1	

DESSERTATION-Part-A

Course Code		**Year**	II	**Semester**	I
Course Category	Program Core	**Branch**	ME	**Course Type**	PRACTICAL
Credits	6	**L-T-P**		**Prerequisites**	
Continuous Internal Evaluation:	50	**Semester End Evaluation:**	---	**Total Marks:**	---

Upon successful completion of the course, the student will be able to

CO	**Course Outcome**	**BTL**
CO 1	Know the recent trends in technologies and engineering	L2
CO 2	Implement the innovative ideas in the field of technologies	L3
CO 3	Solve the industrial problems by using theoretical knowledge	L3
CO 4	Develop the computational methods for simplifying the engineering problems	L4
CO 5	Get the knowledge in design, analysis and testing of engineering prototype models	L4
CO 6	Use techniques skills and modern engineering tools	L4

Contribution of Course outcomes towards the achievement of program outcomes & Strength of correlations (High: 3, Medium: 2, Low: 1)

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO 1		3			3	2		1	2		2	3	1	
CO 2	3		3		2		1	2	2	1	3	3	1	3
CO 3		3			1		1	2	2	1	3	3	2	
CO 4				3		2	1	2	1	1	2	3	2	
CO 5	2	1			1		2	1	2	2		3	3	2
CO 6				3			3	3	3	3	2	3	2	

DESSERTATION-Part-B

Course Code		Year	II	Semester	II
Course Category	Program Core	Branch	ME	Course Type	PRACTICAL
Credits	10	L-T-P		Prerequisites	
Continuous Internal Evaluation:	50	Semester End Evaluation:	100	Total Marks:	150

Upon successful completion of the course, the student will be able to

CO	Course Outcome	BTL
CO 1	Know the recent trends in technologies and engineering	L2
CO 2	Implement the innovative ideas in the field of technologies	L3
CO 3	Solve the industrial problems by using theoretical knowledge	L3
CO 4	Develop the computational methods for simplifying the engineering problems	L4
CO 5	Get the knowledge in design, analysis and testing of engineering prototype models	L4
CO 6	Use techniques skills and modern engineering tools	L4

Contribution of Course outcomes towards the achievement of program outcomes & Strength of correlations (High: 3, Medium: 2, Low: 1)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO 1		3			3	2		1	2		2	3	1	
CO 2	3		3		2		1	2	2	1	3	3	1	3
CO 3		3			1		1	2	2	1	3	3	2	
CO 4				3		2	1	2	1	1	2	3	2	
CO 5	2	1			1		2	1	2	2		3	3	2
CO 6				3			3	3	3	3	2	3	2	