ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M.Tech

MACHINE DESIGN

(Applicable for the Batches Admitted from 2019 - 2020)

R-19

NEC
NARASARAOPETA
ENGINEERING COLLEGE
(AUTONOMOUS)

Kotappakonda Road, Yellamanda (P),
Narasaraopet - 522 601, Guntur Dist.,
Andhra Pradesh, INDIA.

Academic Regulations, Course Structure and Syllabus

M.TECH
Mechanical Engineering
(2 Years Program)

NARASARAOPETA
NEC ENGINEERING COLLEGE
(AUTONOMOUS)

Kotappakonda Road, Yellamanda (Post), Narasaraopet – 522601, Guntur District, AP
Approved by AICTE, New Delhi & Permanently affiliated to JNTUK, Kakinada, Code: 47,
Accredited by NBA&NAAC, RTA Approved Pollution test Centre, ISO 9001 : 2008 Certified Institution
Phone No. : 08647-239905 **Website:www.nrtec.ac.in**

ACADEMIC REGULATIONS - 2019 FOR M.TECH

(Effective for the students admitted into I year from the Academic Year 2019-20 and onwards)

1. **QUALIFICATION FOR ADMISSION**

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit / rank obtained by the candidates at the qualifying entrance test GATE/PGECET or on the basis of any other order of merit as approved by the Government from time to time.

2. **AWARD OF M.TECH. DEGREE**

A student will be declared eligible for the award of the M. Tech. Degree, if he fulfils the following academic requirements.

(a) Pursue a course of study for not less than two academic years and not more than four academic years.

(b) The candidate registers for 80 credits and secure all 80 credits.

3. COURSES OF STUDY

The following courses of study are offered at present as specializations in the M.Tech. courses with English as medium of instruction.

S. No.	Specialization Code	Abbreviation
01	06 - DSCE	Digital Systems and Computer Electronics
02	15 - MD	Machine Design
03	21 - TE	Thermal Engineering
04	38 - DECS	Digital Electronics and Communication Systems
05	42 - P&ID	Power and Industrial Drives
06	58 - CSE	Computer Science and Engineering
07	87 - SE	Structural Engineering

And any other course as approved by the authorities from time to time.

4. STRUCTURE OF THE PROGRAMME

Semester	Credits
I M.TECH I SEM	21
I M.TECH II SEM	21
II M.TECH III SEM	38
II M.TECH IV SEM	
TOTAL	80

Each course is normally assigned a certain number of credits as follows:

- 3 credits for 4 lecture periods.
- 3 credits for 6 laboratory periods per week.
- 1 credit for seminar.
- 2 credits for comprehensive viva
- 35 credits for project work.

The performance of the candidate in each semester shall be evaluated subject wise, with a maximum of 100 marks for theory / practical / seminar / comprehensive viva on the basis of internal evaluation and end semester examinations.

5.1 THEORY

All theory subjects consisting of 6 units in each subject, the assessment shall be for 40 marks through internal evaluation and 60 marks through external end semester examination of 3 hours duration.

5. 1.a. INTERNAL EVALUATION

The internal evaluation will be based on two cycle tests conducted in each semester. The 40 internal marks will be awarded as 75% of the best cycle and 25% of the least cycle examinations, where each cycle of examination contain

Descriptive test - 30 Marks

Assignment test - 10 Marks

Each descriptive test question paper contains3 questions one from each unit covering syllabus from 3 units (first 3 units for first cycle and the remaining 3 units for second cycle). The student has to answer all the three questions (3X10M=30M).The descriptive examination will be conducted for1½ hour duration.

In Assignment Tests 5 or 6 questions will be declared in the class room at least one week in advance. In the test, two questions (one from each unit) will be given at random to each student and the student has to answer it.

The Assignment Test-1 will be conducted for 10 marks covering the syllabus from 1st& 2nd units.The Assignment Test-2 will be conducted for 10 marks from 4th& 5th units.

5.1.b. EXTERNAL EVALUATION

The question paper comprises of 8 questions, there should be one from each unit. Student has to answer 5 questions out of 8, each question carry 12marks (5X12=60). The duration of end theory examination is 3 hours.

5.2 PRACTICALS

For practical subjects evaluation is as follows during the semester

5.2.a. INTERNAL EVALUATION

There shall be continuous evaluation during the semester for 40 internal marks. The internal marks shall be awarded as follows:

Record	- 10 Marks
Day-to-day work	- 15 Marks
Internal Lab Test	- 15Marks

5.2.b. EXTERNAL EVALUATION

For practical subjects there shall be an external examination at the end of the semester for 60 marks in the presence of external examiner.

5.3 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the end semester examination and a minimum of 50% of the total marks in the end semester examination and internal evaluation taken together.

5.4 SEMINAR

For seminar, a student under the supervision of a faculty member shall collect the literature on an advanced topic related to his specialization and review the literature then submit it to the department in a report form during the third semester and shall make an oral presentation before the departmental review committee consisting of the supervisor and head of the department / a senior faculty member. There shall be an internal evaluation for 100 marks in the form of viva voce examination and assessment of report and its presentation. There will be NO external evaluation. A candidate shall be deemed to have secured the minimum academic requirement in seminar, if he secures a minimum of 50% of marks in the examination.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register and he has to submit a fresh report and appear for the evaluation by the committee.

5.5 COMPREHENSIVE VIVA-VOCE

Comprehensive viva voce examination is conducted during the 3rd semester in all the subjects of first & second semesters of the course by a committee consisting of two senior faculty members of the department. There will be NO external evaluation.

A candidate shall be deemed to have secured the minimum academic requirement in Seminar, if he secures a minimum of 50% of marks in the examination.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register and undergo viva voce examination.

5.6 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.3) he has to re-appear for the end semester examination in that subject.

A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate is less than 50% and has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-register subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks in the previous attempt stand cancelled. For re-registration the candidates have to apply to the college by paying the requisite fee and get approval from the authorities before the beginning of the semester in which re-registration is required.

5.7 In case the candidate secures less than the required attendance in any re-registered subject(s), he shall not be permitted to write the End examination in that subject. He shall again re-register the subject when next offered.

5.8 Laboratory examinations must be conducted with two examiners, one of them being the laboratory class teacher or teacher of the respective college and the second examiner shall be appointed by the Principal from the panel of examiners submitted by the respective departments.

5.9 PROJECT WORK

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

5.9.1. A Project Review Committee (PRC) shall be constituted with Head of the Department and two other senior faculty members.

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

5.9.3. After satisfying 5.9.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The students can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

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

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

5.9.6. The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical subjects with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. The candidate has to pass all the theory and practical subjects before submission of the Thesis.

5.9.7. Three copies of the Project Thesis certified by the supervisor shall be submitted to the College.

5.9.8. The thesis shall be adjudicated by one examiner selected by the authorities. For this, the HOD of the concerned dept. shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned.

5.9.9. If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected. The candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the authorities.

5.9.10. If the report of the examiner is favourable, viva-voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the thesis. The Board shall jointly report the candidate's work as one of the following: Grade O(Outstanding)/ Grade A(Excellent)/Grade B(Very Good) /Grade C(Good)/ Grade D(Pass)/ Grade F(Fail).

The Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination.

5.9.11. If the report of the viva-voce is Grade F, the candidate shall retake the viva-voce examination only after three months. If he fails to get a satisfactory report at the second viva-voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the authorities.

6. ATTENDANCE REQUIREMENTS:

(i) A student shall be eligible to appear for the end examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

(ii) Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester for genuine medical reasons and shall be approved by a committee duly appointed by the college. A fee stipulated by the college shall be payable towards condonation of shortage of attendance. However the number of condonations is restricted to two for the entire course.

(iii) A student who is short of attendance in a semester may seek re-admission into that semester when offered next time, within 4 weeks from the date of commencement of class work.

(iv) If any candidate fulfils the attendance requirement in the present semester, he shall not be eligible for re-admission into the same class.

7. COURSE PATTERN:

(i) The entire course of study is of two academic years and every year will have TWO Semesters.

(ii) A student is eligible to appear for the end examination in a subject, but absent for it or has failed in the end examinations may appear for that subject in supplementary examinations, when conducted next.

(iii) When a student is detained due to shortage of attendance, he may be re-admitted in to the same semester/year in which he has been detained.

8. METHOD FOR AWARDING OF GRADE POINTS FOR A SUBJECT:

Theory/ Laboratory / Seminar/ Comprehensive viva/ Project (% of marks in a subject)	Corresponding Grade Points	Letter Grade
91 - 100	10	O (Outstanding)
81 - 90	9	A (Excellent)
71 - 80	8	B (Very Good)

61 - 70	7	C (Good)
51 - 60	6	D (Pass)
< 50	0	F (Fail)

9. Criteria for award of grades/division.

9.1 Calculation of Semester Grade Point Average (SGPA)* for semester

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

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

Where CR= Credits of a subject
GP = Grade Points awarded for a subject

*SGPA is calculated for a candidate who passed all the subjects in that semester.

9.2 Calculation of Cumulative Grade Point Average (CGPA) for Entire Program:

The CGPA is calculated as given below:

$$CGPA = \frac{\sum (CR \, X \, GP)}{\sum CR}$$

Where CR = Credits of a subject
GP = Grade Points awarded for a subject

- The SGPA and CGPA shall be rounded off to 2 decimal point and reported in the transcripts.
- Equivalent percentage = (CGPA – 0.75) x 10

9.3 Award of Division:

After satisfying the requirements prescribed for the completion of the program, the student shall be eligible for the award of M.Tech Degree and shall be placed in one of the following classes:

CGPA	Class
≥ 7.75	First Class with Distinction (Provided all the subjects should pass in the first attempt)
≥ 6.75	First Class (with subject failures)
≥ 5.75 & < 6.75	Second Class

10. REVALUATION:

1. Student can submit the application for revaluation, along with the prescribed fee for revaluation of his answer script(s) of theory subject(s) as per the notification issued by the Controller of Examinations.
2. The Controller of Examinations shall arrange for revaluation of such answer script(s).
3. An External examiner, other than the first examiner shall revaluate the answer script(s).

11. MINIMUM INSTRUCTION DAYS:

The minimum instruction days for each semester shall be 90 working days.

12. There shall be no branch transfer after the completion of admission process.

13. WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the college or if any case of indiscipline is pending against him, the result of such student will be kept withheld. His degree will be withheld in such cases.

14. TRANSITORY REGULATIONS

Discontinued or detained candidates are eligible for readmission as and when next offered.

A candidate, who is detained or discontinued in a semester, on readmission shall be required to do all the subjects in the curriculum prescribed for the batch of students in which the student joins subsequently. However, exemption will be given to those candidates who have already passed such subjects in the earlier semester(s) he was originally admitted into and substitute subjects are offered in place of them as decided by the Board of Studies. However, the decision of the Board of Studies will be final.

14.1 A student who is following JNTUK curriculum and detained due to shortage of attendance at the end of the first semester of first year shall join the autonomous batch of first year first semester. Such students shall study all the subjects prescribed for the batch in which the student joins and considered on par with regular candidates of Autonomous stream and will be governed by the autonomous regulations.

14.2 A student who is following JNTUK curriculum, detained due to shortage of attendance at the end of the second semester of first year or at the subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the subjects in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the subjects of the semester(s) of the batch which he had passed earlier and substitute subjects will be offered in place of them as decided by the Board of Studies. The student has to clear all his backlog subjects up to previous semester by appearing for the supplementary examinations conducted by JNTUK for the award of degree will be sum of the credits up to previous semester under JNTUK regulations and the credits prescribed for the semester in which a candidate seeks readmission and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

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MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT INEXAMINATIONS

- The Principal shall refer the cases of Malpractices in Internal Assessment Test and Semester end examinations to a malpractice prevention committee constituted by him for the purpose. Such committee shall follow the approved levels of punishment. The Principal shall take necessary action against the students based on the recommendations of the committee.
- Any action by the candidate trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder:

	Nature of Malpractices/ Improper conduct	Punishment
	If the candidate:	
1(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination).	Expulsion from the examination hall and cancellation of the performance in that subject only.
1(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination(theory or practical) in which the candidate 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 project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the college.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from classwork and all college 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.	Smuggles in the 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 examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from classwork and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent /any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-incharge 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 result in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, 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 is registered against them.

7.	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 project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from classwork and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6to 8.	Student of the college expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.

11.	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 project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the college for further action to award suitable punishment.	

OTHER MATTERS:

1. Physically challenged candidates who have availed additional examination time and a scribe during their UG / PGECET examinations will be given similar concessions on production of relevant proof / documents.

2. The Principal shall deal in an appropriate manner with any academic problem which is not covered under these rules and regulations, in consultation with the Heads of the departments 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 for ratification.

GENERAL:

1. The academic council may, from time to time, revise, amend or change the regulations, schemes of examinations and / or syllabi.
2. Wherever the words ''he'' ''him'' ''his'', occur in the regulations, they include ''she'', ''her'', ''hers''.
3. The academic regulation should be read as a whole for the purpose of any interpretation.
4. In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the principal is final.

NARASARAOPETA ENGINEERING COLLEGE::NARASARAOPET
(Autonomous)

M.TECH (MACHINE DESIGN)
COURSE STRUCTURE

COURSE: M.TECH I SEMSTER

S.No	Subject Name	Subject Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	Computational Methods In Engineering	19MMD1TH01	3	-	-	40	60	100	3
2	Advanced Mechanics Of Solids	19MMD1TH02	3	-	-	40	60	100	3
3	Analysis and Synthesis of Mechanisms	19MMD1TH03	3	-	-	40	60	100	3
4	Mechanical Vibrations	19MMD1TH04	3	-	-	40	60	100	3
5	**Elective –I**								
	Theory Of Elasticity and Plasticity	19MMD1PE05	3	-	-	40	60	100	3
	Tribology	19MMD1PE06							
	Rotor Dynamics	19MMD1PE07							
	Design For Manufacturing and assembly	19MMD1PE08							
6	**Elective –II**		3	-	-	40	60	100	3
	Gear Engineering	19MMD1PE09							
	Non-Destructive Evaluation	19MMD1PE10							
	Mechatronics systems Design	19MMD1PE11							
	Material Technology	19MMD1PE12							
7	Machine Dynamics Lab	19MMD1LB01	-	-	6	40	60	100	3
	TOTAL		**18**	**-**	**6**	**280**	**420**	**700**	**21**

COURSE: M.TECH II SEMSTER

S.No	Subject Name	Subject Code	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	Finite Element Methods & Applications	19MMD2TH01	3	-	-	40	60	100	3
2	Geometrical Modeling	19MMD2TH02	3	-	-	40	60	100	3
3	Experimental Stress Analysis	19MMD2TH03	3	-	-	40	60	100	3
4	Fatigue, Creep and Fracture Mechanics	19MMD2TH04	3	-	-	40	60	100	3
5	**Elective –III**								
6	Advanced Optimization Techniques	19MMD2PE31	3	-	-	40	60	100	3
	Design of Experiments	19MMD2PE32							
	Condition Monitoring	19MMD2PE33							
	Rapid Tooling & Prototyping	19MMD2PE34							
7	**Elective –IV**		3	-	-	40	60	100	3
	Industrial Robotics	19MMD2PE41							
	Mechanics of Composite Materials	19MMD2PE42							
	Computer Integrated Manufacturing	19MMD2PE43							
	Research Methodology	19MMD2PE44							
	Advanced Computer Aided Design& Analysis Lab	19MMD2LB01	-	-	6	40	60	100	3
	TOTAL		**18**	**-**	**6**	**280**	**420**	**700**	**21**

II Year - III & IV SEMESTERS

S.NO	NAME OF THE SUBJECT	L	P	C
1	Seminar (19MMD3SM)	-	-	1
2	Comprehensive Viva-Voce (19MMD3CV)	-	-	2
3	Project (19MMD4PW)	-	-	35
	TOTAL	-	-	**38**

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1TH01	**COMPUTATIONAL METHODS IN ENGINEERING**						

Course Objectives:

Know how to solve system of equations, ordinary differential equations and partial Differential equations numerically. Understand correlation and regression. Know optimization techniques in solving linear, integer and fractional programming problems.

Learning Outcomes:

Student will be able to

Find the solutions of system of linear and non linear equations.
Solve ordinary and partial differential equations numerically.
Find correlation coefficient and regression.
Optimize linear, integer and fractional programming problems.

UNIT-I

Introduction to numerical methods applied to engineering Problems:

Solving system of linear equations by Gauss Seidel and Relaxation methods. Solving system of non-linear equations by Newton-Raphson method.

UNIT-II

Numerical Solutions of Ordinary Differential Equations:

Boundary Value Problems: Shooting Method–solution through a set of equations - derivative boundary conditions - Rayleigh Ritz Method.

UNIT-III

Numerical Solutions of Partial Differential Equations:

Finite-Difference Approximations to Derivatives, Laplace Equation – Jacobi Method - ADI Method, Parabolic Equation – Crank Nicolsen method.

UNIT-IV

Applied Statistics:

Correlation Analysis - Correlation Coefficient – coefficient of Correlation for grouped bi- variate data – coefficient of determination – Test of significance for correlation coefficient. Regression Analysis - Simple linear regression - Multiple linear regression.

UNIT-V

Optimization Techniques:

Linear Programming Problem – Simplex Method, Artificial variable method –Big-M Method, Integer Programming Problem – Branch and Bound Method, Linear Fractional Programming Problem.

UNIT-VI

Curve fitting and approximation of functions:

Least square approximation fitting of non-linear curves by least squares –computer programs

HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS: Solving wave equation by finite

differences-stability of numerical method – method of characteristics wave equation in two space dimension-computer programs.

TEXT BOOKS:

1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Graw Hill
2. Curtis F.Gerald, Partick.O.Wheatly,"Applied numerical analysis", Addison-Wesley,1989.

REFERENCE BOOKS:

1. Douglas J.Faires,RichedBurden"Numerical methods", Brooks/Cole publishing company,1998.Second edition.
2. Ward Cheney and David Kincaid "Numerical mathematics and computing" Brooks/Cole publishing company1999, Fourth edition.
3. Riley K.F,.M.P.Hobson and BenceS.J,"Mathematical methods for physics and engineering", Cambridge University press,1999.
4. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI.
5. Basic Statistics – Agarrval, B.L. Wiley 1991, 2nd edition. Operations Research – S.D. Sarma.

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1TH02	**ADVANCED MECHANICS OF SOLIDS**						

Course Objectives:

To familiarize with the concepts of stresses and strains in un symmetric bending and torsion using classical methods.

Learning Outcomes:

Student will be able to

Apply the theory of elasticity including strain/displacement and Hooke's Law relationships.

Analyze solid mechanics problems using classical and energy methods.

Solve torsion problems in bars and thin walled methods.

Solve for stresses and deflection beam under unsymmetrical loading.

Assess various failure criteria in engineering problems.

UNIT-I

Theories of Stress and Strain: Definition of stress at a point, stress notation, principal stresses, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains.

Stress–Strain Temperature Relations: Elastic and non-elastic response of a solid, Hooke's law, anisotropic elasticity, Isotropic elasticity, initiation of yield, yield criteria.

UNIT-II

Shear Center:

Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections

UNIT-III

Unsymmetrical bending:

Bending stresses in Beams subjected to nonsymmetrical bending; deflection of straight beams due to nonsymmetrical bending

UNIT-IV

Curved Beam Theory:

Winkler Bach formula for circumferential stress –limitations – correction factors–radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.

UNIT-V

Axi-Symmetric Problems:

Rotating Discs- flat discs, discs of uniform thickness, discs of uniform strength, rotating cylinders.

UNIT-VI

Torsion:

Linear elastic solution, Prandtl elastic membrane (Soap-Film) analogy, narrow rectangular cross section, hollow thin wall torsion members, multiple connected cross sections. Hollow thin wall torsion members, Thin wall torsion members with restrained ends.

TEXT BOOKS:

1. Boresi & Sidebottom, "Advanced Mechanics of materials" Wiely International, 6th edition.
2. Dr Sadhu singh, "Strength of materials" Khanna Publication, 1st edition.

REFERENCE BOOKS:

1. Timoschenko S.P. and Goodier J.N., "Theory of elasticity", McGraw- Hill Publishers, 3rd Edition.
2. L.S Srinath, "Advanced Mechanics of Solids", McGraw Hill Education (India) Pvt. Ltd.3rd edition.

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1TH03	**ANALYSIS AND SYNTHESIS OF MECHANISMS**						

Course Objectives:

To introduce the concepts used for kinematic analysis of planar and spatial mechanisms.

To familiarize with the concepts of force analysis and synthesis of mechanisms.

Learning Outcomes:

Student will be able to

Determine the displacement, velocity and accelerations of links of mechanism.

Apply path curvature characteristics in analysis of mechanisms.

Apply analytical and synthesis techniques in design of mechanisms.

Determine the forces and torque acting by performing force analysis.

Apply forward and reverse kinematic analysis techniques in performance evaluation of manipulators.

UNIT-I

Introduction: Elements of Mechanisms,degrees of freedom,Kutchback equation and grublers criterion -applications of Grublers criterion, transmission angles- extreme values of transmission angles , toggle positions.

Displacement, Velocity and Acceleration Analysis (Analytical methods only): Analysis for four bar and single slider crank mechanisms.

UNIT-II

Path Curvature Theory: Introduction , fixed and moving centrodes , inflection points and inflection circle ,Euler Savary Equation , Bobilliers Construction , Collineation axis , Bobillier theorem ,Hartmann construction , Bresse circle , Return circle , Cusp Points , Crunode points.

UNIT-III

Kinematic Synthesis: Introduction , type, dimensional and number Synthesis , synthesis for function generation, path and motion generation ,Chebyschev Spacing of accuracy points **Graphical Synthesis Techniques:** Motion generation for two prescribed positions and three prescribed positions – path generation for three prescribed positions without and with prescribed timing – function generation for three prescribed positions.

UNIT-IV

Analytical Synthesis Techniques: Four bar and slider crank function generator with three accuracy points– use of complex numbers and dyads – three prescribed positions for motion, path and function generation using dyad.

UNIT-V

Static Force Analysis: Static equilibrium, equilibrium of two and three force members, equilibrium of four force members , static force analysis of four bar and slider crank mechanisms.

Dynamic Force Analysis: D Alembert Principle , dynamic analysis of four bar mechanism and single slider crank mechanism – dynamically equivalent system – inertia of Connecting Rod – inertia force and torque in reciprocating Engine (Analytical Method only).

UNIT-VI

Spatial Mechanisms: D-H transformation matrix; forward kinematic analysis of serial manipulators– Reverse kinematic analysis – iterative solution techniques.

TEXT BOOKS:

1. Erdman and Sandor,"Advanced Mechanism Design (Vol II)",Prentice Hall International 1984.
2. S.S. Rattan, "Theory of Machines",TataMc Graw Hill, 2011.

REFERENCE BOOKS:

1. Uicker, Pennock and Shigley," Theory of machines and Mechanisms", Oxford Univ Press, 2010.
2. AmitabhaGhosh and Ashok Kumar Mallik, " Theory of Mechanism and machines", East West Press pvt Ltd,2nd edition.
3. Robert L.Norton," Design of Machinery", Tata McGraw Hill 3rd edition.

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1TH04	**MECHANICAL VIBRATIONS**						

Course Objectives:

Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.
Determine a complete solution to the modeled mechanical vibration problems.
Correlate results from the mathematical model to physical characteristics of the actual system.
Design of a mechanical system using fundamental principles developed in the class.

Learning Outcomes:

Student will be able to

Understand the causes and effects of vibration in mechanical systems and their classification.
Develop schematic models for physical systems and formulate governing equations of motion.
Understand the role of damping, stiffness and inertia in mechanical systems.
Analyze rotating and reciprocating systems and design machine supporting structures, vibration isolators and absorbers.
Calculate free and forced vibration responses of multi degree freedom systems using modal analysis.
Analysis and design for the control/ to reduce vibration effects in machinery.

UNIT-I

Fundamentals of Vibrations Analysis

Introduction; Elements of vibration; classification of vibration; vibration analysis procedure; spring elements – equivalent stiffness; mass or inertia elements; damping elements – equivalent damping; types of damping; definitions and terminology; simple harmonic motion.

UNIT-II

Free Vibration Analysis - Single Degree Of Freedom Systems:

Undamped Vibrations: Different methods for equation of motion– Newton's second law, D'Alembert's principle, principle of virtual displacement, principle of conservation of energy, Rayleigh's method.
Damped Vibrations: Differential equation of motion; critical damping coefficient and damping ratio; damped natural frequency; logarithmic decrement; energy dissipated in viscous damping

UNIT-III

Forced Vibration Analysis (Single Degree Of Freedom System): Response of damped and undamped systems to harmonic excitation; frequency response curve; magnification factor; harmonic excitation of the base, vibration isolation, transmissibility, force transmission to foundations.
Vibration measuring instruments – working principle of Seismic mass, vibrometer, accelerometer

UNIT-IV

Damped and Undamped Vibrations – Two degree of freedom system Free and forced vibration analysis of a two degree of freedom system – different methods for the formulation of equation equations of motion, natural frequencies, principal modes - physical interpretation and orthogonality; general method, eigen value method

UNIT-V

Torsional Vibrations: Torsional vibration of one, two and three rotor system; Equivalent shafting; torsional vibration of a geared system; coordinate coupling – static and dynamic coupling; whirling of rotating shafts

UNIT-VI

Vibrations of continuous systems : Vibrations of springs, bars and beams, formulation of equation of motion, characteristic equation, eigen values, identification of node and mode shapes.

TEXT BOOKS:

1. G.K. Grover & Nigam , "Mechanical Vibrations", Nem Chand and Brothers, 8th edition
2. S.S. Rao , "Mechanical vibration", pearson India, 4th edition.

REFERENCE BOOKS:

1. Thomson, " Theory of Vibration with Application", pearson India, 5th edition.
2. V.P.Singh,"Mechanical vibration" DhanpatRai& Co.
3. Schaum Series," Mechanical vibration" McGraw-Hill, 1st edition.
4. F.S. Tse, Morse &Hinkle,"Mechanical Vibration", CBS Publisher, 2nd edition.

I M.TECH I SEMESTER **(ELECTIVE-I)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1PE05	**THEORY OF ELASTICITY AND PLASTICITY**						

Course Objectives:

To introduce the basic concepts of theory of elasticity

Learning Outcomes:

Student will be able to

Determine stress distribution and strain components for simple and symmetric problems analyze three dimensional problems using equilibrium and compatibility equations

Determine stresses induced in beams of different cross sections

Apply concepts of plasticity to determine the shear stresses and strain energy

UNIT-I

Elasticity: Two dimensional stress analysis - plane stress - plane strain - equations of compatibility -stress function - boundary conditions.

Problem in rectangular coordinates: Solution by polynomials - Saint Venent's principles – determination of displacement - simple beam problems.

UNIT-II

Problems in polar coordinates: General equations in polar coordinates - stress distribution symmetrical about axis - strain components in polar coordinates - simple and symmetric problems.

UNIT-III

Analysis of stress and strain in three dimensions : Principle stresses–homogeneous deformations -strain spherical and deviatoric stress - hydrostatic strain.

General theorems : Differential equations of equilibrium and compatibility - displacement – uniqueness of solution - reciprocal theorem.

UNIT-IV

Bending of prismatic bars: Stress function - bending of cantilever beam - beam of rectangular cross-section - beams of circular cross-section.

UNIT-V

Plasticity : Plastic deformation of metals - structure of metals - deformation - creep stress relaxation of deformation - strain rate condition of constant maximum shear stress - condition of constant strain energy - approximate equation of plasticity.

UNIT-VI

Methods of solving practical problems: The characteristic method - engineering method – compression of metal under press - theoretical and experimental data drawing.

TEXT BOOKS:

1. S.P. Timoshenko & J.K Goodier , "Theory of Elasticity", MGH,3rd Edition.

REFERENCE BOOKS:

1. E.P. Unksov ,"An Engineering Theory of Plasticity", Butterworths scientific publications, 1961.
2. Hoffman and Sacks, "Theory of Plasticity" , McGraw-Hill, New York, 1953.

I M.TECH I SEMESTER **(ELECTIVE-I)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1PE06	**TRIBOLOGY**						

Course Objectives:

To know the selection of lubricating system for different types of bearings in various environmental conditions;

To understand the principles of design of Hydrostatic and Hydro Dynamic bearings.

Learning Outcomes:

Student will be able to

Select the appropriate bearing materials.

Select the rolling element bearing for the given conditions.

Design hydrostatic, hydrodynamic and air lubrication systems used in bearings.

Minimize the boundary friction and dry friction.

UNIT-I

Introduction: Nature of surfaces and contact-surface topography, friction and wear mechanisms, wear maps, 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.

UNIT-II

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.

UNIT-III

Hydrostatic Bearings: Thrust bearings–pad coefficients- restriction optimum film thickness-journal bearings – design procedure –aerostatic bearings; thrust bearings and journal bearings – design procedure.

UNIT-IV

Hydrodynamic bearings: Fundamentals of fluid formation– Reynold's equation; hydrodynamic journal bearings – Sommer field 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.

UNIT-V

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.

UNIT-VI

Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and ferrography.

Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings–qualitative approach only.

TEXT BOOKS:

1. Rowe WW& O' Dionoghue,"Hydrostatic and Hybrid bearing design" ,Butterworths& Co.Publishers Ltd,1983.
2. Collacott R.A, "Mechanical Fault diagnosis and condition monitoring", Chapman and Hall, London ,1977.
3. Bernard J. Hamrock, "Fundamentals of fluid film lubricant", McGraw-Hill Co., 1994.

REFERENCE BOOKS:

1. Neale MJ, (Editor) "Tribology hand Book" ,Neumann Butterworths,1975.
2. Connor and Boyd JJO (Editors) "Standard hand book of lubrication engineers" ASLE, McGraw Hill Book & Co.,1968.
3. Shigley J, E Charles, " Mechanical Engineering Design", McGraw Hill Co.,6th Edition.

I M.TECH I SEMESTER **(ELECTIVE-I)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1PE07	**ROTOR DYNAMICS**						

Course Objectives:

To develop expertise regarding rotor dynamics and vibration in rotating machinery.
To expose the concepts of rigid rotor dynamics, rotor vibration and critical speeds.

Learning Outcomes:

Student will be able to

Analyze vibrations in rotating machinery.
Determine the whirling speed of rotor.
Identify the effect of bearings on rotor vibrations.
Monitor the condition of rotors

UNIT-I

Introduction to Vibration and the Laval-Jeffcott Rotor Model: Co-ordinate systems, steady state rotor motion, elliptical motion, single degree of freedom systems, free and forced vibrations.

UNIT-II

The two degrees of freedom rotor system, translational motion, natural frequencies and natural modes, steady state response to unbalance, the effect of flexible support.

UNIT-III

Torsional Vibration in Rotating Machinery: modeling of rotating machinery shafting - multi degree of freedom systems - determination of natural frequencies and mode shapes - branched systems - Holzer method.

UNIT-IV

Rigid Rotor Dynamics and Critical Speeds: rigid disk equation - rigid rotor dynamics- rigid rotor on flexible rotor - the gyroscopic effect on rotor dynamics - whirling of an unbalanced simple elastic rotor, simple shafts with several disks - effect of axial stiffness - determination of bending critical speeds - Campbell diagram.

UNIT-V

Influence of Bearing on Rotor Vibration: Support stiffness on critical speeds- stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients - mechanics of hydro dynamic instability- half frequency whirl and resonance whip-design configurations of stable journal bearings

UNIT-VI

Balancing and Condition Monitoring of Rotors: Single plane balancing, multi-plane balancing, balancing of rigid rotors, balancing of flexible rotors noise spectrum, real time analysis, knowledge based expert systems.

TEXT BOOKS:

1. J. S.Rao, "*Rotor Dynamics"*, New Age International Publishers, New Delhi, 2004.
2. S.Timoshenko, D H.Young and W. Weaver , "Vibration Problems in Engineering", John Wiley,2000.

REFERENCE BOOKS:

1. WengJeng Chen and J Edger Gunter, "Introduction to Dynamics of Rotor – Bearing Systems", Trafford Publishing Ltd., London 2007.
2. T. Yamamoto and Y.Ishida , "Linear and Nonlinear Rotordynamics: A Modern Treatment with Applications", John Wiley and Sons Inc, New York, 2001.
3. J. S.Rao, "Vibratory Condition Monitoring of Machines",NarosaPubulishing House, 2000.

I M.TECH I SEMESTER **(ELECTIVE-I)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1PE08	**DESIGN FOR MANUFACTURING AND ASSEMBLY**						

Course Objectives:

To introduce the design factors this will ease the manufacturing and assembly.

Learning Outcomes:

Student will be able to

Incorporate the process constraints & other influencing factors for design.
Design a metal casting product considering trouble shooting elements.
Design a defect free weldment.
Select appropriate material and manufacturing process for product development.
Plan an assembly for ease of manufacture and automation.

UNIT-I

Design for manufacturing: Reduce the cost of manufacturing process, understanding the process and constraints, standard components and process, consider the impact of DFM decisions and other factors.

UNIT-II

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.

UNIT-III

Design consideration in metal casting: Mold and gating system design, directional solidification, and trouble shooting.

UNIT-IV

Design for Welding: Selection of materials for joining, welding defects, minimize the residual stresses etc. design for forging and sheet metal and powder metal process.

UNIT-V

Plastics: Visco elastic and creep behavior in plastics-design guidelines for plastic components-design considerations for injection moulding– design guidelines for machining and joining of plastics

UNIT-VI

Design for assembly and automation: Application of design for manufacture and assembly with selection of materials and ranking of processes like casting, injection moulding, sheet metal working, die casting, powder metal process, investment casting and hot forging, design for assembly and automation.

TEXT BOOKS:

1. George E. Dieter, "Engineering Design – A Material Processing Approach", McGraw Hill International, 2nd Edition , 2001
2. GeofreyBoothroyd, Peter Dewhurst, "Product Design for Manufacture and Assembly", CRC Press, 3rd Edition, 2010.

REFERENCE BOOKS:

1 .O. Molloy , "Design for Manufacturing and Assembly: Concepts, Architectures and Implementation",Chapman and Hall, 1998.

I M.TECH I SEMESTER **(ELECTIVE-II)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1PE09	**GEAR ENGINEERING**						

Course Objectives:

To know the design of gears like spur, helical, bevel and worm gears against different types of failures.

To learn the concepts of gear box design along with optimization parameters.

Learning Outcomes:

Student will be able to

Select and design appropriate gear for the given application and against the failure.

Design the gear box to an application.

Optimize the parameters of gear like weight, space etc.

UNIT-I

Introduction: Principles of gear, Nomenclature, types of gear teeth profiles - Cycloid and Involute, gear manufacturing processes and inspection, selection of right kind of gears.

Gear Failures: Gear tooth failure modes - tooth wear, tooth breakage, pitting, scoring, lubrication failures, gear box casing problems.

UNIT-II

Spur Gears - Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

UNIT-III

Helical gears- Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of helical gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

UNIT-IV

Bevel gears - Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

Worm gears - Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

UNIT-V

Gear trains: Simple, compound and epicyclic gear trains, Ray diagrams, Design of a gear box of an automobile – Constant Mesh and sliding type.

UNIT-VI

Optimal Gear design: Optimization of gear design parameters, Weight minimization, Constraints in gear train design- space, interference, strength, dynamic considerations, rigidity etc., Compact design of gear trains.

TEXT BOOKS:

1. T.V.Sundarajanmurthy, N.Shanmugam,"Machine Deisgn", Anuradha Agencies Pub-Chennai
2. Maleev and Hartman, "Machine Design", C.B.S. Publishers, India.
3. "Design Data Hand Book", International Book House (P).Ltd Delhi
4. "Design Data Hand Book", Anuradha Publications - Chennai

REFERENCE BOOKS:

1. Henry E.Merrit, "Gear engineering" ,Wheeler publishing,Allahabad,1992.
2. Darle W. Dudley,"Practical Gear design", McGraw-Hill book company.
3. Norton, "Machine Design - An Integrated Approach", 2nd Edition, Pearson Publications,
4. 2000.

Note: Design data book is allowed for the examinations.

I M.TECH I SEMESTER **(ELECTIVE-II)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1PE10	**NON-DESTRUCTIVE EVALUATION**						

Course objectives:

To understand the principles behind various NDT techniques.

To study about NDT equipment and accessories.

To learn working procedures of various NDT techniques.

Course Outcomes:

After Completion of this course students will be able to

Demonstrate good grounding in the area of NDT.

To select proper NDT Method for his application

Understand the utilization of test and measurement appropriate to the area of his study/problem

UNIT-I

Ultra Sonic Hardness Testing: Flaw Detection Using Dye Penetrants. Magnetic Particle Inspection introduction to electrical impedance, Principles of Eddy Current testing, Flaw detection using eddy currents.

UNIT-II

Holography: Principles and practices of Optical holography, acoustical, microwave, x-ray and electron beam holography techniques.

UNIT-III

Introduction to X-Ray Radiography: The Radiographic process, X-Ray and Gamma ray Sources, Geometric Principles, Factors Governing Exposure, Radio graphic screens, Scattered Radiation, Arithmetic of exposure, Radiographic image quality and detail visibility, Industrial X-ray films.

UNIT-IV

X-Ray Radiography processes: Fundamentals of processing techniques, Process control, the processing Room, Special Processing techniques, Paper Radiography, Sensitometric characteristics of x-ray films, Film graininess signal to noise ratio in radiographs, the photographic latent image, Radiation Protection

UNIT-V

Introduction to Ultrasonic Testing: Generation of ultrasonic waves, Horizontal and shear waves, Near field and far field acoustic wave description, Ultrasonic probes- straight beam, direct contact type, Angle beam, Transmission/reflection type, and delay line transducers, acoustic coupling and media, Transmission and pulse echo methods, A-scan, B-scan, C-scan, F-scan and P-scan modes.

UNIT-VI

Ultrasonic tests: Flaw sizing in ultrasonic inspection: AVG, Amplitude, Transmission, TOFD, Satellite pulse, Multi-modal transducer, Zonal method using focused beam. Flow location methods, Signal processing in Ultrasonic NDT; Mimics, spurious echos and noise. Ultrasonic flaw evaluation.

Applications

1. NDT in flaw analysis of Pressure vessels, piping
2. NDT in Castings, Welded constructions, etc., Case studies.

TEXT BOOKS:

Ultrasonic testing by Krautkramer and Krautkramer
Ultrasonic inspection 2 Training for NDT : E. A. Gingel, Prometheus Press.

REFERENCE BOOKS:

ASTM Standards, Vol 3.01, Metals and alloys.

I M.TECH I SEMESTER **(ELECTIVE-II)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1PE11	**MECHATRONICS SYSTEMS DESIGN**						

Course objectives:

To know the basic knowledge of modern engineering systems, mechanical and electrical systems and their connection.

To understand the concept of integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.

Learning outcomes:

Appreciate multi-disciplinary nature of modern engineering systems.

Model and analyse mechanical and electrical systems and their connection.

Be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.

Address issues of design, fabrication, and packaging issues of Microsystems.

UNIT – I:

Introduction: Definition and Introduction to Mechatronic Systems. Modeling & Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers. Study of Sensors and Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.

UNIT – II:

Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors. System Models: Mathematical models:- mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.

UNIT – III:

Signal Conditioning: Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, pulse-modulation.

UNIT – IV:

Micro Electronics and mechanical Systems:

MEMS and Microsystems: Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging.

UNIT – V:

Data Presentation Systems: Basic System Models, System Models, Dynamic Responses of System.

UNIT – VI:

Advanced Applications in Mechatronics: Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User friendly design.

TEXT BOOKS:

1. W. Bolton, "Mechatronics", Addison Wesley Longman Publication, 1999.
2. HSU "MEMS and Microsystems design and manufacture", Tata McGraw-Hill Education, 2002.

REFERENCE BOOKS:

1. Lawrence J. Kamm, "Understanding Electro-Mechanical Engineering an Introduction to Mechatronics", Wiley-IEEE Press, 1st edition, 1996.
2. Devdas Shetty and Richard A. Kolk, "Mechatronics System Design", Cengage Learning, 2nd ed, 2011.
3. Mahalik, Mechatronics, Tata McGraw-Hill Education, 2003.
4. HMT, "Mechatronics"- Tata McGraw-Hill Education, 1998.
5. Michel B. Histand and David. Alciatore, "Introduction to Mechatronics & Measurement Systems", McGraw Hill, 2002.
6. Fine Mechanics and Precision Instruments- Pergamon Press, 1971.

I M.TECH I SEMESTER **(ELECTIVE-II)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD1PE12	**MATERIAL TECHNOLOGY**						

Course Objectives:

To gain and understanding of the relationship between the structure, properties, processing, testing and applications of strengthening mechanism, modern metallic, smart, non-metallic, advanced structural ceramic and composite materials so as to identify and select suitable materials for various engineering applications.

Course Outcomes:

After Completion of this course students will be able to

Students will get knowledge on mechanism of plastic deformation and strengthening mechanism.

Students will be able to learn the structure, properties and applications of modern metallic materials, smart materials non-metallic materials and advanced structural ceramics.

Students will be able to understand the importance of advanced composite materials in application to sophisticated machine and structure of components.

UNIT-I

Classification of materials and their properties, Bonds in Solids, Crystallographic planes and directions, Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening.

UNIT-II

Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non-crystalline material.

UNIT-III

Modern metallic Materials: Iron-Iron Carbide Diagram, TTT Diagram, Dual phase steels, high strength low alloy (HSLA) Steel, transformation induced plasticity (TRIP) Steel, maraging steel, intermetalics, Ni and Ti aluminides.Smart materials Classification, shape memory alloys, metallic glass, quasi crystal and nano crystalline materials.

UNIT-IV

Non-metallic materials: Polymeric materials Classification, properties and applications, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers

UNIT-V

Advanced structural ceramics: Ceramic materials Classification, properties and applications, WC, TiC, TaC, Al2O3, SiC, Si3 N4, CBN and diamond-properties, processing and applications.

UNIT-VI

Advanced structural composites: Introduction, types of composite materials, properties, processing and application. Motivation of selection, cost basis and service requirements, selection for mechanical properties, strength, toughness, fatigue and creep.

TEXT BOOKS:

1. Mechanical behavior of materials/Thomas H.Courtney/2nd Edition, McGraw-Hill, 2000
2. Mechanical Metallurgy/George E.Dieter/McGraw Hill, 1998
3. Introduction to Physical Metallurgy, Sidney H. Avner, US, 2nd Edition, 2007 Tata McGrawHill, Noida, 1985.

REFERENCE BOOKS:

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2. Materials Science and Engineering, William D. Callister, 8th Edition, 2010.
3. Material Science and Metallurgy, kodgire V.D, 12th Edition, Everest Publishing House 2002

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	6	40	60	100	3
Code: 19MMD1LB01	**MACHINE DYNAMICS LAB**						

Course Objectives:

To study the behavior of machine elements experimentally when subjected to dynamic forces.

Learning Outcomes:

Student will be able to

Determine gyroscopic effect of rotating body.

Estimate the natural frequency of undamped torsional vibration of rotor.

Perform dynamic balancing of rotating and reciprocating masses.

List of Experiments:

1. Natural frequency of simple pendulum
2. Determine the moment of inertia of a flywheel.
3. Determination of steady state amplitude of forced vibratory system
4. Natural frequency of single rotor system
5. Natural frequency of single rotor with damping
6. Undamped free vibrations of beam
7. Damped free vibrations of beam
8. Force vibrations of beam.
9. Force vibration beam with damped.
10. Friction and Wear Apparatus
11. Determination of the magnitude and orientation of the balancing mass in dynamic balancing
12. Motorized Gyroscopic Couple Apparatus.

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2TH01	**FINITE ELEMENT METHODS AND APPLICATIONS**						

Course objectives:

To illustrate the principle of mathematical modeling of engineering problems

To introduce the basics and application of Finite Element Method

Learning Outcomes:

Understand the concept of finite element method for solving machine design problems.

Formulate and solve manually problems in 1-D structural systems involving bars, trusses, beams and frames.

Develop 2-D FE formulations involving triangular, quadrilateral elements and higher order elements.

Apply the knowledge of FEM for stress analysis, model analysis, heat transfer analysis and flow analysis.

Understand the various types and Higher of elements .

Analyze vibration problems for frequencies and mode shapes of various elements.

UNIT – I:

Introduction to Finite Element Method for solving field problems. Stress and Equilibrium. Boundary conditions. Strain – Displacement relations. Stress – strain relations. One Dimensional Problems: Finite element modeling coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

UNIT – II:

Analysis of Trusses: Stiffness Matrix for Plane Truss and Space Truss Elements, Stress Calculations. Analysis of Beams: Element stiffness matrix for two node, two degrees of freedom per node beam element, Load Vector, Deflection, Stresses.

UNIT – III

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Estimation of Load Vector, Stresses Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. Two dimensional four nodded Isoperimetric elements and numerical integration.

UNIT – IV:

Steady State Heat Transfer Analysis: one dimensional analysis of Slab, fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion.

UNIT-V:

Isoperimetric formulations: Sub, Iso and super parametric elements, four noded quadrilateral element, numerical integration – Gaussian quadrature approach.

UNIT – VI:

Dynamic Analysis: Formulation of finite element model, element – Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, beam. Finite element – formulation to 3 D problems in stress analysis, convergence requirements, Mesh generation.

TEXT BOOKS:

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

REFERENCE BOOKS:

1. JN Reddy, "An introduction to Finite Element Method", McGraw Hill, 3rd. Edition.
2. C. S. Krishnamurthy, "Finite Element Analysis -Theory and Programming", Tata McGraw Hill, 2nd Edition.
3. Daryl L Logan, "A first course in finite element method", Cengage Learning.

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2TH02	**GEOMETRICAL MODELING**						

Course Objectives:

To highlight the importance of geometric modeling in design and manufacturing

Learning Outcomes:

Student will be able to

Use various mathematical equation to represent curves.
Apply the cubic splines in modeling of a product.
Select appropriate synthetic curves in modeling process.
Implement the surface modeling for design of various consumer products.

UNIT-I

Introduction: Definition, explicit and implicit equations, parametric equations.

UNIT-II

Cubic Splines-1: 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. Graphic construction and interpretation, composite pc curves.

UNIT-III

Bezier Curves: Bernstein basis, equations of Bezier curves, properties, derivatives.

UNIT-IV

B-Spline Curves: B-Spline basis, equations, knot vectors, properties and derivatives.

UNIT-V

Surfaces: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

UNIT-VI

Solids: Tricubic solid, Algebraic and geometric form.
Solid modeling concepts: Wire frames, boundary representation, half space modeling, spatial cell, cell decomposition, classification problem.

TEXT BOOKS:

1. Ibrahim Zeid , "CAD/CAM – Theory and Practice", Tata McGraw Hill,2009.
2. Roger &Adams, "Mathematical Elements for Computer Graphics", Tata McGraw Hill, 2nd Edition.

REFERENCE BOOKS:

1. Micheal E. Mortenson, "Geometric Modeling", McGraw Hill ,3rd Edition.
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers, 2nd Edition.

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2TH03	**EXPERIMENTAL STRESS ANALYSIS**						

Course Objectives:

To understand the relation between the mechanics theory and experimental stress analysis.

To highlight the new experimental methods to determine stresses and strains.

Learning Outcomes:

Student will be able to

Measure strains using different types of strain gauges

Evaluate stresses using modern techniques of experimental methods

UNIT-I

Introduction: stress, strain, plane stress and plane strain conditions, compatibility conditions. Problems using plane stress and plane strain conditions, stress functions, mohrs circle for stress strain, three-dimensional stress strain relations.

UNIT-II

Strain Measurement and Recordings: various types of strain gauges, electrical resistance strain gauges,semi conductor strain gauges, strain gauge circuits. introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies.

UNIT-III

Photo elasticity:photo elasticity–polariscope–plane and circularly polarized light, bright and dark field setups, photo elastic materials –isochromatic fringes – isoclinics.

UNIT-IV

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

UNIT-V

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

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

UNIT-VI

Birefringent Coatings: Introduction, coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, fringe order determinations in coatings, stress separation methods.

TEXT BOOKS:

1. Timoshenke and GoodierJr ,"Theory of Elasticity" McGraw Hill Education (India) Pvt
   Ltd, 3e

REFERENCE BOOKS:

1. Love .A.H, "A treatise on Mathematical theory of Elasticity vol-1" nabu press,
2. Dally and Riley," Experimental stress analysis", McGraw-Hill.

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2TH04	**FATIGUE, CREEP AND FRACTURE MECHANICS**						

Course Objectives:

To introduce the concepts of fracture and damage tolerant design using theories of fracture.

Learning Outcomes:

Student will be able to

Determine stress intensity factors by applying Linear Elastic and Elastic Plastic fracture mechanics

Apply fatigue concepts in predicting the life of components

Formulate and solve problems involving the static, fatigue or impact loading of flawed structures.

UNIT-I

Introduction: Prediction of mechanical failure. macroscopic failure modes; brittle and ductile behavior. fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intragranular failure, cleavage and micro-ductility, growth of fatigue cracks, the ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature.

UNIT-II

Griffith's analysis: Concept of energy release rate, G, and fracture energy, R. modification for ductile materials, loading conditions. Concept of R curves.

UNIT-III

Linear Elastic Fracture Mechanics, (LEFM): Three loading modes and the state of stress ahead of the crack tip, theories of fracture, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.

UNIT-IV

Elastic-Plastic Fracture Mechanics; (EPFM): The definition of alternative failure prediction parameters, crack tip opening displacement, and the J integral. measurement of parameters and examples of use.

UNIT-V

Fatigue: definition of terms used to describe fatigue cycles, high cycle fatigue, low cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodman rule and Miners rule. micromechanics of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. total life and damage tolerant approaches to life prediction.

UNIT-VI

Creep deformation: The evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

TEXT BOOKS:

1. T.L. Anderson, "Fracture Mechanics Fundamentals and Applications", CRC press ,2nd Ed..
2. B. Lawn, "Fracture of Brittle Solids", Cambridge Solid State Science Series ,2nd ed.
3. J.F. Knott, "Fundamentals of Fracture Mechanics", Butterworths ,1973.

REFERENCE BOOKS:

1. J.F. Knott, P Withey, "Worked examples in Fracture Mechanics", Institute of Materials, 2nd Edition.
2. S. Suresh, "Fatigue of Materials", Cambridge University Press, 2nd Edition.
3. L.B. Freund and S. Suresh, "Thin Film Materials", Cambridge University Press,2003.

I M.TECH II SEMESTER **(ELECTIVE – III)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2PE31	**ADVANCE OPTIMIZATION TECHNIQUES**						

Course Objectives:

To impart the knowledge of various solution procedures
To introduce different methodologies of designing

Learning Outcomes:

Student will be able to

Classify the optimization problems.
Solve the design issues by using techniques of classical optimization.
Design various mechanical elements.
Apply genetic algorithm for solving the design problems.

UNIT-I :

Introduction: Classification of optimization problems, concepts of design vector, design constraints,design space constraints surface, objective function, surface and multilevel optimization, parametric linear programming.

UNIT-II

Classical Optimization Techniques: Single variable optimization, multilevel Optimization without constraints – multilevel optimization with equality and inequality constraints – Lagrange multipliers methods Kuhn – Tucker conditions.

UNIT-III

Non – Linear Optimization: One–dimensional minimization methods–Fibonacci method, Goldensection method,

Unconstrained Optimization methods: Hooke and jeeves methods, Powell's method,gradient of afunction, Cauchy method, Fletcher – Reeves method, Types of penalty methods for handling constraints.

UNIT-IV

Applications of Optimization in Design and Manufacturing Systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

UNIT-V

Non-Traditional Optimization Techniques: Genetic algorithm (GA) - Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.

UNIT-VI

GENETIC PROGRAMMING (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP. Concepts of simulated annealing, ANN, optimization of fuzzy systems.

TEXT BOOKS:

1. Kalyanmoy Deb , "Optimization for Engineering Design", PHI Publishers, 2nd Edition
2. S.S.Rao , "Engineering Optimization", New Age Publishers,4th Edition.

REFERENCE BOOKS:

1. D.E. Goldberg, Addison, "Genetic algorithms in Search, Optimization, and Machine learning", Wesley Publishers,2007
2. Kalyanmoy Deb , "Multi objective Genetic algorithms" , PHI Publishers,2nd Edition
3. JasbirArora , "Introduction to Optimum Design", McGraw Hill (international) Publishers,3rd Edition.
4. CE Ebeling ,"An Introductgion to Reliability and Maintainability Engineering" , Waveland Printgers Inc., 2009
5. I Bazovsky , "Reliability Theory and Practice", Dover Publications, 2013.

I M.TECH II SEMESTER **(ELECTIVE – III)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2PE32	**DESIGN OF EXPERIMENTS**						

Course objectives:

To get the knowledge of statistical concepts, statistical design and sampling distribution

To analyse the Experimental Prediction of ANOVA and ANOM

Learning Outcomes:

Understand the various statistical concepts, statistical design and sampling distribution

Illustrate various factorial designs for different curves and surfaces

Experiment with Prediction of new response observations

Identify Error variance and application using ANOVA

Experiment with Orthogonal array experiments by using Analysis of Mean (ANOM).

UNIT - I:

Introduction: Strategy of experimentation, some typical applications of experimental design, Basic principles, Guidelines for designing experiments, A brief history of statistical design, Using statistical design in experimentation.

UNIT - II:

Simple comparative experiments : Introduction, Basic statistical concepts, Sampling and sampling Distribution, Inferences about the Differences in means, randomized designs, Inferences about the Differences in means, Paired comparison Designs, Inferences about the Variances of Normal Distributions.

UNIT – III:

Randomized Block Designs: Randomized complete block design, Latin square design, balanced incomplete block design. Introduction To Factorial Design: Basic definition and principles, Advantages of factorials, the two factor factorial design, General factorial design, Fitting response curves and surfaces, Blocking in a factorial design.

UNIT - IV:

Fitting Regression Models : Introduction, Linear regression models, Estimate of parameters in linear regression models, Hypothesis testing in multiple regression, Confidence intervals in multiple regression, Prediction of new response observations, Regression model diagnostics, testing for lack of fit Analysis Of Variance (Anova).

UNIT – V:

Introduction, Example of ANOVA process, Degrees of freedom, Error variance and pooling, Error variance and application, Error variance and utilizing empty columns, the F-test.

UNIT - VI:

Taguchi Method Of Design Of Experiments : Concept design, Parameter design, Tolerance design, Quality loss function, Signal-to- Noise ratio, Orthogonal array experiments, Analysis of Mean(ANOM), Quality characteristics, Selection and testing of noise factors, Selection of control factors, Parameter optimization experiment, Parameter design case study.

TEXT BOOKS:

1. Douglas C Montgomery, "Design and Analysis of Experiments", John Wiley.
2. John P.W.M., "Statistical Design and Analysis of Experiments", Macmillan.
3. Montgomery D.C., Runger G. C., "Introduction to Linear Regression Analysis", John Wiley.

REFERENCES:

1. Myres R.H., Montgomery D. C., "Response Surface Methodology: Process And Product Optimization Using Designed Experiments", Wiley, New York
2. Taguchi, "Introduction to Quality Engineering", Asian Productivity Organization, G.UNIPUB, White Plains, New York.

I M.TECH II SEMESTER **(ELECTIVE – III)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2PE33	**CONDITION MONITORING**						

Course Objectives:

To understand the maintenance scheme, their scope and limitations – apply the maintenance strategies to various problems in the industrial sectors.

Learning Outcomes:

Student will be able to

Develop an appreciation for the need of modern technological approach for plant maintenance to reduce the maintenance expenditure.

Carry out lubrication oil analysis and temperature analysis in vibrating systems.

Analyze for machinery condition monitoring and explain how this compliments monitoring the condition.

Emphasizes on case studies that require gathering information using the modern testing equipment and processing it to identify the malfunction in that system.

UNIT-I

Maintenance strategies, Introduction to condition monitoring, Criticality index, Various techniques for fault detection, Introduction to Non-destructive testing, role of non-destructive testing in condition monitoring.

UNIT-II

Wear debris analysis: Wear mechanisms, wear particles, wear process monitoring techniques -Spectrometric oil analysis program (SOAP), Ferrography, Applications, Adavntages and limitations.

UNIT-III

Temperature monitoring: Need for temperature monitoring, Thermography, Active and passive thermography, IR thermography, applications, advantages and limitations.

UNIT-IV

Corrosion monitoring: Causes and effects of corrosion, Methods of corrosion prevention– reactive coating, applied coatings and corrosion inhibitors, Cathodic protection.

Flaw detection: Discontinuity–Origin and classification, Ultrasonic testing and Magnetic particle inspection.

UNIT-V

Rotating machinery, Identification of machine faults and frequency range of symptoms, localized & distributed faults, ISO Standards for vibration monitoring and analysis, types and benefits of vibration analysis, Vibration signature analysis, Vibration transducers – Proximity probes, velocity transducers, accelerometers, laser Vibrometer.

UNIT-VI

Fault detection in Rolling Element Bearings, Orbit Analysis static & Dynamic Balancing.
Case studies: Induction Motors, Gear Box vibration, Reciprocating engines & Compressors.

TEXT BOOKS:

1. R.A. Collacot ,"Vibration Monitoring & Diagnosis",
2. Isermann R., "Fault Diagnosis Applications", Springer-Verlag, Berlin, 2011.

REFERENCE BOOKS:

1. Rao, J S., "Vibration Condition Monitoring", Narosa Publishing House, 2nd Edition,
   2000.
2. Hand book of Condition Monitoring by B.K.N. Rao.
3. Allan Davies,"Handbook of Condition Monitoring", Chapman and Hall, 2000..
4. Hand book of Non Destructive Application by B.J. Boeing.

I M.TECH II SEMESTER **(ELECTIVE – III)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2PE34	**RAPID TOOLING AND PROTOTYPING**						

Course Objectives:

To introduce Rapid Prototype tools and techniques for design and Manufacturing

Learning Outcomes:

Student will be able to

Assess the need of RPT in Product development.
Use appropriate RT Software for development of Prototype model.
Judge the correct RP Process for Product/Prototype development.
Predict the technical challenges in 3D printing.
List the applications of RPT.

UNIT-I

Introduction to Rapid Prototyping: Introduction to prototyping, traditional prototyping Vs. rapid prototyping (RP), need for time compression in product development, usage of RP parts, generic RP process, distinction between RP and CNC, other related technologies, classification of RP.

UNIT-II

RP Software: Need for RP software, MIMICS, magics, surgiGuide, 3D-doctor, simplant, velocity2,voxim, solidView, 3Dview, etc., software.

Software Issues of RP: Preparation of CAD models, problems with STI, files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP.

UNIT-III

Photo polymerization RP Processes: Sterolighography (SL), SL resin curing process, SL scan patterns, microstereolithography, applications of photo polymerization processes.

UNIT-IV

Powder Bed Fusion RP Processes: Selective laser sintering (SLS), powder fusion mechanism and powder handling, SLS metal and ceramic part creation, electron beam melting (EBM), applications of powder bed fusion processes.

Extrusion-Based RP Systems: Fused deposition modelling (FDM), principles, plotting and path control, applications of extrusion-based processes.

UNIT-V

Printing RP Processes: 3D printing (3DP), research achievements in printing deposition, technical challenges in printing, printing process modeling, applications of printing processes.

Sheet Lamination RP Processes: Laminated Object Manufacturing (LOM), ultrasonic consolidation (UC), gluing, thermal bonding, LOM and UC applications.

Beam Deposition RP Processes: Laser Engineered Net Shaping (LENS), Direct Metal Deposition(DMD), processing – structure - properties, relationships, benefits and drawbacks.

UNIT-VI

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, classification of rapid tooling, direct and indirect tooling methods, soft and hard tooling methods.

Errors in RP Processes: Pre-processing, processing, post-processing errors, part building errors in SLA,SLS, etc.,

RP Applications: Design, engineering analysis and planning applications, rapid tooling, reverse engineering, medical applications of RP.

TEXT BOOKS:

1. Chua Chee Kai., Leong KahFai., Chu Sing Lim, "Rapid Prototyping: Principles and Applications in Manufacturing", World Scientific, 2010.
2. Ian Gibsn., David W Rosen., Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010

REFERENCE BOOKS:

1. Pham, D.T, Dimov, S.S, Rapid Manufacturing, Springer, 2001.

I M.TECH II SEMESTER **(ELECTIVE – IV)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2PE41	**INDUSTRIAL ROBOTICS**						

Course objectives:

To be familiar with the automation and brief history of robot and applications

To give the student familiarities with the kinematics of robots, Knowledge about Autonomous Mobile Robots and their design

Mobile Robot Maneuverability. Knowledge about Mobile Robot Planning & Navigation.

Course Outcomes:

Define and Classify Robots and Structures of Robotic Systems

Define Drives & Control Systems of Robots. Explain Hydraulic Power supply, Hydraulic Motor, Direct Current Servomotors

Define Kinematic Analysis, Direct Kinematic Problem in Robotics. Describe Three dimensional Homogeneous Transformations, Denavit-Hartenberg Convention, Applications of DH method

Define and Classify Autonomous Mobile Robots. Describe Mobile Robot Kinematics Describe Mobile Robot Maneuverability- Degree of mobility, Degree of steerability, Motion Control. Explain Mobile Robot Planning & Navigation.

UNIT-I

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

Control System And Components: basic concept and modais controllers control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system.

UNIT-II

Motion Analysis And Control: Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller.

UNIT-III

End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics.

UNIT-IV

Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, image storage, Image processing and Analysis-image

data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

UNIT-V

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINONAL AND DELAY commands, Branching capabilities and Limitations.

Robot Languages: Textual robot Languages, Generation, Robot language structures, Elements in function.

UNIT-VI

Robot Cell : Design And Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detect ion, Work wheel controller.

Robot Application: Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application.

TEXT BOOKS:

1. Industrial Robotics / Groover M P /Pearson Edu.
2. Introduction to Robotic Mechanics and Control / J J Craig/ Pearson / 3rd edition.

REFERENCE BOOKS:

1. Robotics / Fu K S/ McGraw Hill.
2. Robotic Engineering / Richard D. Klafter, Prentice Hall
3. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.
4. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley & Sons
5. (ASIA) Pvt Ltd.
6. Robotics and Control / Mittal R K &Nagrath I J / TMH.

I M.TECH II SEMESTER **(ELECTIVE – IV)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2PE42	**MECHANICS OF COMPOSITE MATERIALS**						

Course Objectives:

The course aims at enhancing the capacity of the students to analyze structural characteristics of composite structures.

Course Outcomes:

Apply stress-strain relationships in fiber reinforced composite materials.
Explain failure theories related to composite materials
Explain stress-strain characteristics of laminates
Explain elastic properties of laminates
Explain strength characteristics of laminates

UNIT-I

Introduction to Composites: Introduction, Classification, matrix materials, reinforced matrix of composites

UNIT-II

Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina Strength Failure Theories of an Angle Lamina : Maximum Stress Failure Theory Strength Ratio, Failure Envelopes, Maximum Strain Failure Theory ,Tsai–Hill Failure Theory, Tsai–Wu Failure Theory, Comparison of Experimental Results with Failure Theories. Hygro thermal Stresses and Strains in a Lamina: Hygrothermal Stress–Strain Relationships for a Unidirectional Lamina, Hygrothermal Stress–Strain Relationships for an Angle Lamina

UNIT-III

Macromechanical Analysis of a Lamina: Introduction, Definitions: Stress, Strain, Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina

UNIT-IV

Micromechanical Analysis of a Lamina :Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi- Empirical Models ,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion.

UNIT-V

Macromechanical Analysis of Laminates: Introduction ,LaminateCode , Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate , Hygrothermal Effects in a Laminate, Warpage of Laminates,hybrid laminates

UNIT-VI

Failure, Analysis, and Design of Laminates : Introduction , Special Cases of Laminates, Failure
Criterion for a Laminate, Design of a Laminated Composite, static analysis of laminated plates

TEXT BOOKS:

1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University
   Press, 1994.
2. B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley- Interscience, New York, 1980.
3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By Autar
   K. Kaw, Publisher: CRC

REFERENCE BOOKS:

1. R. M. Jones, Mechanics of Composite Materials, McGraw Hill Company, New York, 1975.
2. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969.

I M.TECH II SEMESTER **(ELECTIVE – IV)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2PE43	**COMPUTER INTEGRATED MANUFACTURING**						

Course Objectives:

To use computers in the area of manufacturing to reduce manual processing and linking computers to all the manufacturing machines and increase the productivity, reduce the unnecessary costs.

To study about group technology, Robotics, Flexible manufacturing systems, Automated material Handling Systems and storage Systems, Automated Inspection and Testing

Course Outcomes:

Understand the use of computers in the area of manufacturing.

Understand group technology, Robotics, Flexible manufacturing systems.

Design automated material handling and storage systems for a typical production system.

Understand the Automated Inspection & Testing.

UNIT-I

Introduction: Definition of Automation, Need for Automation, Advantages and Disadvantages of Automation, Types of Production, Functions in manufacturing, Automation Strategies, Introduction to CAD, Applications of Computers in Design, Introduction to CAM, Manufacturing Planning and control, Fundamentals of computer Integrated Manufacturing.

UNIT-II

Group Technology: Introduction, Part families, Parts classification and coding (OPITZ &MULTI CLASS), Production flow analysis, Machine cell design, Types of cell design, Benefits of Group Technology.

Robotics: Robot anatomy, Robot Configuration, Basic Robot motions, Types of drivers, End effectors.

UNIT-III

Flexible Machine Systems: What is FMS, FMS Workstations, Materials Handling and storage system, Computer Control System, Planning the FMS, Applications and Benefits.

UNIT-IV

Automated Material Handling: Introduction, Types of material handling equipment, automated guided vehicle system (AGVS), Applications, Vehicle guidance and routing, Traffic control and safety, System management.

UNIT-V

Automated Storage Systems (As): Storage systems performance, Automated storage

/Retrieval systems (AS / RS), Basic components of AS /RS, AS / RS controls, Special features, applications.

UNIT-VI

Automated Inspection & Testing: Automated inspection principles and methods, sensor technologies for automated inspection, Co-ordinate measuring machines (CMM),construction, operation & programming, CMM benefits and trends. Introduction to machine vision & non contact inspection methods.

TEXT BOOKS:

1. Automation, Production and Computer Integrated Manufacturing – by M.P. Groover (PHI), 1996.

REFERENCE BOOKS:

1. CAD/CAM - MikellP.Groover, and Emory W.Zimmers.Jr. PHI Publishers, 1984.
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMMSarcar, PHI Publishers, 2008.
3. CAD/CAM/CIM, Radhakrishnan and Subramanian, New Age Publishers, 2008.

I M.TECH II SEMESTER **(ELECTIVE – IV)**	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MMD2PE44	**RESEARCH METHODOLOGY**						

Course objectives:

To know the knowledge of framework of research process and various research designs and techniques.

To understand the various sources of information for literature review and data collection and ethical dimensions of conducting applied research by evaluate its quality.

Learning Outcomes:

After successful completion of this course, the students will be able to:

To develop understanding of the basic framework of research process

To develop an understanding of various research designs and techniques.

To identify various sources of information for literature review and data collection

To develop an understanding of the ethical dimensions of conducting applied research.

Appreciate the components of scholarly writing and evaluate its quality.

UNIT - I:

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

UNIT - II:

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

UNIT - III:

Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments.

UNIT - IV:
Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results.

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

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

TEXTBOOKS:

1. Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011
2. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers
3. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Elsevier Inc.

REFERENCE:

1. Michael P. Marder," Research Methods for Science", Cambridge University Press, 2011
2. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age". Aspen Law & Business; 6 edition July 2012

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	6	40	60	100	3
Code: 19MMD2LB01	**ADVANCED COMPUTER AIDED DESIGN & ANALYSIS LAB**						

Course Objectives:

To impart training on Ansys software for analyzing engineering problems.

Learning Outcomes:

Student will be able to

Analyze different engineering problems using ansys software.

I. Modeling

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

II LIST OF EXPERIMENTS USING ANSYS SOFTWAR

1. 2- D truss analysis
2. 3-D truss analysis
3. Stress analysis of a beam
4. Stress analysis of simple 3-D structure
5. Analysis of Plane stress and plane strain problems
6. Evaluation of stress intensity factors in a cracked plate
7. Free vibration analysis of beam / plate
8. Forced vibration analysis of beam / plate
9. Buckling analysis of column / sheet metal
10. Coupled field analysis of solid
11. Optimization of a beam
12. Steady state thermal analysis
13. Transient thermal ana

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