ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

MACHINE DESING

Department of Mechanical Engineering

M.Tech Two Year Degree Course

(Applicable for the batch admitted from 2014-15)

GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)

Seshadri Rao Knowledge Village

GUDLAVALLERU - 521 356, Krishna District, Andhra Pradesh

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ACADEMIC REGULATIONS

M.Tech - Machine Design

ACADEMIC REGULATIONS

1. Duration of the Program

The duration of the program is two academic years consisting of four semesters. However, a student is permitted to complete the course work of M.Tech program in the stipulated time frame of **FOUR** years from the date of joining.

2. Minimum Instruction Days

Each semester consists of a minimum of ninety instruction days.

3. Program Credits

Each specialization of the M.Tech programs is designed to have a total of 80 credits and the student shall have to complete the two year course work and earn all the 80 credits for the award of M.Tech Degree.

4. Attendance Regulations

4.1 A student shall be eligible to appear for End Semester Examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

4.2 Condoning of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester will be considered for genuine reasons such as medical grounds and participation in co-curricular and extra-curricular activities and shall be granted only after approval by a committee duly appointed by the college. Student should submit application for medical leave along with medical certificate from a registered medical practitioner within three days from reporting to the class work after the expiry of the medical leave. In case of participation in co-curricular and extra-curricular activities, either in the college or other colleges, students must take prior written permission from HoD concerned and should also submit the certificate of participation from the organizer of the event within three days after the completion of the event. Only such cases will be considered for condoning attendance shortage.

4.3 A student shall be eligible to claim for condonation of attendance shortage only once during the two years (four semesters) course work.

4.4 A student will not be promoted to the next semester unless he satisfies the attendance requirement of the current semester. He may seek re-admission for that semester when offered next.

4.5 Shortage of Attendance below 65% in aggregate shall in *NO* case be condoned.

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

4.7 A fee stipulated by the college shall be payable towards condoning attendance shortage.

5. Examinations and Scheme of Evaluation

5.1 Theory Courses:

Each theory course shall be evaluated for a total of 100 marks, consisting of 40 marks for internal assessment and 60 marks for semester end examination.

***Internal Assessment*:**

i) Out of 40 marks for internal assessment, 20 marks are for continuous assessment in the form of assignment and seminar and 20 marks are based on two mid-term examinations.

ii) Of the 20 marks for continuous assessment, 10 marks EACH for assignment and seminar.

iii) Each mid-term examination is conducted for 40 marks with two hours duration. Each mid-term examination consists of four questions, each for 10 marks. All the questions need to be answered.

iv) Sum of the 75% marks of best scored mid-term examination and 25% marks of other mid-term examination are scaled down for 20 marks.

***External Assessment*:**

Semester End Examination will have 8 questions, each for 12 marks, out of which 5 questions are to be answered.

5.2 Laboratory Course:

i) For practical subjects the distribution shall be 40 marks for Internal Evaluation and 60 marks for the End-Examinations. There shall be continuous evaluation by the internal subject teacher during the semester for 40 internal marks. Of the 40 marks for internal, 30 marks shall be for day-to-day performance (20 marks for day-to-day evaluation and 10 marks for Record) and 10 marks for an internal laboratory test conducted towards the end of semester.

ii) Semester End examination shall be conducted by the teacher concerned and external examiner for 60 marks.

5.3 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 critically review the literature and submit it to the department in a report form two weeks before the end of the 3rd semester and shall make an oral presentation before the Departmental Review Committee consisting of the supervisor and a senior faculty member / Head of the Department. There

shall be an internal evaluation for 50 marks in the form of viva-voce examination and assessment of report and its presentation. There will be NO external evaluation.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register by paying the prescribed fee at the beginning of 4th semester or subsequent semesters. He has to submit a fresh report two weeks before the end of that semester and appear for the evaluation by the committee.

5.4 Comprehensive Viva-Voce:

Comprehensive Viva-Voce examination is conducted for 50 marks at the end of third semester in all the subjects of first two semesters of the course by a committee consisting of two senior faculty members of the department. There will be NO external evaluation.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register by paying the prescribed fee at the beginning of 4th semester or subsequent semesters and undergo Viva-Voce examination towards the end of that semester.

5.5 Project Work:

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

i) A Project Review Committee (PRC) shall be constituted for each specialization with Head of the Department as Chairman and two other senior faculty members.

ii) Registration of Project Work: A candidate who has been promoted to 3rd semester shall be eligible to register for the project work.

iii) The eligible candidate can choose his project supervisor and submit the title, objective, abstract and plan of action of the proposed project work to the department for approval by the PRC. The candidate whose proposal is approved by the PRC shall register for the project work. The minimum duration of project work will be 36 weeks from the date of registration.

iv) If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the PRC. In case of such changes, the candidate has to register afresh.

v) There shall be three reviews on the progress of the project work by the PRC with an interval of 12 weeks. The candidate needs to submit a report on the progress of his work and present it before the PRC for assessment. The PRC may suggest for an extension of date of submission of dissertation if the progress of work is not satisfactory or absent himself for the review.

vi) A candidate who has passed all the theory, laboratory, seminar and comprehensive viva-voce examinations and shown satisfactory progress of project work is permitted to submit the dissertation after 36 weeks from the date of registration.

vii) If a candidate fails to submit the dissertation by the end of the 4th semester, he has to take the permission for an extension by paying the semester(s) tuition fee.

viii) Three copies of the Project Thesis certified by the supervisor shall be submitted to the Department.

ix) Project evaluation and Viva-Voce examination is conducted at the end of 4th semester by a committee consisting of Project Supervisor, senior faculty of the department, HoD and an External Examiner nominated by the Chief Controller of Examinations out of a panel of three examiners suggested by the department.

The following grades are awarded for the project work:

i. Excellent
ii. Very Good
iii Good
iv. Satisfactory
v. Unsatisfactory

The Grade "unsatisfactory" is treated as Fail. Failed Students should take supplementary examination after making required modifications, if any, in the dissertation with a minimum gap of 8 weeks by paying the required examination fee.

6. Criteria for Passing a Course and Award of Grades:

6.1 Criteria for Passing a Course:

i) A candidate shall be declared to have passed in individual theory/ drawing / design course / laboratory if he secures a minimum of 50% aggregate marks (internal & semester end examination marks put together), subject to securing a minimum of 40% marks in the semester end examination.

ii) The candidate shall be declared to have passed in seminar / comprehensive viva-voce if he secures 50% marks.

iii) The candidate shall be declared to have successfully completed the project work if he secures a minimum of 'satisfactory' grade in the project evaluation and viva-voce examination.

iv) On passing a course of a program, the student shall earn assigned credits in that course.

6.2 Method of Awarding Letter Grade and Grade Points for a Course:

A letter grade and grade points will be awarded to a student in each course based on his performance, as per the grading system given below.

Theory Course (%)	Laboratory (%)	Grade Points	Letter Grade
³ 90	³ 90	10	S
³ 80 & < 90	³ 80 & < 90	9	A
³ 70 & < 80	³ 70 & < 80	8	B
³ 60 & < 70	³ 60 & < 70	7	C
³ 50 & < 60	³ 50 & < 60	6	D
< 50	< 50	0	F (Fail)

S : Outstanding **A** : Excellent **B** : Very Good
C : Good **D** : Fair

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

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

SGPA = $\frac{\sum(CR\,X\,GP)}{\sum CR}$ for each semester.

where CR = Credits of a course
GP = Grade Points awarded for a course

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

6.4 Eligibility for Award of M.Tech Degree:

A student will be declared eligible for the award of the M.Tech Degree if he fulfills the following academic regulations.

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

(b) Registered for **80** credits and secured all **80** credits.

(c) Students, who fail to complete their Two years Course of study within Four years or fail to acquire the **80** Credits for the award of the degree within four academic years from the year of their admission shall forfeit their seat in M.Tech course and their admission shall stand cancelled.

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

The CGPA is calculated as given below:

CGPA = $\frac{\sum(CR\,X\,GP)}{\sum CR}$ for entire program.

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

* CGPA is calculated for a candidate who passed all the prescribed courses excluding project work.

6.6 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 grades:

CGPA	Class	Letter Grade	Description
³ 7.5	First Class with Distinction	A	Excellent
³ 6.5 & < 7.5	First Class	B	Good
³ 6.0 & < 6.5	Second Class	C	Fair

7. Supplementary Examinations :

i) Supplementary examinations will be conducted once in a year along with regular examinations.

ii) Semester end supplementary examinations shall be conducted till next regulation comes into force for that semester after the conduct of the last set of regular examinations under the present regulation.

iii) Thereafter supplementary examinations will be conducted in the equivalent courses as decided by the Board of Studies concerned.

8. Readmission Criteria :

A candidate, who is detained in a semester due to lack of attendance has to obtain written permission from the Principal for readmission into the same semester after duly fulfilling the required norms stipulated by the college and by paying the required tuition fee and special fee in addition to paying an administrative fee of Rs. 1,000/-.

9. Break in Study :

Student, who discontinues the studies for what-so-ever reason, can get readmission into appropriate semester of M.Tech program only with the prior permission of the Principal of the College, provided such candidate shall follow the transitory regulations applicable to the batch he joins. An administrative fee of Rs.2,000/- per each year of break in study, in addition to the prescribed tuition and special fees should be paid by the candidate to condone his break in study.

10. Transitory Regulations:

A candidate, who is detained or discontinued in a semester, on readmission shall be required to do all the courses 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 courses in the earlier semester(s) he was originally admitted into and he will be offered

substitute subjects in place of them as decided by the Board of Studies. However, the decision of the Board of Studies will be final.

10.1 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 courses 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.

10.2 A student who is following JNTUK curriculum, detained due to shortage of attendance at the end of the second semester of first year shall join with the autonomous batch in the second semester. Such candidates shall be required to pass in all the courses 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 courses of the semester(s) of the batch which he had passed earlier and substitute subjects are offered in place of them as decided by the Board of Studies. The student has to clear all his backlog subjects of first semester by appearing for the supplementary examinations conducted by JNTUK for the award of degree. The total number of credits to be secured for the award of the degree will be sum of the credits of first semester under JNTUK regulations and the credits prescribed in second 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.

11. 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, his examinations results and degree will be withheld.

12. Malpractices :

i) The Principal shall refer the cases of malpractices in internal assessment tests and semester end examinations to a malpractice enquiry committee constituted by him for the purpose. Such committee shall follow the approved levels of punishment. The Principal shall take necessary action against the erring students based on the recommendations of the committee.

ii) 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.

DISCIPLINARY ACTION FOR MALPRACTICES/IMPROPER CONDUCT IN EXAMINATIONS

	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, cameras, bluetooth devices etc. 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.
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 candidates 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. The hall ticket of the candidate shall be cancelled.

3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for the examinations of the remaining subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the impostor is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles the Answer book or takes out or arranges to send out the question paper during the examination or answer book during or after the examination.	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. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

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 performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent / Assistant Chief Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in or around the examination hall or organises a walkout or instigates others to walkout or threatens the officer-in-charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the Officer-in-charge or any person on duty in or outside the examination hall of any of his relations or indulges in any other act of misconduct or mischief which results in damage to or destruction of property in the examination hall or any part of the 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. 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 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. The candidate is also debarred for two consecutive semesters from class work and all university examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

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 to appear for the remaining examinations of the subjects of that semester. 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 clauses 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to the police and a police case is 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.
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 examinations.

12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be referred to the Chief Superintendent of Examinations for future action towards suitable punishment.

iii) The involvement of the staff, who are in charge of conducting examinations, valuing examination papers and preparing / keeping records of documents related to the examinations in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned at the examination shall be viewed seriously and appropriate disciplinary action will be taken after thorough enquiry.

13. Other Matters

i) Physically challenged candidates who have availed additional examination time and a scribe during their BE / B.Tech or equivalent examinations will be given similar concessions on production of relevant proof/ documents. Students who are suffering from contagious diseases are not allowed to appear either for internal or semester end examinations.

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

iii) 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.

14. General

i) The Academic Council may, from time to time, revise, amend or change the regulations, schemes of examination and /or syllabi.

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

iii) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chairman of the Academic Council is final.

iv) Wherever the word he, him or his occurs, it will also include she, her and hers.

COURSE STRUCTURE

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SYLLABUS

M.Tech - Machine Design

COURSE STRUCTURE

I Semester

Sl. No.	Name of the Course / Laboratory	No.of Periods per week		No.of Credits
		L	P	
1	Computational Methods in Engineering	4	-	3
2	Advanced Mechanics of Solids	4	-	3
3	Analysis and Synthesis of Mechanisms	4	-	3
4	Mechanical Vibrations	4	-	3
5	Elective - I	4	-	3
6	Elective - II	4	-	3
7	Machine Dynamics Lab	-	6	3
	Total	**24**	**6**	**21**

II Semester

Sl. No.	Name of the Course / Laboratory	No.of Periods per week		No.of Credits
		L	P	
1	Finite Element Methods	4	-	3
2	Geometrical Modeling	4	-	3
3	Condition Monitoring	4	-	3
4	Design for Manufacturing and Assembly	4	-	3
5	Elective - III	4	-	3
6	Elective - IV	4	-	3
7	Modeling and Analysis Lab	-	6	3
	Total	**24**	**6**	**21**

III Semester

Sl. No.	Name of the Course / Laboratory	No.of Credits
1	Seminar	2
2	Comprehensive Viva-Voce	2
3	Dissertation (Initiated in third semester)	-
	Total	**4**

IV Semester

Sl. No.	Name of the Course / Laboratory	No.of Credits
1	Dissertation (Carried out in third & fourth semesters)	34
	Total	**34**

Electives:

I Semester	II Semester
Elective - I	**Elective - III**
Product Design	Fracture Mechanics
Rotor Dynamics	Engineering Optimization
Experimental Stress Analysis	Rapid Tooling and Prototyping
Elective - II	**Elective - IV**
Pressure Vessel Design	Theory of Elasticity
Gear Engineering	Computational Fluid Dynamics
Material Selection for Design	Tribology

SYLLABUS

COMPUTATIONAL METHODS IN ENGINEERING

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To know how to solve system of equations, ordinary differential equations and partial differential equations numerically
- To understand correlation and regression.
- To know optimization techniques in solving linear,integer and fractional programming problems.

Learning Outcomes:

Students 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 sytem of linear equations by Gauss Seidel and Relaxation methods. Solving system of non-linear equations by Newton-Raphson method. Fitting of non-linear curves by least squares.

UNIT - II: Numerical Solutions of Ordinary Differential Equations:

BBoundary 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.

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,Riched Burden”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. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI
4. Basic Statistics – Agarrval, B.L. Wiley 1991, 2nd edition
5. Operations Research – S.D. Sarma

ADVANCED MECHANICS OF SOLIDS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

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

Learning Outcomes:

Students will be able to

- apply the theory of elasticity including strain/displacement and Hooke's law relationships to engineering problems.
- 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.

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

UNIT - III: 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 - IV: Axi-Symmetric Problems:

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

***Torsion*:** Linear elastic solution, Prandtl elastic membrane (Soap-Film) analogy, narrow rectangular cross section, hollow thin wall torsion members, multiple connected cross sections.

UNIT - V: Introduction to Theory of Elasticity:

Equilibrium and Compatibility conditions for elastic solids, 2D elasticity equations for plane stress, plane strain, Airy's stress function, bending of cantilever loaded at the end.

Text Books:

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

ReferenceBooks:

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

ANALYSIS AND SYNTHESIS OF MECHANISMS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

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:

Students 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.

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 - IV: 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 - V: 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",Tata Mc Graw Hill, 2011.

Reference Books:

1. Uicker, Pennock and Shigley," Theory of machines and Mechanisms", Oxford Univ Press,2010.
2. Amitabha Ghosh 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

MECHANICAL VIBRATIONS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To gain the knowled ge of mathematical modeling of a physical system and applying the principles of Newton's Second Law and conservation of energy to derive the equations of motion.
- To study the response of a vibrating system with periodic excitation and understand the principle of vibration isolation.
- To develop the equations of motion for a continuous system in elongation, bending and torsion to find the natural frequencies and mode shapes.

Learning Outcomes:

Students will be able to

- develop a mathematical model for a physical system and derive the governing differential equations.
- determine the natural frequencies of single and two degrees of freedom systems without and with damping.
- determine and analyze the response of machine members or structures in forced vibration with different excitation frequencies.
- apply the techniques of vibration isolation to minimize the transmission of vibrating forces.
- determine the natural frequencies and mode shapes of bars in elongation and torsion and beams in bending.

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.

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 - II: 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; Response of a damped system under rotating unbalance

Vibration measuring instruments – working principle of Seismic mass, Vibrometer, Accelerometer

UNIT - III: 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; Influence coefficients

UNIT - IV: 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 - V: Vibrations of continuous systems

Vibrations of strings, bars and beams, formulation of equation of motion, characteristic equation, Eigen values, identification of node and mode shapes.

Text Books:

1. Mechanical Vibrations by G.S. Grover & Nigam.
2. Mechanical vibration by S.S. Rao.

Reference Books:

1. Theory of Vibration with Application by Thomson.
2. Mechanical vibration by V.P.Singh.
3. Mechanical vibration - Schaum Series.
4. Mechanical Vibration by F.S. Tse, Morse & Hinkle.

Elective - I

PRODUCT DESIGN

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To impart the process of product design.
- To expose the various factors influencing product design.

Learning Outcomes:

Students will be able to

- apply various tools of problem solving to arrive at a fruitful design.
- analyse the factors influencing the design.
- determine the risk and reliability aspects associated with product design.
- select appropriate manufacturing processes to realize the product design.
- design an ecofriendly product.

UNIT - I: Product Design Process:

Design process steps, problem-solving process, creative problem solving, invention, brainstorming, morphological analysis, behavioral aspects of decision making, decision theory

Modeling and Simulation: Triz, role of models in engineering design, mathematical modeling, similitude and scale models, geometric modeling on computer, finite-element analysis.

UNIT - II: Material Selection:

Material selection for new product design, role of processing in design, design for manufacture, design for assembly.

UNIT - III: Risk and Reliability:

Risk and society, Hazard analysis, fault tree analysis. failure analysis and quality: causes of failures, failure modes, failure mode and effect analysis, FMEA procedure, Product liability, Intellectual property.

UNIT - IV: Product Testing:

Thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness, accelerated testing and data analysis, accelerated factors, Weibull probability plotting, testing with censored data.

UNIT - V: Design For Environment:

Need of Design for Environment, techniques to reduce environment impact.

Text Books:

1. George E. Dieter," Engineering Design", Mc GRAW-HILL.
2. Kevin Otto," Product Design", Pearson Education, 2014.

Reference Books:

1. Richard S. Handscombe," The Product Management Handbook", McGRAW-HILL.
2. Ulrich Eppinger," New Product Design and development", TMH.
3. KEN HURST," Engineering Design Principles", ELSEVIEWER.
4. John W. Evans and Jillian Y. Evans," Product Integrity and Reliability in Design", Springer.

Elective - I

ROTOR DYNAMICS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

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:

Students 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. 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 - II: 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 - III: 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 - IV: 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 - V: 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. Timoshenko, D H.Young and W. Weaver , "Vibration Problems in Engineering", John Wiley,2000.

Reference Books:

1. Weng Jeng 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", Narosa Pubulishing House, 2000.

Elective - I

EXPERIMENTAL STRESS ANALYSIS

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

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:

Students 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, semiconductor 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

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 frozenstress method, the scattered-light method.

UNIT - IV: Brittle Coatings:

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

Moire Methods: Introduction, mechanism of formation of moire fringes, the geometrical approach to moire-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 - V: Birefringent Coatings:

Introduction, coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, fringeorder determinations in coatings, stress separation methods.

Text Books:

1. Timoshenke and Goodier Jr ,"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 Rally," Experimental stress analysis", Mc Graw-Hill.

Elective - II

PRESSURE VESSEL DESIGN

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the principles of design of pressure vessels and their components subjected to various loads.

Learning Outcomes:

Students will be able to

- design pressure vessels and various parts of vessels.
- select the suitable material for the pressure vessel .

UNIT - I: Introduction:

Materials-shapes of vessels-stresses in cylindrical, spherical and arbitrary, shaped shells, cylindrical vessels subjected to internal pressure, wind load, bending and torque for computation of pressure vessels-conical and tetrahedral vessels.

UNIT - II: Theory of Thick Cylinders:

Shrink fit stresses in built up cylinders auto frettage of thick cylinders, thermal stresses in pressure vessels.

UNIT - III: Theory of Rectangular Plates:

Pure bending-different edge conditions.

Theory Circular Plates: Simple supported and clamped ends subjected to concentrated and uniformly distributed loads-stresses from local loads, design of dome bends, shell connections, flat heads and cone openings.

UNIT - IV: Discontinuity Stresses in Pressure Vessels:

Introduction, beam on an elastic foundation, infinitely long beam, semi infinite beam, cylindrical vessel under axially symmetrical loading, extent and significance of load deformations on pressure vessels, discontinuity stresses in vessels, stresses in a bimetallic joints, deformation and stresses in flanges.

UNIT - V: **Pressure Vessel Materials and Their Environment:**

Introduction, ductile material tensile tests, structure and strength of steel, Leuder's lines, determination of stress patterns from plastic flow observations, behaviour of steel beyond the yield point, effect of cold work or strain hardening on the physical properties of pressure vessel steels, fracture types in tension, toughness of materials, effect of neutron irradiation of steels, fatigue of metals, fatigue crack growth, fatigue life prediction, cumulative fatigue damage, stress theory of failure of vessels subject to steady state and fatigue conditions.

Text Books:

1. John F.Harvey, Van nostrand Reihold Company, "Theory and design of modern Pressure Vessels" , New York.

Reference Books:

1. Beowll & Yound Ett," Process Equipment Design", WILEY INDIA PVT. LTD.-NEW DELHI,1e.
2. Indian standard code for unfired Pressure vessels IS:2825.
3. Henry H.Bednar, P.E "Pressure Vessel Design Hand Book", C.B.S.Publishers, New Delhi.
4. Timoshenko & Woinosky," Theory of plates and shells" McGraw Hill Education (India) Pvt Ltd,2e.

Elective - II

GEAR ENGINEERING

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce to 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:

Students 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.

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 - III: 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 - IV: Gear Trains:

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

UNIT - V: 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, 2000.

Note: Design data book is allowed for the examination.

Elective - II

MATERIAL SELECTION FOR DESIGN

I – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To familiarize with different advanced materials and their properties.
- To expose the criterions used in selection of materials for components.

Learning Outcomes:

Students will be able to

- use the techniques used for improving the behavior of materials.
- analyze and predict the mechanical properties of materials.
- select suitable materials for design of components.
- choose advanced materials for engineering applications.

UNIT - I: Fundamentals of Material Science:

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. 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 - II: Material Selection Criteria:

Motivation of selection, cost basis and service requirements, selection for mechanical properties, strength, toughness, fatigue and creep, use of material property charts for material selection.

UNIT - III: Modern Metallic Materials:

Dual phase steels, micro alloyed, high strength low alloy (HSLA) Steel, maraging steel, intermetalics, Ni and Ti aluminides, super alloys.

UNIT - IV: Non Metallic Materials:

Polymeric materials and their molecular structures, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers. composites; Introduction, reinforcement, types of composite materials, - properties, processing and application of composite materials.

UNIT - V: Smart Materials:

Smart materials, shape memory alloys, metallic glass, quasi crystal and nano crystalline materials.

Text Books:

1. Thomas H.Courtney, “Mechanical Behavior of Materials” 2nd Edition, McGraw-Hill, 2000.
2. M.F Ashby. Bott, “Material selction in mechanical design” ELSEVIER INDIA PVT. LTD.-NEW DELHI.

Reference Books:

1. Charles J.A/Butterworth Heiremann, “Selection and use of Engineering Materials” ,A Butterworth-heinemann Title, 3e.
2. George E.Dieter, “Mechanical Metallurgy” McGraw Hill, 1998.

MACHINE DYNAMICS LAB

I – Semester

Practical	: 6	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

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

Learning Outcomes:

Students will be able to

- determine gyroscopic effect of rotating body.
- assess the whirling speed of shaft.
- estimate the natural frequency of undamped torsional vibration of rotor.
- perform dynamic balancing of rotating and reciprocating masses.

List of Experiemnts:

1. Natural frequency of simple pendulum.
2. Radius of Gyration compound pendulum.
3. Moment of inertia of bifilar.
4. Moment of inertia of Trifilar.
5. Natural frequency of single rotor system.
6. Natural frequency of double rotor system.
7. Natural frequency of single rotor with damping.
8. Natural frequency of spring mass system.
9. Undamped free vibrations of beam.
10. Damped free vibrations of beam.
11. Force vibrations of beam.
12. Force vibration beam with damped.
13. Journal Bearing Apparatus.
14. Balancing of Reciprocating Masses.
15. Friction and Wear Apparatus.
16. Balancing of Rotating Masses.
17. Motorized Gyroscopic Couple Apparatus.

FINITE ELEMENT METHODS

II – Semester

Practical	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce the concepts of finite element method to solve engineering problems.

Learning Outcomes:

Students will be able to

- apply variational and weighted residual methods to solve differential equations.
- analyze 1-D bar and beam problems using finite element method.
- develop finite element formulations and solve 2-D structural problems using triangular and rectangular elements.
- analyze vibration problems for frequencies and mode shapes.

UNIT - I: Formulation Techniques:

Methodology, engineering problems and governing differential equations, variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, weighted residual methods.

Finite Element Method*:* Concepts of discretization, types of elements, interpolation function, node numbering scheme, assembly and boundary conditions.

UNIT - II: Analysis of 1D Problems

Bar and beam elements - shape functions, stiffness matrix, load vectors, determination of displacements, strains and stresses.

UNIT - III: Two Dimensional Problems

Analysis of 2-D problems using constant strain triangle element, axi symmetric formulations.

UNIT - IV: Isoparametric Formulations

Sub, iso and superparametric elements, four noded quadrilateral element, numerical integration – Guassian quadrature approach.

UNIT - V: Dynamic Analysis

Finite element formulation in dynamic problems in structures using Lagragian Method, consistent and lumped mass models, free vibration analysis, longitudinal and transverse vibrations , mode superposition methods and reduction techniques.

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", McGrawHill,3rd Edition.
2. C. S. Krishnamoorthy, "Finite Element Analysis -Theory and Programming",Tata Mc Graw Hill,2nd Edition.
3. Daryl L Logan, "A first course in finite element method", Cengage Learning.

GEOMETRICAL MODELING

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To highlight the importance of geometric modeling in design and manufacturing.

Learning Outcomes:

Students 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.

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

UNIT - IV: 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 - V: 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.Mallikarjuna Rao, MMM Sarcar, PHI Publishers, 2nd Edition.

CONDITION MONITORING

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

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

Learning Outcomes:

Students 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: Introduction:

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.

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

UNIT - III: 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 - IV: Vibration Analysis of Rotating Machines:

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 - V: Case Studies:

Fault detection - induction motors, gear box vibration, reciprocating engines, and rolling element bearings.

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.

DESIGN FOR MANUFACTURING AND ASSEMBLY

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce to the design factors which will ease the manufacturing and assembly.

Learning Outcomes:

Students 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: Desing Consideration in Metal Casting:

Mold and gating system design, directional solidification, and trouble shooting.

UNIT - III: 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 - IV: Selection of Materials:

Choice of materials, organizing materials and processes.

UNIT - V: Desing for Assemebly 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 Editon, , 2001
2. Geofrey Boothroyd, 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.

Elective - III

FRACTURE MECHANICS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

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

Learning Outcomes:

Students 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 omponents.
- 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.
Linear Elastic Fracture Mechanics: 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 - III: 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 - IV: 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 - V: 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.

Elective - III

ENGINEERING OPTIMIZATION

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

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

Learning Outcomes:

Students 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, Golden section method,

Unconstrained Optimization Methods: Hooke and jeeves methods, Powell's method, gradient of a function, 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.
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. Jasbir Arora , "Introduction to Optimum Design", Mc Graw 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.

Elective - III

RAPID TOOLING AND PROTOTYPING

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce Rapid Prototype tools and techniques for design and Manufacturing.

Learning Outcomes:

Students 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: Photopolymerization RP Processes:

Sterolighography (SL), SL resin curing process, SL scan patterns, microstereolithography, applications of photopolymerization processes.
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 - IV: 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 - V: 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.

Elective - IV

THEORY OF ELASTICITY

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce to the basic concepts of theory of elasticity.

Learning Outcomes:

Students 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.

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

UNIT - II: Analysis of Stress and Strain in Three Dimensions:

Principle stresses – homogeneous deformations - strain spherical and deviatoric stress - hydrostatic strain.

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

UNIT - III: Bending of Prismatic Bars:

Stress function - bending of cantilever beam - beam of rectangular cross-section - beams of circular cross-section.

UNIT IV: Plasticity:

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

UNIT - V: Methods of Solving Practical Problems:

The characteristic method - engineering method - compression of metal under press - theoretical and experimental data drawing.

Text Books:

1.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.

Elective - IV

COMPUTATIONAL FLUID DYNAMICS

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To introduce widely used techniques in solving fluid flow equations, issues that arise in the solution of such equations, and modern trends in CFD.

Learning Outcomes:

Students will be able to

- analyze fluid, thermal systems problems.
- formulate the structure and operation of commercial CFD software.
- determine the velocity field, pressure distribution and heat transfer rates on the boundaries of interior and exterior flows.
- apply some of the popular FD techniques in the solution of fluid flow problem.

UNIT - I: Introduction:

Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, derivation of finite difference equations.
Solution Methods: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes,approximate factorization, fractional step methods, direct method with
tridiagonal matrix algorithm.

UNIT - II: Hyperbolic Equations:

Explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: explicit and implicit schemes, Runge-Kutta method.

UNIT - III: Formulations of Incompressible Viscous Flows:

Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Treatment of Compressible Flows: potential equation, Eluer equations, Navier-stokes system of equations, flowfield-dependent variation methods, boundary conditions, example problems.

UNIT - IV: Finite Volume Method:

Finite volume method via finite difference method,formulations for two and three-dimensional problems.

UNIT - V: Standard Variational Methods:

Linear fluid flow problems, steady state problems, Transient problems.

Text Books:

1. T. J.Chung , "Computational fluid dynamics" , Cambridge University press, 2002.

Reference Books:

1. Frank Chorlton , "Text book of fluid dynamics", CBS Publishers &distributors, 1985.

Elective - IV

TRIBOLOGY

II – Semester

Lecture	: 4	Internal Marks	: 40
Credits	: 3	External Marks	: 60

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:

Students 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 – Reynolds's equation; hydrodynamic journal bearings – Sommerfield number, performance parameters – optimum bearing

with maximum load capacity – friction – heat generated and heat dissipated. hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings - fixed tilting pads, single and multiple pad bearings-optimum condition with largest minimum film thickness.

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.

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

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.

MODELING AND ANALYSIS LAB

II – Semester

Practical	: 6	Internal Marks	: 40
Credits	: 3	External Marks	: 60

Course Objectives:

- To impart training on Ansys software for analyzing engineering problems.
- To impart training on writing MATLAB code for analysis of problems using Finite Element Method.

Learning Outcomes:

Students will be able to

- analyze different engineering problems using ansys software.
- write and execute MATLAB code for solving engineering problems using finite element method.

List of experiments

a) Using Ansys Software:

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 analysis

b) Using MATLAB:

Introduction to MATLAB – Vector and Matrix Manipulations – Matrix functions – Tools for Polynomials – Non linear algebraic equations - Solving Differential equations –writing function subroutines – basic input and output functions – plotting functions.

1. Analysis of Bar structure using Finite Element Method
2. Analysis of Beam Structure using Finite Element Method
3. Analysis of Truss using Finite Element Method
4. Frequency response of systems having more than one degree of freedom
5. Calculation of eigen values and eigen vectors for the system , which has blocks of equal weight that are interconnected by spring
6. Displacement , velocity and acceleration analysis of four bar mechanism.
7. Displacement , velocity and acceleration analysis of single slider crank mechanism.