CHRIST
(DEEMED TO BE UNIVERSITY)
BENGALURU · INDIA

Faculty of Engineering

Department of Mechanical and Automobile Engineering

Syllabus
M.Tech- Machine Design
(Applicable for 2017-18 and 2018-19)

Christ University(Deemed to be University), Bengaluru
Karnataka, India
www.christuniversity.in

Syllabus for MTech- Mechanical Engineering 2018-19 prepared by the Department of Mechanical Engineering, Faculty of Engineering and approved by the Academic Council, Christ University, Bengaluru, India.

Published by the Centre for Publications, Christ University(Deemed to be University), Hosur Road, Bengaluru 560 029, India. publications@christuniversity.in

2018

TABLE OF CONTENTS

1. INTRODUCTION

Christ University(Deemed to be University), formerly Christ College (Autonomous), was born out of the educational vision of St. Kuriakose Elias Chavara, an educationalist and a social reformer of the nineteenth century. He founded the first indigenous congregation, Carmelites of Mary Immaculate (CMI). Established in July 1969, Christ College became the most preferred educational institution in the city of Bengaluru within the first three decades. From 1990 it initiated path breaking reforms in higher education with the introduction of innovative and modern curricula, insistence on academic discipline, imparting of Holistic Education and the support of creative and dedicated staff. Today Christ University is rated among the top ten educational institutions of the country. The UGC conferred Autonomy to Christ College (No. F.13-1/2004) on 7 October 2004 and identified it as an Institution with Potential for Excellence in 2006. On 22July, 2008 under Section 3 of the UGC Act, 1956, the Ministry of Human Resources Development of the Union Government of India, vide Notification No. F. 9-34/2007-U.3 (A), declared it a Deemed to be University, in the name and style of Christ University(Deemed to be University).

VISION
"EXCELLENCE AND SERVICE"

- Christ University, a premier educational institution, is an academic fraternity of individuals dedicated to the motto of excellence and service. We strive to reach out to the star of perfection through an earnest academic pursuit for excellence and our efforts blossom into 'service' through our creative and empathetic involvement in the society to transform it.
- Education prepares one to face the challenges of life by bringing out the best in him/her. If this is well accepted, education should be relevant to the needs of the time and address the problems of the day. Being inspired by Blessed Kuriakose Elias Chavara, the founder of Carmelites of Mary Immaculate and the pioneer in innovative education, Christ University was proactive to define and redefine its mission and strategies reading the signs of the time.

MISSION STATEMENT

"Christ University is a nurturing ground for an individual's holistic development to make effective contribution to the society in a dynamic environment."

CORE VALUES

The values which guide us at Christ University are:

Faith in God
Moral Uprightness
Love of Fellow Beings
Social Responsibility
Pursuit of Excellence

02. COURSE OFFERED

- **Undergraduate Programmes (B. Tech in)**
  B. Tech in-
  - Civil Engineering(CIVIL)
  - Computer Science and Engineering (CSE)
  - Electronics and Communication Engineering (ECE)
  - Electrical and Electronics Engineering (EEE)
  - Information Technology (IT)
  - Mechanical Engineering (MECH)
  - Automobile Engineering
- **Postgraduate Programmes**(M. Tech) (2 Years Program)
  - Master of Technology in Computer Science &Engg.
  - Master of Technology in Communication Systems
  - Master of Technology in Information Technology
  - Master of Technology in Machine Design
  - Master of Technology in Power Systems
  - Master of Technology in Structural Engineering
- **Doctoral Programmes (Ph.D.)** (Doctor of Philosophy)
  - Doctor of Philosophy (Ph.D.) in Computer Science and Engineering
  - Doctor of Philosophy (Ph.D.) in Electronics and Communication Engg.
  - Doctor of Philosophy (Ph.D.) in Civil Engineering
  - Doctor of Philosophy (Ph.D.) in Electrical and Electronics Engineering
  - Doctor of Philosophy (Ph.D.) in Mechanical Engineering
  - Doctor of Philosophy (Ph.D.) in Information Technology

03. ELIGIBLITY CRITERIA

❖ **For Undergraduate Programmes**

A pass in PUC (10+2) or equivalent with 50% marks in aggregate with Mathematics, Physics and Chemistry is the minimum eligibility for admission.

❖ **Lateral Entry:**

Candidates who have successfully completed 3 year diploma in Engineering are eligible to apply for lateral entry into:

- BTech Civil Engineering
- BTech Mechanical Engineering
- BTech Computer Science & Engineering
- BTech Electronics & Communication Engineering
- BTech Electrical and Electronics Engineering
- BTech Information Technology
- BTechAutomobile Engineering

Candidates will be admitted to second year of the programme only after appearing the Christ University selection process for engineering programmes.

❖ **For Postgraduate Programmes**:

- For Master of Technology in Computer Science & Engineering

- A Pass in B.Tech/B.E or M.Sc with 55% aggregate.

- For Master of Technology in Communication Systems
  - A Pass in B.Tech/B.E or M.Sc in Electronics and VLSI Design with 55% aggregate.
- For Master of Technology in Civil Engineering
  - A Pass in BE/BTech or M.Sc in Civil and VLSI Design with 55% aggregate.
- For Master of Technology in Mechanical Engineering
  - A Pass in BE/BTech.

❖ **For Doctoral Programmes (Ph.D.):**

- A pass with 55% marks in post graduation and equivalent in the relevant subject from any recognized university.
- A research proposal (Maximum 1500 words) has to be submitted along with the application.

4. SELECTION PROCESS

1) Candidates can process the admission based on the Undergraduate Entrance Test and Ranking by COMEDK.
   OR
2) Christ University Selection Process as given below:

Process	Particulars	Date	Venue/Centre
Entrance Test	Christ University Entrance test for each candidate	As per the E-Admit Card	As per the E- Admit Card
Personal Interview	Personal interview for 15 minutes for each candidate by an expert panel	As per the E-Admit Card	As per the E- Admit Card
Academic Performance	Assessment of past performance in Class 10, Class 11/12 during the Personal Interview	As per the E-Admit Card	As per the E- Admit Card

5. ADMISSION PROCESS

Candidates will be intimated about the Selection status (Selected/Wait Listed/Not Selected) through the University Notice Board/on the "Application Status" link on University website. The Selection results will be declared within 24 hours of Personal Interview session.

The selected candidates must process admission at **Office of Admissions, Central Block, Christ University within 3 working days of declaration of Selection Process results/as per the stipulated date and time mentioned by Office of Admissions.**

Selected candidates should collect the Fee Challan from the Office of Admissions and remit the Annual fee at the South Indian Bank, Christ University Branch. The **Offer of Admission** will stand cancelled, if failing to remit the fee within the stipulated date and time. **Admission will not be processed without the presence of the candidate and the mandatory original documents mentioned below;**

1. The Offer of Admission Card (E-Admission Card/Mail)
2. Class 10 Marks Statement
3. Class 11 Marks Statement, if Candidate is pursuing class 12 and appearing for final examination during March-April 2016
4. Class 12 Marks Statement, if candidate has appeared and passed the Class 12 examination

The University ID card is a smart card, which is both an ID card as well as a South Indian Bank ATM card with a chip containing the student personal details. All transactions within the University campus after commencement of classes, including fees payment will be processed only through this card. It is also an access card for Library and other restricted places. Candidates are advised to collect the South Indian Bank account opening form along with fees challan and process it at the Bank branch within the University premises.

Candidates who fall under International student category (ISC), if selected, should register with the Foreigner Regional Registration Officer (FRRO/FRO) of the Local Police in Bangalore, India within 14 working days from the date of admission or arriving in Bangalore. All International student category (ISC) candidates if studied in India should obtain an NOC from the previous qualifying institution.

6. GENERAL RULES

- There is a grading scheme for each paper and for all the courses.
- All marks will indicate the marks, percentage obtained, grade and grade point average.
- The grade point average will be calculated as follows: for each subject, multiply the grade point with the number of credits; divide the sum of product by the total number of credits.
- The CGPA [Cumulative GPA] is calculated by adding the total number of earned points [GP x Cr] for all semesters and dividing by the total number of credit hours for all semesters.

$$\mathbf{GPA} = \frac{\sum[\mathbf{GPA x Cr}]}{\sum \mathbf{Cr}}$$

7. Grading scheme for Each Paper: Undergraduate Courses

Percentage	Grade	Grade Point	Interpretation	Class
80 and above	A	4.0	Outstanding	First Class with Distinction
73-79	A-	3.67	Excellent	First Class
66-72	B+	3.33	Very Good	
60-65	B	3.0	Good	
55-59	B-	2.67	Average	Second Class
50-54	C+	2.33	Satisfactory	
45-49	C	2.00	Pass	Pass Class

40-44	D	1.0	Pass	
39 and below	F	0	Fails	Fail

8. Grading scheme for Each Paper: Postgraduate Courses

Percentage	Grade	Grade Point	Interpretation	Class
80 and above	A+	4.0	Excellent	First Class with Distinction
70-79	A	3.5	Very Good	
65-69	B+	3.0	Good	First Class
60-64	B	2.5	Above Average	
55-59	C+	2.0	Average	Second Class
50-54	C	1.5	Satisfactory	
40-49	C-	1.0	Exempted if aggregate is more than 50%	Pass Class
39 and below	F	0	Fails	Fail

9. COURSE OVERVIEW

The Mechanical Engineering Department has well established facilities for carrying out the activities of basic mechanical engineering. It is equipped to meet the present day technological advances and to meet the industrial requirements matching with the global standards. The department has the state of the art laboratories to meet the demand for practical knowledge by the present day industrial applications.

One of the oldest, largest and diversified of all engineering disciplines is mechanical engineering. Rated as one of the most "evergreen" branches, students of mechanical engineering can look forward to an exciting and robust study in the field of Thermal, Design, Materials and Manufacturing Engineering. A Holistic blend of both theory and practicals ensure that students are ready to face the challenges of the industrial world.

10. COURSE OBJECTIVE

The goal of our program is to prepare our graduates for successful professional practice and advanced studies by providing a broad education in mechanical engineering and by offering the opportunity to deepen their technical understanding in a particular concentration area of related technical electives. Following are the course objectives.

1. Join a technically sophisticated workforce as successful, practicing engineers in a wide range of mechanical engineering fields.

2. Continuously improve and expand their technical and professional skills through formal means as well as through informal self-study.
3. Pursue advanced degrees in engineering, business, or other professional fields.
4. Advance themselves professionally and personally by accepting responsibilities and pursuing leadership roles

11. TEACHING PEDAGOGY

Our teaching methodology ensures that students are being exposed to a holistic education experience in an active and dynamic learning environment, giving them the opportunity to identify and realize their potential, and to achieve excellence. In order to realize the objectives, a methodology based on the combination of the following will be adopted:

1. Team/Class room teaching.
2. PowerPoint presentations and handouts.
3. Simulated situations and role-plays.
4. Video films on actual situations.
5. Assignments.
6. Case Studies.
7. Exercises are solved hands on.
8. Seminars.
9. Industry / Field visits.
10. Information and Communication Technology.
11. Project work.
12. Learning Management System.

12. DETAILS OF CIA (Continuous Internal Assessment):

Assessment is based on the performance of the student throughout the semester.

Assessment of each paper

- Continuous Internal Assessment (CIA) for Theory papers: 50% (50 marks out of 100 marks)
- End Semester Examination(ESE) : 50% (50 marks out of 100 marks)

Components of the CIA

CIA I : Assignments/Open book test/Seminar	: 10 marks
CIA II : Mid Semester Examination (Theory)	: 25 marks
CIA III : Quizzes/Seminar/Case Studies/Project Work	: 10 marks
Attendance	: 05 marks
Total	**: 50 marks**

For subjects having practical as part of the subject

End semester practical examination	: 25 marks
Records	: 05 marks
Mid semester examination	: 10 marks
Class work	: 10 marks
Total	**: 50 marks**

13. ASSESSMENT RULES

- **Assessment of Project Work(Phase I)**
  - Continuous Internal Assessment:100 Marks
    - Presentation assessed by Panel Members
    - Assessment by the Guide
    - Project Progress Reports

- **Assessment of Project Work(Phase II) and Dissertation**
  - Continuous Internal Assessment:200 Marks
    - Presentation assessed by Panel Members
    - Assessment by the Guide
    - Project Progress Reports
    - Paper presentation in National/International conference or in Journal publications or at least acceptance letter is mandatory
  - End Semester Examination:100 Marks
    - Viva Voce
    - Demonstration
    - Project Report
  - Dissertation (Exclusive assessment of Project Report): 100 Marks
    - Internal Review : 50 Marks
    - External Review : 50 Marks

- **Assessment of Internship**

  30 Internship days at Industry/Research Laboratories is mandatory and a report should be submitted with certificate before IV semester.

14. QUESTION PAPER PATTERN:

End Semester Examination (ESE):

Theory Papers:

The ESE is conducted for 100 marks of 3 hours duration.

The syllabus for the theory papers is divided into FIVE units and each unit carries equal weightage in terms of marks distribution.

Question paper pattern is as follows.

Two full questions with either or choice, will be drawn from each unit. Each question carries 20 marks. There could be a maximum of three sub divisions in a question. The emphasis on the questions is broadly based on the following criteria:

50 % - To test the objectiveness of the concept
30 % - To test the analytical skill of the concept
20 % - To test the application skill of the concept

Laboratory / Practical Papers:

The ESE is conducted for 50 marks of 3 hours duration. Writing, Execution and Viva – voce will carry weightage of 20, 20 and 10 respectively.

Mid Semester Examination (MSE):

Theory Papers:

- The MSE is conducted for 50 marks of 2 hours duration.
- Question paper pattern; Five out of Six questions have to be answered. Each question carries 10 marks.

Laboratory / Practical Papers:

The MSE is conducted for 50 marks of 2 hours duration. Writing, Execution and Viva – voce will carry weightage of 20, 20 and 10 respectively.

Holistic Education:

End Semester Examination	25 Marks
Participation	25 Marks
Total	**50 Marks**

15. COURSE STRUCTURE:

I SEMESTER

Sl No	Course No	Course Name	Hours			Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MTMA131	Applied Mathematics	3	0	0	100	3	0	0	3
2	MTME132	Theory of Elasticity	3	0	0	100	3	0	0	3
3	MTME133	Dynamics of Mechanism Design	3	0	0	100	3	0	0	3
4	MTME134	Composite Materials Technology	3	0	0	100	3	0	0	3
5	MTME135	Elective – I	3	0	0	100	3	0	0	3
6	MTME151	Advanced CAD Laboratory	0	0	2	50	0	0	2	2
7	MTME152	Simulation Laboratory	0	0	2	50	0	0	2	2
8	MTME171	Professional Practice – I	0	0	4	50	0	0	2	2
9	HE171	Holistic Education - I	1	0	0		1	0	0	1
		Total	**16**	**0**	**8**	**600**	**16**	**0**	**6**	**22**

II SEMESTER

S. No	Course No	Course Name	Hours			Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MTME231	Experimental Stress Analysis	3	0	0	100	3	0	0	3
2	MTME232	Computer Application in Design	3	0	0	100	3	0	0	3
3	MTME233	Advanced Finite Element Analysis	3	0	0	100	3	0	0	3
4	MTME234	Theory of Plasticity	3	0	0	100	3	0	0	3
5	MTME235	Elective II	3	0	0	100	3	0	0	3
6	MTME251	Advanced Design Laboratory	0	0	2	50	0	0	2	2
7	MTME252	Analysis Laboratory	0	0	2	50	0	0	2	2
8	MTME271	Professional Practice –II	0	0	4	50	0	0	2	2
9	HE271	Holistic Education – II	1	0	0	-	1	0	0	1
		Total	**16**	**2**	**8**	**650**	**16**	**0**	**6**	**22**

III SEMESTER

S. No	Course No	Course Name	Hours			Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MTME331	Elective III	3	0	0	100	3	0	0	3
2	MTME332	Elective IV	3	0	0	100	3	0	0	3
3	MTME333	Elective V	3	0	0	100	3	0	0	3
4	MTME371	Project Work (Phase-I)	0	0	3	100	0	0	3	3
5	MTME373	Internship (Industry/Research Lab)	0	0	4	50	0	0	2	2
6	MTCY01	Cyber Security	0	0	4	-	0	0	2	2
		Total	**09**	**0**	**11**	**500**	**09**	**0**	**07**	**16**

IV SEMESTER

Subject Code	SUBJECT TITLE	M	C
MTME471	Project Work (Phase II) and Dissertation	300	9
	TOTAL	**300**	**09**

LIST OF ELECTIVES
M.Tech (Machine Design)
ELECTIVE-I

CODE NO	SUBJECT	M	C	Hours		
				L	T	P
MTME135E1	Advanced Design of Mechanical System	100	3	3	0	0
MTME135E2	Smart Materials and Structures	100	3	3	0	0
MTME135E3	Robotics	100	3	3	0	0

ELECTIVE-II

CODE NO.	SUBJECT	M	C	Hours		
				L	T	P
MTME235E1	Machine Tool Design	100	3	3	0	0
MTME235E2	Mechanical Behavior of Materials	100	3	3	0	0
MTME235E3	Fracture Mechanics	100	3	3	0	0

ELECTIVE-III

CODE NO.	SUBJECT	M	C	Hours		
				L	T	P
MTME331	Design for Manufacture	100	3	3	0	0
MTME331	Rotor Dynamics	100	3	3	0	0
MTME331	Robust Design	100	3	3	0	0

ELECTIVE-IV

CODE NO.	SUBJECT	M	C	Hours		
				L	T	P
MTME332E1	Advanced Theory of Vibration	100	3	3	0	0
MTME332E2	Optimum Design	100	3	3	0	0
MTME332E3	Vehicle Dynamics	100	3	3	0	0

ELECTIVE-V

CODE NO.	SUBJECT	M	C	Hours		
				L	T	P
MTME333E1	Tribology and Bearing Design	100	3	3	0	0
MTME333E2	Theory of Plates and Shells	100	3	3	0	0
MTME333E3	Advanced Mechanisms Design and Simulation	100	3	3	0	0

15. DETAILED SYLLABUS

I SEMESTER

APPLIED MATHEMATICS

Sub Code:MTMA 131 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week:04Exam Hours: 03**

Paper Description:
This paper helps students apply various mathematical concepts in the domain of machine design. The paper is designed for students with an interest in applying mathematical skills in a variety of engineering applications. This paper will be useful for them to pursue a career in research and development.

Paper objective:
At the end of the course the students would:
Be able to apply various numerical techniques in design related problems.
Have detailed concept of Linear Algebra.
Be capable of applying different transformation methods to solve linear as well non lineae differential equations.

Paper Description: This course provides the basic knowledge about the applications of photo elasticity, strain gages, and holographic interferometry. Comparison of test results with theoretical predictions of stress and strain. A thorough discussion of other methods of stress and strain determination (optical fiber strain sensors, acoustoelasticity, thermoelasticity, brittle coating, Moire interferometry, residual stress determination).

Unit – 1.
SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS: System of Linear Algebraic Equations: Crout's method, Doolittile method, Partition method.

Roots of Polynomial: Muller's method, Bairstow's Method, Graeffe's Roots, Squaring Method.
Eigen values and Eigen Vectors by iteration methods: Jacobi and Householder's method for symmetric matrices.

12 Hrs

Unit – 2.
NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION: Numerical Differentiation and Numerical Integration: Newton – Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae.

10 Hrs

Unit – 3.
LAPLACE TRANSFORMATION : Transforms of elementary functions, properties, Inverse Laplace transform, Convolution theorem, Application of Laplace transforms to ordinary differential equations and simultaneous differential equations, Laplace transform of some special functions (periodic functions, Heaviside's unit function and Dirac Delta Function).

14 Hrs

Unit – 4.

LINEAR TRANSFORMATION AND ORTHOGONALITY: Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering.

Inner product spaces: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram - Schmidt process.

12 Hrs

Unit – 5.

FOURIER SERIES AND DIFFERENT TRANSFORMATION METHODS: Fourier series, determination of Fourier coefficients, Finite Fourier transforms, Fourier, Hankel and Mellin's transforms, Perturbation and differential transform methods to solve ODEs and PDEs.

12 Hrs

REFERENCE BOOKS

1. S. S. Sastry, "Numerical Analysis for Engineers", TataMcgraw Hill Edition.
2. Steven C.Chapra, Raymond P.Canale, "Numerical Methods for Engineers", Fourth Edition, TataMcgraw Hill.
3. M K. Jain, S. R. K Iyengar, R K. Jain, "Numerical Methods for Scientific and Engg.Computation", NEW AGE INTERNATIONAL Publishers.
4. Pervez Moin, "Application of Numerical methods to Engineering".
5. David. C. Lay, "Linear Algebra and its applications", 3rd Edition, Pearson Education.
6. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2004.
7. O' Neil, P.V., "Advanced Engineering Mathematics", Thomson Asia Pvt. Ltd., Singapore, 2003.
8. Andrews, L. C. and Philips R. L., "Mathematical Techniques for Engineers and Scientists", Prentice Hall of India, 2006.
9. JiHuan He, "Homotopy perturbation technique", Computer Methods in Applied Mechanics and Engineering Vol. 178, Issues 3-4, August 1999, Pages 257-262.
10. S. J. Liao, "Beyond perturbation", CRC press (2003).
11. VedatSuatErtürk, "Differential Transformation Method For SolvingDifferential Equations of Lane - Emden Type", Mathematical and computer applications, vol. 12(3), 135-139, 2007.
12. Gilbert Strang, "Linear Algebra and its applications", Fourth Edition, Cengage Learning, 2006.

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions.

THEORY OF ELASTICITY

Sub Code: MTME132 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: The course will provide a basic knowledge of the formulation of linear elasticity theory and its application to problems of stress and displacement analysis. The fundamental field equations will be developed including strain energy concepts. Applications will involve the solution to problems of engineering interest including two-dimensional problems of plane strain and plane stress, fracture mechanics, torsion, bending and stress concentration, and an introduction to three-dimensional solutions.

Paper Objectives:

- To obtain the stress strain relation within the elastic body.
- To find the thermal distribution occurring within the elastic body.
- To find the principle stress and strain for a different types of elastic body.

Level of Learning: Advanced.

Learning Outcome:

- To calculate two and three dimensional problems of cylindrical bodies.
- To know the stress strain relation for a body subjected to loading within elastic limit.
- To be able to understand the relation for a body subjected to thermal expansion.

Unit – 1.

INTRODUCTION: Definition and Notation for forces and stresses. Components of stresses, equations of Equilibrium, Specification of stress at a point. Principal stresses and Mohr's diagram in three dimensions. Boundary conditions .Stress components on an arbitrary plane, Stress invariants, Octahedral stresses, Decomposition of state of stress, Stress transformations.

INTRODUCTION TO STRAIN : Deformation**,** Strain Displacement relations, Strain components, The state of strain at a point, Principal strain, Strain transformation, Compatibility equations, Cubical dilatation

14 Hrs

Unit – 2.

STRESS -STRAIN RELATIONS AND THE GENERAL EQUATIONS OF ELASTICITY: Generalized Hooke's; law in terms of engineering constants. Formulation of.elasticity Problems. Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal thermo.

TWO DIMENSIONAL PROBLEMS IN CARTESIAN CO-ORDINATES: Airy's stress function, investigation for simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load, Use of Fourier series to solve two dimensional problems.

14 Hrs

Unit - 3.

TWO DIMENSIONAL PROBLEMS IN POLAR CO-ORDINATES: General equations, stress distribution symmetrical about an axis, Pure bending of curved bar, Strain components in polar co-ordinates, Rotating disk and cylinder, Concentrated force on semi-infinite plane, Stress concentration around a circular hole in an infinite plate.

10 Hrs

Unit - 4

THERMAL STRESSES: Introduction, Thermo-elastic stress -strain relations, Thin circular disc, Long circular cylinder.

TORSION OF PRISMATIC BARS: Torsion of Circular and elliptical cross section bars, Soap film analogy, Membrane analogy, Torsion of thin walled open and closed tubes.

12 Hrs

Unit - 5

ELASTIC STABILITY: Axial compression of prismatic bars, Elastic stability, Buckling load for column with constant cross section.

10 Hrs

TEXT BOOKS

1. Timoshenko and Goodier, "Theory of Elasticity"-'McGraw Hill Book Company.
2. Dym C. L and Shames. I. H, "Solid Mechanics : A variation"- Approach, McGralHilll New York- 1973

REFERENCE BOOKS

1. T.G.Sitharam" Applied Elasticity"- Interline publishing, 2005.
2. L S Srinath, "Advanced Mechanics of Solids "- Tata Mcgraw Hill Company,2008
3. Sadhu Singh ," Theory of Elasticity"- Khanna publisher, 2003
4. Phillips, Durelli and Tsao, "Analysis of Stress and Strain "- McGraw Hill Book.
5. Wang. C. T. "Applied Elasticity".

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions.

DYNAMICS OF MECHANISM DESIGN

Sub Code: MTME133 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: This course provides the basic knowledge of linear and rotational motion and the forces and torques that cause motion. Specific topics include kinematics and kinetics of plane motion. Problems are solved using several different methods including work and energy, impulse and momentum, and inertia methods. Theory is applied to actual engineering applications to solve problems involving hoisting equipment, such as elevators, and balancing of rotating machinery.

Paper Objectives:

- To study the laws of motion i.e dynamics.
- To represent graphical and analytical method of dimensional synthesis.
- To find the different types of sensors and actuators used for different application.

Level of Learning: Advanced.

Learning Outcome:

- To understand the Concept of linkages and lagrange's principles.
- To describe concepts of displacement, velocity and acceleration as vectors and how to determine them.
- To be able to understand motion of a force as a vector.
- To be able to understand concepts of kinetic, potential and mechanical energies and the concept of a conservative force.
- To be able to draw the free-body diagram (FBD) for the system.
- To conduct dynamic force analysis for various mechanisms.
- To be able to solve problems on analysis of frictions in different members like belt drives.

Unit – 1.

GEOMETRY OF MOTION: Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms**:** Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method.

GENERALIZED PRINCIPLES OF DYNAMICS: Fundamental laws of motion, Generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum.

16 Hrs

Unit – 2.

LAGRANGE'S EQUATION: Lagrange's equation from D'Alembert's principles, Examples, Hamiltons equations, Hamiltons principle, Lagrange's, equation from Hamiltons principle, Derivation of Hamiltons equations, Examples.

SYSTEM DYNAMICS: Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances.

13 Hrs

Unit - 3.

SYNTHESIS OF LINKAGES: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle.

10 Hrs

Unit - 4.

6. GRAPHICAL METHODS Of DIMENSIONAL SYNTHESIS: Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages.

9 Hrs

Unit - 5.

ANA1YTICAL METHODS OF DIMENSIONAL SYNTHESIS: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.

SPATIAL MECHANISMS: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.

12Hrs

TEXT BOOKS

1.K.J.Waldron&G.L.Kinzel,"Kinematics, Dynamics and Design of Machinery",Wiley India, 2007.

2. Classi-al Dynamics - Greenwood Prentice Hall of India, 1988.

References Books:

1. E.Shigley&J.J.Jicker," Theory of Machines and Mechanism", McGraw Hill company.

2. Mechanism and Machine Theory - A.G.Ambekar, PHI, 2007.

3. Ghosh and Mallick, "Theory of Mechanism and Mechanism ", East West press 2007.

4. David H. Myszka, "Machines and Mechanisms", Pearson Education, 2005.

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions.

COMPOSITE MATERIALS TECHNOLOGY

Sub Code: MTME134 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: This course provides the basic understanding of the linear elastic analysis of composite materials. This understanding will include concepts such as anisotropic material behavior and the analysis of laminated plates. The students will undertake a design project involving application of fiber reinforced laminates.

Paper Objectives:

- To obtain the basic idea of composite technology in the present scenario.
- Classification and manufacturing of different types of composites.
- Testing of composite material and laboratory set up.

Level of Learning: Advanced.

Learning Outcome:

- To be able to define the concept of composite.
- To differentiate the different types of composites and its manufacturing.
- To understand the setup for testing of composites.
- To know the application of composites in various advanced fields.

Unit - 1.

INTRODUCTION TO COMPOSITE MATERIALS: Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction.

10 Hrs

Unit - 2.

MACRO MECHANICS OF A LAMINA: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems.Invariantproperties.Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

12 Hrs

Unit - 3.

MICRO MECHANICAL ANALYSIS OF A LAMINA: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems.

BIAXIAL STRENGTH THEORIES: Maximum stress theory, Maximum strain theory, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problems.

13 Hrs

Unit - 4.

MACRO MECHANICAL ANALYSIS OF LAMINATE: Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) Engineering constants, Special cases of laminates, Numerical problems.

MANUFACTURING: Lay up and curing - open and closed mould processing, Hand lay, Up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance, Introduction,

material qualification, Types of defects, NDT methods.

12 Hrs

Unit - 5.

APPLICATION DEVELOPMENTS: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.

METAL MATRIX COMPOSITES: Re-inforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications.

13 Hrs

TEXT BOOKS

1. Mein Schwartz,"Composite Materials Handbook", 2nd Edition, McGraw Hill Book Company, 1984.
2.Autar K. Kaw,"Mechanics of composite materials", 2nd Edition edition, Taylor & Francis, 2006.

REFERENCE BOOKS

1. Rober M. Joness, "Mechanics of Composite Materials", Mc-Graw Hill Kogakusha Ltd.
2. Michael W,"Stress analysis of fiber Reinforced Composite Materials", Updated edition DEStech,2009.
3. Krishan K, "Composite Material Science and Engineering", 3rd Edition Chawla Springer,2012
4. P.C. Mallik Marcel Decker, "Fibre Reinforced Composites", 3rd edition, CRC Press, 2007

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions.

ADVANCED CAD LABORATORY

Sub Code: MTME151 **Total Lecture Hrs:30**
Exam Marks: 50 **Hrs/week: 02Exam Hours:03**

Exercises in Sketching, Solid Modeling, Surface modeling, Sheet metal and mechanism design of Mechanical Components and assembly using Parametric and Feature Based Packages like **PRO-E / SOLID WORKS /SOLID EDGE/CATIA / UNIGRAPHICS** etc.

SIMULATION LAB

Sub Code: MTME152 **Total Lecture Hrs:30**
Exam Marks: 50 **Hrs/week:02ExamHours:03**

Exercises in the field of Vibrations, CFD, Rotor dynamics, Heat transfer and Mass transfer will be carried out. At least five exercises with case study. Out of which any two will be asked for end semester exam.

PROFESSTIONAL PRACTICE -I

Sub Code: MTME171 **Hrs/week: 4**

SUBJECT DESCRIPTION: During the seminar session each student is expected to prepare and present a topic on engineering / technology, it is designed to

- Review and increase their understanding of the specific topics tested.
- Improve their ability to communicate that understanding to the grader.
- Increase the effectiveness with which they use the limited examination time.

SUBJECT OBJECTIVE: Students are encouraged to use various teaching aids such as overhead projectors, power point presentation and demonstrative models. This will enable them to gain confidence in facing the placement interviews and intended to increase the score they earn on the upcoming exam above what they would otherwise earn.

LEVEL OF KNOWLEDGE: Basic/Advanced/Working

This course is specially designed for the students of higher degree. It COURSE OBJECTIVEs to train and equip the students towards acquiring competence in teaching, laboratory skills, research methodologies and other professional activities including ethics in the respective academic disciplines.

The course will broadly cover the following aspects:

- Teaching skills
- Laboratory skills and other professional activities
- Research methodology

For teaching suitable courses where strengthening in the training of the students is required will be identified and the student will be asked to prepare lectures on selected topics pertaining to the courses and present these lectures before a panel of faculty members. The student will also be required to prepare question papers which will test the concepts, analytical abilities and grasp in the subject. Wherever the laboratories are involved, students will also be asked to carry out laboratory experiments and learn about the use and applications of the instruments. The general guiding principle is that the students should be able to teach and participate in the undergraduate degree courses in his/her discipline in an effective manner. The students will also assist the faculty in teaching and research activities.

The course will also contain the component of research methodology, in which a broad topic will be assigned to each student and he/ she is supposed to carry out intensive literature survey, data analysis and prepare a research proposal.

Each group will carry out many professional activities beside teaching and research. Such as, purchase of equipment, hardware, software and planning for new experiments and also laboratories etc. Along with these the students will also be assigned some well-defined activities. The student is expected to acquire knowledge of professional ethics in the discipline.

OPERATIONAL DETAILS: Head of the Department will assign a suitable instructor/faculty member to each student. Students and faculty members covering a broad area will be grouped in a panel consisting of 4-5 students and 4-5 faculty members. Within one week after registration, the student should plan the details of the topics of lectures, laboratory experiments, developmental activities and broad topic of research etc in consultation with the assigned instructor/faculty. The student has to submit two copies of the written outline of the total work to the instructor within one week.

In a particular discipline, Instructors belonging to the broad areas will form the panel and will nominate one of them as the panel coordinator. The coordinator together with the instructors will draw a complete plan of lectures to be delivered by all students in a semester. Each student will present 3-4 lectures, which will be attended by all other students and Instructors. These lectures will be evenly distributed over the entire semester. The coordinator will

announce the schedule for the entire semester and fix suitable meeting time in the week. Each student will also prepare one presentation about his findings on the broad topic of research. The final report has to be submitted in the form of a complete research proposal. The References and the bibliography should be sited in a standard format. The research proposal should contain a) Topic of research b) Background and current status of the research work in the area as evident from the literature review c) Scope of the proposed work d) Methodology e) References and bibliography. A report covering laboratory experiments, developmental activities and code of professional conduct and ethics in discipline has to be submitted by individual student. The panel will jointly evaluate all the components of the course throughout the semester and the mid semester grade will be announced by the respective instructor to his student. A comprehensive viva/test will be conducted at the end of the semester jointly, wherever feasible by all the panels in a particular academic discipline/department, in which integration of knowledge attained through various courses will be tested and evaluated. Wherever necessary and feasible, the panel coordinator in consultation with the concerned group may also seek participation of the faculty members from other groups in lectures and comprehensive viva.

Mid semester report and final evaluation report should be submitted in the 9th week and 15th week of the semester respectively. These should contain the following sections:

Section (A): Lecture notes along with two question papers each of 180 min duration, one quiz paper (CIA-I) of 120 min duration on the topics of lectures. The question paper should test concepts, analytical abilities and grasp of the subject. Solutions of questions also should be provided. All these will constitute lecture material.

Section (B): Laboratory experiments reports and professional work report.

Section (C): Research proposal with detailed references and bibliography in a standard format.

Wherever necessary, respective Head of the Departments could be approached by Instructors/panel coordinators for smooth operation of the course. Special lectures dealing with professional ethics in the discipline may also be arranged by the group from time to time.

EVALUATION SCHEME

Component	Instructors	Weightage
Teaching	Lecture materials	7.5
	Lecture presentation	10
Laboratory and	Reports	10
Professional activities	Viva/presentation	7.5
Research	Proposal	2.5
	Viva/presentation	2.5
Comprehensive	Test/ viva	10
	Total	50

COURSE NOTICES: Notices pertaining to this course will be displayed on the respective departmental notice boards by the panel coordinator/ instructor. Students may also check the exam notice board for notices issued by the exam division.

MAKE UP POLICY: All students are required to attend all the lectures and presentations in the panel. Participation and cooperation will also be taken into account in the final evaluation. Requests for makeup should normally be avoided. However, in genuine cases, panel will decide action on a case by case basis.

NOTE: Seminar shall be presented in the department in presence of a committee (Batch of Teachers) constituted by HOD. The seminar marks are to be awarded by the committee. Students shall submit the seminar report in the prescribed Standard format.

II SEMESTER
EXPERIMENTAL STRESS ANALYSIS

Sub Code: MTME231 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: This course provides the basic knowledge about the applications of photo elasticity, strain gages, and holographic interferometry. Comparison of test results with theoretical predictions of stress and strain. A thorough discussion of other methods of stress and strain determination (optical fiber strain sensors, acoustoelasticity, thermoelasticity, brittle coating, Moire interferometry, residual stress determination).

Paper Objectives:

- Stress-Strain Analysis is used in design of various structures such as Tunnels, Beams, Aircraft Structures and Bridges. This will help to validate the structures and evaluate with respect to time.
- The Input of (Experimental) Stress-Strain analysis will be geometry of structure, Materials Selected, properties of material and the stress applied on it. The Output will be the reaction (deformation) to the stress.

Level of Learning: Advanced.

Learning Outcome:

- To be able to describe the Sensitivity & the construction of strain gauges.
- To elucidate the isoclinics& Fringe multiplication techniques.
- To be able to explain the stress separation methods of 3D photoelasticity.
- To describe the Birefringence coating techniques.
- To be able to describe the Moire's Techniques.

Unit – 1.
ELECTRICAL RESISTANCE STRAIN GAGES: Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat Stone's bridges, Constant current circuits**.**
STRAIN ANALYSIS METHODS: Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage.

12 Hrs

Unit – 2.
PHOTOELASTICITY : Nature of light, - wave theory of light,- optical interference - Polariscopes stress optic law - effect of stressed model in plane and circuclarPolariscopes, IsoclinicsIsochromatics fringe order determination - Fringe multiplication techniques - Calibration Photoelastic model materials.
TWO DIMENSIONAL PHOTOELASTICITY STRESS ANALYSIS: Separation methods shear difference method, Analytical separation methods, Model to prototype scaling**.**

14 Hrs

Unit – 3.
THREE DIMENSIONAL PHOTOELASTICITY : Stress freezing method, General slice, Effective stresses, Stresses separation, Shear deference method, Obligue incidence method Secondary principals stresses, Scattered light photoelasticity, Principals, Polariscoope and

stress data analyses**.**

10 Hrs

Unit – 4.

COATING METHODS a) Photoelastic Coating Method: Birefringence coating techniques Sensitivity Reinforcing and thickness effects - data reduction - Stress separation techniques Photoelastic strain gauges **b) Brittle Coatings Method:** Brittle coating technique Principles data analysis - coating materials, Coating techniques.

12 Hrs

Unit – 5.

MOIRE TECHNIQUE: Geometrical approach, Displacement approach- sensitivity of Moire data data reduction, In plane and out plane Moire methods, Moire photography, Moire grid production.

HOLOGRAPHY: Introduction, Equation for plane waves and spherical waves, Intensity, Coherence, Spherical radiator as an object (record process), Hurter, Driffeld curves, Reconstruction process, Holograpicinterferomerty, Realtime. and double exposure methods, Displacement measurement, Isopachics.

12 Hrs

TEXT BOOKS

1. Dally and Riley, "Experimental Stress Analysis",2nd Revised Edition edition,McGraw Hill, 1978
2. Sadhu Singh, "Experimental Stress Analysis "Khanna Publishers, 2011.

REFERENCES BOOKS

1. Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant,"Experimental Stress Analysis", Tata McGraw Hill
2. PhotoelasticityVol I and Vol II - M.M.Frocht,.John Wiley and sons.
3. Strain Gauge Primer - Perry and Lissner.
4. Photo elastic Stress analysis - Kuske, Albrecht and Robertson John Wiley & Sons.
5. Motion Measurement and Stress Analysis - Dave and Adams,

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions.

COMPUTER APPLICATION IN DESIGN

Sub Code: MTME232 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: This course provides the knowledge of Integrating the Design and Manufacturing Processes through a Common Database. A thorough discussion onGraphics Libraries, Coordinate Systems, Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Exchange Methods of Product Definition Data, Initial Graphics Exchange Specification, Drawing Interchange Format, Standard for the Exchange of Product Data will be done.

Paper Objectives:

- This course helps in making a learner to be a competent, in comprehending the algorithms and concepts coded in various kernel of modeling and analysis software.
- The learner will have a clear map, of knowing the functionality of software by experimenting each user command along with the knowledge of background process running behind.

Level of Learning: Advanced.

Learning Outcome:

- To be able to describe the hidden concepts of the 3d modeling software.
- To describe the various graphical concepts, used to store the picture.
- To explain the state-of the art of 2d & 3D spline, conic Curves and So on.
- To find the application of curves in the automobile design industry & crash analysis.

Unit – 1.

INTRODUCTION TO CAD/CAM/CAE SYSTEMS: Overview, Definitions of CAD. CAM and CAE, Integrating the Design and Manufacturing Processes through a Common Database-A Scenario, Using CAD/CAM/CAE Systems for Product Development-A Practical Example.

COMPONENTS OF CAD/CAM/CAE SYSTEMS: Hardware Components ,Vector-Refresh (Stroke-Refresh) Graphics Devices, Raster Graphics Devices, Hardware Configuration, Software Components, Windows-Based CAD Systems.

12 Hrs

Unit – 2.

BASIC CONCEPTS OF GRAPHICS PROGRAMMING: Graphics Libraries, Coordinate Systems, Window and Viewport, Output Primitives - Line, Polygon, Marker Text, Graphics Input, Display List, Transformation Matrix, Translation, Rotation, Mapping, Other Transformation Matrices, Hidden-Line and Hidden-Surface Removal, Back-Face Removal Algorithm, Depth-Sorting, or Painters, Algorithm, Hidden-Line Removal Algorithm, z-Buffer Method, Rendering, Shading, Ray Tracing, Graphical User Interface, X Window System.

10 Hrs

Unit – 3.

GEOMETRIC MODELING SYSTEMS: Wireframe Modeling Systems, Surface Modeling Systems, Solid Modeling Systems, Modeling Functions, Data Structure, Euler Operators, Boolean Operations, Calculation of Volumetric Properties, Nonmanifold Modeling Systems, Assembly Modeling Capabilities, Basic Functions of Assembly Modeling, Browsing an

Assembly, Features of Concurrent Design, Use of Assembly models, Simplification of Assemblies, Web-Based Modeling.

10 Hrs

Unit – 4.

REPRESENTATION AND MANIPULATION OF CURVES: Types of Curve Equations, Conic Sections, Circle or Circular Arc, Ellipse or Elliptic Arc, Hyperbola, Parabola, Hermite Curves, Bezier Curve, Differentiation of a Bezier Curve Equation, Evaluation of a Bezier Curve, B-Spline Curve, Evaluation of a B-Spline Curve, Composition of B-Spline Curves, Differentiation of a B-Spline Curve, Nonuniform Rational B-Spline (NURBS) Curve, Evaluation of a NURBS Curve, Differentiation of a NURBS Curve, Interpolation Curves, Interpolation Using a Hermite Curve, Interpolation Using a B-Spline Curve, Intersection of Curves.

REPRESENTATION AND MANIPULATION OF SURFACES: Types of Surface Equations, Bilinear Surface, Coon's Patch, Bicubic Patch, Bezier Surface, Evaluation of a Bezier Surface, Differentiation of a Bezier Surface, B-Spline Surface, Evaluation of a-B-Spline Surface, Differentiation of a B-Spline Surface, NURBS Surface, Interpolation Surface, Intersection of Surfaces.

14 Hrs

Unit – 5.

CAD AND CAM INTEGRATION : Overview of the Discrete Part Production Cycle, Process Planning, Manual Approach, Variant Approach, Generative Approach, Computer-Aided Process Planning Systems, CAM-I CAPP, MIPLAN and MultiCAPP, MetCAPP, ICEM-PART, Group Technology, Classification and Coding, Existing Coding Systems, Product Data Management (PDM) Systems.

STANDARDS FOR COMMUNICATING BETWEEN SYSTEMS: Exchange Methods of Product Definition Data, Initial Graphics Exchange Specification, Drawing Interchange Format, Standard for the Exchange of Product Data.

TUTORIALS: Computational exercises involving Geometric Modeling of components and their assemblies.

14 Hrs

TEXT BOOKS

1. Kunwoo Lee, "Principles of CAD/CAM/CAE systems",Addison Wesley, 1999
2. Radhakrishnan P,"CAD/CAM/CIM",New Age International, 2008

REFERENCE BOOKS

1. Ibrahim Zeid, "CAD/CAM Theory & Practice", McGraw Hill, 1998
2.Bedworth, Mark Henderson & Philip Wolfe, "Computer Integrated Design and Manufacturing" -McGraw hill ,1991.
3. Pro-Engineer, Part modeling Users Guide, 1998

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions

ADVANCED FINITE ELEMENT ANALYSIS

Sub Code: MTME233 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: This course provides the knowledge about the applications of the finite-element method, as needed for research in computational science and engineering, applications to mechanics of solids and fluids, thermal problems, etc.; variational foundations of the finite-element method, error estimates, and adaptive analysis; finite-element methods for parabolic and hyperbolic problems, mixed finite-element methods; and applications to systems of equations.

Paper Objectives:

- To find the behavior of the element.
- Irregular shape can be modeled.
- Finding the shape function for different elements.
- Changing the element types and boundary condition to obtain the accurate result.

Level of Learning: Advanced.

Learning Outcome:

- To be able to know the behavior of the element under different loading condition.
- To be able to model irregular bodies and also find the areas of it.
- To calculate approximate solution for differential equations.
- To be able to minimize an error using FEA software and get faster solution.

Unit – 1.

INTRODUCTION TO FINITE ELEMENT METHOD: Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design. Mathematical Preliminaries,
Differential equations formulations, Variational formulations, weighted residual methods
ONE-DIMENSIONAL ELEMENTS-ANALYSIS OF BARS AND TRUSSES: Basic Equations and Potential Energy Functional, 1-0 Bar Element, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multi-point constraint, 2-D Bar Element, Shape functions for Higher Order Elements.

12 Hrs

Unit – 2.

TWO-DIMENSIONAL ELEMENTS-ANALYSIS OF PLANE ELASTICITY PROBLEMS: Three-Noded Triangular Element (TRIA 3), Four-Noded Quadrilateral Element (QUAD 4), Shape functions for Higher Order Elements (TRIA 6, QUAD 8)
AXI-SYMMETRIC SOLID ELEMENTS-ANALYSIS OF BODIES OF REVOLUTION UNDER AXI-SYMMETRIC LOADING: Axisymmetric Triangular and Quadrilateral Ring Elements. Shape functions for Higher Order Elements.

12 Hrs

Unit – 3.

THREE-DIMENSIONAL ELEMENTS-APPLICATIONS TO SOLID MECHANICS PROBLEMS: Basic Equations and Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Shape

functions for Higher Order Elements.

10 Hrs

Unit – 4.

BEAM ELEMENTS-ANALYSIS OF BEAMS AND FRAMES:1–D Beam Element, 2–D Beam Element, Problems.

HEAT TRANSFER/FLUID FLOW: Steady state heat transfer, 1 D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1 D heat transfer in thin fins. Basic differential equation for fluid flow in pipes, around solid bodies, porous media.

12 Hrs

Unit – 5.

DYNAMIC CONSIDERATIONS: Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilatateral element, beam element. Lumped mass matrix, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

14 Hrs

TEXT BOOKS

1. Chandrupatla T. R., "Finite Elements in engineering",2nd Edition, PHI, 2007.
2. Lakshminarayana H.V., "Finite Elements Analysis",Procedures in Engineering, Universities Press, 2004

REFERENCE BOOKS

1. Rao S. S, "Finite Elements Method in Engineering",4th Edition, Elsevier, 2006
2. P.Seshu, "Textbook of Finite Element Analysis",PHI, 2004.
3. J.N.Reddy, "Finite Element Method",McGrawHill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
4. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis", 4th Edition, Wiley & Sons, 2003.

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions

THEORY OF PLASTICITY

Sub Code: MTME234 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: Theory of plasticity is one of the major branches within the context of solid mechanics. The course explores the important constitutive behavior of idealized plastic solids through a rigorous study of classical mathematical theory on plasticity. This course provides the knowledge about the Yield criteria for ductile metal, plastic yield criteria established in constitutive modeling, Upper and lower bound theorems and corollaries and to solve Problems of metal forming.

Paper Objectives:

- To know Yield criteria for ductile metal.
- To understand the plastic stress-strain relations.
- To learn Upper and lower bound theorems and corollaries.
- To solve Simple forms of indentation problems using upper bounds.

Level of Learning: Advanced.

Learning Outcome:

- To demonstrate Idealized stress-strain diagrams for different material models.
- To recognize typical plastic yield criteria established in constitutive modeling.
- To demonstrate the physical interpretation of material constants in mathematical formulation of constitutive relationships.
- To demonstrate experimental verification of the Prandtl-Rouss equation.
- To be able to solve Problems of metal forming.
- To know the stress strain relation for a body subjected to loading in plastic region.

Unit – 1.

Definition and scope of the subject, Brief review of elasticity, Octahedral normal and shear stresses, Spherical and deviatric stress, Invariance in terms of the deviatoric stresses, Representative stress.

Idealised stress-strain diagrams for different material models, Engineering and natural strains, Mathematical relationships between true stress and true strains, Cubical dilation, finite strains co-efficients Octahedral strain, Strain rate and the strain rate tensor.

12 Hrs

Unit – 2.

Yield criteria for ductile metal, Von Mises, Tresca, Yield surface for Isotropic Plastic materials, Stress space, Experimental verification of Yield criteria,

Yield criteria for an anisotropic material. **10 Hrs**

Unit – 3.

Stress - Strain Relations, Plastic stress-strain relations, PrandtlRoeuss Saint Venant, Levy - Von Mises, Experimental verification of the Prandtl-Rouss equation, Yield locus, Symmetry convexity, Normality rule.,

Upper and lower bound theorems and corollaries.

12 Hrs

Unit – 4.

Application to problems: Uniaxial tension and compression, bending of beams, Torsion of rods and tubes, Simple forms of indentation problems using upper bounds.
Problems of metal forming I: Extrusion, and Drawing. **14 Hrs**

Unit – 5.
Problems of metal forming II: Rolling and Forging.
Slip line theory, Introduction, Basic equations for incompressible two dimensional flows, continuity equations, Stresses in conditions of plain strain convention for slip-lines, Geometry of slip lines, Properties of slip lines.

12 Hrs

TEXT BOOKS

1. R.A.C..Slater", Engineering Plasticity - Theory and Application to Metal Forming Process ", McMillan Press Ltd.2016
2. Sadhu Singh, "Theory of Plasticity and Metal forming Process "Khanna Publishers, Delhi,8th Edition 2015

REFERENCE BOOKS

1. Plasticity for Mechanical Engineers - Johnson and Mellor.
2. Haffman and Sachs ,"Theory of Plasticity"
3. Chakraborty,"Theory of plasticity"Oxford : Elsevier Butterworth-Heinemann,3rd Edition 2007

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions

ADVANCED DESIGN LABORATORY

Sub Code: MTME251 **Total Lecture Hrs:30**
Exam Marks: 50 **Hrs/week:02** **Exam Hours:03**

1. Universal vibration testing
2. Experimental stress using Photo elastic materials
3. Beam stress analysis on straight and curved beams
4. Tensile, compression, bending and shear stress analysis using computerized UTM
5. Wear testing.
6. Determination of transmissibility ratio of a vibrating table
7. Free beam transverse vibration system
8. Spring mass system

ANALYSIS LABORATORY

Sub Code: MTME252 **Total Lecture Hrs:30**
Exam Marks: 50 **Hrs/week:02** **Exam Hours:03**

Analysis of Mechanical Components – Use of FEA Packages, like ANSYS NASTRON etc…, Kinematics and dynamics simulation.Analysis of velocity and acceleration for mechanical linkages of different mechanisms.

PROFESSIONAL PRACTICE-II

Sub Code: MTME271 **Hrs/week:4**

SUBJECT DESCRIPTION: During the seminar session each student is expected to prepare and present a topic on engineering / technology, it is designed to

- Review and increase their understanding of the specific topics tested.
- Improve their ability to communicate that understanding to the grader.
- Increase the effectiveness with which they use the limited examination time.

SUBJECT OBJECTIVES: Students are encouraged to use various teaching aids such as overhead projectors, power point presentation and demonstrative models. This will enable them to gain confidence in facing the placement interviews and intended to increase the score they earn on the upcoming exam above what they would otherwise earn.

LEVEL OF KNOWLEDGE: Basic/Advanced/Working

This course is specially designed for the students of higher degree. It COURSE OBJECTIVEs to train and equip the students towards acquiring competence in teaching, laboratory skills, research methodologies and other professional activities including ethics in the respective academic disciplines. The course will broadly cover the following aspects:

- Teaching skills
- Laboratory skills and other professional activities
- Research methodology

For teaching suitable courses where strengthening in the training of the students is required will be identified and the student will be asked to prepare lectures on selected topics pertaining to the courses and present these lectures before a panel of faculty members. The student will also be required to prepare question papers which will test the concepts, analytical abilities and grasp in the subject. Wherever the laboratories are involved, students will also be asked to carry out laboratory experiments and learn about the use and applications of the instruments. The general guiding principle is that the students should be able to teach and participate in the undergraduate degree courses in his/her discipline in an effective manner. The students will also assist the faculty in teaching and research activities. The course will also contain the component of research methodology, in which a broad topic will be assigned to each student and he/ she is supposed to carry out intensive literature survey, data analysis and prepare a research proposal. Each group will carry out many professional activities beside teaching and research. Such as, purchase of equipment, hardware, software and planning for new experiments and also laboratories etc. Along with these the students will also be assigned some well-defined activities. The student is expected to acquire knowledge of professional ethics in the discipline.

OPERATIONAL DETAILS: Head of the Department will assign a suitable instructor/faculty member to each student. Students and faculty members covering a broad area will be grouped in a panel consisting of 4-5 students and 4-5 faculty members. Within one week after registration, the student should plan the details of the topics of lectures, laboratory experiments, developmental activities and broad topic of research etc in consultation with the assigned instructor/faculty. The student has to submit two copies of the written outline of the total work to the instructor within one week.

In a particular discipline, Instructors belonging to the broad areas will form the panel and will nominate one of them as the panel coordinator. The coordinator together with the instructors will draw a complete plan of lectures to be delivered by all students in a semester. Each student will present 3-4 lectures, which will be attended by all other students and Instructors. These lectures will be evenly distributed over the entire semester. The coordinator will announce the schedule for the entire semester and fix suitable meeting time in the week. Each

student will also prepare one presentation about his findings on the broad topic of research. The final report has to be submitted in the form of a complete research proposal. The References and the bibliography should be cited in a standard format. The research proposal should contain a) Topic of research b) Background and current status of the research work in the area as evident from the literature review c) Scope of the proposed work d) Methodology e) References and bibliography. A report covering laboratory experiments, developmental activities and code of professional conduct and ethics in discipline has to be submitted by individual student. The panel will jointly evaluate all the components of the course throughout the semester and the mid semester grade will be announced by the respective instructor to his student. A comprehensive viva/test will be conducted at the end of the semester jointly, wherever feasible by all the panels in a particular academic discipline/department, in which integration of knowledge attained through various courses will be tested and evaluated. Wherever necessary and feasible, the panel coordinator in consultation with the concerned group may also seek participation of the faculty members from other groups in lectures and comprehensive viva.
Mid semester report and final evaluation report should be submitted in the 9thweek and 15thweek of the semester respectively. These should contain the following sections:
Section (A): Lecture notes along with two question papers each of 180 min duration, one quiz paper (CIA-I) of 120 min duration on the topics of lectures. The question paper should test concepts, analytical abilities and grasp of the subject. Solutions of questions also should be provided. All these will constitute lecture material.
Section (B): Laboratory experiments reports and professional work report.
Section (C): Research proposal with detailed references and bibliography in a standard format.
Wherever necessary, respective Head of the Departments could be approached by Instructors/panel coordinators for smooth operation of the course. Special lectures dealing with professional ethics in the discipline may also be arranged by the group from time to time.

EVALUATION SCHEME:

Component	Instructors	Weightage
Teaching	Lecture materials	7.5
	Lecture presentation	10
Laboratory and	Reports	10
Professional activities	Viva/presentation	7.5
Research	Proposal	2.5
	Viva/presentation	2.5
Comprehensive	Test/ viva	10
	Total	50

COURSE NOTICES: Notices pertaining to this course will be displayed on the respective departmental notice boards by the panel coordinator/ instructor. Students may also check the exam notice board for notices issued by the exam division.

MAKE UP POLICY: All students are required to attend all the lectures and presentations in the panel. Participation and cooperation will also be taken into account in the final evaluation.

Requests for makeup should normally be avoided. However, in genuine cases, panel will decide action on a case by case basis.

NOTE: Seminar shall be presented on interdisciplinary topics in the department in presence of a committee (Batch of Teachers) constituted by HOD. The seminar marks are to be awarded by the committee. Students shall submit the seminar report in the prescribed Standard format

SEMESTER III

ELECTIVE-I
ADVANCED DESIGN OF MECHANICAL SYSTEM

Sub Code: MTME135E1 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: Design of mechanical system and components enhanced by application of computer and also finding the mechanical property of the materials like fatigue, creep, and corrosion wear etc.

Paper Objectives:

- To know the role of failure prevention analysis in mechanical design.
- Fatigue life estimation using S-N approach
- Life estimation by ε-N approach.
- To understand the Statistical Aspects of Fatigue

Level of Learning: Basic.

Learning Outcome:

- Students can able to estimate life of the simple mechanical components through various fatigue design approaches.
- They can carry out fatigue testing for different test specimens.
- Students can able to demonstrate Surface Failure due to fatigue.

UNIT-1

INTRODUCTION: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.

FATIGUE OF MATERIALS: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods,Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.

12 Hours

UNIT II-2

STRESS-LIFE (S-N) APPROACH: S-**N** curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.

STRAIN-LIFE(E-N)APPROACH: Monotonic stress-strain behavior ,Strain controlled test methods ,Cyclic stress-strain behavior ,Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.

12 Hours

UNIT-3

LEFM APPROACH: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation.

STATISTICAL ASPECTS OF FATIGUE: Definitions and quantification of data scatter, Probability distributions, Tolerance limits, Regression analysis of fatigue data, Reliability

analysis, Problems using the Weibull distribution.

10 Hours

UNIT-4

FATIGUE FROM VARIABLE AMPLITUDE LOADING: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.

8 Hours

UNIT-5

SURFACE FAILURE: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.

8Hours

TEXT BOOKS

1. Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens, Henry o. Fuchs, "Metal Fatigue in engineering", John wileyNewyork", Second edition.2014.
2. Jack. A. Collins,"Failure of Materials in Mechanical Design", John Wiley Newyork1993.
3. Robert L. Norton, Machine Design, Pearson.

REFERENCE BOOKS

1. S.Suresh, "Fatigue of Materials", Cambridge university press, Cambridge, U.K,2015
2.Julie.A.Benantine,"Fundamentals of Metal Fatigue Analysis", Pearson; Facsimile edition 1990
3. "Fatigue and Fracture", ASM Hand Book, Vol 19,2002.

Scheme of Examination:

Two Questions to be set from each unit. On **EITHER OR CHOICE** basis, students have to answer any **FIVE** full questions out of TEN questions

SMART MATERIALS & STRUCTURES

Sub Code: MTME135E2 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: The course describes the physical properties of the materials, techniques and technology used to control the motion by using the sensors, actuators and transducers.

Paper Objectives:

- To select the smart materials and there description of the products.
- To test the smart material and selection of sensors for different application.
- To known role of sensors.
- Fatigue life estimation using S-N approach

Level of Learning: Basic.

Learning Outcome:

- Able to understand the overview of Smart materials
- Able to describe the attributes of Smart Materials.
- To explain the operation of Smart Sensors.
- To elucidate the signal conditioning techniques.
- To build and analyze the application of Smart Sensor

UNIT-1

OVERVIEW: of Smart Materials, Structures and Products Technologies.

SMART MATERIALS (PHYSICAL PROPERTIES):piezoelectric materials, materials, magnetostrictiveelectrostrictive materials, magnetoelectric materials, magnetorheological fluids, electrorheological fluids, shape memory materials, fiber-optic sensors.

10 Hours

UNIT-2

SMART SENSOR, ACTUATOR AND TRANSDUCER TECHNOLOGIES: smart sensors: accelerometers; force sensors; load cells; torque sensors; pressure sensors; microphones; impact hammers; mems sensors; sensor arrays smart actuators: displacement actuators; force actuators; power actuators; vibration dampers; shakers; fluidic pumps; motors smart transducers: ultrasonic transducers; sonic transducers; air transducers.

10 Hours

UNIT-3

MEASUREMENT, SIGNAL PROCESSING, DRIVE AND CONTROL TECHNIQUES: quasi-static and dynamic measurement methods; signal-conditioning devices; constant voltage, constant current and pulse drive methods; calibration methods; structural dynamics and identification techniques; passive, semi-active and active control; feedback and feed forward control strategies.

14 Hours

UNIT-4

DESIGN, ANALYSIS, MANUFACTURING AND APPLICATIONS OF ENGINEERING SMART STRUCTURES AND PRODUCTS: Case studies incorporating design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products.

9 Hours

UNIT-5

EMPHASIS ON STRUCTURES: automation and precision manufacturing equipment, automotives, consumer products, sporting products, computer and telecommunications

products, medical and dental tools and equipment.

9 Hours

TEXT BOOKS

1.M. V. Gandhi and B. So Thompson,"Smart Materials and Structures" Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. B. Culshaw, "Smart Structures and Materials"Artech House, Boston, 1996 (ISBN :0890066817).
3.A. V. Srinivasan, "Smart Structures: Analysis and Design "- Cambridge University Press, Cambridge; New York, 2010 (ISBN: 0521650267).

REFERENCE BOOKS

1.A. J. Moulson and J. M. Herbert,"Electroceramics: Materials, Properties and Applications "-. John Wiley & Sons, ISBN: 0471497429 ,2ND Edition 2015.
2.PiezoelectricSensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
3.K. Uchino,"Piezoelectric Actuators and Wtrasonic Motors" - Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4.Handbook of Giant Magnetostrictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5.K. Otsuka and C. M. Wayman, "Shape Memory Materials" - Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X).

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

ROBOTICS

Sub Code: MTME135E3 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: This course provides the extensive knowledge about Robotics and Automation, their application to various fields, a discussion on Robot manipulators and trajectory planning involving Kinematics, Velocity, Statics, Dynamics and Space scheme. Automation provides an overall view about the Manufacturing system and operations.

Paper Objectives:

- The objective is to give an overview of the components, sensing elements used in programming techniques and applications of robots with identify the characteristics of a variety of robots. This include fundamental concept of programming and detail discussion of manipulators.
- Automation includes what is meant by a manufacturing system and describes single and multi-station systems. Provides overall importance of part or product variety for manufacturing systems.

Level of Learning: Advanced

Learning Outcome:

- The study includes mathematical formulation for a robot body.
- Know the movement of robot arm based on their translation or rotational moment.
- Selection of particular sensors and actuators for different robot application.
- Designing a robot with widest range of applications for current and future products with minimum cost using suitable actuators, sensors etc
- Will be able to apply the concepts of design Engineering and its application in various engineering application.
- To correlate the theoretical principles with application based studies.

UNIT-1

INTRODUCTION AND MATHEMATICAL REPRESENTATION OF ROBOTS: History of Robots, Types of Robots, Notation, Position and Orientation of a Rigid Body, Some Properties of Rotation Matrices, Successive Rotations, Representation by X-Y-Z, Z-Y-Z Euler Angles, Transformation between coordinate system, Homogeneous coordinates, Properties of Types of Joints: Rotary, Prismatic joint, Cylindrical joint, Spherical joint, Representation of links using Denvit-Hartenberg parameters: Link parameters for intermediate, first and last links, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator, The planar four bar mechanisms, Three DOF parallel manipulator, A six- DOF parallel(hybrid) manipulator. , TAB

KINEMATICS OF SERIAL AND PARALLEL MANIPULATORS: Degrees of freedom of a manipulator, Loop constraint equations. Direct kinematics of 2R and 3R manipulator, Puma560 manipulator, SCARA manipulator, Stanford arm, The Planar four bar mechanism, Direct kinematics of Stewart-Gough Platform. Inverse kinematics of 2R, 3R manipulator, Inverse kinematics of Stewart-Gough Platform.

14 Hours

UNIT-2

VELOCITY AND STATICS OF MANIPULATORS: Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R, 3R manipulators, Jacobian of serial manipulator, Three DOF parallel manipulator Velocity ellipse of 2R manipulator, Singularities of serial and parallel manipulators 2R, 3R, four bar mechanism,

three DOF parallel manipulator, Maipulator, Statics of serial manipulators, Static force and torque analysis of 3R manipulator, Statics of parallel manipulator, Singularity in force domain.
DYNAMICS OF MANIPULATORS: Inertia of a link, Recursive formulation of dynamics using Newton Euler equation, Equation of motion of 2R and 3R manipulators using Lagrangian, Newton-Euler formulation.

12 Hours

UNIT-3
TRAJECTORY PLANNING: Joint space schemes, cubic trajectory, Joint space schemes with via points, Cubic trajectory with a via point, Third order polynomial trajectory planning, Linear segments with parabolic blends, Cartesian space schemes, Cartesian straight line and circular motion planning, Trajectory planning for orientation.

10 Hours

UNIT-4
CONTROL: Feedback control of a single link manipulator- first order, second order system, PID control, PID control of multi link manipulator, Non-linear control of manipulators-computed torque method, Force control of manipulator, Cartesian control of manipulators, Force control of manipulators-force control of single mass, Partitioning a task for force and position control- lever, peg in hole Hybrid force and position controller.

13 Hours

UNIT-5
ACTUATORS: Types, Characteristics of actuating system: weight, Power-to-weight ratio, Operating pressure, Stiffness vs. compliance, Use of reduction gears, Comparision of hydraulic, Electric, pneumatic, actuators, Hydraulic actuators, Proportional feedback control, Electric Motors: DC motors, Reversible AC motors, Brushless DC motors, Stepper motors-structure and principle of operation, Stepper motor speed-torque characteristics.
SENSORS: Sensor characteristics, Position sensors- potentiometers, Encoders, LVDT, Resolvers, Displacement sensor, Velocity sensor- encoders, tachometers, Acceleration sensors, Force and Pressure sensors - piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, Optical, Ultrasonic, Inductive, Capacitive, Eddy-current proximity sensors.

11 Hours

TEXT BOOKS
1. Fundamental Concepts and Analysis - Ghosal A., Robotics, Oxford, 2006.
2. Introduction to Robotics Analysis - Niku, S. B., Systems, Applications, Pearson Education, 2008.
REFERENCE BOOKS
1. Introduction to Robotics: Mechanica and Control - 2nd Edition - Craig, J. J., Addison-Welsey, 2nd edition 1989.
2. Fundamentals of Robotics, Analysis and Control - Schilling R. J., PHI, 2006.
3. Robotics Control, Sensing, Vision and Intelligence - Fu, K, S., Gonzalez R. C., Lee C.S.

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

ELECTIVE -II
MACHINE TOOL DESIGN

Sub Code: MTME235E1 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: The course describes working of machine tool drive and controlling of speed and feed drives, designing the dynamic of machine tool and there mechanisms.

Paper Objectives:
- To know the design consideration for the manufacturing and selection of tool.
- To Know the tool life and there regulation when it is under operating condition
- To know the feed and speed of tool
- Understand the dynamic consideration of the machine tool and there terminology

Level of Learning: Basic.

Learning Outcome:
- Describes the tool life and manufacturing of different tools.
- Explains the regulation and general consideration for the selection of tool.
- Students will know the tool working using computer software and simulation of tool.

UNIT-1
MACHINE TOOL DRIVE: working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, General requirements of machine tool design, Layout of machine tools.

10Hours

UNIT-2
REGULATION OF SPEED AND FEED RATES: Aim of speed feed regulation, stepped regulation of speed, design of speed box, Design of feed box, Special cases of gear box design, Set stopped regulation of speed and feed rates.

12Hours

UNIT-3
DESIGN OF MACHINE TOOL STRUCTURE: Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Static and dynamic stiffness, Design of beds and columns, Design of housing models, Techniques in design of machine tool structure.

10 Hours

UNIT-4
DESIGN OF GUIDE-WAYS AND POWER SCREWS: Function and type of guide-ways, design of slide-ways, Protecting devices for slide-ways, Design of power screws.

12 Hours

UNIT-5
DESIGN OF SPINDLES AND SPINDLE SUPPORTS: materials for spindles, design of spindles, Antifriction bearings, Sliding bearings.
DYNAMICS OF MACHINES TOOLS: General procedure of assessing dynamic stability of EES, Cutting processing, Closed loop system, Dynamic characteristics of cutting process,

Stability analysis.

16 Hours

TEXT BOOKS

1. N.K. Mehta ,"Machine Tool Design",New Delhi Tata Mcgraw-Hill Publishing Company 3rdEdition,2017
2. Machine Tool design Handbook - CMTI McGraw Hill Education; 1st edition , 2017

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

MECHANICAL BEHAVIOR OF MATERIALS

Sub Code: MTME235E2 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: The paper describes basic concept of material behavior, when they subjected to dynamic load, and the selection of materials.

Paper Objectives:
- To know the behavior material under different loading condition.
- Selection of material for different application based on the subject of loading.
- Using certain principles how the material behave for that particular condition.

Level of Learning: Basic.

Learning Outcome:
- Students will able to understanding on the state of stresses and strains in engineering components as a result of different loading conditions.
- Students will able to provide the principles and equations, and necessary tools to analyze structural members under axial loads, bending, shear, and torsion.
- Students can introduce the behavior of various engineering materials, its performance under loads, and design

UNIT-1
BASIC CONCEPTS OF MATERIAL BEHAVIOR: Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity –.Griffith's theory, – Ductile, brittle transition in steel–High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.

12 Hours

UNIT-2
BEHAVIOR UNDER DYNAMIC LOADS AND DESIGN APPROACHES: Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress- life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

10 Hours

UNIT-3
SELECTION OF MATERIALS: Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

12 Hours
UNIT-4

MODERN METALLIC MATERIALS: Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

10 Hours

UNIT-5

NON METALLIC MATERIALS: Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications.

16 Hours

TEXT BOOKS

1. George E.Dieter," Mechanical Metallurgy", McGraw Hill,3rd edition,2017
2. Thomas H. Courtney, "Mechanical Behavior of Materials",McGraw Hill, 2nd edition, 2017

REFERENCE BOOKS

1. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., "Selection and use of engineering materials", 34d edition), Butterworth-Heiremann, 1997.
2. Flinn, R.A., and Trojan, "P.K., Engineering Materials and their Applications", (4th Edition) Jaico, 1999.
3. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
4. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

FRACTURE MECHANICS

Sub Code: MTME235E3 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: This course provides the basic knowledge about fracture mechanics and their use in modern machine design. A through discussion on failure of material due to crack and various types of crack are discussed.

Paper Objectives:

- To understand the fracture mechanics principles.
- To find Stress intensity factors and plane strain fracture toughness for different components.
- To known the concepts of LEFM and EPFM.
- To know the behavior material under different loading condition.

Level of Learning: Basic.

Learning Outcome:

- Students can able to describe fracture mechanics approach to design.
- Selection of proper nondestructive testing method to analyze a physical structure.
- Students can able to demonstrate Fracture and Fatigue Control in Structures.

UNIT-1

FRACTURE MECHANICS PRINCIPLES: Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, Numerical problems.

8 Hours

UNIT-2

THE AIRY STRESS FUNCTION: Complex stress function. Solution to crack problems.Effect of finite size.Special cases, Elliptical cracks, Numerical problems.

PLASTICITY EFFECTS, IRWIN PLASTIC ZONE CORRECTION: Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, Plastic constraint factor. The Thickness effect, numerical problems.

14 Hours

UNIT-3

DETERMINATION OF STRESS INTENSITY FACTORS AND PLANE STRAIN FRACTURE TOUGHNESS: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. Plane strain fracture toughness test, The Standard test.Size requirements.Non-linearity.Applicability.

THE ENERGY RELEASE RATE, CRITERIA FOR CRACK GROWTH: The crack resistance(R curve). Compliance, J integral.Tearing modulus.Stability.

16 Hours

UNIT-4

ELASTIC PLASTIC FRACTURE MECHANICS: Fracture beyond general yield. The Crack-tip opening displacement.The Use of CTOD criteria.Experimental determination of CTOD.Parameters affecting the critical CTOD.Use of J integral.Limitation of J integral.

DYNAMICS AND CRACK ARREST: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness.

14 Hours

UNIT-5

FATIGUE CRACK PROPAGATION AND APPLICATIONS OF FRACTURE MECHANICS: Crack growth and the stress intensity factor. Factors affecting crack propagation. variable amplitude service loading, Means to provide fail-safety, Required information for fracture mechanics approach, Mixed mode (combined) loading and design criteria.

8 Hours

TEXT BOOKS

1. David Brock, "Elementary Engineering Fracture Mechanics"- Springer; 4th ed. edition 2005
2. AndersonT.L,"Fracture Mechanics-Fundamental and Application "-CRC press,4th Edition,2017.

REFERENCE BOOKS

1. S.A. Meguid,"Engineering fracture mechanics" Elsevier.
2. Jayatilake,"Fracture of Engineering Brittle Materials", Applied Science - London.
3. Rolfe and Barsom, "Fracture and Fatigue Control in Structures ", Prentice Hall.2nd Revised edition , 1987.
4. Karen Hellan, "Introduction to fracture mechanics"- McGraw Hill,1987
5. Knott,"Fundamentals of V fracture mechanisms"- Butterworths.
6. Fracture –LiefbowitzVolime II.

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

ELECTIVE-III
DESIGN FOR MANUFACTURE

Sub Code: MTME331E1 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: Paper describes during the manufacturing process how the component will behave and there effects of manufacturing process.

Paper Objectives:
- To know the design consideration for manufacturing of components.
- To describe the different types of features in the design for manufacturing the components.
- To know the geometrical tolerance for manufacturing the components.

Level of Learning: Basic.

Learning Outcome:
- Students will know the design consideration for manufacturing the components.
- Describes the reading and design of limits fits and geometrical tolerance for the manufacturing components.
- Able to understand the overall design consideration required for manufacturing

UNIT-1
EFFECT OF MATERIALS AND MANUFACTURING PROCESS ON DESIGN: Major phases of design, Effect of material properties on design Effect of manufacturing processes on design. Material selection process cost per unit property, Weighted properties and limits on properties methods.
TOLERANCE ANALYSIS: Process capability, mean, varience, skewness ,kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law. **12 Hours**

UNIT-2
SELECTIVE ASSEMBLY: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1,Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, Laminated shims, examples.
DATUM FEATURES: Functional datum, Datum for manufacturing, changing the datum, Examples. **12 Hours**

UNIT-3
DESIGN CONSIDERATIONS: Design of components with casting consideration, Pattern, Mould, and Parting line, Cored holes and Machined holes, identifying the possible and probable parting line, casting requiring special sand cores, designing to obviate sand cores.
10 Hours

UNIT-4
COMPONENT DESIGN: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish- machining operations.

TRUE POSITIONAL THEORY: Comparison between co-ordinate and convention method of feature location. Tolerance and true position tolerancing virtual size concept, Floating and fixed fasteners, Projected tolerance zone, Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging. **12 Hours**

UNIT-5

DESIGN OF GAUGES: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft. **14 Hours**

TEXT BOOKS

1. Harry Peck, "Designing for Manufacturing "- Pitman Publications, 1983.
2. Machine Design - Dieter McGraw hill Publications
3. R.K. Jain ,"Engineering Metrology" - Khanna Publication ,2011

REFERENCE BOOKS

1. Geoffrey Boothroyd, peter dewhurst, Winston Knight,"Product design for manufacture and assembly" - Merceldekker.Inc. New york,CRC Press,3rd Edition,2010
2. " Material selection and Design", Vol. 20 - ASM Hand book.

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

ROTOR DYNAMICS

Sub Code: MTME331E2 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: Paper deal with different parameter to consider for shaft/rotor design. Vibration generation during rotation of shaft and finite element method for doing calculation for it.

Paper Objectives:

- To know the critical speed of shaft for the rotating body.
- To find the fluid flow with in the body when it subjected to dynamic consideration.
- To know the lubrication characteristics used in the fluid film flow

Level of Learning: Basic.

Learning Outcome:

- Explain the fundamentals of the fluid flow and dynamics of machinery.
- Describe the techniques for studying motion of machines and machine components.
- Describes critical speed of shaft for variable diameter.

UNIT-1

FLUID FILM LUBRICATION: Basic theory of fluid film lubrication, Derivation of generalized Reynolds equations, Boundary conditions, Fluid film stiffness and Damping coefficients, Stability and dynamic response for hydrodynamic journal bearing, Two lobe journal bearings.

STABILITY OF FLEXIBLE SHAFTS: Introduction, equation of motion of a flexible shaft with rigid support, Radial elastic friction forces, Rotary friction, friction Independent of velocity, friction dependent on frequency, Different shaft stiffness Constant, gyroscopic effects, Nonlinear problems of large deformation applied forces, instability of rotors in magnetic field.

12 Hours

UNIT-2

CRITICAL SPEED: Dunkerley's method, Rayleigh's method, Stodola's method.

ROTOR BEARING SYSTEM: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, Simple model with one concentrated mass at the center.

10 Hours

UNIT-3

TURBO ROTOR SYSTEM STABILITY BY TRANSFER MATRIX FORMULATION: General turborotor system, development of element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions.

10 Hours

UNIT-4

TURBO ROTOR SYSTEM STABILITY BY FINITE ELEMENT FORMULATION: General turborotor system, generalized forces and co-ordinates system assembly element matrices, Consistent mass matrix formulation, Lumped mass model, linearised model for journal bearings, System dynamic equations Fix stability analysis non dimensional stability analysis, unbalance response and Transient analysis.

15 Hours

UNIT-5
BLADE VIBRATION: Centrifugal effect, Transfer matrix and Finite element, approaches .

12 Hours

TEXT BOOKS
1. Cameron Longmans "Principles of Lubrication" ,John Wiley & Sons Inc; 3rd edition ,2016
2.Yiwei Li ,James H. Starnes Jr ,"Nonconservative problems of the Theory of elastic stability"- Bolotin, Pergamon. Cambridge University Press ,2001
REFERENCE BOOKS
1. E.C. Pestel and F.A. Leckie, "Matrix methods of Elastomechanics" McGraw Hill.
2.Timosenko, Young, "Vibration Problems in Engineering"- Von Nostrand,2017
3..Zienkiewicz, "The Finite Element Method", McGraw Hill

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

ROBUST DESIGN

Sub Code: MTME331E3 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: Paper describes the various parameters to consider while designing a machine component, and there reliability, it also gives information about various international standards to consider while designing orthogonal arrays.

Paper Objectives:

- To learn steps in robust design, parametric design and tolerance design.
- To know the role of S-N ratios in reliability improvement.
- To know the parametric and tolerance design system
- Understand the concept of Taguchi's orthogonal arrays.

Level of Learning: Basic.

Learning Outcome:

- Students will know the Taguchi quality philosophy and illustration through numerical examples.
- Describes the quadratic loss function and variation of quadratic loss function.

UNIT-1

QUALITY BY EXPERIMENTAL DESIGN : Quality, western and Taguchi quality philosophy, Elements of cost, Noise factors causes of variation, Quadratic loss function and variation of quadratic loss functions. **Robust Design :**Steps in robust design : parameter design and tolerance design, reliability improvement through experiments, illustration through numerical examples.

EXPERIMENTAL DESIGN: Classical experiments: factorial experiments, terminology, factors. Levels, Interactions, Treatment combination, randomization, 2-level experimental design for two factors and three factors. 3-level experiment deigns for two factors and three factors, factor effects, factor interactions, Fractional factorial design, Saturated design, Central composite designs, Illustration through numerical examples**.**

14 Hours

UNIT-2

MEASURES OF VARIABILITY : Measures of variability, Concept of confidence level, Statistical distributions : normal, log normal and Weibull distributions. Hipothesis testing, Probability plots, choice of sample size illustration through numerical examples.

ANALYSIS AND INTERPRETATION OF EXPERIMENTAL DATA: Measures of variability, Ranking method, column effect method and ploting method, Analysis of variance (ANOVA), in factorial experiments: YATE's algorithm for ANOVA,Regression analysis, Mathematical models from experimental data, illustration through numerical examples.

12 Hours

UNIT-3

TAGUCHI'S ORTHOGONAL ARRAYS : Types orthogonal arrays, Selection of standard orthogonal arrays, Linear graphs and interaction assignment, dummy level technique, Compound factor method, modification of linear graphs, Column merging method, Branching design, Strategies for constructing orthogonal arrays.

12 Hours

UNIT-4

SIGNAL TO NOISE RATIO (S-N RATIOS) : Evaluation of sensitivity to noise, Signal to noise ratios for static problems, Smaller – the – better types, Nominal – the – better – type, larger – the- better – type. Signal to noise ratios for dynamic problems, Illustrations through numerical examples.

11 Hours

UNIT-5

PARAMETER DESIGN AND TOLERANCE DESIGN: Parameter and tolerance design concepts, Taguchi's inner and outer arrays, Parameter design strategy, Tolerance deign strategy, Illustrations through numerical examples**.**

RELIABILITY IMPROVEMENT THROUGH ROBUST DESIGN : Role of S-N ratios in reliability improvement ; Case study; Illustrating the reliability improvement of routing process of a printed wiringboardsusing robust design concept.

11 Hours

TEXT BOOKS

1.Madhav S. Phadake,"Quality Engineering using Robust Design" Prentice Hall, Englewood Clifts, New Jersey 07632, 1st Edition,2008.

2.DouglasMontgomery,"Design and analysis of experiments "- Willey India Pvt. Ltd., V8th Ed., 2013.

3. Phillip J. Ross: Taguchi,"Techniques for Quality Engineering"McGraw Hill Int. Ed., 2nd edition.1996.

REFERENCE BOOKS

1. Thomas B. Barker,"Quality by Experimental Design" Marcel Dekker Inc ASQC Quality Press, 2005

2. C.F. Jeff Wu, Michael Hamada,"Experiments planning, analysis and parameter design optimization"John Willey Ed., 2002.

3."W.L. Condra, Marcel Dekker"Reliability improvement by Experiments: Marcel Dekker Inc ASQC Quality Press,2001

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

ELECTIVE-IV
ADVANCED THEORY OF VIBRATION

Sub Code: MTME332E1 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: It describes how vibration is important in the mechanical systems, and also describes measuring and controlling systems, damping factors affecting the vibration its application in solving engineering problems.

Paper Objectives:
- To obtain the idea of classification of vibration, modal analysis.
- To acquire the knowledge of damping factor and measuring instruments.
- To know the DOF and the damping factors
- To understand the measuring instruments

Level of Learning: Advanced.

Learning Outcome:
- This course is an introduction to noise and vibrations in design. Free and forced vibrations of systems will be examined.
- Applied theory includes the study of the fundamental single degree of freedom (DOF) and 2DOF systems using Newton's second law of motion, the energy method, Langrange's equations and determination of natural frequencies, properties, and noise standards.
- Design part of the course includes system under shock and impact loading, vibration isolation and control. In addition the course will include noise control and design of mechanical systems for noise reduction.
- The course includes design related lab and assignments, and design based projects.
- Students will know the Taguchi quality philosophy and illustration through numerical examples.

UNIT-1
REVIEW OF MECHANICAL VIBRATIONS: Basic concepts; free vibration of single degree of freedom systems with and without damping, Forced vibration of single DOF-systems, Force and motion isolation, Two DOF-systems, natural frequency.

11 Hours

UNIT-2
TRANSIENT VIBRATION OF SINGLE DEGREE-OF FREEDOM SYSTEMS: Impulse excitation, Arbitrary excitation, Laplace transform formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation, Finite difference numerical computation.

10 Hours

UNIT-3
VIBRATION CONTROL: Introduction, Vibration isolation theory, Vibration isolation theory for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, and Vibration dampers.

VIBRATION MEASUREMENT AND APPLICATIONS: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis.

12 Hours

UNIT-4

MODAL ANALYSIS & CONDITION MONITORING: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis.

NON LINEAR VIBRATIONS: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations.

13 Hours

UNIT-5

RANDOM VIBRATIONS : Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response.

CONTINUOUS SYSTEMS: Vibrating string, Longitudinal vibration of rods, Torsional vibration of rods, Suspension bridge as continuous system, Euler equation for beams, Vibration of membranes.

14 Hours

TEXT BOOKS

1. William T. Thomson, Marie Dillon Dahleh, ChandramouliPadmanabhan,"Theory of Vibration with Application", Pearson Education,5th edition,2008

2.S. Graham Kelly,"Fundamentals of Mechanical Vibration". McGraw Hill.2nd edition,2000

3. S. S. Rao., "Mechanical Vibrations",Pearson Education,4th edition,2003

Reference Book:

1. S. Graham Kelly,"MechanicalVibrations"Schaum's Outlines, Tata McGraw Hill, 2007.

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

OPTIMUM DESIGN

Sub Code: MTME332E2 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: The theory of elasticity introduces the stress, strain, and there relations with in the elasticity, and its application in solving engineering problems.

Paper Objectives:

- Introduction to classical optimization technique.
- To learn non-linear programming
- To know the constrained optimization techniques.

Level of Learning: Advanced.

Learning Outcome:

- Students can demonstrate the multivariable optimization with no constrained.
- Students can able to solve problems on basic approach of the penalty function method.

UNIT-1

INTRODUCTION: Engineering application of optimization, Statement of optimization problem, Classification of optimization problems, **Classical optimization techniques I:** single variable optimization, Multivariable optimization with no constraints.

9 Hours

UNIT-2

CLASSICAL OPTIMIZATION TECHNIQUES II: Multivariable optimization with equality constraints and inequality constraints, Kuhn - Tucker conditions.
NON - LINEAR PROGRAMMING: One - dimensional minimization methods**:** Unimodal function, Unrestricted search, Exhaustrive search, Dichotomous search, Fibonacci method, Golden section method.

13 Hours

UNIT-3

INTERPOLATION METHODS: Quadratic, Cubic and Direct root interpolation methods.
UNCONSTRAINED OPTIMIZATION TECHNIQUES: Direct search methods**:** Univariate method, Hook and Jeeves' method, Powell's method, Simplex method.

15 Hours

UNIT-4

DESCENT METHODS: Steepest descent, Conjugate gradient, Quasi - Newton, Davidon - Fletcher - Powell method.
CONSTRAINED OPTIMIZATION TECHNIQUES: Direct methods: characteristics of a constrained problem, Indirect methods: Transformation techniques, Basic approach of the penalty function method.

13 Hours

UNIT-5

DYNAMIC PROGRAMMING: Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem,

Examples.

10 Hours

TEXT BOOKS

1. S. S. Rao, "Optimisation - Theory and Application" - Willey Eastern.
2. R.L Fox,"Optimization methods for Engg. Design "Addison – Wesley.

REFERENCE BOOKS

1.Ram,"Optimisation and Probability in System Engg"VanNostrand.
2. K. V. Mital and C. Mohan, "Optimization methods" - New age International Publishers, 2016

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

VEHICLE DYNAMICS

Sub Code: MTME332E3 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: The subject describes the residual stresses in the welding parts, transient response of the system and also the critical speed affecting the system.

Paper Objectives:

- To know the response of idealized suspension systems.
- To learn sinusoidal transmissibility function to predict means square motion of spring mass.
- Find the kinematic behavior of vehicles with rigid wheels and with compliant tyres

Level of Learning: Advanced.

Learning Outcome:

- Understand the engineering system with classical mechanics.
- Know the components of vehicle dynamics based on suspension, steering, automobile layout and traction control system.
- The aerodynamic study includes automobile drag co-efficient, down force, center of pressure.

UNIT-1

VEHICLE RIDE: Human response to vibration: ISO standards, Response of idealized suspension systems to stop and sinusoidal disturbances in bounce and to wheel out of balance. Combined pitch and bounce motion: application to multi wheel station vehicles. Random ground input excitation: Use of sinusoidal transmissibility function to predict mean square motion of spring mass. **12 Hours**

UNIT-2

WHEELED VEHICLE HANDLING: Handling control loop, vehicle transfer function. Kinematic behavior of vehicles with rigid wheels and with compliant tyres: neutral steer point, static margin, over and under-steer.

12 Hours

UNIT-3

TRANSIENT RESPONSE: Natural frequency and damping in yaw. Frequency response in yaw. Extension of two degree of freedom theory to include effects of traction and braking, aerodynamics, self-aligning torque, dual wheels and bogies, Handling of multi-axle vehicles. Development of equations of motion to include roll of sprung mass: Effect on steady state and frequency response.

12 Hours

UNIT-4

TRACKED VEHICLE HANDLING: Analysis of sprocket torques and speeds, required to skid steer a tracked vehicle. Extension of theory to include three degrees of freedom.Modification of theory to allow for soil conditions and lateral weight transfer Application of theory of steering of articulated and half-track vehicles.

12 Hours

UNIT-5

DERIVATION OF GENERALIZED EQUATIONS: Equation of motion for a vehicle: stability derivative notation. Solution with two degree of freedom in the steady state: stability factor,

characteristic and critical speeds.

12 Hours

Texts/References

1. Vehicle Dynamics, 19&9,IR Ellis, Business Book.
2. Theory of Ground vehicles, 2001,JY Wong, Wily.
3. Vehicles & Bridging, igSs/Tytler, Brassey's.
4. Fundamental of vehicle dynamics: Thomas D Gillespie

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

ELECTIVE-V
TRIBOLOGY AND BEARING DESIGN

Sub Code: MTME333E1 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: Tribology and Bearing Design deals with the study of basic laws of friction and lubrication in machineries. This subject also deals with the study of different type of lubrication in detail and also about the different types of bearing and their design.

Paper Objectives:
- To study the types of contacts, types of bearing.
- Design a bearing based on their application and types of load.
- To know the response of idealized bearing systems.

Level of Learning: Advanced.

Learning Outcome:
- Describes the general bearings technology and classification of bearings.
- Students can able to understand the selection of bearing for different application.
- Understand the engineering system with classical mechanics.

UNIT-1
INTRODUCTION TO TRIBOLOGY: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories. Newton's Law of viscous forces, Effect of pressure and temperature on viscosity.
HYDRODYNAMIC LUBRICATION: Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's poiseuille's theory, viscometers.Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems.
12 Hours

UNIT-2
HYDRODYNAMIC BEARINGS: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity.Location of center of pressure, Numerical problems.
JOURNAL BEARINGS: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance. Comparison between lightly loaded and heavily loaded bearings, Numerical problems.
14 Hours

UNIT-3
EHL CONTACTS: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant.Grubin type solution. Introduction to gas lubricated bearings. Governing differential equation for gas lubricated bearings.
10 Hours

UNIT-4
HYDROSTATIC BEARINGS: Types of hydrostatic Lubrication systems Expression for discharge, load carrying capacity, Flow rate, Condition for minimum power loss. Torque calculations.Numerical problems.

POROUS & GAS BEARINGS: Introduction to porous bearings. Equations for porous bearings and working principal, Fretting phenomenon and it's stages

12 Hours

UNIT-5

MAGNETIC BEARINGS: Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal.Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.

12 Hours

TEXT BOOKS

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001.
2. Susheel Kumar Srivasthava "Tribology in industry" S.Chand and Co.

REFERENCE BOOKS

1. Dudley D.Fulier" Theory and practice of Lubrication for Engineers", New York Company.1998
2. Moore "Principles and applications of Tribology" Pergamon press.
3. Pinkus '0' Stemitch. "Theory of Hydrodynamic Lubrication"
4. Gerhandschwetizer, HannesBleuler&AlfonsTraxler, "Active Magnetic bearings", Authors working group, www.mcgs.ch., 2003.
5. Radixmovsky, "Lubrication of Bearings - Theoretical principles and design" The Oxford press Company, 2000.

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

THEORY OF PLATES AND SHELLS

Sub Code: MTME333E2 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: The paper describes in detail the various stresses to which a rectangular plate structure is subjected. It also describes the loading conditions for rectangular plate structure and their differential equations. Types of shell structures and the different load conditions are also discussed elaborately.

Paper Objectives:

- To find bending of plates using differential equation for certain plates under different boundary and loading condition.
- To know the symmetrical bending for cylindrical and rectangular plates.
- To knowTheory, solutions using both analytical and numerical techniques.

Level of Learning: Advanced.

Learning Outcome:

- Describes the pure bending of plates for circular plates and rectangular plates.
- Explains the deformation of plates for different cross section.
- Students can handle symmetrical problems.

UNIT-1

BENDING OF LONG RECTANGULAR PLATE INTO A CYLINDRICAL SURFACE, DIFFERENTIAL EQUATION- Bending of plated with different boundary conditions - Long plate on elastic foundation.

PURE BENDING: Moment and curvature relations problems of simply supported plates- Strain energy impure bending.

12 Hours

UNIT-2

SYMMETRICAL BENDING OF CIRCULAR PLATES: Differential equation uniformly loaded plates, Plates concentricity loaded plates- loaded at the center.

12 Hours

UNIT-3

RECTANGULAR PLATES: Differential equations - Solution of simply supported plate Various loading conditions, viz, uniformly distributed load, hydrostatic pressure and concentrated load, central as well as noncentral, Navier and Levy type solutions with various edge boundary conditions, viz., all edges simply supported, Two opposite edge fixed and two adjacent fixed.

BENDING OF PLATE UNDER COMBINED ACTION: of lateral and transverse loads derivation of differential equation, simply supported rectangular plate.

12 Hours

UNIT-4

INTRODUCTION TO SHELL STRUCTURES- General description of various types. Membrane Theory of thin shells (Stress Analysis): Cylindrical shells - Spherical Shells- Shells of double curvature, Viz, cooling tower Hyperbolic, Parabolic and elliptic paraboloid.

MEMBRANE DEFORMATION OF SHELLS: Symmetrical 'loaded shell, symmetrically loaded spherical shell. General Theory of cylindrical shells: Circular; Cylindrical shell loaded symmetrically.
12 Hours

UNIT-5
General equation of circular cylindrical shells. Approximate investigation of: bending of circular cylindrical shell.

12 Hours

TEXT BOOKS
1.Timoshenko, Woinowsky and Krieger, "Theory of plates and Shells" McGraw Hill, Newyork.2ND Edition,2017
2.Flugge, "Stresses in Shells "Springer Verlag, Berlin.
3.Goldnvizer,"Theory of Elastic Thin Shells" - Pergamon Press, New York,2014
4.R. Szilard ,"Theory and analysis of plates" - Prentice hall.

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions

ADVANCED MECHANISMS DESIGN AND SIMULATION

Sub Code: MTME333E3 **Total Lecture Hrs: 60**
Exam Marks: 100 **Hrs/week: 04** **Exam Hours: 03**

Paper Description: Paper deal with various branches of engineering such as strength of material, digital signal processing, finite element method etc.

Paper Objectives:

- To know the modeling and simulation of physical systems.
- To learn study of sensors and transducers and electrical actuation
- To know the simulation and its concept.

Level of Learning: Advanced.

Learning Outcome:

- Describes the actuation of mechanical and electrical actuation of systems.
- Explains the study of sensors and transducers for the real time application.

UNIT-1

INTRODUCTION: Definition and Introduction to Mechatronic Systems. Modeling & Simulation of Physical systems Overview of Mechatronic Products and their functioning measurement systems.Control**.**

STUDY OF SENSORS AND TRANSDUCERS: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.

12 Hours

UNIT-2

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.

12 Hours

UNIT-3

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

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.

12 Hours

UNIT-4

DATA PRESENTATION SYSTEMS: Basic System Models, System Models, Dynamic Responses of System. **12 Hours**

UNIT-5

ADVANCED APPLICATIONS IN MECHATRONICS: Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design. **12 Hours**

TEXT BOOKS

1. W. Bolton, "Mechatronics" 2 Ed. earson Education; 4 edition ,2010
2. HSU "MEMS and Microsystems design and manufacture"- TMH McGraw Hill Education; 1 edition ,2017

REFERENCE BOOKS

1. Kamm, "Understanding Electro-Mechanical Engineering an Introduction to Mechatronics"- PHI. Wiley-Blackwell , 1995
2. "Fine Mechanics and Precision Instruments"- Pergamon Press, .1971.
3. Shetty and Kolk "Mechatronics System Design"-Thomson,Cengage; 2 edition 2012
4. Mahalik "Mechatronics"- TMH.
5. "Mechatronics"– HMT, TMH.
6. Michel .B. Histand&David"Introduction to Mechatronics & Measurement Systems"–. Alciatore.McGraw Hill Education; 4 edition ,July 2017

Scheme of Examination:

Two Questions to be set from each unit. On EITHER OR CHOICE basis, students have to answer any FIVE full questions out of TEN questions