CHRIST
UNIVERSITY
BANGALORE, INDIA

Declared as Deemed to be University under Section 3 of UGC Act 1956

FACULTY OF ENGINEERING

Kengeri Campus, Kanminike, Kumbalgodu, Bangalore – 560060

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE AND SYLLABUS

MASTER OF TECHNOLOGY
(Machine Design)

MODIFIED FOR THE YEAR
2012 *and* 2013

TABLE OF CONTENTS

1. INTRODUCTION

Christ University was formerly Christ College (Autonomous) affiliated to Bangalore University. Established in July 1969, Christ College became the most preferred educational institution in the city of Bangalore within the first three decades. From 1990 onwards it scaled from heights to heights. By the introduction of innovative and modern curriculum, insistence on academic discipline, imparting of Holistic Education and with the help of the creative and dedicated staff, Christ College has been continually rated among the top 10 educational institutions of the country. It has the rare distinction to be the first institution in Karnataka to be accredited by National Assessment and Accreditation Council (NAAC) UGC for quality education. On 7 October 2004, UGC has conferred Autonomy to Christ College (No.F.13-1/2004). On May 20, 2005, it became the first College in South India to be reaccredited with A+ by NAAC. UGC has identified it as an Institution with Potential for Excellence in June 2006. July 22, 2008 is the most glorious day in the history of the institution. Under Section 3 of the UGC Act, 1956, Ministry of Human Resources Development of the Union Government of India, vide Notification No. F. 9-34/2007-U.3 (A), has declared it a Deemed to be University, in the name and style of Christ University

Christ 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

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

Department of Mechanical Engineering

VISION

TO IMPART EXCELLENT TECHNICAL EDUCATION IN MECHANICAL ENGINEERING PROGRAMS THAT WILL ENABLE THE STUDENTS TO SERVE THE SOCIETY

MISSION

"To develop Mechanical Engineering students into responsible and passionate professionals, who are able to actively pursue and solve real life problems in a dynamic environment through prudent, lean and creative usage of resources"

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-

  - 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 (AE)

- **Int. BTech with MBA**
  - Int. BTech(CIVIL) with MBA (Finance/HR/Marketing/Lean Operations & Systems)
  - Int. BTech(CSE) with MBA (Finance/HR/Marketing/Lean Operations & Systems)
  - Int. BTech(ECE) with MBA (Finance/HR/Marketing/Lean Operations & Systems)
  - Int. BTech(EEE) with MBA (Finance/HR/Marketing/Lean Operations & Systems)
  - Int. BTech(IT) with MBA (Finance/HR/Marketing/Lean Operations & Systems)
  - Int. BTech(MECH) with MBA (Finance/HR/Marketing/Lean Operations & Systems)
- **Int. BTech with M. Tech** (5 Years Program)
  - Int. BTech(Civil) with MTech (Structural Engineering)
  - Int. BTech(CSE) with MTech (CSE)
  - Int. BTech(ECE) with MTech (Communication Systems)
  - Int. BTech(EEE) with MTech (Power Systems)
  - Int. BTech(IT) with MTech (IT)
  - Int. BTech(Mech) with MTech (Machine Design)
- **Postgraduate Programmes** (M. Tech) (2 Years Program)
  - Master of Technology in Computer Science & Engg.
  - Master of Technology in Communication Systems
- **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 Mechanical Engineering

03. ELIGIBLITY CRITERIA

- **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

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.

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.

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

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.

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 : Mid Semester Examination (Theory)	: 25 marks
CIA II : Assignments	: 10 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**

Mid semester practical examination will be conducted during regular practical hour with prior intimation to all candidates. End semester practical examination will have two examiners an internal and external examiner.

12. 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:100 Marks
    - Presentation assessed by Panel Members
    - Assessment by the Guide
    - Project Progress Reports
  - 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 Seminar**
  - Continuous Internal Assessment:50 Marks
    - Presentation assessed by Panel Members

12. 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**

14. COURSE STRUCTURE

COURSE STRUCTURE: M.Tech (Machine Design)

I SEMESTER

Sl No	SUBJECT CODE	SUBJECT TITLE	M	C
1	MTME131	Applied Mathematics	100	4
2	MTME132	Computer Applications In Design	100	4
3	MTME133	Dynamics and Mechanism Design	100	4
4	MTME134	Composites Materials Technology	100	4
5	MTME135	Elective – I	100	4
6	MTME151	Advanced CAD Laboratory	50	2
7	MTME152	Automation Laboratory	50	2
8	HE171	Holistic Education - I	0	1
		TOTAL	600	25

II SEMESTER

Sl No	SUBJECT CODE	SUBJECT TITLE	M	C
1	MTME231	Experimental Stress Analysis	100	4
2	MTME232	Theory of Elasticity	100	4
3	MTME233	Mechanical Behavior of Materials	100	4
4	MTME234	Fracture Mechanics	100	4
5	MTME235	Elective II	100	4
6	MTME251	Simulation Laboratory	50	2
7	MTME252	Analysis Laboratory	50	2
8	MTME271	Professional Practice – I	50	2
9	HE271	Holistic Education – II	0	1
		TOTAL	650	27

III SEMESTER

Sl No	SUBJECT CODE	SUBJECT TITLE	M	C
1	MTME331	Elective III	100	4
2	MTME332	Elective IV	100	4
3	MTME333	Elective V	100	4
4	MTME371	Project Work (Phase-I)	100	3
5	MTME372	Professional Practice –II	50	2
6	CY01	Cyber Security	----	2
		TOTAL	450	21

IV SEMESTER

Sl No	SUBJECT CODE	SUBJECT TITLE	M	C
1	MTME471	Project Work (Phase II) and Dissertation	300	9
2	MTME472	Seminar	50	2
		TOTAL	350	11

ELECTIVES

ELECTIVE-I

SUBJECT CODE	SUBJECT TITLE
MTME135	Rotor Dynamics
MTME135	Smart Materials and Structures
MTME135	Robotics

ELECTIVE-II

SUBJECT CODE	SUBJECT TITLE
MTME235	Machine Tool Design
MTME235	Design for Manufacture
MTME235	Reliability, Maintenance Management and Safety

ELECTIVE-III

SUBJECT CODE	SUBJECT TITLE
MTME331	Advanced Design of Mechanical System
MTME331	Advanced Finite Element Analysis
MTME331	Robust Design

ELECTIVE-IV

SUBJECT CODE	SUBJECT TITLE
MTME332	Advanced Theory of Vibration
MTME332	Optimum Design
MTME332	Vehicle Dynamics

ELECTIVE-V

SUBJECT CODE	SUBJECT TITLE
MTME333	Tribology and Bearing Design
MTME333	Theory of Plates and Shells
MTME333	Advanced Mechanism Design &Simulation

15. DETAILED SYLLABUS

SEMESTER – I

Code No.	Course Title	M	C
MTME 131	APPLIED MATHEMATICS	100	4

Scope and Objectives

The learning objectives promote the significant mathematical learning that needs to take place across the primary phase to secure confidence and accuracy in pupils' mathematics

Outcomes

Graduates will demonstrate the knowledge of differential equation, vector calculus, matrix theory, probability theory.

UNIT – I: Approximations and Solution of Equation 16 Hours

Approximations and Round off Errors : Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving, Simple mathematical model, Conservation Laws of Engineering.

Roots of Equations: Bracketing methods - Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration. Roots of Polynomial: Polynomials in Engineering and Science, Muller's method, Bairstow's Method, Graeffe's Roots, Squaring Method.

UNIT – II: Numerical Diffrentiation and Numerical Integration 10 Hours

Numerical Diffrentiation 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.

UNIT – III: Solution of Eigenvalue Problems 12 Hours

System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss - Jordan Elimination Method, Crout's method, Doolittile method, Partition method, error Analysis for direct methods.

Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi and Householder's method for symmetric matrices, Power method, Inverse power method (Rayleigh quotient method) .

UNIT - IV: Linear Transformation and Orthogonality 12 Hours

Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering

Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets, Orthogonal projections, The Gram - schmidt process, Least Square problems, Inner product spaces.

UNIT-V: Modern methods for non-linear differential equations 10 Hours

Homotopy perturbation and differential transform methods - simple examples

RECOMMENDED READINGS

1. S. S. Sastry, "Numerical Analysis for Engineers", Tata Mcgraw 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. Ji Huan He, "Homotopy perturbation technique", Computer Methods in Applied Mechanics and Engineering Vol. 178, Issues 3-4, August 1999, Pages 257-262.

10. Vedat Suat Ertürk, "Differential Transformation Method For Solving Differential Equations of Lane - Emden Type", Mathematical and computer applications, vol.12(3), 135-139, 2007.

Code No.	Course Title	M	C
MTME132	COMPUTER APPLICATIONS IN DESIGN	100	4

SCOPE AND OBJECTIVE

- *This course helps in making a learner to be a competent, in comprehending the algorithms and concepts coded in various kernels of modeling and analysis software packages.*
- *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.*

OUTCOMES

- *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.*
- *To design the various assemblies (top-down or bottom-up) assembly*

UNIT-I **12 Hours**

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.

2. **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.

UNIT-II **8 Hours**

3. **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 Painter.s, Algorithm, Hidden-Line Removal Algorithm, z-Buffer Method, Rendering, Shading, Ray Tracing, Graphical User Interface, X Window System.

UNIT-III **8 Hours**

4. **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.

UNIT-IV **14 Hours**

5. **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.

6. **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.

UNIT-V **10 Hours**

7. **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.

8. **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

ESSENTIAL READING:

1. Kunwoo Lee**, "Principles of CAD/CAM/CAE systems"-**Addison Wesley, 1999

2. RadhakrishnanP.,etal.,"**CAD/CAM/CIM**"-New Age International, 2008

RECOMMENDED READING:

1. Ibrahim Zeid, "**CAD/CAM** – **Theory & Practice**", McGraw Hill, 1998

2. Bedworth, Mark Henderson & Philip Wolfe, **"Computer Integrated Design and Manufacturing"** -McGraw hill inc., 1991.

3. **Pro-Engineer**, Part modeling Users Guide, 1998

Code No.	Course Title	M	C
MTME133	DYNAMICS AND MECHANISM DESIGN	100	4

SCOPE AND OBJECTIVES

- *To study the laws of motion ie dynamic.*
- *To represent graphical and analytical method of dimensional synthesis.*
- *To find the different types of sensors and actuators used for different application.*

OUTCOMES

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

UNIT-I **16 Hours**

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.

2. 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.

UNIT-II **13 Hours**

3. 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.

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

UNIT-III **7 Hours**

5. 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.

UNIT-IV **8 Hours**

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.

UNIT-V **12 Hours**

7. 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.

8. Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.

ESSENTIAL READINGS:

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

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

RECOMMENDED READING:

1. **Theory of Machines and Mechanism** - E.Shigley& J.J.J]icker McGraw Hill company.

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

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

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

Code No.	Course Title	M	C
MTME134	COMPOSITES MATERIALS TECHNOLOGY	100	4

SCOPE AND OBJECTIVES

- *To obtain the basic idea of composite technology in the present scenario.*
- *Classification and manufacturing of different types of composites.*
- *Testing of composite materials*

UNIT-I **6 Hours**

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.

UNIT-II **8 Hours**

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.Invariant properties.Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

UNIT-III **12 Hours**

3. Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems.

4. Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problems.

UNIT-IV **14 Hours**

5. 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.

6. 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.

UNIT-V **12 Hours**

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

8. Metal Matrix Composites: Re-inforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications.

ESSENTIAL READING:

1. **Composite Materials handbook,** Mein Schwartz McGraw Hill Book Company, 1984.

2. **Mechanics of composite materials,** Autar K. Kaw CRC Press New York.

RECOMMENDED READING:

1. **Mechanics of Composite Materials,** Rober M. JonessMc-Graw Hill Kogakusha Ltd.

2. **Stress analysis of fiber Reinforced Composite Materials,** Michael W, HyerMc-Graw Hill International.

3. **Composite Material Science and Engineering,** Krishan K. Chawla Springer.

4. **Pibre Reinforced Composites,** P.C. Mallik Marcel Decker

Code No.	Course Title	M	C
MTME151	ADVANCED CAD LAB	50	2

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 / NX / ANSYS / NASTRAN** etc.

Code No.	Course Title	M	C
MTME152	AUTOMATION LAB	50	2

Experiments related with Hydraulic and Pneumatic equipment in the FESTO lab.

SEMESTER – II

Code No.	Course Title	M	C
MTME231	EXPERIMENTAL STRESS ANALYSIS	100	4

Scope and 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.*

OUTCOMES

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

UNIT-I **12 Hours**

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**.**

2. 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.

UNIT-II **14 Hours**

3. Photoelasticity : Nature of light, - wave theory of light,- optical interference - Polariscopes stress optic law - effect of stressed model in plane and circuclar Polariscopes, Isoclinics Isochromatics fringe order determination - Fringe multiplication techniques - Calibration Photoelastic model materials.

4. Two Dimensional Photoelasticity Stress Analysis: Separation methods shear difference method, Analytical separation methods, Model to prototype scaling**.**

UNIT-III **6 Hours**

5. 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**.**

UNIT-IV **8 Hours**

6. 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.

UNIT-V **12 Hours**

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

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

ESSENTIAL READING:

1. **Experimental Stress Analysis** - Dally and Riley, McGraw Hill.
2. **Experimental Stress Analysis -** Sadhu Singh Hanna publisher.

RECOMMENDED READING

1. **Experimental Stress Analysis** - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill.
2. **Photoelasticity Vol 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,

Code No.	Course Title	M	C
MTME232	THEORY OF ELASTICITY	100	4

SCOPE AND OBJECTIVES

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

OUTCOMES

- *Solve two and three dimensional problems of cylindrical bodies.*
- *Know the stress strain relation for a body subjected to loading within elastic limit.*
- *Got the relation for a body subjected to thermal expansion.*

UNIT-I **14 Hours**

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.

2. **Introduction to Strain :** Deformation**,** Strain Displacement relations, Strain components, The state of strain at a point, Principal strain, Strain transformation, Compatibility equations, Cubical dilatation

UNIT-II **12 Hours**

3. **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.

4. **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.

UNIT-III **8 Hours**

5. **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.

UNIT-IV **12 Hours**

6. **Thermal Stresses:** Introduction, Thermo-elastic stress -strain relations, Thin circular disc, Long circular cylinder.

7. **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.

UNIT-V **6 Hours**

8 **Elastic Stability:** Axial compression of prismatic bars, Elastic stability, Buckling load for column with constant cross section.

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"-** App[roach, McGral Hilll New York- 1973

Reference Books:

1. T.G.Sitharam" **Applied Elasticity**"- Interline publishing.

2. L S Srinath" **Advanced Mechanics of Solids** "- tata Mcgraw Hill Company.

3. Sadhu Singh ," **Theory of Elasticity**"- Khanna publisher

4. Phillips, Durelli and Tsao, " **Analysis of Stress and Strain** "- McGraw Hill Book.

5. Wang. C. T. "**Applied Elasticity".**

Code No.	Course Title	M	C
MTME235	MECHANICAL BEHAVIOR OF MATERIALS	100	4

SCOPE AND OBJECTIVE

- *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*.

OUTCOMES

- *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 considerations.*

UNIT-I **12 Hours**

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.

UNIT-II **10 Hours**

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.

UNIT-III **10 Hours**

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.

UNIT-IV **8 Hours**

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.

UNIT-V **7 Hours**

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.

ESSENTIAL READING

1. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988

2. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000

3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (34d edition), Butterworth-Heiremann, 1997.

4. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.

5. Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.

6. Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.

7. www.astm.org/labs/pages/131350.htm.

Code No.	Course Title	M	C
MTME235	FRACTURE MECHANICS	100	4

SCOPE AND OBJECTIVES

- *Introduction to fracture mechanics principles.*
- *To find Stress intensity factors and plane strain fracture toughness for different components.*
- *To known the concepts of LEFM and EPFM.*

OUTCOMES

- *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-I **6 Hours**

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.

UNIT-II **12 Hours**

2. The Airy stress function. Complex stress function. Solution to crack problems. Effect of finite size. Special cases, Elliptical cracks, Numerical problems.

3. Plasicity 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.

UNIT-III **14 Hours**

4. 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.

5. The energy release rate, Criteria for crack growth. The crack resistance(R curve). Compliance, J integral. Tearing modulus. Stability.

UNIT-IV **12 Hours**

6. 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.

7. 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.

UNIT-V **6 Hours**

8. 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.

ESSENTIAL READING:

1. Elementary Engineering Fracture Mechanics - David Brock, Noordhoff.
2. Fracture Mechanics-Fundamental and Application - Anderson, T.L CRC press1998.

RECOMMENDED READING:

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

Code No.	Course Title	M	C
MTME271	PROFESSIONAL PRACTICE	50	2

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 over head 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 aims 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 equipments, 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 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.

Code No.	Course Title	M	C
MTME251	SIMULATION LAB	50	2

Analysis of Mechanical Components – Use of FEA Packages, like ANSYS NASTRON etc…,
Excesses shell include FEA analysis of

i) Machine elements under static loads

ii) Heat transfer in mechanical systems

iii) Determination of natural frequency

iv) Axi-Symmetric

v) Non-linear systems

Code No.	Course Title	M	C
MTME252	ANALYSIS LAB	50	2

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.

ELECTIVE-I

Code No.	Course Title	M	C
MTME135	ROBOTICS	100	4

SCOPE AND OBJECTIVE

- *To study the introduction of robot.*
- *Derive the mathematical representation of kinematic and dynamic manipulator.*
- *To find the different types of sensors and actuators used for different application.*

OUTCOMES

- *The study includes mathematical formulation for a robot body.*
- *Know the movement of robot arm based on there translation or rotational moment.*
- *Selection of particular sensors 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.*

UNIT-I **14 Hours**

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

2. 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.

UNIT-II **12 Hours**

3. 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.

4. 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.

UNIT-III **7 Hours**

5. 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.

UNIT-IV **8 Hours**

6. 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.

UNIT-V **11 Hours**

7. 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.

8. 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.

ESSENTIAL READING:

1. **Fundamental Concepts and Analysis** - Ghosal A., Robotics, Oxford, 2006.

2. **Introduction to Robotics Analysis -** Niku, S. B., Systems, Applications, Pearson Education, 2008.

RECOMMENDED READING:

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. G., McGraw Hill, 1987.

ELECTIVE-II

Code No.	Course Title	M	C
MTME235	RELIABILITY, MAINTENANCE MANAGEMENT & SAFETY	100	3

UNIT-I **10 Hours**

1. Reliability Engineering: System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Optimization, Reliability – Cost trade off, Prediction and analysis, Problems.

UNIT-II **10 Hours**

2. Maintainability, Availability & Failure Analysis: Maintainability & Availability – Introduction, formulae, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability, simple problems, Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

UNIT-III **8 Hours**

3. Maintenance Planning and Replacement: Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

UNIT-IV **16 Hours**

4. Maintenance Systems: Fixed time maintenance, Condition based maintenance, Operate to failure, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terrotechnology.

5. Condition Monitoring: Techniques-visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring, Condition monitoring of hydraulic system, Machine diagnostics - Objectives,

Monitoring strategies, Examples of monitoring and diagnosis, Control structure for machine diagnosis.

UNIT-V **8 Hours**

6. Safety Aspects: Importance of safety, Factors affecting safety, Safety aspects of site and plant, Hazards of commercial chemical reaction and operation, Instruments for safe operation, Safety education and training, Personnel safety, Disaster planning and measuring safety effectiveness, Future trends in industrial safety.

RECOMMENDED READING:

1. Concepts in Reliability Engineering L.S. Srinath Affiliated East West Press
2. Maintainability and Reliability Handbook Editors: Ireson W.A. and C.F.
Coombs McGraw Hill Inc.
3. Failure Diagnosis and Performance Monitoring L.F. Pau Marcel Dekker
4. Industrial Maintenance Management S.K. Srivastava S. Chand & Co Ltd.
5. Management of Industrial Maintenance Kelly and M.J. Harris Butterworth and Co.
6. Maintenance, Replacement and Reliability A.K.S. Jardine Pitman Publishing
7. Engineering Maintainability: How to Design for Reliability and Easy Maintenance
B.S. Dhillon Prentice Hall of India

ELECTIVE-III

SUBJECT CODE	SUBJECT TITLE
MTME331	**Advanced Design of Mechanical System**
MTME331	**Advanced Finite Element Analysis**
MTME331	**Robust Design**

ELECTIVES: III

Code No.	Course Title	M	C
MTME331	ADVANCED DESIGN OF MECHANICAL SYSTEM	100	4

SCOPE AND OBJECTIVES

- *To known 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*.

OUTCOMES

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

UNIT I **12 Hours**

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.

2. 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.

UNIT II **12 Hours**

3. Stess-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 behaviour, S-N curve

representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.

4. Strain-Life(ε-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.

UNIT III **10 Hours**

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

6. 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.

UNIT IV **8 Hours**

7. 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.

UNIT V **8 Hours**

8. 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.

ESSENTIAL READING:

1. **Metal Fatigue in engineering**, Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens, Henry o. Fuchs,

John wiley Newyork, Second edition. 2001.

2. **Failure of Materials in Mechanical Design,** Jack. A. Collins, John Wiley, Newyork 1992.

3. **Machine Design**, Robert L. Norton, Pearson.

RECOMMENDED READING:

1. **Fatigue of Materials,** S.Suresh, Cambridge university press, Cambridge, U.K.

2. **Fundamentals of Metal Fatigue Analysis,** Julie.A.Benantine Prentice Hall,1990

3. **Fatigue and Fracture,** ASM Hand Book, Vol 19,2002.

Code No.	Course Title	M	C
MTME233	ADVANCED FINITE ELEMENT ANALYSIS	100	4

SCOPE AND OBJECTIVES

- *To find the behavior of the element.*
- *Modeling of irregular shapes.*
- *Finding the shape function for different elements.*
- *Changing the element types and boundary condition to obtain the accurate result*.

OUTCOMES

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

UNIT I **12 Hours**

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

2. **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

UNIT II **10 Hours**

3. **Two-Di;1ensional 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)

4. **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

UNIT III **10 Hours**

5. **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

UNIT IV **10 Hours**

6. **Beam Elements-Analysis of Beams and Frames:** 1–D Beam Element, 2–D Beam Element, Problems.

7. **Heat Transfer *I* 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.

UNIT V **10 Hours**

8. **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.

ESSENTIAL READING:

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

RECOMMENDED READING:

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"-** McGraw -Hill 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.

Code No.	Course Title	M	C
MTME331	ROBUST DESIGN	100	4

SCOPE AND OBJECTIVES

- *To learn steps in robust design, parametric design and tolerance design.*
- *To know the role of S-N ratios in reliability improvement*.

OUTCOMES

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

UNIT-I **13 Hours**

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.

2. 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**.**

UNIT-II **7 Hours**

3. 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.

4. 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.

UNIT-III **8 Hours**

5. 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.

UNIT-IV **6 Hours**

6. 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.

UNIT-V **11 Hours**

7. 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**.**

8. 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.

ESSENTIAL READING:

1. **Quality Engineering using Robust Design -** Madhav S. Phadake: Prentice Hall, Englewood Clifts, New Jersey 07632, 1989.

2. **Design and analysis of experiments -** Douglas Montgomery: Willey India Pvt. Ltd., V Ed., 2007.

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

RECOMMENDED READINGs:

1. **Quality by Experimental Design -** Thomas B. Barker : Marcel Dekker Inc ASQC Quality Press, 1985

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

3. **Reliability improvement by Experiments -** W.L. Condra, Marcel Dekker: Marcel Dekker Inc ASQC Quality Press, 1985

ELECTIVE-IV

SUBJECT CODE	SUBJECT TITLE
MTME332	**Advanced Theory of Vibration**
MTME332	**Optimum Design**
MTME332	**Vehicle Dynamics**

Code No.	Course Title	M	C
MTME332	ADVANCED THEORY OF VIBRATION	100	4

SCOPE AND OBJECTIVES

- *To obtain the idea of classification of vibration, modal analysis.*
- *To acquire the knowledge of damping factor and measuring instruments.*

OUTCOMES

- *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.*

UNIT-I 7 Hours

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-system: natural frequency.

UNIT-II **7 Hours**

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.

UNIT-III **11 Hours**

3. Vibration Control: Introduction, Vibration isolation theory, Vibration isolation theory for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, Vibration dampers.

4. Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis.

UNIT-IV **13 Hours**

5. Modal analysis & Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis.

6. 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.

UNIT-V **14 Hours**

7. 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.

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

ESSENTIAL READING:

1. **Theory of Vibration with Application, -** William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, , 5th edition Pearson Education.

2. **Fundamentals of Mechanical Vibration**. - S. Graham Kelly. 2nd edition McGraw Hill.

3. **Mechanical Vibrations,** - S. S. Rao., 4th edition Pearson Education.

RECOMMENDED READING:

1. **Mechanical Vibrations -** S. Graham Kelly, Schaum's Outlines, Tata McGraw Hill, 2007.

Code No.	Course Title	M	C
MTME332	OPTIMUM DESIGN	100	4

SCOPE AND OBJECTIVE

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

OUTCOMES

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

UNIT-I **7 Hours**

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.

UNIT-II **13 Hours**

2. Classical Optimization Techniques II: Multivariable optimization with equality constraints and inequality constraints, Kuhn - Tucker conditions.

3. Non - linear Programming: One - dimensional minimization methods**:** Unimodal function, Unrestricted search, Exhaustrive search, Dichotomous search, Fibonacci method, Golden section method.

UNIT-III **12 Hours**

4. Interpolation Methods: Quadratic, Cubic and Direct root interpolation methods.

5. Unconstrained Optimization Techniques: Direct search methods**:** Univariate method, Hook and Jeeves' method, Powell's method, Simplex method.

UNIT-IV **13 Hours**

6. Descent Methods: Steepest descent, Conjugate gradient, Quasi - Newton, Davidon - Fletcher - Powell method.

7. Constrained Optimization Techniques: Direct methods: characteristics of a constrained problem, Indirect methods: Transformation techniques, Basic approach of the penalty function method.

UNIT-V **7 Hours**

8. Dynamic Programming: Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples.

ESSENTIAL READING:

1. **Optimisation - Theory and Application -** S. S. Rao, Willey Eastern.

2. **Optimization methods for Engg. Design -** R.L Fox, Addison – Wesley.

RECOMMENDED READING:

1. **Optimisation and Probability in System Engg -** Ram, Van Nostrand.

2. **Optimization methods -** K. V. Mital and C. Mohan, New age International Publishers, 1999

Code No.	Course Title	M	C
MTME332	VEHICLE DYNAMICS	100	4

SCOPE AND 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.*

OUTCOMES

- *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-I **12 Hours**

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.

UNIT-II **12 Hours**

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.

UNIT-III **12 Hours**

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.

UNIT-IV **8 Hours**

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.

UNIT-V **8 Hours**

Derivation of generalized equations of motion for a vehicle: stability derivative notation. Solution with two degree of freedom in the steady state: stability factor, characteristic and critical speeds.

ESSENTIAL READING

1. Vehicle Dynamics, 19&9,IR Ellis, Business Book.

2. Theory of Ground vehicles, 2001,JY Wong, Wily.

RECOMMENDED READING

1. Vehicles & Bridging Ss/Tytler, Brassey's.

2. Fundamental of vehicle dynamics: Thomas D Gillespie

ELECTIVE-V

SUBJECT CODE	SUBJECT TITLE
MTME333	**Tribology and Bearing Design**
MTME333	**Theory of Plates and Shells**
MTME333	**Advanced Mechanism Design &Simulation**

Code No.	Course Title	M	C
MTME333	TRIBOLOGY AND BEARING DESIGN	100	4

SCOPE AND OBJECTIVE

- *To study the types of contacts, types of bearing.*
- *Design a bearing based on their application and types of load.*

OUTCOMES

- *Describes the general bearings technology and classification of bearings.*
- *Students can able to understand the selection of bearing for different application.*

UNIT-I **12 Hours**

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.

2. 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.

UNIT-II **14 Hours**

3. 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.

4. 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.

UNIT-III **8 Hours**

5. 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.

UNIT-IV **12 Hours**

6. Hydrostatic Bearings: Types of hydrostatic Lubrication systems Expression for discharge, load carrying capacity, Flow rate, Condition for minimum power loss. Torque calculations.Numerical problems.

7. Porous & Gas Bearings: Introduction to porous bearings. Equations for porous bearings and working principal, Fretting phenomenon and it's stages

UNIT-V **6 Hours**

8. **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.

ESSENTIAL READING:

1. 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.

RECOMMENDED READING:

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.

Code No.	Course Title	M	C
MTME333	THEORY OF PLATES AND SHELLS	100	4

SCOPE AND 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.*

OUTCOMES

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

UNIT-I **12 Hours**

1. Bending of long rectangular plate into a cylindrical surface, Differential equation - Bending of plated with different boundary conditions - Long plate on elastic foundation.

2. Pure Bending: Moment and curvature relations problems of simply supported plates-Strain energy impure bending.

UNIT-II **6 Hours**

3. Symmetrical Bending of Circular Plates: Differential equation uniformly loaded plates, Plates concentricity loaded plates- loaded at the center.

UNIT-III **12 Hours**

4. 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.

5. Bending of plate under combined action of lateral and transverse loads derivation of differential equation, simply supported rectangular plate.

UNIT-IV **12 Hours**

6. 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.

7. Membrane Deformation of Shells: Symmetrical 'loaded shell, symmetrically loaded spherical shell. General Theory of cylindrical shells: Circular; Cylindrical shell loaded symmetrically.

UNIT-V **6 Hours**

8. General equation of circular cylindrical shells. Approximate investigation of: bending of circular cylindrical shell.

RECOMMENDED READING:

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

Code No.	Course Title	M	C
MTME333	ADVANCED MECHANISMS DESIGN AND SIMULATION	100	4

SCOPE AND OBJECTIVES

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

OUTCOMES

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

UNIT-I **10 Hours**

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

2. Study of Sensors and Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.

UNIT-II **11 Hours**

3. Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors.

4. System Models: Mathematical models:- mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.

UNIT-III **13 Hours**

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

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

UNIT-IV **8 Hours**

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

UNIT-V **10 Hours**

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

ESSENTIAL READING:

1. **"Mechatronics"** - W. Bolton, 2 Ed. Addison Wesley Longman, Pub, 1999

2. HSU "**MEMS and Microsystems design and manufacture**"- TMH

RECOMMENDED READING:

1.Kamm, "**Understanding Electro-Mechanical Engineering an Introduction to Mechatronics"-** PHI.

2. **"Fine Mechanics and Precision Instruments"-** Pergamon Press, .1971.

3. Shetty and Kolk "**Mechatronics System Design**"-Thomson.

4. Mahalik "**Mechatronics**"- TMH.

5. **"Mechatronics"–** HMT, TMH.

6. **"Introduction to Mechatronics & Measurement Systems"**– Michel .B. Histand& David. Alciatore.Mc Grew Hill.