

# **Dr. Babasaheb Ambedkar Technological University**

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

P.O.: Lonere, Dist.: Raigad,  
Pin 402 103, Maharashtra  
Telephone and Fax. : 02140 - 275142  
[www.dbatu.ac.in](http://www.dbatu.ac.in)



## **Department of Mechanical Engineering**

**Proposed Course Structure & Contents**

**for**

**M.Tech. Program in Machine Design Engineering**

**From I to IV Semester**

**Finalized in BoS meeting held on 7th April, 2017**

## Vision

The vision of the Department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

## Mission

Imparting quality education, looking after the holistic development of students and conducting need-based research and extension activities.

## Post Graduate Attributes

The Post Graduate Attributes are the knowledge skills and attitudes which the students have at the time of post-graduation.

These Post Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of engineering problems involving research.
2. **Problem analysis:** Identity, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for engineering problems involving research and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to research activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the research based engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice to research problems.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader of a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

### **Program Educational Objectives**

PEO1	To train students with in-depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areas of Machine Design Engineering.
PEO2	To enable post graduates to carry out innovative and independent research work, disseminate the knowledge in Academia/Industry/Research Organizations to develop systems and processes in the related field.
PEO3	To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.
PEO4	To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning ability for their successful professional career.

### **Program Outcomes**

At the end of the program the student will be able to:

PO1	Acquire, demonstrate and apply advanced knowledge in the area of Machine Design Engineering.
PO2	Identify problems in the field of Machine Design Engineering, formulate them and solve by using advanced techniques.
PO3	Conduct independent research and generate new knowledge for the benefit of community, society Industry and country.
PO4	Apply various numerical methods, advanced software and engineering tools to model, analyze and solve Machine Design Engineering problems.
PO5	Work effectively in interdisciplinary teams for solving real life problems in the related field.
PO6	Apply engineering and scientific principles for the effective management of Mechanical systems.
PO7	Effectively communicate through technical reports, presentations and scientific publications with the engineering community as well as society at large.
PO8	Demonstrate traits of management in handling engineering projects, related finance, and coordinate with workforce towards achieving goals.
PO9	Demonstrate high level of professional and intellectual integrity, ethics of research and scholarly standards.
PO10	Examine critically the outcomes of one's actions and make corrective measures subsequently.
PO11	Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.
PO12	Engage in life-long reflective and independent learning with high level of enthusiasm and commitment.

**DEPARTMENT OF MECHANICAL ENGINEERING**  
**MASTER OF TECHNOLOGY**  
**(MACHINE DESIGN ENGINEERING)**

Syllabus effective from 2017-2018

**Semester-I**

Course Code	Name of the Course	L	T	P	C
MMD101	Advanced Methods in Engineering Design	03	01	--	04
MMD102	Analysis and Synthesis of Mechanisms	03	01	--	04
MMD103	Advanced Mechanical Vibrations	03	01	--	04
MMD104A to MMD104K	Elective-I	03	--	--	03
	Elective-II	03	--	-	03
BSH101	Communication Skills	02	--	-	02
MMD105	Design Lab – I	--	--	03	02
<b>Total for Semester-I</b>		<b>17</b>	<b>03</b>	<b>02</b>	<b>22</b>

**List of Elective Courses – Semester I**

MMD104A	Stress Analysis
MMD104B	Experimental Stress Analysis
MMD104C	Advanced Machine Design
MMD104D	Failure Analysis and Design
MMD104E	Theory of Elasticity and Plasticity
MMD104F	Process Equipment Design
MMD104G	Tribology in Design
MMD10H	Mechanics of Composite Materials
MMD104I	Instrumentation & Automatic Control
MMD104J	Material handling equipment Design
MMD104K	Machine Tool Design

**Semester-II**

Course Code	Name of the Course	L	T	P	C
MMD201	Finite Element Method	03	1	-	04
MMD202	Design Optimization	03	1	-	04
MMD203A to MMD203K	Elective-III	03	-	-	03
	Elective- IV	03	-	-	03
MMD204A to MMD204D	Elective-V	03	-	-	03
MMD205	Seminar-I	--	04	-	02
MMD206	Mini Project	--	--	03	02
<b>Total for Semester II</b>		<b>15</b>	<b>06</b>	<b>03</b>	<b>21</b>

### List of Elective Courses – Semester II

MMD203A	Engineering Fracture Mechanics
MMD203B	Robotics
MMD203C	Mechatronics
MMD203D	Biomechanics
MMD203E	Computational Techniques in Engineering Design
MMD203F	Advanced Engineering Materials
MMD203G	Design for Manufacture and Assembly
MMD203H	Design of Piping System
MMD203I	Vehicle Dynamics
MMD203J	Noise, Vibrations and Harshness
MMD203K	Rotor Dynamics

### Elective-V (Open Elective Courses)

MMD204A	Research Methodology
MMD204B	Design of Experiments
MMD204C	Modeling and Simulation
MMD204D	Soft Computing Techniques

### Semester-III

Course Code	Name of the Course	L	T	P	C
MMD301	*Project Management and Intellectual Property Rights (Self Study Course)	--	--	--	02
MMD302	Project Stage -I	---	--	--	10
Total for Semester III		--	--	--	12

### Semester-IV

Course Code	Name of the Course	L	T	P	C
MMD401	Project Stage-II	-	-	-	20
Total for Semester IV		-	-	-	20

**Semester-I**  
**Advanced Methods in Engineering Design**

MMD101	Advanced Methods in Engineering Design	PCC	3-1-0	4 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:** Mechanics of Materials, Machine Design

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

## **Course Contents:**

### **Unit 1**

DESIGN PHILOSOPHY: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability.

### **Unit 2**

PRODUCT DESIGN: Product strategies, value, planning and specification, concept generation, concept selection, concept testing.

### **Unit 3**

DESIGN FOR MANUFACTURING: Forging design, casting design, Design process for non-metallic parts, Plastics, Rubber, Ceramic, Wood and Glass parts like. Material selection in machine design.

### **Unit 4**

FAILURE THEORIES: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory, Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles, Fatigue failure theories ,cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation.

### **Unit 5**

SURFACE FAILURES: Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.

### **Unit 6**

ECONOMIC FACTORS INFLUENCING DESIGN: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design.

## **Texts/References:**

1. Smith Seely, "Advanced Mechanics of Materials", John Willey & Sons Publications.
  2. Timoshenko, "Strength of Materials"
  3. Kocanda, "Fatigue Failure of Metal", Sijthoff and Noordhoff International Publications.
  4. Frost N. E., "Metals Fatigue", Oxford University Press, London.
  5. Benhan& Crawford, "Mechanics of Engineering Materials", John Willey & Sons Pub.
  6. Spotts M. F., "Mechanical Design Analysis", PHI Publications, New Delhi.
-

**Semester-I**  
**Analysis and Synthesis of Mechanisms**

MMD102	Analysis and Synthesis of Mechanisms	PCC	3-1-0	4 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:** Theory of Machines, Kinematics of Machinery

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution



## **Course Contents:**

### **Unit 1**

BASIC CONCEPTS; Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods.

### **Unit 2**

CURVATURE THEORY: Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell mechanisms.

### **Unit 3**

KINEMATIC SYNTHESIS OF PLANAR MECHANISMS-GRAPHICAL: accuracy (precision) points, Chebyshev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, centre and circle point curves,

### **Unit 4**

KINEMATIC SYNTHESIS OF PLANAR MECHANISMS – ANALYTICAL: Analytical synthesis of four-bar and slider-crank mechanisms, Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers, three accuracy point synthesis using complex numbers.

### **Unit 5**

COUPLER CURVES: Equation of coupler curve, Robert-Chebyshev theorem, double points and symmetry.

### **Unit 6**

KINEMATIC ANALYSIS OF SPATIAL MECHANISMS: Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms

## **Texts/Reference:**

1. R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, New York, 1980.
2. Robert L. Norton, "Design of Machinery", Tata McGraw Hill Edition
3. Hamilton H. Mabie, "Mechanisms and Dynamics of Machinery", John Wiley and sons New York
4. S. B. Tuttle, "Mechanisms for Engineering Design" John Wiley and sons New York
5. A. Ghosh and A.K. Mallik, "Theory of Machines and Mechanisms", Affiliated East-West Press, New Delhi, 1988.

6. A.G. Erdman and G.N. Sandor, “Mechanism Design – Analysis and Synthesis”, (Vol. 1 and 2), Prentice Hall India, 1988.
  7. A.S. Hall, “Kinematics and Linkage Design”, Prentice Hall of India.
  8. J.E. Shigley and J.J. Uicker, “Theory of Machines and Mechanisms”, 2nd Edition, McGraw-Hill, 1995.
- 

**Semester-I**  
**Advance Mechanical Vibration**

MMD103	Advance Mechanical Vibration	PCC	3-1-0	4 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:** Dynamics of Machinery, Mechanical Vibrations

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												

CO6												
-----	--	--	--	--	--	--	--	--	--	--	--	--

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

## **Course Contents:**

### **Unit 1**

**MULTI-DEGREE OF FREEDOM SYSTEM:** Free Vibration Equation of motion, Influence Coefficients (Stiffness and Flexibility), Generalized Coordinates, and Coordinate Coupling. Lagrangian and Hamilton Equations, Matrix Method, Eigen value and Eigen Vector Method

### **Unit 2**

**VIBRATION MEASUREMENT:** Basic signal attributes, Vibration measuring sensors (Displacement, Velocity, and Acceleration), Piezoelectric Accelerometers, Method for Calibrating Accelerometer, Basic Process of Digital Frequency Analyzer, Digital Analyzer operating principles, Measurement of phase, Phase fundamentals, Comparing two waveforms using reference, Cross Channel phase analysis, Electronic Filters, Time and orbital domain, Time and frequency domains, Evaluation of vibration severity, ISO standards: ISO 10816 and ISO 7919

### **Unit 3**

**MODAL ANALYSIS:** Introduction, Free vibration response using modal analysis, Forced vibration response using modal analysis, Experimental modal analysis: Necessary equipment, signal processing, Measurement of mode shapes, Introduction to damage detection in structures using changes in modal frequency and mode shapes

### **Unit 4**

**VIBRATION CONTROL:** Conventional Methods: By Mass/Inertia, Stiffness, Damping (Vibration Isolation Principles). Dynamic vibration absorbers. Introduction to Semi-Active and Active Vibration Control

### **Unit 5**

**NON-LINEAR VIBRATIONS:** Basics of non-linear vibration, Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase-plane techniques, Duffing's equation, Jump phenomenon, Limit cycle, Perturbation method.

### **Unit 6**

**VIBRATION ANALYSIS FOR MACHINERY MALFUNCTION:** Analysis of machinery vibration problems, Methodology of vibration analysis, Condition/vibration monitoring data collection, Trending of data, Time wave form analysis, Signature analysis, Absolute Phase analysis and cross channel phase analysis, Orbit analysis. Root Cause Analysis. Methodology of diagnosis of unbalance, misalignment and antifriction bearing defects. Frequency

calculation and their significance in signature analysis of antifriction bearing, Mechanical Looseness, diagnosis of foundation problem.

**Texts/References:**

1. Leonard Meirovitch – Elements of Vibration Analysis, McGraw Hill
  2. Thomson W.T , Theory of Vibration with Applications., Prentice Hall India.
  3. Rao V and J Srinivas, Mechanical Vibrations, PHI Learning Pvt. Ltd.
  4. S.S Rao, Mechanical Vibrations, Pearson Education India
- 

**Semester-I  
Communication Skills**

BSH1101	Communication Skills	PCC	2-0-0	2 Credits
	Continuous Assessment (25 Marks)	Pract/Oral (25 Marks)		Total (50 Marks)

**Pre-Requisites: None**

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

CO1	Students are found to be confident while using English
CO2	Engage in analysis of speeches or discourses and several articles
CO3	Identify and control anxiety while delivering speech
CO4	Write appropriate communications (Academic/Business)
CO5	Prepared to take the examinations like GRE/TOFEL/IELTS
CO6	Identify and control the tone while speaking
CO7	Develop the ability to plan and deliver the well-argued presentations

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	2		1		2		2	1			2	3
CO2	2						1	2		1	2	3
CO3					1		1	2			2	3
CO4	2		1		1		3	1	2	1	2	3
CO5	1											1
CO6					2		2	2			2	3
CO7			2	1	2	2	3	3	1	1	3	3

## **Course Contents:**

### **Unit 1:**

**COMMUNICATION AND COMMUNICATION PROCESSES:** Introduction to Communication, Forms and functions of Communication, Barriers to Communication and overcoming them, Verbal and Non-verbal Communication, Ways of Effective Communication.

### **Unit 2:**

**ORAL COMMUNICATION:** Use of Language in Spoken Communication, Features of Good Communication, Principles and Practice of Group Discussion, Public Speaking (Addressing Small Groups and Making Presentation), Interview Techniques, Appropriate Use of Non-verbal Communication, Presentation Skills, Telephonic Etiquettes, Extempore, Elocution, Describing Experiences and Events.

### **Unit 3:**

**STUDY OF SOUNDS IN ENGLISH:** Introduction to phonetics, Study of Speech Organs, Study of Phonemic Script, Articulation of Different Sounds in English, Stress Mark.

### **Unit 4:**

**ENGLISH GRAMMAR:** Grammar: Forms of Tenses, Articles, Prepositions, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Common Errors, Sentence Formation and Sentence Structures, Use of Appropriate Diction.

### **Unit 5:**

**WRITING SKILLS:** Features of Good Language, Difference between Technical Style and Literary Style, Writing Emails, Formal and Informal English, Business Writing, Advertisements, Essay Writing, (Technical, Social, and Cultural Topics), Technical Reports: Report Writing: Format, Structure and Types, Writing Memorandum, Circulars, Notices, Agenda and Minutes, Technical Manuals, Brochures  
Letter Writing: Types, Parts, Layouts, Letters and Applications, Use of Different Expressions and Style, Writing Job Application Letter and Resume.

### **Unit 6:**

**READING SKILLS & LISTENING SKILLS:**

**Reading:** Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.

**Listening:** Importance of Listening, Types of Listening, Barriers to Listening.

## **Texts/Reference:**

1. Mohd. Ashraf Rizvi, Communications Skills for Engineers, Tata McGraw Hill
2. Sanjay Kumar, Pushp Lata, Communication Skills, Oxford University Press, 2016
3. Meenakshi Raman, Sangeeta Sharma, Communication Skills, Oxford University Press,

2017

4. Teri Kwal Gamble, Michael Gamble, Communication Works, Tata McGraw Hill Education, 2010

**Semester-I**  
**Stress Analysis**

MMD104A	Stress Analysis	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

## **Course Contents:**

### **Unit 1**

THEORY OF ELASTICITY: Plane stress & Plane strain, Two dimensional problems in Rectangular & Polar co-ordinate system, Analysis of stresses & strains in three dimension.

### **Unit 2**

THEORY OF TORSION: Torsion of general prismatic bars of solid section, Membrane Analogy, Torsion of Thin walled tubes, Torsion of Thin walled Multiple-Cell closed sections, Torsion of rolled section.

### **Unit 3**

BENDING OF PRISMATIC BARS, UNSYMMETRIC AND PLASTIC BENDING: Concept of shear centre in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section and closed section.

The plastic flow process, shape factor, spring back, plastic bending with strain hardening material, plastic hinges, plastic deflection.

### **Unit 4**

PLATE BENDING: Bending of plate to cylindrical surface, bending of a long uniformly loaded rectangular plate, pure bending in two perpendicular directions, bending of circular plates loaded symmetrically w.r.t. center. Circular plate with circular hole at center symmetrically loaded & load distributed along inner & outer edges, Bending of circular plates of variable thickness.

### **Unit 5**

PRESSURIZED CYLINDERS & ROTATING DISKS: Governing equations, stresses in thick walled cylinder under internal & external pressure, shrink fit compound cylinders, stresses in rotating flat solid disk, flat disk with central hole, disk with variable thickness, disk of uniform strength.

### **Unit 6**

CONTACT STRESSES: Geometry of contact surfaces, methods of computing contact stresses and deflection of bodies in point contact, stress for two bodies in line contact with load normal to contact area and load normal and tangent to contact area. Introduction to analysis of low speed impact.

## **Texts/References:**

1. Advanced strength and Applied stress analysis - Richard G Budynas, McGraw Hill
2. Advanced Mechanics of solids - L S Srinath, McGraw Hill
3. Advanced Mechanics of Materials - Cook and Young, Prentice Hall
4. Theory of elasticity - Timoshenko and Goodier, McGraw Hill
5. Advance Strength of Materials- Vol 1 & 2 – Timoshenko, CBS publisher

6. Advanced Mechanics of Materials – Boresi, Schmidt, Sidebottom, Willey  
 7. Mechanics of Materials - Vol 1 & 2 - E J Hearn, Butterworth- Heinemann
- 

**Semester-I**  
**Experimental Stress Analysis**

MMD104B	Experimental Stress Analysis	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												



Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

## **Course Contents:**

### **Unit 1**

INTRODUCTION: Need of stress analysis; Why experimental methods? Merits and demerits of experimental methods.

### **Unit 2**

BASICS OF ELASTICITY: Stress at a point; stress equations of equilibrium; 2-D state of stress; Strains and displacements; Stress strain relationship for 2-D state of stress; Plane stress and plane strain approach.

### **Unit 3**

MEASUREMENT OF STRAIN: Strain gauges: Mechanical, optical, electrical, acoustical and semiconductor; Grid method of strain analysis.

### **Unit 4**

ELECTRICAL STRAIN GAUGES: Gauge construction; Strain gauge adhesives and mounting techniques; Gauge sensitivity and gauge factor; Strain gauge linearity, hysteresis and zero shift; Temperature compensation; Environmental effects: moisture, humidity and hydrostatic pressure, high and cryogenic temperatures; The Wheatstone bridge; Calibration of strain gauge circuit; Strain analysis method: 3-element rectangular rosette, torque gauge.

### **Unit 5**

BASICS OF OPTICS: Nature of light; Wave theory of light; Optical instruments; Plane and circular polariscopes.

### **Unit 6**

THEORY OF PHOTOELASTICITY: Stress optics law; Effects of a stressed model in a plane polariscope; Effects of principal stress directions; Effects of principal stress difference; Effects of a stressed model in circular polariscope in dark and light field arrangements; 2-D Photoelasticity; Isochromatic and isoclinic fringe patterns; Materials for 2-D Photoelasticity; Introduction to moiré fringe technique and coating methods.

## **Texts/References:**

1. Doyle, J.F.: Modern Experimental Stress Analysis. J. Wiley, 2004.
  2. Dove Adams, Experimental Stress Analysis, McGraw Hill, 1992.
  3. CC Perry and HR Lissner, "The Strain Gage Primer", McGraw-Hill, 2000.
  4. Abdul Mubeen, "Experimental Stress Analysis", DhanpatRai and Sons, 2001.
  5. PS Theocaris, "Moire Fringes in Strain Analysis", Pergammon Press, 2002.
-

**Semester-I**  
**Advanced Machine Design**

MMD104C	Advanced Machine Design	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

**Course Contents:**

## **Unit 1**

**INTRODUCTION:** Statistical Considerations in Design for factor of safety, relationship between actual load and load capability, selection of factor of safety based on percentage estimates for tolerances on actual load and load capability and where the occurrence of the failure phenomenon would be disastrous.

## **Unit 2**

**OPTIMUM DESIGN:** Optimum design for mechanical elements by considering adequate design, optimum design, P.D.E., S.D.E., limit equations, principles of optimum design with normal specifications, redundant specifications, incompatible specifications, optimum design of tensile bar, torsion shaft, beams, step shafts and with combined loading.

## **Unit 3**

**MECHANICAL SPRINGS:** Design of square or rectangular bar helical springs, Belleville springs, ring springs, torsion bar springs, theory of square or rectangular bar helical springs under axial loading, cone or flat disc spring theory.

## **Unit 4**

**CAMS:** Basic curves, cam size determination, calculating cam profiles, advance curves, polydyne cams, dynamics of high speed cam systems, surface materials, stresses and accuracy, ramps.

## **Unit 5**

**FLAT PLATE:** Stress resultants in a flat plate, kinematics strain- displacement, relations for plates, equilibrium equation for small displacement, theory of plates, stress-strain temperature relations for isotropic elastic plates, strain energy of a plate, boundary conditions for plates, Circular plates with hole and without hole with different types of support and loading.

## **Unit 6**

**Advances in machine design:** Defining design, creativity, invention and innovation, design methodology, patterns of evaluation, design patents, functional approach, performance specifications, Quality Function Deployment, improvement of ideality, design strategy, problem definition, objective, top down and bottom up approaches, system, problem formulation, substance field analysis, morphological analysis, creative problem solving, inventive principle, evaluation of ideas or concepts, product design specifications, selection of best design.

## **Texts/References:**

1. Robert L. Norton, Machine Design: An Integrated Approach, Prentice-Hall New Jersey, USA.
2. George E Dieter, Engineering Design, McGraw Hill, 2008.

3. J.E. Shigley and L.D. Mitchell, Mechanical Engineering Design, McGraw Hill International Book Company, New Delhi.
  4. Hamrock, Schmid and Jacobian, Fundamentals of machine elements, 2<sup>nd</sup> edition, McGraw-Hill International edition.
  5. Karl T. Ulrich and Steven D. Eppinger, Product design and development, 3<sup>rd</sup> edition, Tata McGraw Hill.
  6. A.K. Chitale and R.C. Gupta, Product Design and Manufacturing, Prentice Hall
- 

**Semester-I**  
**Failure Analysis and Design**

MMD104D	Failure Analysis and Design	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												

CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

## **Course Contents:**

### **Unit 1**

**THEORIES OF FAILURE:** Maximum shear stress theory, Maximum normal stress theory, Maximum distortion energy theory, Maximum strain theory, Applicability of theories of failure.

### **Unit 2**

**FRACTURE:** Type of fracture, Theoretical cohesive strength of metals, Griffith theory of brittle fracture, fracture single crystals, Metallographic aspects of fracture, Dislocation theories of brittle fracture, Ductile fracture, Notch effects, Fracture under combined stresses.

### **Unit 3**

**ELEMENTS OF FRACTURE MECHANICS:** Strain- energy release rate, Stress intensity factor, Fracture toughness, Plane - strain toughness testing, Crack-opening displacement, J-Integral to solve energy of crack formation, R-curves, Toughness of material.

**FATIGUE FAILURE:** Stress cycle, S-N curve, Description of fatigue fractured parts, Phases of fatigue fracture, Fatigue crack propagation, Effects of metallurgical variables, Temperature, Stress concentration, Size and surface factors, Fatigue under combined stresses.

### **Unit 4**

**CREEP FAILURE:** Creep curve, Structural changes and mechanisms during creep, Activation energy for steady-state creep, Fracture at elevated temperature.

**BRITTLE FRACTURE:** Transition temperature curves, Fracture analysis diagrams, Various types of embrittlement, Fracture under very rapid loading.

### **Unit 5**

**DUCTILE FRACTURE:** Condition for necking, Dislocation and void formation activities, Types of fractured parts.

**ASSESSMENT OF TYPES OF FRACTURES BY OBSERVATION:** Comparison between different fractured parts undergoing various type of fracture.

### **Unit 6**

**DESIGN APPLICATION OF THE KNOWLEDGE OF FAILURE:** Design considering fatigue-Geber's parabola, Soderberg equation, lubricating optimally to combat bearing failures. Selection of materials to prevent seizure, galling, etc. Wear reduction techniques, Fracture toughness consideration in design.

## **Texts/ References:**

1. Madoyag, F., Metal Fatigue Design and Theory.
2. Sors, L., Fatigue Design of Machine Components, Pergamon Press.
3. Rolfe, S.T. and Barson, J.M., Fracture and Fatigue Control Structures, Prentice Hall.
4. Broek, D., Elementary Engineering Fracture Mechanics, Noordhoff.

5. Dieter, G.E., Mechanical Metallurgy, McGraw Hill Book Co., New Delhi.

---

**Semester-I**  
**Theory of Elasticity and Plasticity**

MMD104E	Theory of Elasticity and Plasticity	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

**Course Contents:****Unit 1**

INTRODUCTION: Stress transformation and Strain transformation at a point in an elastic body, 3D Problems, Rigid body translation and rotation of an element in space. Generalized Hook law, Separation of Elastic Strains and rigid body displacement for a general displacement field  $u, v, w$ . Principal Stress and Strains.

**Unit 2**

TWO DIMENSIONAL PROBLEMS IN ELASTICITY: Plane Stress and Plane Strain Problems. Differential equations of equilibrium and compatibility equations. Boundary Conditions & Stress Functions. Problems in Rectangular coordinates, Polynomial solutions, Cantilever loaded at the end, simply supported load beam under uniformly distributed load, linear loading, Two dimensional problems in polar coordinated, stress distribution symmetrical about an axis, pure bending of curved bar, Displacement for symmetric loaded cases, Bending of curved bar by forces at end. Effect of circular hole in plate under in plane loading. Concentrated load at point of Straight boundary. Stresses in circular disk. Forces acting on end of wedge.

**Unit 3**

THREE DIMENSIONAL PROBLEMS IN ELASTICITY: Differential equation of equilibrium in 3D, Condition of Compatibility, Determination of Displacement, Principal of superposition, Uniqueness theorem, Problems of Rods under axial stress, Bar under its own weight, Pure bending of Prismatic rods, Torsion of Prismatic bars of Elliptical, rectangular, triangular and other sections, Membrane Analogy-Torsion of narrow rectangular bars. Torsion of hollow shaft and thin tubes.

**Unit 4**

BENDING OF PRISMATIC BARS AS A PROBLEM OF ELASTICITY IN 3D: Bending of a cantilever, Stress function, Circular and rectangular sections, Non-symmetrical cross section. Shear Centre for different cross sections of bars, Calculation of deflections.

**Unit 5**

ENERGY THEOREMS: Applications of complimentary energy theorems to the problems of elasticity.

**Unit 6**

INTRODUCTION TO PLASTICITY: Criteria of yielding, strain hardening, rules of plastic flow, different stress strains relations. Total Strain theory, theorems of limit analysis. Elastoplastic bending and torsion of bars.

**Texts/References:**

1. Wang, "Applied Elasticity", McGraw hill book Co.
2. Timoshenko, "Theory of Elasticity", McGraw hill book Co.
3. J. Chakrabarti, "Theory of Plasticity", McGraw hill book Co.

**Semester-I**  
**Process Equipment Design**

MMD104F	Process Equipment Design	Elective	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, student should be able to:

CO1	Understand the factors influencing design of pressure vessel
CO2	Calculate thickness and thickness variation for cylindrical storage tank.
CO3	Estimation of thickness for thin and thick wall pressure vessels
CO4	Design of flange and gasket selection for cylindrical pressure vessels
CO5	Selection of various blade and baffle arrangement for agitators
CO6	Design of support for horizontal and vertical vessel

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	1		1			1	1	1				1
CO2	2	2	1			1	1	1				1
CO3	2	2	2			1	1	1				1
CO4	2	2	2			1	1	1				1
CO5	2	2	1			1	1	1				1
CO6	2	2	2			1	1	1				1



Note: 1- Means least contribution,

2- Means medium contribution,

3- Maximum contribution

## **Course Contents:**

### **Unit 1**

DESIGN CONSIDERATIONS FOR PRESSURE VESSEL: Introduction; Selection of type of vessel, Methods of fabrication, Effect of fabrication methods, Various criteria in vessel design, Economic considerations, Types of process equipment, Constructional requirement and applications., Fabrication and testing, Inspection and non-destructive testing of equipment.

### **Unit 2**

STORAGE VESSEL: Design methods of atmospheric storage vessel: storage of fluids, storage of non-volatile liquids, storage of volatile liquids, storage of gases, Optimum tank proportion, Bottom design, Shell design, Wind girder for open top tank, Rub curb angle, Self supported roof, Design of rectangular tank.

### **Unit 3**

PRESSURE VESSEL: Unfired process vessel with internal and external pressure, Operating condition, Selection of material, Design condition, Stresses, Design criteria, Design of shell subjected to internal and external pressure, Cylindrical vessel under combined loading, Design of heads and closures: flat head and formed heads for vessel. Design consideration for reactors and chemical process vessels. Flange facings, Gaskets, Design of flanged joint, Flange thickness, and Blind flanges.

### **Unit 4**

HIGH PRESSURE VESSEL: Design of thick walled high-pressure vessel, Constructional features, Materials for high-pressure vessels, Multilayer vessel with shrink fit construction, Thermal expansion for shrink fitting, stress in multishell or shrink fit construction, autofrettage, Pre-stressing. Tall vessels and their design, Stress in shell, Determinations of longitudinal stresses, Longitudinal bending stresses due to eccentric loads, Determination of resultant longitudinal stresses.

### **Unit 5**

AGITATED VESSEL: Type of agitators, Baffling, Power requirement for agitation, Design based on torque and bending moment, Design based on critical speed, Blade design, Hub and key design, Stuffing box and gland design, Turbine agitator design,

### **Unit 6**

SUPPORT FOR PRESSURE VESSEL: Bracket or lug support: Thickness of the base plate, Thickness of web (gusset) plate, Column support for bracket base plate for column or leg support. Skirt Support: Skirt design, Skirt bearing plate, and Anchor bolt design, Design of bolting chair. Saddle Support: Longitudinal bending moment, Stresses in shell at saddle.

## **Texts/References:**

- 1) Process Equipment Design by V.V .Mahajani and S. B. Umarji. Macmillan Publisher India Ltd.
- 2) Process equipment design by L.E.Brownell and E.H.Young, John Wiley and Sons.
- 3) Introduction to process Equipment Design by B.C. Bhattacharya

- 4) Pressure Vessel Design Manual by Dennis Moss, Elsevier  
 5) Theory and Design of Pressure Vessels by John F. Harvey, P. E., CBS Publication
- 

**Semester-I**  
**Tribology in Design**

MMD104G	Tribology in Design			PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)		End Semester Exam (60 Marks)			Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

## **Course Contents:**

### **Unit1**

SURFACES, FRICTION AND WEAR: Topography of Surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non-metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistance materials, Surface treatment, Surface modifications, Surface coatings.

### **Unit 2**

LUBRICATION THEORY: Lubricants and their physical properties lubricants standards, Lubrication Regimes in Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects.

### **Unit 3**

OTHER TYPES OF LUBRICATION: Electro-hydrodynamic (EHD), Magneto hydrodynamic lubrication, Hydro static lubrication, Gas lubrication, Solid lubrication.

### **Unit 4**

DESIGN OF FLUID FILM BEARINGS: Design and performance analysis of thrust and journal bearings, Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings, Hydrostatic Bearing design.

### **Unit 5**

ROLLING ELEMENT BEARINGS: Geometry and kinematics, Materials and manufacturing processes, Contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, Bearing life capacity and variable loads, ISO standards, Oil films and their effects, Rolling Bearings Failures.

### **Unit 6**

TRIBO MEASUREMENT AND INSTRUMENTATION: Surface Topography measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, bearing vibration measurement

## **Texts/References:**

1. Cameron A., "Basic Lubrication Theory", Ellis Horwood Ltd., UK, 1981
2. Halling J. (Editor) – "Principles of Tribology", Macmillian, 1984.
3. Williams J.A., "Engineering Tribology", Oxford Univ. Press, 1994.
4. Neale, M.J., "Tribology Hand Book", Butterworth Heinemann, 1995.
5. Stolarski T.a., "Tribology in Machine Design", Industrial Press Inc., 1990.

-----

**Semester-I**  
**Mechanics of Composite Materials**

MMD104H	Mechanics of Composite Materials	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

## **Course Contents:**

### **Unit 1**

INTRODUCTION, BASIC CONCEPTS AND CHARACTERISTICS: Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus, Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials.

### **Unit 2**

ELASTIC BEHAVIOUR OF UNIDIRECTIONAL LAMINA: Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters.

### **Unit 3**

STRENGTH OF UNIDIRECTIONAL LAMINA: Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macro-mechanical failure theories, Applicability of various failure theories.

### **Unit 4**

ELASTIC BEHAVIOR OF LAMINATE: Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, general load–deformation relations, Analysis of different types of laminates.

### **Unit 5**

HYGROTHERMAL EFFECTS: Hygro-thermal effects on mechanical behaviour, Hygro-thermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage.

### **Unit 6**

STRESS AND FAILURE ANALYSIS OF LAMINATES: Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials

## **Texts/References:**

1. Isaac M. Daniels, Ori Ishai, “Engineering Mechanics of Composite Materials”, Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, “Analysis and Performance of fiber composites”, John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., “Composite Materials: Engineering and Science”, CRC Press, Boca Raton, 2003.
4. Madhujit Mukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press, 2004.
5. Mazumdar S. K., “Composite Manufacturing – Materials, Product and Processing Engineering”, CRC Press, Boca Raton, 2002.

-----

**Semester-I**  
**Instrumentation & Automatic Control**

MMD104I	Instrumentation & Automatic Control	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

**Course Contents:**

**Unit 1**

Introduction to measurements for scientific and engineering application need and goal. Broad category of methods for measuring field and derived quantities

**Unit 2**

Principles of measurement, parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data

**Unit 3**

Measurement of field quantities, thermometry, heat flux measurement, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration, measurement of the above by probe and non-instructive techniques

**Unit 4**

Measurement of derived quantities, torque, power, thermo physical properties, radiation and surface properties

**Unit 5**

Analytical methods and pollution monitoring, mass spectrometry, chromatography, spectroscopy

**Unit 6**

Basics of P, PI, PID controllers, pneumatic and hydraulic controllers, electronic controllers, applications to machine tools, furnaces, material handling etc

**Texts/References**

- 1) Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.
- 2) Beckwith TG. N. Lewis Buck and Marangoni R.D: Mechanical Measurements, Narosa Publishing House, New Delhi
- 3) Liptak B.G. Instrument Engineers' Handbook
- 4) Bolton W, Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg.
- 5) Modern Electronic Instrumentation and Measurement Technique by A.D. Helfrick and W.D. Cooper
- 6) Johnson C.D., Process Control Instrumentation
- 7) J.P.Holman: Experimental Methods For Engineers, McGraw Hill International Edition, Seventh Edition

**Semester-I**  
**Material Handling Equipment Design**

MMD104J	Material Handling Equipment Design	PEC	3-0-0	3 Credits
---------	------------------------------------	-----	-------	-----------

Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)
--------------------------	-------------------------------------	---------------------------------	----------------------

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

**Course Contents:**

**Unit 1**

ELEMENTS OF MATERIAL HANDLING SYSTEM: Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipment's.



## **Unit 2**

SELECTION OF MATERIAL HANDLING EQUIPMENT'S: Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials.

## **Unit 3**

DESIGN OF MECHANICAL HANDLING EQUIPMENT'S:

Design of Hoists: Drives for hoisting, components, and hoisting mechanisms; rail traveling components and mechanisms; hoisting gear operation during transient motion; selecting the motor rating and determining breaking torque for hoisting mechanisms.

Design of Cranes: Hand-propelled and electrically driven E.O.T. overhead Traveling cranes; Travelling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius; fixed post and overhead traveling cranes; Stability of stationary rotary and travelling rotary cranes.

## **Unit 4**

DESIGN OF LOAD LIFTING ATTACHMENTS: Load chains and types of ropes used in Material Handling System; Forged, Standard and Ramshorn Hooks; Crane Grabs and Clamps; Grab Buckets; Electromagnet; Design consideration for conveyor belts; Application of attachments.

## **Unit 5**

STUDY OF SYSTEMS AND EQUIPMENT USED FOR MATERIAL STORAGE: Objectives of storage; Bulk material handling; Gravity flow of solids through slides and chutes; Storage in bins and hoppers; Belt conveyors; Bucket-elevators; Screw conveyors; Vibratory Conveyors; Cabin conveyors; Mobile racks etc.

## **Unit 6**

MATERIAL HANDLING / WAREHOUSE AUTOMATION AND SAFETY CONSIDERATIONS: Storage and warehouse planning and design; computerized warehouse planning; Need, Factors and Indicators for consideration in warehouse automation; which function, When and How to automate; Levels and Means of Mechanizations, Safety and design; Safety regulations and discipline.

## **Texts/References:**

- 1] N. Rudenko, 'Material Handling Equipments', Peace Publishers, Moscow.
- 2] James M. Apple, 'Material Handling System Design', John-Willlwy and Sons Publication, New York.
- 3] John R. Immer, 'Material Handling' McGrawHill Co. Ltd., New York.
- 4] Colin Hardi, 'Material Handling in Machine Shops'. Machinery Publication Co. Ltd., Landon.
- 5] M .P. Nexandrn, 'Material Handling Equipment', MIR Publication, Moscow.
- 6] C. R. Cock and J. Mason, 'Bulk Solid Handling', Leonard Hill Publication Co. Ltd., U.S.A.
- 7] Spivakovsy, A.O. and Dyachkov, V.K., 'Conveying Machines', Volumes I and II, MIR Publishers, 1985.
- 8] Kulwiac R. A., 'Material Handling Hand Book', 2nd edition, JohnWilly Publication,

NewYork.

-----

**Semester-I**  
**Machine Tool Design**

MMD104K	Machine Tool Design		Elective	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)			Total (100 Marks)

**Pre-Requisites: None**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Study kinematics of various machine tools.
CO2	Understand principles of various machine tool feed and speed drives.
CO3	Design power screws, slideways and machine tool spindle with bearings.
CO4	Design structure and other auxiliary mechanism of machine tool.
CO5	Apply modular design aesthetics and ergonomics for machine tool.
CO6	Study acceptance test of machine tools and methods of machine tool condition.

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	2	2	1	3		1	2			1		1
CO2	2	2	1	2		1	1			1		1
CO3	2	1		2	2						1	1
CO4	2	1		2	2						1	1
CO5	2	2		1	2	2			2	2	1	1
CO6	2	2	1	2	2	1		1		1		1

## **Course Contents:**

### **Unit 1**

Introduction to metal cutting machine tools- criteria for the selection of operating capacity and design parameters, kinematics of machine tools.

### **Unit 2**

Basic principles of machine tool design, estimation of drive power, machine tool drives, electrical, mechanical and fluid drives, stepped and step less speed arrangements and systems.

### **Unit 3**

Design of machine tool spindles and bearings, design of power screws, design of slide ways, selective and pre-selective mechanisms.

### **Unit 4**

Machine tool structures-beds, columns, tables and supports, stock feed mechanism, Measurement and control of machine tools, protective and safety devices, design of precision machine tools.

### **Unit 5**

Micro-feeding mechanisms, concept of modular design and integration of SPM's, Concepts of aesthetic and ergonomics applied to machine tools.

### **Unit 6**

Acceptance tests standardization of machine tools, machine tool conditioning, latest trends in machine tool design, Introduction to CAD techniques.

## **Texts/References:**

1. N. K.Mehta , Machine tool design, Tata Mcgraw-hill, New Delhi, 1989.
2. N.Acherkan, Machine tool design, Vol. 3 and 4, Mir publisher, Moscow, 1968.
3. A.Koenigsburger, Design principles of metal cutting machine tools, Pergamon press, 1964.
4. C.M.T.I. Machine tool design course notes, C.M.T.I. Bangalore.
5. G.Sen and A.Bhattacharya , Principles of machine tools, Vol. 2, NCB, Calcutta, 1973.

---

**Semester I**  
**Design Lab**

MMDL105	Design Lab	PCL	3-0-0	3 Credits
	Continuous Assessment (25 Marks)	Oral / Practical (25 Marks)		Total (50 Marks)

**Pre-Requisites: None**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

**Course Contents:**

1. Experiment on damped vibration
2. Torsional vibration analysis
3. Experiment based on failure analysis of mechanical component.
4. Design of mechatronic system for mechanical application

5. Demonstration of process control such as temp, level, flow, etc control using PID controller

(Experiments No 6 to 15 to be performed using commercially available software)

6. 2D element problem linear static analysis

7. 3D element problem linear static analysis

8. Static analysis of any mechanical component

9. Dynamic analysis of any mechanical component

10. Modal analysis of cantilever beam

11. Thermal analysis of mechanical component

12. Design and modeling of mechanical component using commercial software

13. Stress Analysis of composite shaft

14. Modal analysis of composite shaft

15. Optimization techniques using MATLAB

**Note: Minimum 3 experiments to be performed from 1 to 5 and 7 experiments from remaining.**

---

**Semester-II**  
**Finite Element Methods**

MMD201	Finite Element Methods	PCC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Understand the basics principle of FE method
CO2	Identify mathematical model for solution of common problems
CO3	Solve structural, thermal problem using FE in 1D Case
CO4	Derive element stiffness matrix by different methods
CO5	Understand the formulation for 2D and 3D case
CO6	Recognize need for and engage in lifelong learning

**Mapping of course outcomes with program outcomes**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	3	3	1		1							1
CO3	2	2	1	2	2				2			1
CO4	3								2			
CO5	3	2										
CO6			1									3

**Course Contents:**

**Unit 1**

1-D PROBLEMS: Introduction to structural analysis and FEM, Introduction to approximate solutions and FEM, summary of linear elastic mechanics.

**Unit 2**

1-D PROBLEMS: Principles of linear elastic mechanics, principles of virtual displacements and minimum potential energy, Rayleigh Ritz method, exact v/s approximate solution, beam elements.

**Unit 3**

2-D PROBLEMS: Plane stress and plane strain conditions, triangular elements, constant strain triangle, linear strain triangle, Boundary conditions, body forces and stress recovery, quadrilateral elements.

#### Unit 4

2-D PROBLEMS: Lagrange and Serendipity shape functions, isoparametric formulation, numerical integration, modeling with isoparametric elements, requirements for convergence, patch test, nonconforming elements, reduced integration.

#### Unit 5

3-D PROBLEMS: Axisymmetric solids, governing equations, axisymmetric elements and their applications, mixed formulations, bending of flat plates (Kirchhoff Theory), continuity requirements and boundary conditions.

#### Unit 6

3-D PROBLEMS: Discrete Kirchhoff's elements, thick plate elements, plate bending applications, shells as assemblage of flat plates, finite element formulation for dynamic problems, mass properties, introduction to elastic stability for frames and plates.

#### Texts / References:

1. R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley and Sons, second edition, 1981.
  2. C.S. Krishnamurti, Finite element method, Tata Mc-Graw Hill Publication.
  3. K.J. Bathe, Finite Element Method and Procedures, Prentice hall, 1996.
  4. Tirupathi, R., and Chandrupatla, Finite Elements in Engineering, PHI Publication, New Delhi.
  5. Bruce Irons and Soharab Ahmed, Techniques of Finite Elements, John Wiley and Sons, New York.
  6. K.J. Bathe, Finite Element Method, Prentice Hall, 1987.
  7. O.P., Gupta, Finite and Boundary Element Methods in Engineering, Oxford and IBH.
- 

### Semester-II Design Optimization

MMD202	Design Optimization	PCC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Prerequisite:** None

**Course Outcomes:** At the end of the program the student will be able to:

CO1	
CO2	

CO3	
CO4	
CO5	

### Mapping of course outcomes with program outcomes

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	1	1						1		1		1
CO2	2	1	1					1				
CO3		2							1			
CO4	1				2	1				2		1
CO5			1	2	1	1	2		1	2		1

### Course Contents:

#### Unit 1

INTRODUCTION: Optimal problem formulation, engineering optimization problems, optimization algorithms. Single Variable Optimization Algorithms: Optimality criteria, bracketing methods, region elimination methods, point estimation methods, gradient based methods, root finding using optimization techniques.

#### Unit 2

MULTIVARIABLE OPTIMIZATION ALGORITHMS: Optimality criteria, unidirectional search, direct search methods, gradient based methods, Computer programs on above methods.

#### Unit 3

CONSTRAINED OPTIMIZATION ALGORITHMS: Kuhn-Tucker conditions, transformation methods, sensitivity analysis, direct search for constrained minimization, linearized search techniques, feasible direction method, generalized reduced gradient method, gradient projection method, Computer programs on above methods.

#### Unit 4

SPECIAL OPTIMIZATION ALGORITHMS: Integer programming, Geometric programming, Genetic Algorithms, Simulated annealing, global optimization, Computer programs on above methods.

#### Unit 5

OPTIMIZATION IN OPERATIONS RESEARCH: Linear programming problem, simplex method, artificial variable techniques, dual phase method, sensitivity analysis

#### Unit 6

STOCHASTIC PROGRAMMING: Basic concepts of probability theory, random variables Distributions – mean, variance, Correlation, co variance, joint probability distribution stochastic linear, dynamic programming.



**Texts/References:**

1. Deb Kalyanmoy, "Optimization in Engineering Design", PHI, New Delhi
2. Rao S. S. "Engineering Optimization", John Wiley, New Delhi.
3. Deb Kalyanmoy, "Multi-objective Algorithms using Evolutionary Algorithms", John Wiley, New Delhi.
4. Paplambros P. Y. and Wilde D. J., "Principles of Optimum Design: Modeling and Computation", Cambridge University Press, UK
5. Chandrupatla, "Optimization in Design", PHI, New Delhi.

**Semester-II**  
**Engineering Fracture Mechanics**

MMD203A	Engineering Fracture Mechanics	PCC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Prerequisite:**

**Course Outcomes:** At the end of the program the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												

**Course Contents:****Unit 1**

INTRODUCTION: - Macroscopic failure mode, ideal fracture strength, energy release rate, Fracture Modes

## **Unit 2**

**FRACTURE CRITERIA:** Griffith criterion, Irwin's Fracture Criterion, Stress Intensity Approach, Stress intensity factor, crack tip plasticity, crack opening displacement, plastic constraint

## **Unit 3**

**METHODS FOR EVALUATING FRACTURE TOUGHNESS:**

Numerical Methods: - Finite Elements (FE), Finite Differences (FD), Boundary Integral Equations (BIE)

Experimental Methods: - Compliance Method, Photoelasticity. Interferometry and Holography

## **Unit 4**

**EXPERIMENTAL EVALUATION OF FRACTURE TOUGHNESS:** Plane strain fracture toughness,  $J$ -Integral

## **Unit 5**

**FATIGUE MECHANICS:** S-N diagram, fatigue limit, fatigue crack growth rate, Paris law.

## **Unit 6**

**CREEP MECHANICS:** Creep deformation, creep strength, creep-fatigue interaction

## **Texts/References:**

1. Fundamentals of Fracture Mechanics, T. Kundu, Pub. CRC Press (Taylor and Francis), 2008, ISBN 0-8493-8432-5
2. T. Anderson, Fracture Mechanics, CRC Pub.
3. D. Broek, Elementary Engineering Fracture Mechanics, 4th Revised Edition, Kluwer Academic Pub., 1991, ISBN 90-247-2656-5.
4. K. Hellan, Introduction to Fracture Mechanics, McGraw-Hill, 1984.
5. G. Sih, Handbook of Stress Intensity Factors.
6. Timoshenko, S.P. and J.N. Goodier, "Theory of Elasticity", McGraw Hill (1970).
7. Broek, D., "Elementary Engineering Fracture Mechanics", 4th edition, MartinusNijhoff(1987).
8. Rolfe, S.T. and J.M. Barsom, "Fracture and Fatigue Control in Structures, Applications of Fracture Mechanics", Prentice Hall (1977).
9. Hellan, K., "Introduction to Fracture Mechanics" McGraw-Hill (1985).
10. Maiti S. K., Fracture Mechanics: Fundamentals and Applications, Cambridge University Press, 2015.

## **Handbooks:**

1. Tada, H., Paris, P. and Irwin, G., "The stress Analysis of Cracks Handbook" 3rd edition, ASME Pren (2000).
2. Rooke, D.P. and Cartwright, D.J., "Compendium of Stress Intensity Factors", Her Majestys Stationery Office, London (1976).
3. Murakami, Y. Editor in Chief, "Stress Intensity Factors Handbook", Pergamon

Press (1988) (3 Volumes).

-----

**Semester-II**  
**Robotics**

MMD203B	Robotics	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Study the manipulators and its kinematics.
CO2	Classify the actuators and study their characteristics.
CO3	Understand the motions of robots and its control.
CO4	Determination of the solution to inverse kinematics and trajectory planning in robot movements.
CO5	Acquire the knowledge of sensors used in robots.
CO6	Write a program for robot motion and control.

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	2			1								
CO2	2			1								1
CO3	2			1								
CO4	2			1						2		
CO5	2			1								1
CO6	2			1								

**Course Contents:**

**Unit 1**

INTRODUCTION: Review, forward and inverse kinematics, dynamics, Robots with Flexible Elements: Robots with Flexible Joints, Robots with Flexible Links

**Unit 2**

PARALLEL MECHANISMS AND ROBOTS: Definitions, Type of Synthesis of Parallel Mechanisms, Kinematics, Velocity and Accuracy Analysis, Singularity Analysis, Workspace Analysis, Static Analysis and Static Balancing, Dynamic Analysis, Design

**Unit 3**

MOBILE ROBOTS: Wheeled mobile robots: mobile robot kinematics, Mobility of Wheeled Robots, State-Space Models of Wheeled Mobile Robots, Wheeled Robot Structures, sensors for mobile robots, planning and navigation Legged robots: Analysis of Cyclic Walking, Control of Biped Robots Using Forward Dynamics, Biped Robots in the ZMP Scheme, Multilegged Robots, Performance Indices

**Unit 4**

COOPERATIVE MANIPULATORS: Kinematics and Statics, Cooperative Task Space, Dynamics and Load Distribution, Task-Space Analysis,

**Unit 5**

CONTROL OF MANIPULATORS: Manipulator control problem; Linear and nonlinear control schemes; PID control scheme; Force control.

**Unit 6**

IMAGE PROCESSING AND ANALYSIS WITH VISION SYSTEMS: Acquisition of images, digital images, image processing techniques, noise reduction, edge detection, image analysis, object recognition by features, application of vision systems

**Texts / References:**

1. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, Robotics, McGraw Hill New york, 1987.
2. Y. Koren, Robotics for Engineers, McGraw Hill, 1985.
3. J. J. Craig, Robotics, Addison-Wesley, 1986.

**Semester-II  
Mechatronics**

MMD203C	Mechatronics	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:** Basic Electronics

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

CO1	Define sensor, transducer and understand the applications of different sensors and transducers
CO2	Explain the signal conditioning and data representation techniques
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Write a PLC program using Ladder logic for a given application
CO5	Understand applications of microprocessor and micro controller
CO6	Analyze PI, PD and PID controllers for a given application

**Mapping of course outcomes with program outcomes**

Program	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
---------	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------

Outcomes→												
Course Outcomes ↓												
CO1	1	1	1	3	2				2	1		1
CO2	3	2			3	3	2				1	3
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3			1	3	2	3					2
CO6		3	3		3	3	1	1	3			2

## Course Contents:

### Unit1

**INTRODUCTION:** Introduction to Mechatronic systems, elements, advantages and practical examples of Mechatronic systems.

**SENSORS AND TRANSDUCERS:** Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

### Unit2

**SIGNAL CONDITIONING AND DATA REPRESENTATION:** Types of electronic signals, need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays, Data representation systems, Displays, seven segment displays, LCD displays, Printers, Data loggers, Data Acquisition Cards/Systems

### Unit3

**ELECTRICAL DRIVES:** Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.

**PNEUMATICS AND HYDRAULICS:** Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electro-pneumatic valves, Electro- pneumatic circuits using single and double solenoid methods. Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

### Unit4

**MICROPROCESSOR AND MICROCONTROLLER:** 8085 microprocessor, architecture, various types of registers and their functions in 8085 $\mu$ P, Instruction sets, interfacing, applications. 8081 microcontroller, architecture, Instruction sets, various pins and their functions interfacing, applications.

**PROGRAMMABLE LOGIC CONTROLLER:** Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for Selection of PLCs, Programming: Ladder logic and FBD

### Unit 5

**CONTROL SYSTEMS:** Open and closed loop system; block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using spring, Dashpot and Mass equivalence.

### Unit 6

**STABILITY OF SYSTEMS:** On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stability criteria.

### Texts / References:

1. HMT Limited, Mechatronics, Tata McGraw-Hill, 1998.
2. Bolton, W. Mechatronics; Electronic Control System in Mechanical Engineering, Pearson Education Asia, 1999.
3. Raven, Automatic Control Engineering, McGraw Hill, New York, 1986

## Semester-II Biomechanics

MMD203D	Biomechanics	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:** None

**Course Outcomes:** At the end of the course, student should be able to:

CO1	Explain various forces and mechanisms and define Newton's law of motion, work and energy, moment of inertia
CO2	Describe forces and stresses in different human joints
CO3	Discuss bio fluid mechanics in cardiovascular and respiratory system in human body
CO4	Differentiate between hard tissues and soft tissues
CO5	Understand concepts of implants and Identify different techniques used in biomechanics implants

### Mapping of course outcomes with program outcomes

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course												

Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

## Course Contents:

### Unit 1

INTRODUCTION: Review of principle of mechanics, vector mechanics-resultant forces of coplanar & non-coplanar and concurrent & non-concurrent forces, parallel forces in planes, equilibrium of coplanar forces, Newton's law of motion, work and energy, moment of inertia.

### Unit 2

BIOMECHANICS OF JOINTS: Skeletal joints, forces and stresses in human joints, type of joints, biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle.

### Unit 3

BIOFLUID MECHANICS: Introduction, viscosity and capillary viscometer, Rheological Properties of blood, laminar flow, cardiovascular and respiratory system.

### Unit 4

HARD TISSUES: Bone structure and composition, Mechanical properties of bones, cortical and cancellous bones, visco-elastic properties, Maxwell and Vigot model – Anisotropy

### Unit 5

SOFT TISSUES: Structure and functions of soft tissue: cartilage, tendon, ligament and muscle, Material properties of cartilage, tendon and ligament and muscle

### Unit 6

BIOMECHANICS OF IMPLANT: Specification for prosthetic joints, biocompatibility, requirement of biomaterial, characterization of different type of biomaterials, fixation of implants.

## Texts & References:

1. Y. C. Fung, Biomechanics: Mechanical properties of living tissues, springer-verlag, 2<sup>nd</sup> edition, 1993
  2. D. J. Schneck and J D Bronzino, Biomechanics-principle and applications, CRC Press, 2<sup>nd</sup> edition, 2000
-

**Semester-II**  
**Computational Techniques in Design Engineering**

MMD203E	Computational Techniques in Design Engineering	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, student should be able to:

CO1	Solve a set of algebraic equations representing steady state models formed in engineering problems
CO2	Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables
CO3	Predict the system dynamic behavior through solution of ODEs modeling the system
CO4	Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.
CO5	Demonstrate proficiency of using MATLAB, VB, ANSYS, EES etc.,

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1		2	1									
CO2			1									
CO3	1					1						
CO4		1		2								
CO5		1		1								
CO6		2	1	3								2

**Course Contents:**

**Unit1**

DATA ANALYSIS AND CURVE FITTING: Errors in numerical calculations, Interpolation by central differences, sterling Bessel & Everett Formulae, Interpolation Formula for unequal Intervals, Spline Interpolation, Cubic Splines. Least square method for linear & non-linear functions, weighted least square methods.

**Unit 2**

SOLUTION OF LINEAR SYSTEM OF EQUATIONS: Gauss Elimination with Pivoting, LU Decomposition method, Iterative methods, Eigen vectors-Jacobi method, Jacob's method, Gauss Siedel method.



### Unit 3

Solution of Ordinary Differential Equation, Numerical Differentiation & Integration: Differentiation by Finite Differences, Numerical Integration by Newton-Cotes formula & Gauss Quadrature. Picard's Method, Euler's & Modified Euler's Method, Runge-Kutta Method (up to fourth order), Predictor-Corrector Methods, Milne Sompson, Adams Bashforth Moulten Methods.

### Unit 4

BOUNDARY VALUE AND EIGEN VALUE PROBLEMS: Shooting method, finite difference method to solve boundary value problems, Polynomial method, power method to solve Eigen value problems.

### Unit 5

SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS: Finite difference method, solution of Laplace & Parabolic equations.

### Unit 6

Mathematical Modeling of Physical Problems, modeling Concept, Modeling of Linear Differential Equations of Second order.

### Texts/References:

1. Dr. B.S. Grewal, Numerical methods for science & Engg., Khanna publications.
2. M.K. Jain, Numerical methods for Scientific & Engg. Computation, New age international publication.
3. E. Balagurusamy, Numerical methods, Tata Mc Graw Hill Publications.
4. K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd Edition, Wiley-India, 2004.
5. J. D. Hoffman and Steven Frankel, Numerical Methods for Engineers and Scientists, 2nd Edition, McGraw-Hill, 2001
6. S. D. Conte and Carl de Boor, Elementary Numerical Analysis - An Algorithmic Approach, 3rd Edition, McGraw-Hill, 1980.
7. S. S. Shastry, Introductory methods of numerical analysis, Third edition, Prentice hall of India publications pvt. Ltd.
8. Swami, Saran Singh, Computer programming and numerical methods.
9. J.N. Kapoor, Mathematical modeling

-----

### Semester-II

#### Design for Manufacturing & Assembly

MMD203F	Design for Manufacturing and Assembly	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, student should be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

**Course Contents:****Unit1**

DESIGN FOR MANUFACTURING: reduce the cost of manufacturing process, understanding the process and constraints, standard components and process, consider the impact of DFM decisions and other factors.

**Unit2**

DESIGN CONSIDERATION IN METAL CASTING: Mold and Gating System Design, Directional Solidification, and Troubleshooting.

**Unit 3**

DESIGN FOR WELDING: selection of materials for joining, welding defects, minimize the residual stresses etc. Design for forging and sheet metal and powder metal process.

**Unit 4**

SELECTION OF MATERIALS: choice of materials, organizing material and processes.

**Unit 5**

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

## Unit6

Design for assembly and automation

### Texts/References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
  2. Harry Peck, "Design for Manufacture", Pittman Publication 1983.
  3. Robert Matousek, "Engineering Design – A systematic approach", Blackie & sons Ltd., 1963.
  4. James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Co., 1986
  5. Swift K. G. "Knowledge based design for manufacture", Kogan Page Ltd., 1987.
- 

### Semester-I Advance Engineering Materials

MMD203G	Advance Engineering Materials	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

### Pre-Requisites:

**Course Outcomes:** At the end of the course the student will be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

### Mapping of course outcomes with program outcomes

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												

CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution    2- Means medium contribution    3- Maximum contribution

## **Course Contents:**

### **Unit 1**

**SPECIAL STEELS:** Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels etc.

### **Unit 2**

**ALLOY CAST IRON:** Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant cast iron: Composition, Properties and their applications.

### **Unit 3**

**LIGHT METALS AND THEIR ALLOYS:** Aluminum, magnesium and titanium alloys: Metallurgical aspects, Properties and applications

### **Unit 4**

**SUPER ALLOYS:** Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications.

### **Unit 5**

**NANO MATERIALS:** Definition, Types, Properties and applications, Carbon nano tubes, Methods of production.  
**SMART MATERIALS:** Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto- rheological fluids.

### **Unit 6**

BIOMATERIALS: Property requirement, biocompatibility, bio-functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications

**Texts/References:**

1. The Science and Engineering of Materials by D. R. Askeland and P. P. Phule, Thomson Publication
2. Advances in Material Science by R. K. Dogra and A. K. Sharma
3. Material science by Van Black.
4. Engineering Materials and Applications by R. A. Flinn and P. K. Trojan
5. Materials, their Nature, Properties and Fabrication by R. A. Lindberg and S. D. Sehgal, S Chand & Co.
6. Light Alloys: Metallurgy of Light Metals by I. J. Polmear
7. Engineering Materials: Properties and applications of Metals and alloys by CP Sharma, PHI
8. Engineering Materials: Polymers, ceramics and composites by AK Bhargava, PHI
9. Nano Technology by AK Bandyopadhyay, New age international publishers

**Semester-II**  
**Design of Piping System**

MMD203H	Design of Piping System	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, student should be able to:

CO1	Understand the piping connections, fittings, piping codes, standards and piping representation
CO2	Describe different piping layouts and understand the design of different piping systems
CO3	Analyze and identify the suitable pipe installations
CO4	Calculate different stresses and reactions in given piping layout
CO5	Explain different process auxiliaries in piping systems
CO6	Design of piping in various systems such as refrigeration, steam power plant, underground piping system etc.

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												

CO2												
CO3												
CO4												
CO5												
CO6												

## **Course Contents:**

### **Unit1**

PROCESS PIPING: Scope of Piping; Code and Standards; Mechanical Design Fundamentals; Mechanical design of piping system; Wall thickness; Piping size selection; Steel and cast iron pipe; Steel and wrought iron pipe; Light wall pipe; Tubing; Pipe connection and fittings; Rail fittings; Piping elements and specialties; Pipe representation; Welded and flanged fittings; Valves.

### **Unit2**

PIPING SYSTEM LAYOUT AND DESIGN: Piping layout; Equipment Layout; Process Piping Layout; Utility Piping Layout; Pipe flow sheets; Tube fastening and attachment; Non-ferrous tube fittings; Ducts and elbows; Pipe and tube design data; Design of steam piping; Design of oil piping; Design of cast iron pipe; Miscellaneous design and applications: Pipeline; Flexibility expansive forces in pipelines; Expansion stresses and reaction pipelines.

### **Unit3**

PIPE INSTALLATION: Selection of materials; Piping design; Basic principle; Piping sketches; Steam reducing and regulating valves; Selection of pipe size; Pipe hydraulics and sizing; Flow of water in pipes; Economical pipe selection; Selection of steam pipe size; Determination of steam pipe size; Development of plot plan; Flexibility analysis.

### **Unit4**

PROCESS AUXILIARIES: Piping; Explanation of code; Methods of fabrication; Nominal pipe size; Non-metallic piping and tubing; Pipe sizing by internal diameter; Choosing the final pipe size; Process steam piping; Pressure relief system; Pressure relief devices; Design of pressure relief system; Layout by scale model method.

### **Unit5**

MECHANICAL PIPING DESIGN: Piping drawings; Piping stress design; Internal or external fluid pressure stresses; Design of overhead piping; Design of underground piping; Erection of piping and support; Insulation; Drainage piping design; Design of natural gas pipeline.

### **Unit6**

DESIGN OF PIPING SYSTEM FOR THE FOLLOWING APPLICATIONS: Refrigeration piping system, Cryogenic piping system, Transmission piping system, Steam power plant piping system, Underground steam-piping system, Underground petroleum piping, Submerged piping for petroleum products, Piping system sprinklers, Non-metallic piping; Selection and joining techniques; Cross Country Pipe Technology.

## **Texts/References:**

1. J. M. Coulson, R. K. Sinnott and J. F. Richardson, 'Chemical Engineering' vol.6, Maxwell

- McMillan International Edition.
2. Sabin Crocker, 'Piping Handbook' Fifth Edition, McGraw Hill Publication.
  3. Sahu G. K. handbook of Piping Design, New Age International, 1998
- 

**Semester-II**  
**Vehicle Dynamics**

MMD203I	Vehicle Dynamics	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, student should be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

**Course Contents:**

**Unit 1**

INTRODUCTION TO VEHICLE DYNAMICS

**Unit 2**

LONGITUDINAL DYNAMICS: Vehicle Load Distribution – Acceleration and Braking - Brake Force Distribution, Braking Efficiency and Braking Distance - Longitudinal dynamics of a Tractor-Semi Trailer

**Unit3**

**TIRE MECHANICS – AN INTRODUCTION:** Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance – Tire Construction and Force Development- Contact Patch and Contact Pressure Distribution

**Unit 4**

**A SIMPLE TIRE MODEL:** Lateral Force Generation - Ply Steer and Conicity - Tire Models – Magic Formula Classification of Tire Models and Combined Slip

**Unit 5**

**LATERAL DYNAMICS:** Bicycle Model - Stability and Steering Conditions - Understeer Gradient and State Space Approach – Handling Response of a Vehicle - Mimuro Plot for Lateral Transient Response - Parameters affecting vehicle handling characteristics

**Unit 6**

**VERTICAL DYNAMICS:** Rollover Prevention - Half Car Model - Quarter Car Model

**Texts/References:**

1. Pacejka, Hans. Tire and vehicle dynamics. Elsevier, 2005.
2. Wong, Jo Yung. Theory of ground vehicles. John Wiley & Sons, 2001.
3. Moore, Desmond F. "The friction of pneumatic tyres." (1975).
4. Jazar, Reza N. Vehicle dynamics: theory and application. Springer, 2008
5. Gillespie, Thomas D. Fundamentals of vehicle dynamics, 1992

**Semester-II****Noise, Vibration and Harshness**

MMD203J	Noise, Vibration and Harshness	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, student should be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**



Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

## Course Contents:

### Unit 1

NVH IN THE AUTOMOTIVE INDUSTRY: Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

### Unit 2

SOUND AND VIBRATION THEORY: Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.

### Unit 3

TEST FACILITIES AND INSTRUMENTATION: Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings., Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis

### Unit 4

SIGNAL PROCESSING: Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.

### Unit 5

NVH CONTROL STRATEGIES & COMFORT: Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimisation of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.

### Unit 6

NVH LEGISLATIONS: Psycho-acoustics and effect of noise on human beings, Ambient air quality standards, Noise specifications for automotive vehicles – pass-by & stationary and Noise specifications for generator sets, fire crackers and household articles.

## Texts/References:

1. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
2. Ewins D. J., Model Testing: Theory and Practice, John Wiley, 1995.
3. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993.

4. McConnell K, “Vibration Testing Theory and Practice”, John Wiley, 1995.
  5. Legislation standard
  6. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press, 1989
  7. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987
- 

**Semester-II**  
**Rotor Dynamics**

MMD204K	Rotor Dynamics	PEC	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, student should be able to:

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

**Course Contents:**

**Unit 1**

Introduction to Vibration and the Laval-Jeffcott Rotor Model: Co-ordinate systems, Steady state rotor motion, Elliptical motion, Single degree of freedom systems, Free and forced vibrations.

**Unit 2**

The two degrees of freedom rotor system, Geared systems, Translational motion, Natural

frequencies and Natural modes, Steady state response to unbalance, The effect of flexible support.

### Unit 3

Torsional Vibrations of Rotating Machinery: Modeling of rotating machinery shafting, Multi degree of freedom systems, Determination of natural frequencies and mode shapes, Branched systems, Numerical methods for fundamental frequency.

### Unit 4

Rigid Rotor Dynamics and Critical Speed: Rigid disk equation - Rigid rotor dynamics, Rigid rotor and flexible rotor, the gyroscopic effect on rotor dynamics, whirling of an unbalanced simple elastic rotor, Unbalance response, Orbital Analysis and Cascade Plots, Simple shafts with several disks, Effect of axial stiffness, Determination of bending critical speeds, Campbell diagram.

### Unit 5

Influence of Bearings on Rotor Vibrations: Support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings, Computation and measurements of journal bearing coefficients, Mechanics of Hydro Dynamic Instability, Half frequency whirl and Resonance whip, Design configurations of stable journal bearings.

### Unit 6

Balancing of Rotors: Single plane balancing, Multi-plane balancing, balancing of rigid rotors, Balancing of flexible rotors, Influence coefficient and modal balancing techniques for flexible rotors.

### Texts/References:

1. J. S. Rao, "Rotor Dynamics", New Age International Publishers, New Delhi.
  2. S. Timoshenko, D H. Young and W. Weaver, "Vibration Problems in Engineering", John Wiley.
  3. W J Chen and J E Gunter, "Introduction to Dynamics of Rotor – Bearing Systems", Trafford Publishing Ltd.
  4. T. Yamamoto and Y. Ishida, "Linear and Nonlinear Rotor Dynamics: A Modern Treatment with Applications", John Wiley.
  5. V J. S. Rao, "Vibratory Condition Monitoring of Machines", Narosa Publishing House.
- 

### Semester-II Research Methodology

MMD204A	Research Methodology	OE	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites: None**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Understand and Describe importance of research.
CO2	Classify and select appropriate resources for Research.
CO3	Analyze the contents of literature and identify further scope.
CO4	Formulate a Research Problem.
CO5	Develop effective written and oral Presentation skills.

**Mapping of course outcomes with program outcomes**

Program Outcomes→ Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		3				1		3			2
CO2	2		2	1			1		1			2
CO3	2		3	3			1		1	2		2
CO4	2	3	3	2					2	2		2
CO5	2		1	3			3					3

**Course contents:****Unit 1**

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

**Unit 2**

Research process – Criteria for good research – Problems encountered by Indian researchers. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

**Unit 3**

Hypothetical proposals for future development and testing, selection of Research task.

**Unit 4**

Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

## Unit 5

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

### Texts/References:

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
  2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.
  3. C. R. Kothari, Research Methodology, New Age Publishers.
  4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.
- 

## Semester-II Design of Experiments

MMD204B	Design of Experiments	OE	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites: None**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.
CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of experiments.

### Mapping of course outcomes with program outcomes

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	1	1		1	1	1	1	1		1	1	1
CO2	3	2	1	3	2	1	2	1	1	2	1	1
CO3	3	2	1	3	2	1	2	1	1	2	1	1
CO4	3	3	1	3	2	1	2	1	1	2	1	1
CO5	2	3	1	2	3	2	2	1	1	2	1	1

**Course Contents:**

## **Unit 1**

Introduction: Modern quality control, quality in engineering design, history of quality engineering.

The Taguchi Approach to quality: Definition of quality, loss function, off-line and on-line quality control, Taguchi's quality philosophy.

## **Unit 2**

Full Factorial Designs: Experimentation as learning process, traditional scientific experiments, three factor design, replicating experiments, factor interactions, normal plots of estimated effects, mechanical plating experiments, two factor design, four factor design, Taguchi design and western design.

## **Unit 3**

Fractional Factorial Design: Fractional factorial design based on eight run experiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over an sixteen run experimental design, blocking two level designs, other two level designs.

## **Unit 4**

Evaluating Variability: Necessity to analyze variability, measures of variability, the normal distribution, using two level designs to minimize variability, signal-to-noise ratio, minimizing variability and optimizing averages.

Taguchi Inner and Arrays: Noise factors, experimental designs for control and noise factors, examples.

## **Unit 5**

Experimental Design for Factors at Three and Four level: Necessity to use more than two level, factors at four levels, factors at three levels. Analysis of Variance in Engineering Design: Hypothesis testing concepts, using estimated effects as test statistics, analysis of variance for two level designs, when to use analysis of variance.

## **Unit 6**

Computer Software for Experimental Design: Role of computer software in experimental design, summary of statistical packages, example of use of software packages. Using Experiments to improve Processes: Engineering design and quality improvement, steps to implementing use of engineering design.

## **Texts/References:**

1. D.C. Montgomery, Design and Analysis of Experiments, 5<sup>th</sup> Edition, John Wiley and Sons, New York, 2004.
2. R.H. Lochner and J.E. Matar, Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design, Chapman and Hall, London, 1983.

**Semester-II**  
**Modeling and Simulation**

MMD204C	Modeling and Simulation	OE	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)		Total (100 Marks)

**Pre-Requisites:** None

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

CO1	Define simulation, its limitations and applications.
CO2	Apply simulation to queuing and inventory situations.
CO3	Acquire knowledge to generate the random numbers for simulation models.
CO4	Analyze the data and verify model of simulation.
CO5	Learn software's and programming languages for developing simulation model.
CO6	Discuss case studies in manufacturing simulation.

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	2											1
CO2	2			1								
CO3	2	2	1	2								1
CO4	2	2	1	2						2	1	
CO5	2	2	2	3						1		2
CO6	2						2			1		

**Course Contents:**

**Unit 1**

Introduction to systems and modeling – discrete and continuous system - Limitations of simulation, areas of application - Monte Carlo Simulation.

**Unit 2**

Discrete event simulation and their applications in queueing and inventory problems.

**Unit 3**

Random number generation and their techniques - tests for random numbers. Random variable generation.

#### Unit 4

Analysis of simulation data. - Input modeling – verification and validation of simulation models – output analysis for a single model.

#### Unit 5

Simulation languages and packages - FORTRAN, C, C++, GPSS, SIMAN V, MODSIM III, ARENA, QUEST, VMAP - Introduction to GPSS – Case studies.

#### Unit 6

Simulation of manufacturing and material handling system, Case studies.

#### Texts/References:

1. Jerry Banks and John S, Carson II “Discrete Event System Simulation”, Prentice Hall, 1984.
2. Geoffrey Gordon., “System Simulation”, Prentice Hall, 1978.
3. Francis Neelamkivil, “Computer Simulation and Modelling”, John Wiley and sons, 1987.

---

### Semester-I Soft Computing Techniques

MMD204D	Soft Computing Techniques	Elective	3-0-0	3 Credits
Class Test (20 Marks)	Continuous Assessment (20 Marks)	End Semester Exam (60 Marks)	Total (100 Marks)	

**Pre-Requisites:** None

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

CO1	Classify different optimization and evolutionary algorithms.
CO2	Apply optimization techniques to real life problems.
CO3	Learn and apply neural network prediction algorithm to solve engineering problems.
CO4	Understand and apply fuzzy based logic function for predicting results.
CO5	Acquire and use knowledge of genetic algorithm to optimize real life problems.
CO6	Study different hybrid soft computing methods and its applications.

#### Mapping of course outcomes with program outcomes

Program	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
---------	-----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	------



Outcomes→												
Course Outcomes ↓												
CO1	2		2							1		2
CO2	2	2	2	2						1		2
CO3	2	2	2	2						1		
CO4	2	2	2	2						1		
CO5	2	2	2	2						1		
CO6	2	2	2	2						1		1

### Unit 1

**INTRODUCTION:** Soft Computing: Introduction of soft computing, Evolutionary Algorithms vs. Conventional optimization techniques, various types of soft computing techniques, applications of soft computing. Artificial Intelligence: Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A\* algorithm, AO\* Algorithms and various types of control strategies. Knowledge representation issues, Propositional and predicate logic, monotonic and non-monotonic reasoning, forward Reasoning, backward reasoning.

### Unit 2

**OPTIMIZATION CONCEPTS:** Objective functions, constraints, Search space, local optima, global optima, fitness functions, search techniques, etc.

### Unit 3

**NEURAL NETWORKS:** Artificial neural network: Introduction, characteristics- learning methods – taxonomy – Evolution of neural networks- basic models – important technologies – applications. McCulloch-Pitts neuron – linear separability – hebb network – supervised learning network: perceptron networks – adaptive linear neuron, multiple adaptive linear neuron, BPN, RBF, TDNN- associative memory network: auto-associative memory network, hetero-associative memory network, BAM, hopfield networks, iterative auto-associative memory network & iterative associative memory network – unsupervised learning networks: Kohonenself organizing feature maps, LVQ – CP networks, ART network.

### Unit 4

**FUZZY LOGIC:** Fuzzy logic: Introduction – crisp sets- fuzzy sets – crisp relations and fuzzy relations: cartesian product of relation – classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. Membership functions: features, fuzzification, methods of membership value assignments- Defuzzification: lambda cuts – methods – fuzzy arithmetic and fuzzy measures: fuzzy arithmetic – extension principle – fuzzy measures – measures of fuzziness -fuzzy integrals – fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules-decomposition of rules, aggregation

of fuzzy rules, fuzzy reasoning-fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making.

### Unit 5

**GENETIC ALGORITHM:** Genetic algorithm- Introduction – biological background – traditional optimization and search techniques – Genetic basic concepts. Genetic algorithm and search space – general genetic algorithm – operators – Generational cycle – stopping condition – constraints – classification genetic programming – multilevel optimization – real life problem- advances in GA.

### Unit 6

**HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS:** Neuro-fuzzy hybrid systems – genetic neuro hybrid systems – genetic fuzzy hybrid and fuzzy genetic hybrid systems – simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers.

### Texts/References:

1. J.S.R.Jang, C.T. Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI /Pearson Education 2004.
2. S.N.Sivanandam and S.N.Deepa, “Principles of Soft Computing”, Wiley India Pvt Ltd, 2011.
3. S.Rajasekaran and G.A.VijayalakshmiPai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications”, Prentice-Hall of India Pvt. Ltd., 2006.
4. George J. Klir, Ute St. Clair, Bo Yuan, “Fuzzy Set Theory: Foundations and Applications” Prentice Hall, 1997.
5. David E. Goldberg, “Genetic Algorithm in Search Optimization and Machine Learning” Pearson Education India, 2013.
6. James A. Freeman, David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education India, 1991.
7. Simon Haykin, “Neural Networks Comprehensive Foundation” Second Edition, Pearson Education, 2005.

---

### Semester -II Seminar-I

MMD205	Seminar-I	PCC	0-0-4	2 Credits
	Continuous Assessment (50 Marks)	Practical/Oral (50 Marks)		Total (100 Marks)

**Pre-Requisites:** Nil

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Identify and compare technical and practical issues related to the area of course specialization.
CO2	Outline annotated bibliography of research demonstrating scholarly skills.
CO3	Prepare a well-organized report employing elements of technical writing and critical thinking.
CO4	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

### Mapping of course outcomes with program outcomes

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	2	2	1		1	2		2	2	2	1	2
CO2		2				2		1	2	1		1
CO3						1	1	2	2	2		2
CO4	1	2	1	1		1	1	1	2	1		1

### Objective:

To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self-confidence and courage that are essential for an engineer.

Individual students are required to choose a topic of their interest from Manufacturing Systems Management related topics preferably from outside the M. Tech syllabus or an extension of syllabus and give a seminar on that topic for about 30 minutes. The Seminar can also be a case study from a Mechanical organization. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

### Semester-II Mini Project

MMD206	Mini Project	PCC	0-0-4	2 Credits
	Continuous Assessment (50 Marks)	Practical/Oral (50 Marks)		Total (100 Marks)

**Pre-Requisites:**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

**Mapping of course outcomes with program outcomes**

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	2	2	1		2	2	1	1	2	2	1	2
CO2	1	1	2	2			2	2	1	2	1	2
CO3	2	2		3					2	2		1
CO4				2				2	2	3		1
CO5		1		2	2			2	2	3		1

**Objectives:**

To train students in identification, analysis, finding solutions and execution of live engineering and managerial problems. It is also aimed to enhance the capabilities of the students for group activities.

Individual students are required to choose a topic of their interest. The subject content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from manufacturing organizations as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50.

Internal marks will be awarded by respective guides as per the stipulations given below.

Attendance, regularity of student (20 marks)

Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

Report = 25 marks

Concept/knowledge in the topic = 15 marks

Presentation = 10 marks

Total marks = 50 marks

**Semester-III**  
**Project Management and Intellectual Property Rights**

MMD301	Project Management and Intellectual Property Rights	PCC	0-0-4	2 Credits
	Continuous Assessment (50 Marks)	Practical/Oral (50 Marks)	Total (100 Marks)	

**Pre-Requisites: None**

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,
CO2	Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.
CO3	exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.
CO4	Develop awareness at all levels (research and innovation) of society to develop patentable technologies.
CO5	Apply trade mark law, copy right law, patent law and also carry out intellectual property audits
CO6	Manage and safeguard the intellectual property and protect it against unauthorized use

**Mapping of course outcomes with program outcomes**

Program Outcomes→ Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1					1		1			
CO2	1		2				1		2			2
CO3						1		1				
CO4						1			1			
CO5			1						1			1

CO6												
-----	--	--	--	--	--	--	--	--	--	--	--	--

## **Course Contents:**

### **Project Management:**

#### **Unit 1**

**INTRODUCTION TO PROJECT MANAGEMENT:** Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization. Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks.

#### **Unit 2**

**DEVELOPING PROJECT PLAN:** Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.

#### **Unit 3**

**PROJECT IMPLEMENTATION:** Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management. Post-Project Analysis.

### **Intellectual Property Rights (IPR):**

#### **Unit 4**

**INTRODUCTION TO IPR:** Overview & Importance; IPR in India and IPR abroad; Patents; their definition; granting; infringement; searching& filing; Utility Models an introduction;

#### **Unit 5**

**COPYRIGHTS:** Copyrights, their definition; granting; infringement; searching & filing, distinction between related and copy rights; Trademarks, role in commerce, importance, protection, registration; domain names;

#### **Unit 6**

**INDUSTRIAL DESIGNS:** Industrial Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications, international protection; Plant varieties; breeder's rights, protection; biotechnology & research and rights managements; licensing, commercialization; ; legal issues, enforcement ;Case studies in IPR.

### **Texts/References:**

1. Shtub, Bardand Globerson, Project Management: Engineering, Technology, and Implementation, Prentice Hall, India
2. Lock, Gower, Project Management Handbook.

3. Prabuddha Ganguli, IPR published by Tata McGraw Hill 2001

---

**Semester-III**  
**Master's Research Project (Phase – I)**

MMD302	Master's Research Project (Phase – I)	PCC	0-0-0	10 Credits
	Continuous Assessment (50 Marks)	Practical/Oral (50 Marks)	Total (100 Marks)	

**Pre-Requisites:** Previously studied course subjects.

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

**Mapping of course outcomes with program outcomes**

Program Outcomes→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	2	2	1		2	2	1	1	2	2	1	2
CO2	1	1	2	2			2	2	1	2	1	2
CO3	2	2		3					2	2		1
CO4				2				2	2	3		1
CO5		1		2	2			2	2	3		1

**Objective:**

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project, experimental project, computer simulation project or an empirical study involving data collection and analysis from manufacturing organizations. The topic should be on Manufacturing Systems Management or any of the topics related with Machine Design Engineering stream. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute. If found essential they may be permitted to continue their project outside the parent institute subject to the conditions of M. Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee

consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members. The student is required to undertake the masters research project phase-I during the third semester and the same is continued in the 4<sup>th</sup> semester (Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

-----

### Semester-IV Master's Research Project (Phase – II)

MMD401	Master's Research Project (Phase – II)	PCC	0-0-0	20 Credits
	Continuous Assessment (100 Marks)	Practical/Oral (100 Marks)		Total (200 Marks)

**Pre-Requisites:** Previously studied course subjects.

**Course Outcomes:** At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

### Mapping of course outcomes with program outcomes

Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course Outcomes ↓												
CO1	2	2	1		2	2	1	1	2	2	1	2
CO2	1	1	2	2			2	2	1	2	1	2
CO3	2	2		3					2	2		1
CO4				2				2	2	3		1
CO5		1		2	2			2	2	3		1

### Objectives:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.



Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.

-----