Dr. Babasaheb Ambedkar Technological University

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

(under Maharashtra Act No. XXIX of 2014)

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Course Structure and Contents

for

M.Tech. in Design Engineering/Machine Design Engineering/Mechanical Design Engineering

From 1st Semester - 4th Semester

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 engineeringsolutions in societal and environmental contexts, and demonstrate theknowledge 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 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 Design Engineering.
PO2	Identify problems in the field of 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 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.

Abbreviations

PEO:	Program Educational Objectives
PO:	Program Outcomes
CO:	Course Outcomes
L:	No. of Lecture hours (per week)
T:	No. of Tutorial hours (per week)
P:	No. of Practical hours (per week)
C:	Total number of credits
BSH:	Basic Science and Humanity
BSC:	Basic Sciences Course
PCC:	Professional Core Course
OEC:	Open Elective Course
PEC:	Professional Elective Course
BHC:	Basic Humanity Course
ESC:	Engineering Science Course
HSMC:	Humanity Science and Management Course
NCC:	National Cadet Corps
NSS:	National Service Scheme

MASTER OF TECHNOLOGY
(Design Engineering/ Machine Design Engineering/ Mechanical Design Engineering)

Syllabus with effect from July 2018

Semester-I

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
							Theory		CA	PR/OR	Total
			L	T	P		TH	Test			
MDE11	PCC	Advanced Methods in Engineering Design	3	1	--	4	60	20	20	--	100
MDE12	PCC	Analysis and Synthesis of Mechanisms	3	1	--	4	60	20	20	--	100
MDE13	PCC	Advanced Mechanical Vibrations	3	1	--	4	60	20	20	--	100
MDE14A	Elective I	Advanced Machine Design	3	--	--	3	60	20	20	--	100
MDE14B		Mechanics of Composite Materials									
MCADM14C		Instrumentation and Automatic Control									
MDE14D		Experimental Stress Analysis									

MME14E		Robotics									
MDE14F		Advanced Engineering Materials									
MDE14G		Stress Analysis									
MDE15A	Elective II	Tribology in Design	3	--	--	3	60	20	20	--	100
MDE15B		Theory of Elasticity and Plasticity									
MDE15C		Failure Analysis and Design									
MDE15D		Machine Tool Design									
MDE15E		Process Equipment Design									
MDE15F		Computational Techniques in Engineering Design									
BSH16	HSMC	Communication Skills	2	--	--	2	--	--	25	25	50
MDE17	PCC	Design Lab	--	--	3	2	--	--	25	25	50
		Total	**17**	**3**	**3**	**22**	**300**	**100**	**150**	**50**	**600**

Semester-II

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
							Theory		CA	PR/OR	Total
			L	T	P		TH	Test			
MDE21	PCC	Finite Element Method	3	1	--	4	60	20	20	--	100
MDE22	PCC	Design Optimization	3	1	--	4	60	20	20	--	100
MDE23A	Elective III	Vehicle Dynamics	3	--	--	3	60	20	20	--	100
MDE23B		Engineering Fracture Mechanics									
MDE23C		Noise, Vibration and Harshness									
MCAAD23D		Design of Piping System									
ME-XX24A	Elective IV	Mechatronics	3	--	--	3	60	20	20	--	100
MDE24B		Design For Manufacture and Assembly									
MDE24C		Rotor Dynamics									
MOE25A	Elective V	Research Methodology	3	--	--	3	60	20	20	--	100
MOE25B		Design of Experiments									
MOE25C		Advanced Optimization Techniques									

MOE25D		Environmental Engineering and Pollution Control									
MOE25E		Soft Computing Techniques									
MOE25F		Manufacturing Automation									
MOE25G		Modeling and Simulation									
MDE26	PCC	Seminar	--	--	4	2	--	--	50	50	100
MDE27	PCC	Mini Project	--	--	4	2	--	--	50	50	100
		Total	**15**	**2**	**8**	**21**	**300**	**100**	**200**	**100**	**700**

Semester-III

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
							Theory		CA	PR/OR	Total
			L	T	P		TH	Test			
MMECH31	PCC	Project Management (Self Study Course)	--	--	--	2	--	--	50	50	100
		OR									
MMECH32		Intellectual Property Rights (Self Study Course)	--	--	--	2	--	--	50	50	100
MDE33	PCC	Project Stage -I	---	--	--	10	--	--	50	50	100
		Total	---	--	--	**12**	--	--	**100**	**100**	**200**

Semester-IV

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
							Theory		CA	PR/OR	Total
			L	T	P		TH	Test			
MDE41	PCC	Project Stage -II	---	--	--	20	--	--	100	100	200
		Total	---	--	--	**20**	--	--	**100**	**100**	**200**

Semester-I
Advanced Methods in Engineering Design

MDE11	Advanced Methods in Engineering Design	PCC	3-1-0	4 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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.

Analysis and Synthesis of Mechanisms

MDE12	Analysis and Synthesis of Mechanisms	PCC	3-1-0	4 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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, Chebesychev 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-Chebychev 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. Nortan ,"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.

Advanced Mechanical Vibration

MDE13	Advance Mechanical Vibration	PCC	3-1-0	4 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

Advanced Machine Design

MDE14A	Advanced Machine Design	Elective I	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

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

PO's → CO's↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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, 2nd edition, McGraw- Hill International edition.
5. Karl T. Ulrich and Steven D. Eppinger, Product design and development, 3rd edition, Tata McGraw Hill.
6. A.K. Chitale and R.C. Gupta, Product Design and Manufacturing, Prentice Hall
7. T.K. Varadan and K. Bhaskar, “Analysis of Plates - Theory and Problems”, Narosa Publishing House

8. Stephen P. Timoshenko and S. Woinowsky-Krieger, “Theory of Plates and Shells”, Tata McGraw Hill
9. Spring Design and Manufacture, Tubal Cain
10. Mechanical Springs, A D Brown
11. Fundamentals of Machine Design, R C Juvinall and K M Marshek, Wiley India
12. Mechanical Design of Machine Elements and Machines: A failure prevention perspective, Wiley India
13. Dislocations and Mechanical Behaviour of Materials, M N Setty, PHI.
14. Mechanical Behaviour of Materials, T C Courney, Overseas Press India
15. Metal Fatigue in Engineering, R I Stephens, A Fatemi, R R Stephens, H O Fuchs, John Wiley
16. Introduction to Optimum Design, Jasbir Arora, Academic Press

Mechanics of Composite Materials

MDE14B	Mechanics of Composite Materials	Elective I	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

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

PO’s → CO’s↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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, OriIshai, "Engineering Mechaincs 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. MadhujitMukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004.
5. Mazumdar S. K., "Composaite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 2002.

Instrumentation and Automatic Control

MCADM14C	Instrumentation and Automatic Control	Elective I	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

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

PO's → CO's↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

Experimental Stress Analysis

MDE14D	Experimental Stress Analysis	Elective I	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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.

Robotics

MME14E	Robotics	Elective I	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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.

Advance Engineering Materials

MDE14F	Advance Engineering Materials	Elective I	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

Stress Analysis

MDE14G	Stress Analysis	Elective I	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

Tribology in Design

MDE15A	Tribology in Design	Elective II	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

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

PO's → CO's↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

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

Course Contents:

Unit 1

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. StolarskiT.a., “Tribology in Machine Design”, Industrial Press Inc., 1990.

Theory of Elasticity and Plasticity

MDE15B	Theory of Elasticity and Plasticity	Elective II	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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 roads, 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.

Failure Analysis and Design

MDE15C	Failure Analysis and Design	Elective II	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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 embitterment, 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, Noordnoff.
5. Dieter, G.E., Mechanical Metallurgy, McGraw Hill Book Co., New Delhi.

Machine Tool Design

MDE15D	Machine Tool Design	Elective II	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

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→ Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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 andA.Bhattacharya , Principles of machine tools, Vol. 2, NCB, Calcutta, 1973.

Process Equipment Design

MDE15E	Process Equipment Design	Elective II	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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 rectors 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

Theory and Design of Pressure Vessels by John F. Harvey, P. E., CBS Publication.

Computational Techniques in Engineering Design

MDE15F	Computational Techniques in Engineering Design	Elective II	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

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

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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 McGraw 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.

Communication Skills

BHS16	Communication Skills	HSSC	2-0-0	2 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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

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

Course Contents:

UNIT 1
Introduction to communication, Necessity of communication skills, Features of good communication, Speaking skills, Feedback & questioning technique, Objectivity in argument

UNIT 2
Verbal and Non-verbal Communication, Use and importance of non-verbal communication while using a language, Study of different pictorial expressions of non-verbal communication and their analysis

UNIT 3
Academic writing, Different types of academic writing, Writing Assignments and Research Papers, Writing dissertations and project reports

UNIT 4
Presentation Skills: Designing an effective Presentation, Contents, appearance, themes in a presentation, Tone and Language in a presentation, Role and Importance of different tools for effective presentation

UNIT 5
Motivation/Inspiration: Ability to shape and direct working methods according to self-defined criteria Ability to think for oneself, Apply oneself to a task independently with self-motivation, Motivation techniques: Motivation techniques based on needs and field situations

UNIT 6
Self Management, Self Evaluation, Self discipline, Self criticism, Recognition of one's own limits and deficiencies, dependency, etc.
Self Awareness, Identifying one's strengths and weaknesses, Planning and Goal setting, Managing self- emotions, ego, pride, Leadership and Team Dynamics

Reference Books:

1. Mitra, Barun, *Personality Development and Soft Skills*, Oxford University Press, 2016
2. Ramesh, Gopalswamy, *The Ace of Soft Skills: Attitude, Communication and Etiquette forSuccess*, Pearson Education, 2013
3. Covey, Stephen R., *Seven Habits of Highly Effective People: Powerful Lessons in Personal Change*
4. Rosenberg Marshall B., *Nonviolent Communication: A Language of Life*

Design Lab - I

MDE17	Design Lab - I	PCC	0-0-3	2 Credits

Examination Scheme:

Practical	
Internal Assessment: 25 Marks	External Exam: 25 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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
1. (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 anlysis 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.

Finite Element Methods

MDE21	Finite Element Methods	PCC	3-1-0	4 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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 SoharabAhmed,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.

Design Optimization

MDE22	Design Optimization	PCC	3-1-0	4 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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.

Vehicle Dynamics

MDE23A	Vehicle Dynamics	Elective III	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

Engineering Fracture Mechanics

MDE23B	Engineering Fracture Mechanics	Elective III	3-0-0	3 Credits

Examination Scheme:

Theory

Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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.
1. 6 Timoshenko, S.P. and J.N. Goodier, "Theory of Elasticity", McGraw Hill (1970).
2. 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., "Compedium 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).

Noise, Vibration and Harshness

MDE23C	Noise, Vibration and Harshness	Elective III	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

Design of Piping System

MCAAD23D	Design of Piping System	Elective III	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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:

Unit 1
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.

Unit 2
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.

Unit 3
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.

Unit 4
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.

Unit 5
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.

Unit 6
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. Richerdson,'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

Mechatronics

ME-XX24A	Mechatronics	Elective IV	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

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

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

Unit 1

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.

Unit 2

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

Unit 3

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.

Unit 4

Microprocessor and Microcontroller

8085 microprocessor, architecture, various types of registers and their functions in 8085µP, 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 Masse quivalence.

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 Systemin Mechanical Engineering, PearsonEducationAsia,1999.
3. Raven, Automatic Control Engineering, McGraw Hill, NewYork,1986

Design for Manufacture & Assembly

MDE24B	Design for Manufacture and Assembly	Elective IV	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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□ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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. 3.Robert Matousek, "Engineering Design – A systematic approach", Blackie & sons Ltd., 1963.
4. 4.James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Co., 1986
5. 5.Swift K. G. "Knowledge based design for manufacture", Kogan Page Ltd., 1987.

Rotor Dynamics

MDE24C	Rotor Dynamics	Elective IV	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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.

Research Methodology

MOE25A	Research Methodology	OE	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks

End Term: 60 Marks	

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

PO's → CO's↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

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

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 McGraw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Design of Experiments

MOE25B	Design of Experiments	OE	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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, summery 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, 5th Edition, John Wiley and Sons, NewYork, 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.

Advanced Optimization Techniques

MOE25C	Advanced Optimization Techniques	OE	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

Prerequisite: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Enables to acquire mathematical methods and apply in engineering disciplines.
CO2	Apply methods of optimization to solve a linear, non-linear programming problem by various methods
CO3	Optimize engineering problem of nonlinear-programming with/without constraints, by using this techniques
CO4	Use of dynamic programming problem in controlling in industrial managements.
CO5	Simulate Thermal engineering system problem. Understand integer programming and stochastic programming to evaluate advanced optimization techniques.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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
SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMITION: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci

method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

Unit 2

MULTI VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION: Direct search method –Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method.

Variable metric method.

Unit 3

GEOMETRIC PROGRAMMING: Polynomials – arithmetic – geometric inequality – unconstrained G.P– constrained G.P

DYNAMIC PROGRAMMING: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

Unit 4

LINEAR PROGRAMMING: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints.

Simulation: Introduction – Types – Steps – application – inventory – queuing – thermal system.

Unit 5

INTEGER PROGRAMMING: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

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. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin
6. Optimization Techniques/Benugundu & Chandraputla/Person Asia

Environmental Engineering and Pollution Control

MOE25D	Environmental Engineering and Pollution Control	OE	3-0-0	3 Credits

Examination Scheme:

<table>
<tr><th colspan="2">Theory</th></tr>
<tr><td>Mid Term: 20 Marks</td><td rowspan="2">Internal Assessment: 20 Marks</td></tr>
<tr><td>End Term: 60 Marks</td></tr>
</table>

Course Objectives:

1. To Understand the need of pollution control, its impact, control
2. To familiarize the students about the pollution control techniques
3. To carry out the real life problem

Course Outcomes:

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

CO1	Identify effects of industrialization on environmental pollution in various field.
CO2	Describe photochemical smog, acid Rain, Greenhouse effect, ozone depletion, global warming.
CO3	Suggest pollution control techniques for vehicles, refrigeration, industries, chemical and power plant.
CO4	Do Case study on any industry and analyze carbon exertion rate, water pollution, soil pollution etc.
CO5	Design pollution control devices for vehicle, analyze and find out replacement CFC refrigerant with HC refrigerant.

Mapping of COs with POs:

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

Course Content

Unit I

Impact of industrialization and modernization - pollution and pollutants. Air pollution and its effects - air pollution - sources - pollutants – organic and inorganic pollutants - gaseous pollutants– nitrogen oxides - particulate pollutants - effect of pollutants on plants – animals and human beings.

Unit II

photochemical oxidants - photochemical smog – acid Rain - Green house effect - ozone depletion - global warming -Environmental pollution techniques for air pollution - monitoring and Control measures of air pollution - dust control equipment - Electrostatic precipitators and scrubbers.

Unit III

Water pollution and its effects structure - water pollution - sources -Pollutants - industrial effluents - domestic wastes - agrochemicals -Heavy metals - effect of pollutants on plants - animals and human beings Bod - eutrophication - waste water treatment - indicator orgnisms -Oxidation pond - water pollution analysis and monitoring – drinking Water standards. Soil pollution and its effects - soil pollution - sources - solid waste Disposal and their effects - pesticides - types and effect of pollutants on Plants - animals and human beings - biomagnification - fertilizers and its Effect of pollutants on plants - animals and human beings –

UNIT IV

soil pollution Control measures - soil microbes and function - biofertilizer. Noise pollution and its effects - noise pollution - sources – noise Exposure level and standards - impacts - noise control and abatement Measures.

Unit V

Marine pollution - sources and control of marine pollution – criteria Employed for disposal of pollutants in marine system – coastal Management. Radioactive pollution and its impacts - radioactive - sources - effect of Pollutants of plants - animals and human beings - prevention and control Measures of radioactive pollution.

Unit VI

Assessment and control of pollution - environmental standards - Assessment of pollution effects due to air - water - soil and radioactive Pollution - biotechnology in pollution control - microbial role in Pollution control - biomonitoring and bioremediation - pollution control Legislations for air - water - land etc. Biotechnology in pollution control - bioremediation (organic and Inorganic pollutants) - bioleaching and biomineralization.

Text/References

1. Environmental Pollution Analysis:Khopkar.
2. Environmental Science – A study of Inter relationships, E. D. Enger, B. E. Smith, 5th ed., W C B publication.
3. Environmental Pollution Control Engineering: C. S. Rao
4. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
5. J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.

Soft Computing Techniques

MOE25E	Soft Computing Techniques	OE	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 Marks	

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

PO's → CO's↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

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

Course Contents:

Unit 1
INTRODUCTION

Soft Computing: Introduction of soft computing, Evolutionary Algorithms vs. Convectional 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, Prepositional 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 autoassociative 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.

Manufacturing Automation

MOE25F	Manufacturing Automation	OE	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												

CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

UNIT 1
Product cycle, manufacturing functions, types of automation, degree of automation, technical, economic and human factors in automation.

UNIT 2
Technologies- mechanical, electrical, hydraulic, pneumatic, electronic, hybrid systems, comparative evaluation.

UNIT 3
Development of small automation systems using mechanical devices, synthesis of hydraulic circuits.

UNIT 4
Circuit optimization techniques, illustrative examples of the above types of systems.

UNIT 5
Industrial logic control systems logic diagramming, programmable controllers.

UNIT 6
Applications, designing for automation, cost-benefit analysis.

Texts/References:

1. A.N.Gavrilov, *Automation and Mechanization of Production Processes in Instrument Industry*, Pergaman Press, Oxford, 1967.
2. G.Pippengerm, *Industrial Hydraulics*, MGH, New York, 1979.
3. F.Kay , *Pneumatics for Industry*, The Machining Publishing Co., London,1969.
4. Ray, *Robots and Manufacturing Assembly*, Marcel Dekker, New York, 1982.

Modeling and Simulation

MOE25G	Modeling and Simulation	OE	3-0-0	3 Credits

Examination Scheme:

Theory	
Mid Term: 20 Marks	Internal Assessment: 20 Marks
End Term: 60 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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, Caste 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 Neelamkovil, "Computer Simulation and Modelling", John Willey and sons,1987.

Seminar-I

MDE26	Seminar-I	PCC	0-4-0	2 Credits

Examination Scheme:

Internal Assessment: 50 Marks	External Exam: 50 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→ Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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.

Mini Project

MDE27	Mini Project	PCC	0-0-4	2 Credits

Examination Scheme:

Practical	
Internal Assessment: 25 Marks	External Exam: 25 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

MMECH31	**Project Management**	**PCC**	**0-0-0**	**2 Credits**

Continuous Assessment 50 Marks	PR/OR 50 Marks	Total 100 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

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

Course Contents:

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 (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.

TEXT BOOKS/REFERENCES:

1. Shtub,BardandGloberson,ProjectManagement:Engineering,Technology,andImplementation,Prentice Hall, India
2. Lock, Gower, Project Management Handbook.

Intellectual Property Rights

MMECH32	Intellectual Property Rights	PCC	0-0-0	2 Credits

Continuous Assessment 50 Marks	PR/OR 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

Course Outcomes	Program 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:

Unit-1
- Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents ;their definition; granting; infringement ;searching & filing; Utility Models an introduction;

Unit-2
- Copyrights ; their definition; granting; infringement ;searching & filing, distinction between related and copy rights; Trademarks ,role in commerce ,importance , protection, registration; domain names;

Unit-3
- Industrial Designs ; 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.

TEXT BOOKS/REFERENCES:

1. Prabuddha Ganguli, IPR: Unleashing the Knowledge Economy, published by Tata McGraw Hill 2001.

Project Stage – I

MDE33	Project Stage – I	PCC	0-0-0	10 Credits

Examination Scheme:

Internal Assessment: 50 Marks	External Exam: 50 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→ Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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 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^{th} 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
Project Stage - II

MDE41	Project Stage – II	PCC	0-0-0	20 Credits

Examination Scheme:

Internal Assessment: 100 Marks	External Exam: 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→ / Course Outcomes ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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.