Department of Mechanical Engineering

SCHEME & SYLLABUS

B.Tech. Mechanical Engineering

2023-24

Shri G S Institute of Technology & Science Indore

[Govt. Aided Autonomous Institute Estd. In 1952]

Vision and Mission of Institute

Vision:

A front-line institute in science and technology making significant contributions to Human resource development envisaging dynamic needs of the society.

Mission:

To generate experts in science and technology akin to society for its accelerated Socio-economic growth in professional and challenging environment imparting Human values.

Vision and Mission of Department

Vision:

To be recognized globally for outstanding education and research leading to develop well qualified engineers who are innovative, entrepreneurial and successful in advanced fields of Mechanical engineering and research.

Mission:

M1- To provide state of the art education to students of Mechanical Engineering.

M2- To enable the students to cater the needs of society and industries.

M3- To excel in research and development activities in Mechanical Engineering.

Program Educational Objective (PEOs)

PEO1: To develops students for applying Mechanical Engineering knowledge and problem solving skill in their professional careers.

PEO2: To create interest in lifelong learning by pursuing higher education in specific field.

PEO3: The mechanical Engineering graduates shall have high moral values/ ethics to build an efficient team with appropriate soft skill capabilities.

Program Outcomes

Graduates Engineers will be able to

(i) Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

(ii) Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

(iii) Design/Development of Solutions: Design solutions for complex engineering problems 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.

(iv) 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 for complex problems.

(v) Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

(vi) 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.

(vii) Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

(viii) Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

(ix) Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

(x) 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.

(xi) 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 in a team, to manage projects and in multidisciplinary environments.

(xii) Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes

Graduates Engineers will be able to

PSO1: Apply mechanical design engineering, thermal engineering and interdisciplinary knowledge for analyzing, designing, and manufacturing products to address the need of society.

PSO2: Implement state of the art knowledge and technology in order to fulfill current industrial requirement.

Contents

B. Tech. 1st Year (Common to all Branches of Engineering and Technology)

ME10149: ENGINEERING GRAPHICS

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 10149	Engineering Graphics	3	-	4	2	2	4	70	30	40	60	200

PRE-REQUISITES: Nil

Course Objectives

1. To familiarize the student with- drawing instruments, engineering scales and curves.
2. To understand the projections of 1D, 2D and 3D elements using orthographic and isometric views.
3. To familiarize him/ her with the sectioning of solids and development of surfaces.
4. To familiarize him with modern drafting/designing tools and learn to communicate through it.

Course Outcomes: At the end of the course students will be able to answer

CO 1	Distinguish standard drawing conventions, draw curves and scales using drawing instruments
CO 2	Apply the concept of orthographic projection of lines and planes.
CO 3	To draw the projections of various solids inclined to both planes and its sections and true shape.
CO 4	Differentiate development of surfaces and concept of isometric projection.
CO 5	To draw Orthographic Projections of simple objects and machine parts using drafting tools and software's for creating 2-D and 3-D shapes.

COURSE CONTENTS

THEORY

Unit 1

Basic Concepts, Scales and Curves: Principles of Engineering Graphics and their significance, usage of Drawing instruments, lines, lettering and dimensioning. Scales- Plain, Diagonal Scales, Conic sections including the Rectangular Hyperbola. Cycloidal curves, Involute and Archemedian Spiral.

Unit 2

Projections of Line and Planes: Principles of Orthographic Projections- Conventions, Projection of points and lines inclined to both planes, HT, VT. Projections of planes, inclined Planes -Auxiliary Planes AIP and AVP.

Unit 3

Projection of Solids: Projections of Right regular Solids inclined to both the planes. Auxiliary Views
Sections of Solids: Sections of Geometrical Solids, True shape.

Unit 4

Development of Surfaces: Development of surfaces of Right Regular Solids- Prism, Pyramid, Cylinder and Cone

Isometric Projections: Principles of isometric projection- Isometric Scale. Isometric Views and projections of Lines, Planes and circles: Conversion of Orthographic Views of Simple and compound Solids brackets and simple machine parts into isometric view and projections.

Unit 5

Orthographic Projections: Conversion of isometric Views to Orthographic Views of simple machine parts.

Introduction to Drafting Software: Use and applications of Computer aided drafting (CAD) tools.

ASSESSMENT:

The following methods shall be adopted for the assessment of this course;

1. **Theory Examination** (70 marks) on the basis of end term theory paper examination (from Units 1 to 5)

2. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
3. **Sessional Work** (40 marks) on the basis of assignments, internal viva and attendance. Student are require to submit at least six imperial drawing sheets/ computer aided drawing print.
4. **Practical examination** (60 marks) on the basis of evaluating practical knowledge, Quiz and viva voce (From Unit 1 to5).

TEXT BOOKS RECOMMENDED:

1. N.D. Bhatt and V.M. Panchal, Engineering Drawing Plane and Solid Geometry, Charotar Publishing House.

REFERENCE BOOKS:

1. Agrawal Basant and Agrawal C.M. (2018), Engineering Drawing, McGraw Hill Publishing.
2. Shah, MB & Rana BC (2008), Engineering Drawing and Computer Graphics; Pearson Education.
3. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
4. (Corresponding set of) CAD Software Theory and use

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	–	–	–	–	–	–	–	–	3	1
CO2	3	2	1	1	1	–	–	–	–	–	–	–	3	1
CO3	3	2	1	–	1	–	–	–	–	–	–	–	3	1
CO4	3	2	1	–	1	–	–	–	–	–	–	–	3	1
CO5	3	2	1	–	–	–	–	–	–	–	–	–	3	1
Average	**3**	**2**	**1**	**1**	**1**	–	–	–	–	–	–	–	**3**	**1**

CODE	Subject Name	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26011	**Fluid Mechanics**	**4**	**-**	**2**	**3**	**1**	**4**	**70**	**30**	**40**	**60**	**200**

Pre-requisites: ME1055, PH1005, MA1006, MA1056 and IM1059

Course Assessment: The following methods are adopted for the assessment of this course

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO 1	Determine the fluid pressure and use various devices for measuring fluid pressure. Calculate hydrostatic force and use of law of conservation mass to fluid flow
CO 2	Apply fluid flow patterns and describe continuity equation.
CO 3	To analyze a variety of practical fluid flow and measuring devices and utilize Fluid Mechanics principles in design. Apply Bernoulli's equation to fluid flow problems and boundary layer theory to determine lift and drag forces on a submerged body.
CO 4	Apply appropriate equations and principles to analyze pipe flow problems.
CO 5	Apply boundary layer concepts.

COURSE CONTENTS

Unit I

(a) Introduction: Fluids and the continuum, Fluid properties, Surface tension, Bulk modulus and thermodynamic properties, Newton's law of viscosity and its coefficients. Newtonian & non-newtonian Fluids.

(b) Hydrostatics and Buoyancy: Pascal's law, Hydrostatics law, Force on immersed plane and curved surfaces, center of pressure, laws of buoyancy, Meta center and Metacentric height, Stability of floating bodies.

Unit II

(a) Fluid Kinematics : Langragian & Eulerian Method, Description of Fluid Flow, Stream Line, Path line and Streak Line, Types of Flow and Types of motion, local and connective acceleration, continuity equation., Circulation, Velocity potential, Stream function, Laplace equation, Flow nets.

(b) Compressible Flow: Introduction, Mach Number, Isentropic Flow, Stagnation Properties.

Unit III

(a) Fluid Dynamics: System and control volume, Reynold transport theorem, Euler's equation, Bernoulli's equation, Momentum and Moment of Momentum Equation. Their application,

(b) Forces on Immersed Bodies: Lift and Drag, Stream Lined and Bluff bodies, Flow around Circular Cylinders and Aerofoils.

Unit IV

(a) Viscous Flow: Preliminary Concepts, governing equations, Viscous flow through parallel plates and pipes

(b) Flow Through Pipes: Reynold Number, Laminar and Turbulent flow, Navier Stoke's equation, Pressure gradient, Head loss in Turbulent Flow (Darcey's Equation), Friction factor, Minor losses, Hydraulic and Energy gradient, Pipe networks.

Unit V

(a) Boundary Layer Theory. Von Karman Momentum Equation, Laminar Boundary Layer, Turbulent Boundary Layer, Boundary Layer Separation.

(b) Introduction to Open Channel Flow

Reference Books:

1. Shames, Fluid Mechanics, Tata McGraw-Hill, 1962
2. Massey, B.S., Mechanics of Fluids, Routledge Publication, 2006
3. Kumar D.S., Fluid Mechanics, S K Kataria Publication, 2003
4. Frank M. White, Fluid Mechanics, Tata McGraw-Hill

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	1	-	-	-	-	-	3	2
CO2	3	2	2	2	-	-	2	-	-	-	-	-	3	1
CO3	3	1	1	-	-	-	1	-	-	-	-	-	2	1
CO4	3	2	2	2	-	-	-	-	-	-	-	-	2	1
CO5	2	2	2	2	-	-	-	-	-	-	-	-	2	1
Avg.	2.68	1.6	1.6	2	-	-	-	-	-	-	-	-	2.4	1.2

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26002	Strength of Materials	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: CE10003 and ME10649

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Distinguish elastic constants, types of stresses and mechanical properties of materials
CO2	Apply shear force and bending moment diagrams to analyze the resistance offered by the beam andable to solve practical problems in real world scenario
CO3	Evaluate principal stresses and strains analytically and graphically
CO4	Determine the deflection and curvature in beams with different supports and buckling of column.
CO5	Analyze and design thin cylinders and energy stored due to deformation

COURSE CONTENTS

Unit 1

Stress and Strain: Tension, compression and shear, Complementary shear stresses. Elastic constants andtheir relationship. Thermal stresses. Statically indeterminate system, Shear stress in a circular member due to Torsion. Mechanical Testing of materials: Tensile, Compression, Shear, Torsion, Fatigue, Impact, Hardness Tests

Unit 2

Bending Moment and Shear Forces: Diagrams of Shear Forces and Bending Moment for determinate beams. Relation between loads, shearing forces and bending moments.
Bending Stress: Theory of bending, bending and shear stresses in beams and their distributions, modulusof section and modulus of rupture, beams of varying cross section, beam of uniform strength. Introduction to composite beams

Unit 3

Stress on oblique section of a bar subjected to axial stress, compound stress. Principal stress and strain,plane stress and plane strain and their Mohr's Circle. Combined direct and bending stress.

Unit 4

Deflection: Uniform curvature, Relation between curvature and deflection, cantilevers and simply supported beams of varying cross section. Macaulay's method, Moment area method, deflection due toshear. Propped beam. Parts subjected to column action with and without lateral loading.

Unit 5

Elastic strain energy : Resilience, Proof Resilience, Material under tension, Static, Sudden and Fallingloads, Strain Energy due to direct shear, bending and torsion, Castigliano's theorem.
Thin walled pressure vessels- stresses, strain and deformation due to internal fluid pressure.

Text Books:

1. Ramamrutham S., Strength of Materials, Dhanpat Rai, 2003
2. Ryder, G.H., Strength of Materials, Macmillan India, 2002

Reference Books:

1. Popov, E.P., Mechanics of Solids, Prentice-Hall (India), 2001
2. Beer &Johnston, Mechanics of Material. Tata McGraw-Hill, 2004
3. Ratan, S.S., Strength of Materials, Tata McGraw-Hill, 2011

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	1	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	1	3	1
Average	**3**	**2.2**	**2**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**1**	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
MA 26004	Mathematics-III	3	1	-	4	-	4	70	30	-	-	100

Course Assessment: The following methods are adopted for the assessment of this course;
1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%)
2. Theory Examination (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

The outcomes of this course are:
1. To identify real phenomena as models of partial derivative equations. Solve real problems by identifying them appropriately from the perspective of partial derivative equations
2. To demonstrate their understanding of the Dirichlet conditions by using them to evaluate infinite series. Calculate the Fourier transform of elementary functions from the definition.
3. To select and combine the necessary Laplace transform techniques to solve second-order ordinary differential equations involving the Dirac delta (or unit impulse).
4. Apply the concept of approximation methods to solve differentiation and integration problems.
5. To define principal concepts about sampling. Explains the advantages of sampling. Lists the stages of sampling process. Categorizes and defines the sampling methods.

COURSE CONTENTS

Unit 1

Partial Differential Equations: Formation of partial differential equations, partial differential equations of first order and first degree i.e., Pp + Qq = R, Linear homogeneous partial differential equation of nthorder with constant coefficient, separation of variables, Application to simple problems of heat, Wave and Laplace equations.

Unit 2

Fourier Series and Fourier Transformation : Expansion of functions in a Fourier series, Half range series,Sine and Cosine series and change of interval. Fourier Integral. Fourier transforms: sine and cosine transforms and their application to solution of linear Partial Differential Equations.

Unit 3

Laplace Transform : Definition of Laplace Transform, Laplace Transform of elementary and periodic functions, properties of Laplace Transform including Laplace Transform of derivatives, Inverse LaplaceTransform and its properties, Convolution Theorem, Application of Laplace Transform to ordinary differential equations with constant and variable coefficients.

Unit 4

Calculus of Finite Differences : Difference table, Operators E and Δ, Newton's forward and backward interpolation formula for equal intervals, Lagrange's interpolation formula and divided difference method for unequal intervals, Numerical Differentiation and Integration (Trapezoidal rule, Simpson's 1/3 rule ,Simpson's 3/8 rule and Weddle's rule).

Unit 5

Statistics: Brief idea of Sampling, t, F and $\chi 2$ distributions and their applications, ANOVA, Statistical Quality Control (SQC), Control Charts, Sampling inspection, Acceptance sampling, Producer's and Consumer's risk, O. C. curve, Taguchi method.

Textbooks Recommended:
1. Ramana B V, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.
2. Das H. K, Higher Engineering Mathematics, S. Chand New Delhi, 2011.

Reference Books:
1. Kreyszig Erwin, Advanced Engineering Mathematics, 8th edition, John Willy and sons Publications, 1999.
2. Jain, R.K. and Iyengar S.K, Advanced Engineering Mathematics, Narosa Publishing House, New-Delhi, 2006.
3. Vedamurthy V.N. & Iyengar S.N., Numerical Methods, Vikas Publishing, 2008.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	_	_	_	_	1	_	_	3	_	_
CO2	3	3	2	1	_	_	_	_	1	_	_	3	_	_
CO3	3	3	2	1	_	_	_	_	1	_	_	3	_	_
CO4	3	3	2	1	_	_	_	_	1	_	_	3	_	_
CO5	3	3	2	1	_	_	_	_	1	_	_	3	_	_
Average	3	3	2	1	_	_	_	_	1	_	_	3	_	_

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26008	Materials Science	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: CE10001, ME10505, CH10508 and PE10901

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Description of various types of crystal structures and their relation with material properties
2. Mechanical properties of materials and role of individual material in varying the preperties.
3. Various phases of materials, phase diagrams role of phases on properties of materials through iron carbon equilibrium diagram and Time Temp Transformation (TTT) diagram and effect of heat treatment.
4. Various ferrous and non ferrous materials used and powder metallurgy technique.
5. Testing of materials through non destructive means. Knowing fundamental of composite materials including their types, applications and constituents.

COURSE CONTENTS

UNIT I

Description of crystal structure, seven crystal systems. Bravais lattice. Symmetry and properties of simplecrystal structure. Miller Indices. Direction and Plane Indices.

Schottky and Frenkel defects. Dislocation, Edge dislocation, Screw Dislocations, Slip Planes. Stress Fields of Dislocations. Grain Boundaries, Dislocation densities, Diffusion in solid, Fick's Law,

UNIT II

Mechanical Properties and Mechanical Working of Metals: Various mechanical properties like Strength, Stiffness, elasticity, plasticity, ductility, hardness, impact strength, malleability, brittleness, toughness, resilience, Creep and stress rupture.

Alloying: characteristics of alloying elements C,Mn,Cr,Ni, Ph, S, Mo, Pb,Si, etc. The effects of alloying elements on mechanical behavior of steel Cu, Al etc.

UNIT III

Equilibrium Diagram: Allotropy structure of alloys, Lever rule, phase rule, various types of phase diagrams. Cooling curves, Iron carbide equilibrium diagram. Strengthening mechanisms, TTT diagram, Heat treatment procedure for steel, Hardening, Hardenability, Defects in heat treated Parts.

UNIT IV

Ferrous and Non-ferrous metals and alloys: Properties and application of various steels and cast irons. Effect of impurities in ferrous metal. High speed steels, Stainless steel, Other steels. Properties and application of aluminium and its principle alloys, Copper and its principle alloys.

Powder Metallurgy: Manufacturing of metal powders. Sintering and secondary operations. Projects of finished parts. Design considerations and applications.

UNIT V

Non-destructive Testing: Dye penetration, Ultrasonic, Magnetic, Eddy Current, Radiography NDT tests. A brief discussion of the properties and applications of the rare metals like Titanium, Uranium, Berylliumand Zirconium. Composite material: properties, applications, types and theirs characteristics.

Text Books:

1. Abdul Mubeen, Material Science, Galgotia Publications, 2003
2. Raghvan V., Material Science and Engineering, PHI Learning Pvt. Lt, 2006

Reference Books:

1. Cedric W. Richards, Engineering Material Science, Literary Licensing, LLC, 2012
2. Chalmers, Physical Metallurgy, Chapman & Hall, London, 1969
3. John Walff, Structure and Properties of Material, J Wiley Eastern University Ed., 1986

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	–	–	–	–	–	–	–	–	–	–	1	1
CO2	3	1	–	–	–	–	–	–	–	–	–	–	1	1
CO3	3	1	–	2	–	–	–	–	–	–	–	–	1	1
CO4	3	1	2	–	–	–	–	–	–	–	–	–	2	1
CO5	3	1	1	–	–	–	–	–	–	–	–	–	2	1
Average	**3**	**1**	**1.5**	**2**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**1.4**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26005	Engineering Thermodynamics	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: PH 10016 and CH 10516

Course Assessment: The following methods are adopted for the assessment of this course

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

COURSE OUTCOMES: At the end of the course students will be able to answer

CO1	Apply first and second laws on thermodynamics systems and explain their applications.
CO2	Evaluate entropy changes in a wide range of processes and determine the available and unavailable energy. Analysis for the performance of different air standard cycles.
CO3	Evaluate properties of pure substances and gas mixtures. Demonstrate various types of high pressure boilers and their relative merits and demerits.
CO4	Performance evaluation of boilers. Apply the fundamentals of thermodynamics for analysis of boiler Performance. Procedure to draw Heat Balance Sheet.
CO5	Classify the concept of draught. Evaluate draught created by chimney. Demonstrate reactive system of combustion process for different fuels. Analyze dry flue gases.

COURSE CONTENTS

Unit 1

(a) **First Law of thermodynamics:** Work and Heat Transfer, First Law of thermodynamics applied to a closed system, applied to Steady and variable Flow Processes.

(b) **Second Law of Thermodynamics:** Limitations of First law of thermodynamics, Heat Engine and Heat Pump, Kelvin Plank and Clausius statements and their equivalence, Reversibility and Irreversibility, Causes of irreversibility, Carnot's Theorem.

Unit 2

(a) **Entropy & Availability:** Clausius theorem, Clausius inequality, entropy principle, calculation of entropy, changes for various processes, principle of increase of entropy, Available and unavailable energy, Maximum Work in a Reversible Cycle.

(b) **Air Standard Cycles:** Otto, Diesel, Dual and Brayton Cycles; Air Standard Efficiencies; Mean Effective Pressure. Condition for maximum work output from these cycles. Comparison between Otto, Diesel and Dual cycles for different conditions.

Unit 3

(a) **Properties of Steam:** P-v diagram, p-T diagram, p-v-T surface, T-s diagram, Mollier diagram, Types of steam, dryness fraction, calculation of Enthalpy, specific volume, internal Energy and entropy of steam, Heating cooling and expansion of steam.

Unit 4 (b) **High Pressure Boilers:** Fire tube and water tube boilers, Advantages of high pressure boilers, Construction and working of Lamont Boiler, Benson Boiler, Loeffler Boiler, Schmidt-Hartmann Boiler and Velox boilers, their Relative Merits and Demerits.

Unit 5

Boiler Performance: Evaporation, Equivalent Evaporation, factor of Evaporation. Boiler efficiency. Factors affecting Performance of Boilers. Boiler Trials. Heat Balance Sheet.

(a) **Draught:** Types of draught. Natural Draught and artificial Draught viz. Mechanical draught (Forced, Induced and Balanced) and Steam Jet Draught. Height of the chimney required for Natural Draught. Condition for maximum discharge through chimney, efficiency of chimney.

(b) **Combustion**: Principle of combustion, Stoichiometric Combustion, Analysis of flue gases by Orsat Apparatus. Requirement of Theoretical Amount of Air, Calculation of Constituents of Flue Gas with Excess Air, Optimizing Excess Air and Combustion.

Text Book Recommended:

1. Kumar, D.S., Thermodynamics, Kataria & Sons Publication, 2003
2. Nag P.K., Engineering Thermodynamics, Tata McGraw-Hill, 1988
3. R Yadav, Fundamentals of Thermodynamics, Central Publishing House, 1999

Reference Books:

1. Van Wylen, Thermodynamics, Wiley, 1994
2. Mathur & Mehta, Thermal Engineering, Jain Brothers Publication, 1987
3. Cengel Y A, Thermodynamics, Tata McGraw-Hill, 2008

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	-	-	-	-	-	-	-	-	3	1
CO2	3	3	3	3	-	-	1	-	-	-	-	-	3	2
CO3	3	3	2	2	-	-	-	-	-	-	-	-	3	1
CO4	1	3	2	1	-	-	-	-	-	-	-	-	3	3
CO5	3	3	2	1	-	-	1	-	-	-	-	-	3	2
Average	**2.6**	**3**	**2.2**	**1.6**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**1.8**

HU 21481/26481/28481/29481: Values, Humanities and Professional Ethics

Hours Per Week			Credits		Maximum Marks				
L	T	P	Th	Pr	Theory		Practical		Total
					CW	END SEM	SW	END SEM	
-	2	-	2	-	100	-	-	-	100

Pre-requisites: NIL

Assessment: Only **Sessional Work** (100 marks) on the basis of internal viva (30), Attendance (20), Quizes /Tests (30) and Presentations (20) will be awarded against the assessment done throughout the session.

Course Objectives:

1 To make students understand of his/her social responsibility as an engineer.
2 To create an awareness on Engineering Ethics, Indian constitution and Human Values
3 To make students capable of doing self-exploration and recapitulation
4 To make students aware of the global problems

COURSE OUTCOMES: At the end of the course students will be able to answer

CO1**:** Explain and elaborate the social institutions and Constitution of India through which the society and nation isgoverned.
CO2: Describe the kinds of values and ethics and their importance
CO3: Contextualize the professional attitude and approaches as per needs of society and values.
CO4: Explain and illustrate the process of Social, Political and Technological changes in context to global changes

COURSE CONTENTS

1. Role of Humanities in Engineering education, Morals, Values and Ethics, social institutions and association, social stratification in India, social change, Universal and Situational values, coexistence of self and body and their needs and activities.

2. Constitution of India - Preamble, Rights and Duties. Directive Principles, Parliamentary and presidential democracy, The Problem of hierarchy of values and their choice, the views of Mahatma Gandhi on concept Indian nation and democracy.

3. Ethical and decision making capability and its development: Meaning of Ethical dilemma, Concept of personal and group Ethics: Balance between -rights and duties, The Problem of Sustenance of value in the process of Social, Political and Technological changes.

4. Engineering Ethics: engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger variety of moral issued - types of inquiry - moral dilemmas – moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy Models of Professional Roles.

5. Global Issues: Multinational corporations - Environmental ethics - computer ethics - weapons development – engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership.

Books for references

1. Little, William: An Introduction of Ethics (Allied Publisher, Indian Reprint1955)
2. William, K Frankena : Ethics (Prentice Hall of India,1988)
3. Gaur R. R., Sangal R. and Bagaria G. P., Haman Values and Professional Ethics, Excel Books, New Delhi, 2010
4. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw-Hill, New York 1996.
5. Govindarajan M, Natarajan S, Senthil Kumar V. S, Engineering Ethics, Prentice Hall of India, New Delhi, 2004.
6. Introduction to the Constitution of India, D.D. Basu

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	–	1	–	–	–	2	1	2	–	1	–	1	1	1
CO2	1	1	–	–	–	2	–	3	1	2	–	2	1	
CO3	1		–	1	–	2	–	3	1	1	–	1	1	1
CO4	1	1	2	1	–	3	2	3	1	1	–	3	2	1
CO5	1	1	2		1	2	3	2	2	1	–	2	1	1
Average	**1**	**1**	**2**	**1**	**1**	**2.2**	**2**	**2.6**	**1.25**	**1.2**	**–**	**1.8**	**1.2**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26556	Mathematics-IV	3	1	-	4	-	4	70	30	-	-	100

Course Assessment: The following methods are adopted for the assessment of this course;

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%)
2. End semester Theory Exam (70%)

Course Outcomes: At the end of the course students will be able to answer

1. To obtain the series solution of Bessel's and Legendre's differential equations.
2. Explain the concept of vector calculus and its applications.
3. Distinguish the various concepts of function of complex variables and its applications.
4. Apply the concept of numerical analysis for solving linear, nonlinear and ordinary equations.

COURSE CONTENTS

Unit 1

Special Functions: Method of Frobenius series solution for Bessel and Legendre's Differential Equations, Recurrence relation, Generating functions and Orthogonality of Bessel's function andLegendre's function.

Unit 2

Vector Calculus: Gradient, Divergence and Curl, Vector Identities, Directional derivative, line, surfaceand volume integrals, Applications to Gauss, Stokes and Green's theorem.

Unit 3

Functions of Complex Variables-I : Analytic Functions, Cauchy-Continuity, Analytic Functions, CauchyRiemann equations in Cartesian and Polar Coordinates, Harmonic and Conjugate Harmonic functions, Complex Integration – Cauchy's Integral Theorem and Cauchy Integral Formula

Unit 4

Functions of Complex Variables-II: Taylor's series (Theorem), Laurent Series (Theorem), Zeros and poles, Residue Theorem, Evaluation of simple Real Integrals. Conformal Mapping-Mapping of Elementary functions $w = z^n$, z^2, e^2, sinz, Bilinear Transformations.

Unit 5

Numerical solution of linear and non-linear algebraic equations: Bisection (or Bolzano) method, methodof false position, Newton Raphson method. Solution of Simultaneous algebraic equations: Direct method- Gauss Elimination method, Gauss Jordan method, Iterative method-Jacobi's method, Gauss Seidal method. Numerical Solution of Ordinary Differential Equations: Taylor's Method, Picard's Method and Runge-Kutta Method.

Text Books:

1. Ramana B V, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Ltd., New Delhi,2006.
2. Das H. K, Higher Engineering Mathematics, S. Chand New Delhi, 2011.
3. Balaguruswamy E., Numerical Methods, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1999.

Reference Books:

1. Jain, R.K. & Iyengar S.K, Advanced Engineering Mathematics, Narosa Publishing House, New-Delhi,2006
2. Sastry S.S., Engineering Mathematics, Prentice Hall of India private limited, New Delhi.
3. Vedamurthy V.N. and Iyengar S.N., Numerical Methods, Vikas Publishing, 2008.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	_	_	_	_	1	_	_	3	_	_
CO2	3	3	2	1	_	_	_	_	1	_	_	3	_	_
CO3	3	3	2	1	_	_	_	_	1	_	_	3	_	_
CO4	3	3	2	1	_	_	_	_	1	_	_	3	_	_
CO5	3	3	2	1	_	_	_	_	1	_	_	3	_	_
Average	3	3	2	1	_	_	_	_	1	_	_	3	_	_

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26551	Machine Design I	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 10049 and ME 26002

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Distinguish machine component behavior under different types of loads, select factor of safety and identify the failure criteria.
CO2	Design keys, cotters, couplings, joints and lever
CO3	Design of pressure vessels and pipe joints
CO4	Design of bolted joint, effect of contact stress and selection of antifriction bearing
CO5	Design of riveted and welded joints

COURSE CONTENTS

Unit 1

Engineering design, Phases of design, design consideration, Ergonomics consideration, Factor of safety, Material selection, manufacturing consideration, Standardization, Preferred sizes.
Modes of failure, Types of loads, statistical nature of loading, change in stresses due to type of loading, preliminary stress calculations.

Unit 2 Theories of failure and application to the design problems: Principal stress theory, maximum shear stress theory, principal strain theory, maximum strain energy theory, maximum distortion energy theory, etc.

Unit 3 Design of shaft, keys and coupling: Types of keys and their design, design for transmission by shaft through rigid and flexible coupling, stress distribution and angle of twist. Design of different types of lever.

Pressure vessels and cover plates: Analysis of thick pressure vessels, compound cylinders, design considerations for pressure vessels

Unit 4 Pipe and pipe joints: design of different types of pipe joints for high pressure
Design of cotter joint and knuckle joint.

Threaded fasteners: Classification, standard specifications, effect of initial tension, Effect of static and dynamic load, eccentric loading, types of nut - bolt - washers, design of threaded fasteners, turnbuckle
Contact stress and deformation: Contact surfaces - their geometries and deformations, contact stress distributions.

Unit 5 Antifriction bearing: types of bearings, life and load criteria of bearings, different applications and selection procedure of bearings.

Design of Riveted Joints: Types of rivet joints, rivet heads, terminology, caulking and fullering, analysis of riveted joint, efficiency of a riveted joint, design of boiler joints and structural joints, direct and eccentric loading.
Design of Welded Joints: Welding process, merits and demerits of welded joint, analysis of heat affected zone, Types of welded joints, Strength of a welded joint, welded joint subject to bending moment, torsional moment, direct and eccentric loading

Text Books:

1. Sharma and Aggarwal, Machine Design, S K Kataria and Sons, 2001
2. V. Bhandari, Design of Machine Elements, Tata McGraw-Hill, 20014

Reference Books:

1. R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, John Wiley, 1991
2. Shigley and Mischke, Mechanical Engineering Design, Tata McGraw-Hill, 2001

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	1	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	1	3	1
Average	**3**	**2.2**	**2**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**1**	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26562	Kinematics of Machine	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 26002 and ME 26008.

Course Assessment: The following methods are adopted for the assessment of this course

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO 1	Analyze the motion of planar four link mechanisms
CO 2	Draw velocity and acceleration diagrams of planar mechanisms by relative velocity, Instantenous center and graphical differentiation method.
CO 3	Construct different types of cam profile as per given follower motion.
CO 4	Determine parameters of gears and velocity ratio of gear trains
CO 5	Find out the gyroscoipc effect in case two-wheelers, four-wheelers, ships aeroplanes.

COURSE CONTENTS

Unit 1

Kinematic link, Kinematic pairs, Kinematic chain, classification, Inversion of four bar chain, single slider crank chain, and double slider crank chain. Degree of freedom of chain and mechanism, Grubler'sand Kutchbach Criterion.

Number synthesis with number of links less than or equal to eight.

Mechanism with lower pairs, Straight line mechanism, Pantograph, Steering gear mechanisms, Hook'sjoint, Engine Indicator mechanism.

Unit 2

Velocity and acceleration analysis, Graphical approach, Relative velocity and relative acceleration approach, Problems with corioli's component of acceleration. Klein's construction, Instantaneous centremethod, Keneddy's theorem and its applications.

Analytical method: Velocity and acceleration of single slider crank chain. Complex algebra approach tovarious mechanism

Unit 3

Cams: Types of cams and followers, Reciprocating and Oscillating followers, Cam profiles with specified follower motion e.g. simple harmonic motion, uniform velocity motion, Uniform accelerationand retardation motion and cycloidal motion. Cam with specified contours, Displacement, velocity andacceleration of followers.

Unit 4

Toothed Gearing: Spur gearing, definition, Condition for correct gearing. Tooth profiles- cycloidal andinvolute gears, Tooth proportions, Interference and its prevention, Bevel gearing, Helical gearing, Wormand wheel

Gear trains, Simple, Compound, Reverted and Epicyclic Gear trains and their applications, Tabular andalgebraic approach of solution. Differential gear box.

Unit 5

Gyroscopes: Products of Inertia, Principle Axis, Gyroscopic Motion, Gyroscopic Torque, Gyrostabilizer, Gyrocompass, Application to Ships, Aero planes, Automobiles and two wheel vehicles.Synthesis of basic four link mechanism.

Text Books:

1. Bevan T., Theory of Machines, C B S Publishers, 1993
2. Ambekar A. G., Mechanism & Machine Theory, Prentice-hall of India, 2007
3. Ratan S.S., Theory of Machines, Tata Mcgraw Hill, 2009

References Books:

1. Shigley J. E., Theory of Machines (Kinematics), Tata Mcgraw Hill, 1981

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	1	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	1	3	1
Average	**3**	**2.2**	**2**	**–**	**–**	**–**	**–**	–	**–**	**–**	**–**	**1**	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
EC 26564	Advanced Electronics Engg	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: MA 10001 and PH 10016

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
2. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

Course Outcomes: At the end of the course students will be able to answer

1. Design and analyze diode based electronics circuits and subsystem which can perform logical and arithmetic operation.
2. Analyze BJT based electronic circuits.
3. Classify the digital circuits through basic logic gates.
4. Analyze and design converters which facilitate the conversion of real world analog signals to digital and vice versa.
5. Differentiate basic internal logic and design of microprocessor and its programming.

COURSE CONTENTS

Unit 1

General principles, working and characteristics of semiconductor diodes, transistors, introduction torectifiers and amplifiers.

Unit 2

Power supply and their ratings, CRO, Multi-meter, Function Generator, their specifications and applications in testing and measurement.

Unit 3

Binary numbers, their additions, subtraction etc., Boolean algebra, logic gates, logic functions, realization of logic gates by electronic devices, positive and negative logic, half adder, full adder,coder, decoder, flip-flop, synchronous and asynchronous circuits, counters, registers, memories.

Unit 4

Digital display systems, LED and seven segment display concept and use of D/A and A/D converters.

Unit 5

Introduction to Microprocessors, Programmers view to 8085 and its application.

Books & References Recommended

1 Bapat Y.N., Electronics Circuit and Systems- Analog and Digital TMH
2 Gaonkar, Introduction to Microprocessor, Wiley Easter
3 Theraja B.L., Basic Electronics (Solid State), 1993, S. Chand
4 Malvino, Basic Electronics TMH
5 Morris Mano, Digital Circuits & Logic Design,2nded., 2000, PHI

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	0	-	-	-	-	-	-	-	0	-	1
CO2	3	2	2	2	-	-	-	-	-	-	-	1	-	1
CO3	3	2	2	2	-	-	-	-	-	-	-	1	-	2
CO4	3	2	3	-	-	-	-	-	-	-	-	1	-	1
CO5	3	2	3	3	2	-	-	-	-	-	-	1	-	3
Average	**3**	**2**	**2.4**	**2.3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1.6**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
IP 26552	Manufacturing Processes-I	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 26008.

Course Assessment:

The following methods are adopted for the assessment of this course;

3. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
4. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

Course Outcomes: At the end of the course students will be able to answer

1. Discuss the underlying principles and process of common casting processes
2. Explain the construction and operations of common melting furnaces
3. Provide the various allowances to the patterns and convert the OEM drawing to pattern drawing
4. Design the core considering strength and other conditions
5. Design multi-cavity layout

COURSE CONTENTS

Unit 1

Foundry: Selection of pattern materials, Pattern allowances, Molding sand & their properties, testing of molding sand, cores and chaplets, casting defects & remedies. Special Casting Techniques: Gravity die or permanent mould casting, Pressure die casting, CO_2 molding, Investment mould casting, shell molding, centrifugal casting and continuous casting, Introduction to gating and feeding system

Unit 2

Welding: Classification of processes, power sources, characteristic curves, welding parameters of MMAW, electrode classification and their nomenclature, TIG welding, MIG welding, Submerged arcwelding and atomic hydrogen welding processes, Theory of resistance welding and various processes. Welding of materials: Parameters & processes used in welding of mild steel, alloy steel, stainless steel and Aluminium alloys, Welding Defects and remedies.

Unit 3

Hot Working of Metals: Rolling principle and rolling stand arrangements, forging operations, drop, press and machine forgings, forging defects, extrusion principles, hot extrusion processes. Cold workingof metals: Shearing, blanking and punching, tube drawing, wire drawing, squeezing, cold rolling, forging and bending operations.

Unit 4

Linear & angular measurement, Comparator, Slip gauges, angle gauges, sine bar, auto-colimeter, screwthread and gear measurement, measurement of straightness, flatness & square-ness.

Unit 5

Limits, fits and tolerances. Interchangeability, types of fits, allowances, hole & shaft basis system, standard limit system, tolerance & fundamental deviation, gauges & gauge design. Acceptance test, andalignment test for lathe, milling, shaping & drilling machines. Surface texture, Interferometry, Coordinate measuring machine & Toolmaker's microscope.

Text Books:

1. Rao P. N., Manufacturing Technology.
2. Lindberj, Manufacturing Process.
3. Campbell, Principles of Manufacturing materials & Process.

References Books:

1. Parmar R. S., Welding Processes and Technology.
2. Jain P. L., Principle of Foundry Technology

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	–	2	–	2	2	2	–	–	–	–	2	–	2
CO2	3	2	2	2	2	2	–	2	–	–	–	2	3	3
CO3	3	2	2	2	2	2	–	–	2	–	2	2	3	3
CO4	3	2	3	2	2	2	–	–	–	2	–	2	3	3
CO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Average	2.75	2	2.25	2	2	2	2	2	2	2	2	2	3	2.75

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26881	Machine Drawing & Computer Graphics	-	-	2	-	1	1	-	-	40	60	100

Pre-requisites: ME 10049

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
2. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

Course Outcomes: At the end of the course students will be able to answer

CO1	Develop the skill of drafting using CAD software
CO2	Apply standard drawing conventions and practices
CO3	Represent surface finish and tolerances of machine elements in drawing.
CO4	Draw the machine elements like couplings, cotters, riveted, bolted and welded joints.
CO5	Prepare an assembly drawing using part drawings of machine components.

COURSE CONTENTS

Unit 1

Introduction to computer aided drafting. Basic commands of common computer aided drafting packagesfor 2-D & 3-D. Machine Drawing practice with CAD software

Unit 2

Sectioning and drawing conventions for types of threads, welded joints, Surface roughness value and grade. Fits and tolerances- symbols and applications, Dimensioning, Use of standards and codes (BIS, ISO etc.)
Orthographic projections of simple machine parts such as threaded fasteners, pulleys, keys, cotters, pins,nut-bolt, gear etc.

Unit 3

Types of assembly drawings, norms and sequences of preparing assembly drawings
Orthographic projections of riveted joints, cotter joint, knuckle joint, flanged coupling, universalcoupling, Oldham's coupling, pipe joints.

Unit 4

Bearings: Bush bearing, Plummer block, foot step bearing.
Engine parts like piston, connecting rod, eccentric, and crankshaft.

Unit 5

Types of valves like ball valve, flap valve, stop valve, feed check valve, safety valves, blow off cock,tool post.

NOTE: *Each candidate should complete himself at least four full imperial size sheets during the semester*

Text Books:

1 Bhatt N.D. and Panchal V.M., Machine Drawing, Charotar Publishing House, 2000
2 K L Narayana, P Kannaiah, K Venkata Reddy, Machine Drawing, New Age International Publication, 2014

References Books:

1 IS Code: SP 46 – 2003, Engineering Drawing Practice
2 Laxminarayan and Mathur, Machine Drawing, Jain Bros, New Delhi, 1983

CO-PO MAPPING:

CO1	2	2	1	–	3	–	–	–	2	2	–	2	3	2
CO2	2	2	1	–	1	–	–	–	2	2	–	2	3	1
CO3	2	2	2	–	2	–	–	–	2	2	–	2	2	1
CO4	3	2	2	–	3	–	–	–	2	2	–	2	2	2
CO5	3	2	2	–	3	–	–	–	2	2	–	2	2	2
Average	2.40	2.00	1.60	_	2.40	_	_	_	2.00	2.00	_	2.00	2.40	1.60

HU 21507/26507/28507/29507: Economics for Engineers

Hours Per Week			Credits		Maximum Marks				
L	T	P	Th	Pr	Theory		Practical		Total
					CW	END SEM	SW	END SEM	
3	-	-	3	-	30	70	-	-	100

Pre-requisites: NIL

Course Assessment: Through End-Sem. Theory Exam, Theory Sessionals, Mid-Sem Tests, and Assignments

COURSE OBJECTIVES:

1. To develop the optimizing skills of technology-use in engineering problems
2. To articulate economic analytical skills so as to contextualize the solutions of engineering problems.
3. To explore the potential of students in economic perspective of engineering professional goals.
4. To make sense of need of entrepreneurship and understand the financial reports of a business.

COURSE OUTCOMES: After completion of course, the students will be able to:

CO1: Explain economic cyclic flow and Estimate the demand and demand elasticity for a product.
CO2: Plan the production; choose appropriate production technology (combination of production factors); and estimate feasible range of production.
CO3: Analyze the production-cost-profit relation and select the suitable project for investment
CO4: Estimate price and the equilibrium for a firm/organization in different competitive market situations.
CO5: Review, summarize and compare the financial statements of an accounting entity and able to apply financial ratio technique for financial analysis.
CO6: Identify the problems, see the opportunity, and ideate the solution to the problems

COURSE CONTENTS

Unit 1 Nature and scope of economics, Economic cyclic flow, Central Economic problems, macro and micro economics, concept, determinants and law of demand and supply, Elasticity of demand, Equilibrium price, consumer surplus and equilibrium.

Unit 2 Production, cost and Revenue: Production function, laws of return to variable proportion, Laws of return to scale, cost concepts, cost functions and their inter relation, Revenue Concepts and functions, break-even analysis, Time value of money and Investment analysis- NPV, IRR, ARR and payback period method.

Unit 3 Pricing and Market: Price determination and firm's equilibrium under perfect competition and monopoly, price-output determination under monopolistic competition, kinked demand curve, collusive and non-collusive oligopoly.

Unit 4 Entrepreneur, entrepreneurship and start-up, characteristics of an entrepreneur, forms of business organization, phases of startup, small medium and large scale enterprise, problems, opportunities, Design Thinking and Ideation. Business model.

Unit 5 Accountancy: Accountancy and bookkeeping, GAAP, Assets, Liabilities and Capital, types of accounts, Journal, Ledger, Trial Balance and Financial Statements, Financial Ratio Analysis.

Books & Reference Recommendation:

1. Jhingal M.L., Economics of development and Planning, Vrinda Publication (40th Ed./latest).
2. Ahuja H. L., Advance economic theory, S Chand Publication, (21st Ed./Latest)
3. Riggs, Bedworth and Randhawa, Engineering Economics, Tata McGraw-Hill, (4th Ed./latest)
4. Principles of accountancy, Nirmal Jain,
5. Entrepreneurship by Rajeev Roy, 2nd edition

CO-PO MAPPING:

CO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2				2		1					1	2
CO2	2			2		1	1			2		2	2
CO3	1	2			2	2				3	1	1	
CO4	1				2	2				3		1	
CO5		3		2	2	1		2	2	3	1	2	2
Average	1.5	2.5	0	2	2	1.5	1	2	2	2.75	1	1.4	2

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36011	Dynamics of Machines	3	1	2	4	1	5	70	30	40	60	200

Pre-requisites: ME26005 and ME26562.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO 1	Apply friction and lubrication mechanism to analysis of friction in different machine elements like thrust and radial load bearings, power screw, belt drive etc.
CO 2	Analyze various friction devices like clutch, brake and dynamometers.
CO 3	Illustrate construction, working and Dynamic analysis of different governors.
CO 4	Analyze dynamics of reciprocating mechanism and flywheel.
CO 5	Computation of unbalance in rotating and reciprocating machines.

COURSE CONTENTS

Unit 1

Friction and Lubrication: Screw Friction, Sliding and Rolling Friction, the Law of Solid Friction. Fluid Friction, Angle of Friction, Friction Circle, Journal Bearings, Thrust Bearings, Mitchell Thrust Bearing, Pivot and Collar Bearing, Ball and Roller Bearing, Belt, Rope and Chain Drives.

Unit 2

Clutches, Brakes and Dynamometer: Plate Clutch, Cone Clutch, band brake, the band and block brake, absorption dynamometer, prony, rope and band brake, hydraulic absorption dynamometerpropulsion and braking vehicles.

Unit 3

Governors: Principles of Power Control, Types of Governors, Watt, Porter and Spring Loaded Governor, Governor Characteristics, Effect of Friction.

Unit 4

Transmission of Power by Mechanism: Inertia Forces of Reciprocating parts, Piston Efforts and Crank Effort Diagrams, Fluctuation of energy and speed. The Flywheel.

Unit 5

Balancing : Static Balancing, Balancing of revolving masses, Primary balancing of reciprocating masses, locomotive balancing, hammer blow, pitching and swaying couple, secondary balancing of reciprocating masses. Condition of balance in V-Engine, radial engine and multi cylinder inline engine.Industrial practices of rotor balancing, Field balancing of rotors

Text Books:

1. Ambekar A. G., Mechanism & Machine Theory, Prentice-hall of India, 2007
2. Ghosh, A. & Malik, A.K., Theory of Mechanisms and Machines, East-West Press, 1988

Reference Books:

1. Bevan Thomas, Theory of Machine, CBS Pub. India, 2005
2. Green W. G., Theory of Machines, Blackie, London, 1962
3. Martin G. H., Kinematics & Dynamics of Machine, Overseas Press (India), 2008

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	–	3	1
CO2	3	1	1	–	–	–	–	–	–	–	–	–	3	2
CO3	3	2	1	–	–	–	–	–	–	–	–	–	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	–	3	2
CO5	3	3	2	1	–	–	–	–	–	–	–	–	3	1
Average	**3**	**2**	**1.6**	**1**	–	–	–	–	–	–	–	–	**3**	**1.4**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36003	Measurement and Automatic Control	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME26011 and ME26004

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Analyze measurement instruments, identify errors, and conduct uncertainty analysis
CO2	Utilize temperature and pressure/velocity measurement techniques effectively
CO3	Design and implement strain and motion/force/torque measurement systems proficiently
CO4	Enhancement of analytical skills for mathematical modeling and understand control system concepts
CO5	Analyze system responses and apply stability criteria to control systems

COURSE CONTENTS

Unit 1

Basic Concepts of Measurement: General measurement system, Noise and interference, Calibration, Static Performance Characteristics of measuring instrument and measurement system, Sequential and random tests. Measurement errors; error sources: calibration, data acquisition, data reduction; Design stage uncertainty analysis; combining elemental errors; Bias & Precision errors; Error propagation, Higher order uncertainty analysis.

Unit 2

Temperature Measurements: Temperature standards, Temperature scales; Thermometry based on thermal expansion: Liquid in glass thermometers, Bimetallic Thermometers; Electrical resistancethermometry: Resistance Temperature Detectors, Thermistors; Thermoelectric Temperature Measurement: Temperature measurement with thermocouples, thermocouple standards.

Pressure and Velocity Measurements: Relative pressure scales, pressure reference instruments, barometer, manometer, deadweight tester, pressure gauges and transducers, total and static pressure measurement in moving fluids

Flow measurements: Pressure differential meters: Orifice meter, Venturi meter; rota-meter.

Unit 3

Strain Measurements: Stress and strain, resistance strain gauges, gauge factor, strain gauge electrical circuits, multiple gauge bridge, bridge constant, apparent strain and temperature compensation, bending compensation

Motion, Force and Torque Measurements: Displacement measurement: Potentiometers, Linear variable differential transformers, rotary variable differential transformer; Velocity measurement: moving coil transducers; angular velocity measurement: electromagnetic techniques, stroboscopic measurement; Force measurement: load cells, piezoelectric load cells; Torquemeasurement: measurement of torque on rotating shafts, Power estimation from rotational speed and torque.

Unit 4

Introduction to control systems: Examples of control systems. Open loop and closed loop control.

Mathematical modeling of dynamic systems: Transfer function, impulse response function, blockdiagram of closed loop system, block diagram reduction, modeling of mechanical systems, modeling ofelectrical systems, signal flow graphs, modeling of fluid systems, liquid level systems, hydraulicsystems, modeling of thermal systems.

Unit 5

Transient and steady state response analyses: First order systems, unit step and unit impulse responseof first order systems, second order systems, unit step and unit impulse response of second order systems, transient response specifications. Routh Hurwitz stability criteria, Introduction to Bode plot and root locus method. System modelling using MATLAB.

Text Books:

1. Nakra B.C., Chaudhary K.K., Instrumentation, Measurement and Analysis, Tata McGraw Hill, New Delhi, 2004
2. Nakra B.C., Chaudhary K.K., Control Systems, Tata McGraw Hill, New Delhi, 1985
3. Modern Control Engineering, 4e, Katsuhiko Ogata, Pearson Education, New Delhi, 2004

Reference Books:

1. Richard S. Figiola & Donal E. Beasley, Theory and Design for Mechanical Measurements, 5e, John Wiley, 2005
2. Gopal M., Control Systems Principles and Design, 2e, Tata McGraw Hill, New Delhi, 2006
3. Beckwith and Buck, Mechanical Measurements, Addison-Wesley Pub. Co., 1982

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	–	–	–	–	–	–	–	–	–	–	1	1	1
CO2	3	3	3	–	–	–	–	–	–	–	–	1	1	1
CO3	3	2	3	1	–	–	–	–	–	–	–	1	1	1
CO4	3	3	3	–	–	–	–	–	–	–	–	1	2	1
CO5	3	2	2	1	–	–	–	–	–	–	–	–	–	–
Average	**3**	**2.5**	**2.75**	**1**	–	–	–	–	–	–	–	**1**	**1.25**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36006	Heat & Mass Transfer	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: ME 26005 and ME 26011.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

COURSE OUTCOMES: At the end of the course students will be able to answer

CO1	Explain basic modes of heat transfer. Application of Fourier's law in plane, composite walls, cylinder and sphere.
CO2	Analyze finned surfaces and assess how fins can enhance heat transfer and unsteady state heat conduction.
CO3	Describe various convection modes and their application to solve heat transfer problems for tubes, flat plates For laminar and turbulent flow.
CO4	Design heat exchangers using LMTD and NTU methods and explain heat transfer with change of phase.
CO5	Apply the principles of radiation heat transfer and basics of mass transfer to real world problems.

COURSE CONTENTS

Unit 1

Introduction: Various modes of Heat Transfer. Fourier's low, Thermal conductivity, Newton's law, film coefficient, combined conduction and convection: overall heat transfer coefficient, Stephan Boltzman's law.

Conduction: General heat condition equation in Cartesian coordinate, one dimensional study state, conduction through plane wall, cylinder and spheres. Composite wall cylinders and spheres. Critical thickness of insulation.

Unit 2 Effects of variable thermal conductivity on temperature distribution and heat flux.

Fins: Heat transfer from fins of uniform cross section for different boundary condition. Fins effectiveness and fins efficiency.

Unit 3 Brief introduction to Unsteady State Heat Conduction: Lumped parameters, Heisler chart.

Boundary Layer: Fundamentals, Equations of energy in the boundary layer. Thermal boundary layer. The Nusselt number.

Convection Heat Transfer: Mechanism of convection, free and forced Dimensionless numbers used in convections.

Unit 4 Empirical relations for convective heat transfer through tubes and flat plate, Heat transfer in turbulent flow. Reynold's Analogy.

Heat exchangers: Basic types of heat exchangers. The overall heat transfer coefficient and fouling factor. Log – Mean temperature difference. Effectiveness – NTU approach.

Recent Development in the heat transfer: Elementary idea about heat pipe, transpiration and ablation cooling, heat transfer in high speed flow etc.

Unit 5 Heat transfer with change of phase: Fundamentals of boiling heat transfer. Boiling curve and various boiling regions. Condensation heat transfer phenomena.

Radiation: Thermal Radiation. Monochromatic and total emissive power, absorptivity, reflectivity and transmissivity, Kirchoff's law, Black and Gray bodies, Plank's distribution law, Stefan Boltzman's law, Heat transfer by radiation between Black surfaces. Electrical analogy for solving Radiation problems.

Mass Transfer: Fick's Law, Analogy between heat and mass transfer through molecular diffusion, mass transfer by convection, Evaluation of mass transfer coefficient.

Text Books Recommended:

1. Holman J. P., Heat Transfer, Tata McGraw Hill, 1968
2. Kumar, D.S., Heat &Mass transfer, S K Kataria & Sons, 2009
3. Cengel Y. A., Heat Transfer, Tata McGraw Hill, 2005

Reference Books:

1. Eckert & Drake, Heat &Mass Transfer, Tata McGraw Hill, 1979
2. Ozisic, Basic Heat Transfer, Tata McGraw Hill, 1975
3. Incropera & DeWitt, Fundamentals of Heat and Mass Transfer, Wiley, 1996

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	2	–	–	–	–	–	3	3
CO2	3	3	3	3	2	–	–	–	–	–	–	–	3	3
CO3	3	3	3	3	3	–	–	–	–	–	–	–	3	3
CO4	3	3	3	3	3	–	1	–	–	–	–	–	3	3
CO5	3	3	3	3	–	–	–	–	–	–	–	–	3	3
Average	**3**	**3**	**3**	**3**	**2.75**	**1**	**1.5**	–	–	–	–	–	**3**	**3**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36007	Steam and Gas Power Systems	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 26005.

Course Assessment:
The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Analyze simple power plant cycles including reheat, regenerative and binary cycles.
CO2	Evaluate performance of nozzle and its efficiency. Explain and differentiate between impulse and reaction turbines. Analyze various energy losses in turbines
CO3	Explain the working principle of gas turbines and calculate its efficiency for various modifications in cycles.
CO4	Describe elements and principle of operation for Jet propulsion systems and calculate thrust, power and efficiency.
CO5	Analyze Combined cycle steam and gas power system. Purpose of condenser in steam power system

COURSE CONTENTS

UNIT 1

Thermodynamic Cycle of Steam Plant. Analysis and calculation of reheat. Regenerative & BinaryCycles.

UNIT 2

Nozzle flow analysis conditions for maximum flow.. Theory of steam injectors.
Basic types of Steam turbines. Governing and lubrication of steam turbines. losses in turbine

UNIT 3

Thermodynamic Cycle of Gas turbine Plant. Analysis and calculation of Reheating, regenerative andmultistage compression cycle.

UNIT 4

Jet propulsion systems: Air Breathing and Rocket propulsion. Principle of operation, calculation ofthrust and efficiency.

UNIT 5

Combined cycles of steam and gas turbine Power plant.
Steam condensers. Principle and working. Types of condensers. Cooling water calculations.

Text Books:
1. Yadav, R., Steam & Gas Turbine, Standard Publishers, 2007
2. Cohen, Rogers, & Saravanamuttoo, Gas Turbine Theory, Prentice Hall, 2001

Reference Books:
1. Noeb Hussain, Steam turbine theory and Design, Tata McGraw-Hill, 1984
2. Yahaya S.M., Turbine Compressors & Fans, Tata McGraw Hill, 2005
3. Khajuria & Dubey, Gras Turbine & Propulsive System, Dhanpat Rai and Sons, 1984

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	–	–	–	–	–	–	–	–	3	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	3	3	1
CO3	3	3	2	–	–	–	–	–	–	–	–	3	3	1
CO4	3	3	2	–	–	–	–	–	–	–	–	3	3	1
CO5	3	3	2	–	–	–	–	–	–	–	–	3	3	1
Average	**3**	**3**	**2**	–	–	–	–	–	–	–	–	**3**	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
IP 36062	MANUFACTURING PROCESSES -II	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: IP26553.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	To apply fundamental knowledge about basic mechanism of metal cutting, conventional machine tools and estimation and relationship between performance measures and machining parameters
CO2	To explain Shaping, Milling and Broaching operation and their importance.
CO3	To illustrate Grinding functions and processes on grinding machines.
CO4	To demonstrate Gear elements and gear manufacturing and finishing processes.
CO5	To infer the surface finishing, super finishing and polishing processes and their importance.

COURSE CONTENTS

UNIT 1

Principle of generation of surfaces, classification of machining processes, Geometry of single point and multipoint cutting tools like drill, milling cutter etc. Classification of lathe, lathe accessories. work holding & supporting devices, types of hand _drill, different methods of taper Turing, thread cutting & calculation of gear ratios. Concepts of feed speed & depth of cut, Capstan, turret, automates and copying machines.

UNIT 2

Constructional features and operations of shaper, planner, slotter, drilling & poring machines. Classification of Milling machines, principal parts, milling cutter and various operation performed, gear cutting and indexing, Broaching operation & types of broaching machines and geometry of broaching tools.

UNIT 3

Theory of grinding: Various types and constructional features of grinding machines, Surface, cyiindrical and center-less grinding. Types of abrasives, grinding wheels, bonding materials, Selection O f wheels & marking system, Balancing, dressing & truing of wheels, Introduction to lapping, honing, super-finishing, polishing and buffing. Classification of unconventional machining processes, principles and applications of processes like AJM, ECM. EDM and USM.

UNIT 4

Mechanics of Metal Culting: Metal cutting analysis, orthogonal and oblique cutting, Mechanics of cutting, shear angle relationsinip, Merchant circle and Force analysis for orthogonal cutting, dynamometry. Cutting tool, materials and their properies. Machinability an Economics of Machining: Tool Wear, tool life and methods of improving tool life, friction and heat in metal cutting, distribution of heat, Machinability and selection of economic speed & feed, Cutting fluids.

UNIT 5

Metal Working Analysis: Plastic deformation of metals, force analysis for wire drawing, forging, rolling and extrusion processes. Press Working: Power presses, load calculation in shearing, blanking, drawing, bending and forming operation Elements of dies and punches, clearance, center of pressure, blank-layout. Progressive, combination and compound dies.

Text Books:

1. Chapman, Workshop Technology Part-II aud III.
2. Pandey and Singh, Production Engineering.
3. Lindberg, Manufacturing Processes

Reference Books:

1. Khere and Vajpayee, Dimensional Metrology
2. Juneja B.L.. Manufacturing Processes.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	–	2	–	2	2	2	–	–	–	–	2	–	2
CO2	3	2	2	2	2	2	–	2	–	–	–	2	3	3
CO3	3	2	2	2	2	2	–	–	2	–	2	2	3	3
CO4	3	2	3	2	2	2	–	–	–	2	–	2	3	3
CO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Average	**2.75**	**2**	**2.25**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2.75**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36501	Refrigeration & Air Conditioning	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 26005 and ME36006.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Describe the basic concepts of refrigeration system and explain various types of refrigerants and their properties
CO2	Explain and analyze vapour compression systems
CO3	Analyze vapour absorption systems, low temperature and unconventional refrigeration systems
CO4	Analyze air-conditioning processes using the principles of psychometry
CO5	Explain air-conditioning systems and their applications in real world scenario.

COURSE CONTENTS

Unit 1

Principles of refrigeration : Review of revised Carnot cycle. Coefficient of Performance, Ton of Refrigeration, Various types of Refrigeration systems.

Air Refrigeration System : Bell Coleman Cycle, air cycle systems for aircraft. Boot Strap Type and simple evaporative system.

Unit 2

Refrigerants : Classification, Nomenclature, Desirable properties, important refrigerants, secondary refrigerants

Vapour Compression Systems : The Simple cycle. The Analysis of the simple cycle, effects of suction superheat and under cooling representation of cycle on T-S and P-H diagrams.

Unit 3

Vapour Absorption System: The simple Absorption cycle, use of heat exchanger, analysis and rectifier, the electrolux system Lithium – Bromide Water Absorption system.

Low Temperature Refrigeration: Limitations of vapour compression systems for production of low temperature. Cascade System of Refrigeration. Multistage systems. Use of Flash Intercooler Dry ice, its manufacture and uses. Joule-Thomson Effect and liquification of gases. Application of low temperatures.

Unit 4

Unconventional Refrigeration System: Steam jet and thermo-electric refrigeration systems, their principle of working and application. Psychrometric Process: Different psychrometric chart. By-pass factor.

Comfort Air Conditioning: Factors affecting human comfort. Flienyer's Equation. Effective temperature, comfort chart and comfort zone. Air conditioning load calculation: Sensible and latent loads, principles for calculation of building heat transmission, solar heat gain, infiltration and occupancy loads, load due to electric motors and electric driven machineries, other sources of heat gain.

Unit 5

Air conditioning Systems: Unitary and central air conditioning systems, evaporative cooling system, heat pump.

Air conditioning equipment: Direct expansion and chilled water coils, air washers, apparatus dew point temperature, cooling towers, simple heat factor. Requirement of air for heating and cooling system. Fans and Blowers for air conditioning, their classification and characteristics, grills and registers.

Ducts and Piping: Principles of layout and design of duct system, refrigerants and water pipings pressure losses through ducts and pipings.

Application of Refrigeration and Air conditioning: Food preservation, industrial air conditioning, survey of applications, manufacturing of ice.

Text Books:

1. Arora C. P., Refrigeration and Air Conditioning,, Tata McGraw-Hill Education, 2000
2. Ananthanarayanan, Basic Refrigeration and Air Conditioning, Tata McGraw-Hill Education, 2005
3. Prasad Manohar, Refrigeration and Air Conditioning, New Age International, 2003

Reference Books:

1. Dossat, R.J., Principles of Refrigeration, Pearson Education India, 1996
2. Whitman, Johnson & Tomczyk, Refrigeration and Air Conditioning Technology. Cengage Learning, 2009
3. Hundy, & TtoTT,hcleW Refrigeration and Air Conditioning, Butterworth-Heinemann, 2008
4. Althouse, hilleor hriligWct, lliW-qTi hit GoTiiTioTiTs. CooiWcqtT TrtTarigT & RtqeeiqTo, noictT Bc&tisctqTioT

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-		-	-	-	-	-	-	3	1
CO2	3	3	2	3	-		1	-	-	-	-	-	3	1
CO3	3	2	2	2	-		-	-	-	-	-	-	3	1
CO4	3	3	2	2	-		-	-	-	-	-	-	3	1
CO5	3	3	2	2	-		-	-	-	-	-	-	3	1
Average	3	2.8	2	2.2	-	-	1	-	-	-	-	-	3	1

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36503	Machine Design – II	3	-	4	3	2	5	70	30	40	60	200

Pre-requisites: ME 26002, ME26008 and ME26551.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Apply the theory of dynamics loading, fatigue, endurance limits, creep and stress concentration to solve engineering problems.
CO2	Design analysis of different types of gears.
CO3	Design of different types of springs, axle and shaft, power screw
CO4	Design analysis and selection of different types of journal bearings, selection of belts and chains
CO5	Design analysis of various I.C. engine components

COURSE CONTENTS

Unit 1

Dynamic loading, fatigue and endurance limits, creep: Effect of abrupt changes in the geometries instresses, stress concentration, stress concentration factors and methods of reduction, notch sensitivity. Types of dynamic loading, S - N curves, fatigue life, fatigue strength, Bauschinger effects, low-highcycle fatigue, effect of various factors, Different criteria for design of parts subjected to fatigue.

Tribological consideration in design of machine components such as clutches and brakes

Unit 2

Gears: Material selection for different types of gears, reviews of kinematic considerations, design ofspur, bevel, worm, helical gears, different case studies of failures.

Unit 3

Springs: Design of different types of springs subjected to axial, torsion, bending, and different combinations of loads and stresses. Different applications and case studies of design, Helical, leaf, spiraletc. types of springs.

Power screw: Parts of power screw, thread profiles of power screws, stress distribution, analysis and design of power screws for various applications.

Unit 4

Design of journal bearings: Specifying bearing modulus, minimum oil film thickness, flow of oil and bearing dimensions.

Belts, Rope and chain Drive: Types of belts and their selection criteria, types of ropes and chains and design criteria for their selections for various applications, matched sets of belts, calculations of differenttensions, lengths, sections, materials, etc.

Unit 5

Design of engine components: such as– cylinder, piston, connecting rod, crank and crank shaft, etc.

Text Book:

1 Bhandari V.B., Design of Machine Elements, Tata McGraw Publication, 2014
2 Sharma and Agrawal, Machine Design, S.K. Kataria and Sons, 2012

Reference Books:

1 Shigley and Mischke, Mechanical Engineering Design, Tata McGraw Publication, 2001
2 Robert C. Juvinall and Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley, 2006
3 Black V, Machine Design, Tata McGraw Publication, 1988

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3			2					2	3	1
CO2	3	3	3	3	1							2	3	1
CO3	3	3	3	3	1							2	3	1
CO4	3	3	3	3	1							2	3	1
CO5	3	3	3	3	2							2	3	1
Average	**3**	**3**	**3**	**3**	**1.25**		**2**					**2**	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36506	Fluid Machinery	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 26011 and ME 26005.

Course Assessment: The following methods are adopted for the assessment of this course

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Describe the working of impact of jet and Pelton turbine along with their performance parameters.
CO2	Describe the working of Francis and Kaplan along their performance parameters. To select and analyze an appropriate turbine with reference to given situation in power plants.
CO3	Discuss the operation of centrifugal pumps and to estimate performance parameters of a given Centrifugal and Reciprocating pump.
CO4	Discuss the operation of reciprocating pumps and their performance parameters.
CO5	Explain basic concepts of homogeneity and visualize dimensional analysis.

COURSE CONTENTS

Unit 1

Theory of Fluid Machinery: Impact of jet, velocity triangles, Euler's Equation for work done, efficiencies. Impulse flow turbines and their constructional details, characteristics of turbines, unit quantities, specific speed, governing of turbines, Phenomenon of water hammer, type of surge tank

Unit 2

Reaction Turbines: Francis, Propeller, Kaplan, Bulb Turbine, their constructional details, characteristics of turbines, unit quantities, specific speed, governing of turbines. , types of cavitation,cavitation effects, Thoma cavitation factor, apparatus for cavitation tests, effects of cavitation in pumpsand turbine, prevention of cavitation..

Unit 3

Rotodynamics Pump: Classifications of Rotodynamics pumps and their constructional details, Vector diagram, Work done by impellor, Efficiencies, Specific speed, Performance characteristics, NPSH, Cavitation Specific Speed, Multi-staging.

Unit 4

Positive Displacement and other Pumps: Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels and separation, Comparison of centrifugal and reciprocating pumps, Performance characteristics. Hydraulic ram, Jet pumps, Air lift pumps.

Unit 5

Dimensional Analysis: Dimensional homogeneity, Buckingham Theorem and its Applications,parameters, similitudes modelling criteria and distorted models.

Text Books:

1. Yahya, S.M., Turbines, Compressor & Fans, Tata McGraw Hill.
2. JagdishLal, Hydraulic Machine, Metropolitan book co.
3. Kumar, D.S., Fluid mechanics and Hydraulic Machines, S K Kataria& Sons Publication.

Reference Books:

1. Govindarao, N.S., Fluid Flow Machines, Tata McGraw Hill.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	1	-	-	-	2	-	-		3	2
CO2	3	2	2	3	1	-	-	-	2	-	-	1	3	2
CO3	3	2	2	3	3	-	-	-	2	-	-	1	3	1
CO4	3	2	2	2	1	-	-	-	-	-	-	-	3	1
CO5	3	3	3	2	-	-	-	-	-	-	-	1	3	2
Average	**3**	**2.2**	**2.2**	**2.6**	**1.5**	-	-	-	**2**	-	-	**1**	**3**	**1.6**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36509	Internal Combustion Engines	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME26005.

Course Assessment: The following methods are adopted for the assessment of this course-

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Analyze various air standard and actual cycles. Classify internal combustion engines based on different parameters.
CO2	Describe various qualities of engine fuels, carburetor fundamentals and its function for automobiles.
CO3	Analyze the phenomenon of combustion and describe the functioning of fuel injection system in SI engine and analyze the combustion phenomenon in CI engine.
CO4	Discuss pollutant formation and their control. Explain modern trends in IC engines
CO5	Describe various mechanisms of lubrication and cooling systems. Evaluate the performance of engines.

COURSE CONTENTS

UNIT I

Air-Standard cycle and their analysis, Comparison of cycles. Classification of engine and their application, Engine Designand operating parameters. Fuel-air cycles and their analysis. Thermochemistry of fuel air mixture. Properties of workingfluids and thermodynamics charts. Actual cycles and their analysis of SI and CI Engine cycles.

UNIT II

Fuel and Carburetion: Important qualities of engine fuels and their chemical compositions. Energy enthalpy and heatingvalues. Entropy and maximum work from Internal combustion and engine efficiency (Chemical equilibrium and Reaction rate) Carburetor fundamental and its type, Modern carburetor design and function and characteristics for automobiles.Fuel Injection system in SI engine and flow in intake manifold. Mean velocity and turbulence characteristics and swirl. Combustion in S.I. Engine: Combustion SI engine, Analysis of mixture of combustion flame structure and speed, factorsinfluencing combustion and rate of pressure rise. Abnormal combustion, knock and surface ignition and fuel factor and mixture. Combustion chambers for SI Engine combustion models.

Injection system of SI Engine: Requirement and classification, Components Ignition system in SI engine its requirement.Modern Ignition system i.e. Electronic spark advance system and firing order in multi-cylinder engine.

UNIT III

Combustion in CI engine: Type of combustion system, Fuel spray behavior, ignition delay and factors effecting it. Phenomenon of knock in CI engine and its compression with SI engine. Combustion chambers for CI engine. Combustion models.

UNIT IV

Pollutant formation and its control, Nature and extent of problem. Formation and control of Nitrogen oxides, Carbon mono oxides, Unburnt hydrocarbons and particulate of emission. Various emission control Standards, its measure and its prevention.

Modern trend in IC engine, Wankle rotary engine. Free piston engine and their application.

UNIT V

Engine friction and lubrication and cooling Mechanical friction and factor controlling it. Blow by losses, pumping losses.Lubrication of engine components. Lubrications systems, Properties of lubricants and additives used. Heat transfer and its parameters. Characteristics of efficient cooling and types of cooling system and their comparisons. Performance and Testing: Engine operating characteristic and its parameters variable effecting SI and CI Improvementsperformance map.

Two Stroke Engine: Types of scavenging process and various terminology. Actual scavenging process. Advantage disadvantages of SI and CI engines and compression, Supercharging.

Text Books:

1. John B. Heywood, I. C. Engines Fundamental, McGraw Hill Publication, 1988
2. Mathur & Sharma, I. C. Engine, Dhanpatrai Publication,2010
3. Ganeshan, I. C. Engine, Tata McGraw Publication, 2012

References Books:

1. Ashely S. and Campbel, Thermodynamics & Analysis of Combustion Engines, Wiley, 1979
2. Taylor, The Internal Combustion in Engine in Theory and Practice, MIT Press, 1985
3. Benson, The I. C. Engine, Claredon Press Oxford, 1982

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3			2					2	3	1
CO2	3	3	3	3	1							2	3	1
CO3	3	3	3	3	1							2	3	1
CO4	3	3	3	3	1							2	3	1
CO5	3	3	3	3	2							2	3	1
Average	**3**	**3**	**3**	**3**	**1.25**		**2**					**2**	**3**	**1**

IP36504: Industrial Engineering and Production Management

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
IP36504	**Industrial Engineering and Production Management**	**3**	**-**	**-**	**3**	**-**	70	30	-	-	**100**

COURSE OUTCOMES: At the end of the course students will be able to answer

1. Distinguish the basic concepts of industrial engineering.
2. Analyze the fundamentals of production management, PPC, and facilitiesplanning.
3. Apply the quantitative models in aggregate production planning and scheduling.
4. Explain the fundamentals of materials management.
5. Explain the fundamentals of quality control.

Unit 1 - Methods Engineering: Introduction to work study and productivity, Method study, recording techniques, work measurement tools and techniques. **Workplace design**: fundamentals of workplacedesign, Introduction to job evaluation and wage Incentive schemes.

Unit 2 - Production Management: Introduction, Evolution of Operations Management, Decision making, Types of production systems, Facilities planning and design-Layout analysis. **Production Planningand Control:** PPC Functions, Location decision, Production Control- process, methods/techniques,Forecasting- its methods, need, approaches and their utility.

Unit 3 - Aggregate Planning: Introduction, objectives, framework, and various approaches, L.P. Model, transportation model, Master Production Schedule-RCCP. **Scheduling:** Scheduling for different types of production systems, sequencing rules, Johnson's rule, machine loading, shop loading, linebalancing, L.O.B.

Unit 4 - Materials Management: Purchasing - Objectives, significance, policies and methods. Stores - Objective, Policies, and procedures etc. **MRP and Inventory control:** Introduction to MRP, Typesof inventory control, E.O.Q. model, Selective inventory control, JIT and KANBAN concepts.

Unit 5 - Quality control: Quality planning and quality control, operation, economics of quality control,process capability studies, and control charts for variables and attributes.

Text Book:

1. Work Study by International Labour Organisation (ILO), Geneva.
2. Chase, Acquilino. Jacobs- Operations Management, Tata MC Hills, India.
3. P. Gopalkrishnan and M. Sundaresan- Materials Management: Integrated Approach, Prentice Hall, NewDelhi.

Reference Book:

1. B. Mahadevan , Operations Management, Himalaya publications, India
2. Norman Gaither , Operations Management, Cengage publications, India

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	1	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	1	3	1
Average	**3**	**2.2**	**2**	–	–	–	–	–	–	–	–	**1**	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46018	Automobile Engineering	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 26005 and ME 36509.

Course Assessment:
The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Analyze and evaluate vehicle structures for safety and integrity.
2. Predict vehicle handling and understand steering system design.
3. Optimize vehicle ride comfort, stability, and performance.
4. Understand and analyze friction clutches, electrical systems, and general automobile engineering principles.
5. Analyze vehicle performance and understand transmission systems for efficient operation.

COURSE CONTENTS

UNIT I

Vehicle Structure: Fine frame, integral body structure, engine, transmission and body structure mountings,sub frames collision safety, type of rubber flexible mounting.
Vehicle ride characteristics: human response, vehicle ride.

UNIT II

Handling System and Steering System: Study state handling characteristics and response to input. Steeringgear box fundamental design. Need for power steering, steering linkages ball and socket joints.
Suspension: Suspension geometry camber, Swivel & Castor angle. Suspension roll centres body roll stability. Antiroll stiffness. Rubber Spring pump or limiting stop. Axle location, front wheel drive, independent suspension, Macpherson stut & rear wheel. Hotchkiss drive springs & shock absorber.

UNIT III

Pneumatic Tyre: Mechanics of type forces, rolling resistance, tractive effort & step. Cornering properties & stiffness, Performance on roads. Tyre material & construction, Thread design & its marking identification.
Brakes, Braking fundamentals, Brake shoe & pad fundamentals brake & shoe expander & adjuster disc brakes. Dual brake system, anti-locking brakes air operated power brakes.

UNIT IV

Friction Clutch: Clutch fundamentals, Angular driven plate, Cushioning &torsional damping, Friction material, clutch alignment, types of clutch – diaphragm, multiplate etc., hydraulically operated automatictransmission clutch.
Electrical System: Self-starting mechanism & battery charging system, Lighting & wiring system for horn,lamp indicators etc
General: Air conditioning, auto inspection motor vehicle acts, emission standard & its control.

UNIT V

Transmission: The necessity for a Gear box, five speed and reverse synchromesh, Gear box synchronization& engagement, remote controlled gear selection & engagement, splitter & range change gear box, over drive considerations setting gear ratios, Hydrokinetic fluid coupling & torque converter, final drive transmission, crown wheel & pinion axle adjustment, differential locks, skid reducing universal joint, fourwheel drive & two wheel drive.
Performance Characteristics of Road Vehicles: Tractive effort weight & axle loads, aerodynamics forces, vehicle power plant & transmission characteristics & its prediction operating fuel economy.

Text Books:

1. Hinz, Advanced Automobile.
2. Crouse Anglin, Automotive Mechanics, TMH 10th Edition, 2006

References Books:

1. Newton, Steeds & Garrett, The Motor Vehicle, Butterworth-Heinemann, 2001
2. Wong, Theory of Ground Vehicle, Wiley, 2008
3. The Series of Judge, The Modern Motor Engg., 1960

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	–	–	–	–	–	–	–	–	1	–	2
CO2	3	3	–	–	–	–	–	–	–	–	–	1	–	1
CO3	3	3	2	–	–	–	–	–	–	–	–	1	1	1
CO4	3	3	1	–	–	–	–	–	–	–	–	1	2	1
CO5	3	3	–	–	–	–	–	–	–	–	–	1		1
Average	**3**	**3**	**1.67**	–	–	–	–	–	–	–	–	**1**	**1.5**	**1.2**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46051	Vibration & Noise Control	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 26002, ME 26562 and ME 36011.

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO 1	Develop mathematical models of machines/structures as SDOF Systems and estimation of natural frequencies, damping factors.
CO 2	Determine response of SDOF damped Systems under external excitation
CO 3	Analyze 2DOF systems to find out modal data, design of undammed dynamic vibration absorber, Analyze modal parameters.
CO 4	analyze vibration records and determine sound levels on logarithmic scale (dB), loudness, and loudness levels
CO 5	Apply techniques of noise control as per industry norms.

COURSE CONTENTS

UNIT I

Introduction: Periodical motion, harmonic motion, the vector method of representing vibrations, displacement, velocity and acceleration in harmonic motion, work done in harmonic motion, superposition of simple harmonic motion, beat phenomenon, non harmonic periodic motions. Harmonicanalysis

System having single degree of freedom, free vibration of systems without damping, Equilibrium andEnergy Method for determining natural frequency. Reyleigh's Method, Equivalent Systems (systems withcompound springs, shafts of different diameter Equivalent length, effects of mass of spring and shaft). Free vibration of systems with Viscous, Coulomb and Structural damping. Equations of motion –Discussion of its solutions.

UNIT II

Forced vibrations of systems with and without damping, Method of complex algebra, equivalent viscousdamping, impressed force due to unbalance, transmissibility, support motion, Vibration isolation, commercial isolators.

Whirling of shafts: Whirling of light flexible shaft with an unbalance disk at the centre of its length withand without damping, discussion of the speeds above and below the critical speed, uniform shaft with andwithout unbalanced masses attached along its length (by Reyleigh Method) for simply supported and fixed ends.

Vibration & Noise Measurement: Principle of frequency, amplitude, velocity and acceleration measuringinstruments

UNIT III

System with two-degree of freedom: Torsional systems, Degenerate Systems, Coupled vibrations, vehiclesuspension, Undamped dynamic vibration absorber, Centrifugal absorber, friction damper.

Modal Analysis, Orthogonality of Eigenvectors, Decoupling of Equations of Motion, Modal Mass, ModalStiffness and Modal Damping, General solution in terms of normal mode (Normal Mode Summation) Introduction to Experimental Modal Analysis

UNIT IV

Machine vibration data acquisition, Vibration Severity and Standards, analysis of vibration records,Vibration Monitoring

Noise and its causes, Subjective response to sound, sound pressure/ intensity/ power level and their inter-relation, Inverse Square Law, Decibel scale, Threshold of hearing, Audible Frequency Range, Sound wave propagation, Radiation Fields of Sound Source, Near field, Far field, Free field, Direct field, Reverberant field, Diffuse field, Loudness and equal loudness contours

UNIT V

Noise Control: Effect of machine / process noise on operators, employees and local residents. Standardsof noise level and exposure limits. Frequencies of interest and Frequency Weighting networks, Sound spectra and octave band analysis, 1/1 and 1/3 Octave filters. Background noise, Measurement of noise, Acoustic Chambers, Anechoic Chamber, Reverberation chamber,

Sound absorbing materials, Sound Absorption and Reflection Coefficients, Noise reduction coefficient, Methods of industrial noise control.

Text Books:

1. J S Rao and K Gupta, Theory and Practice of Mechanical Vibrations, New Age international
2. Ambekar A.G., Mechanical Vibrations & Noise Engineering, Prentice Hall of India, 2006
3. C. Sujatha, Vibration & Acoustics, Mc Graw Hill Education
4. Thomson, Theory of Mechanical Vibration, 5th Ed., Prentice Hall, 1998

References Books:

1. TseMorse & Hinkle, Mechanical Vibrations, CBS Publication, 2002
2. S. S. Rao, Mechanical Vibrations, Pearson

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	–	–	–	–	–	–	–	–	1	2	2
CO2	3	3	2	–	–	–	–	–	–	–	–	1	2	2
CO3	3	3	2	–	–	–	–	–	–	–	–	1	2	2
CO4	3	3	2	2	1	–	2	–	–	–	–	1	2	2
CO5	3	3	2	–	1	3	2	–	–	–	–	1	2	2
Average	**3**	**3**	**2**	**2**	**1**	**3**	**2**	–	–	–	–	**1**	**2**	**2**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46020	Computer Aided Design	3	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 2606, ME 3606, ME3601, ME3607

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work:** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination:** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO 1	Distinguish the application of CAD Hardware and Software.
CO 2	Explain the Mathematical modeling of curves representation for geometric modeling and geometric models transformation
CO 3	Design and application of parametric representation of curves for surface modeling.
CO 4	Apply solid modeling tools and understanding about reverse engineering
CO 5	Apply numerical methods for analysis of the various types of models

COURSE CONTENTS

UNIT I

CAD Hardware: Types of systems, Systems evaluating criteria, Input devices, output devices. Hardware Integration, Networking.

CAD Software: Graphics standards, Modes of graphics operation, modelling and viewing, CAD data Exchange, overview of different solid modelling software.

UNIT II

Geometric Modelling: Types of Mathematical representation of curves, parametric representation of Analytic and synthetic curves, wire frame modelling.

Introduction of transformation of geometric models, visual realism.

UNIT III

Surface Modelling: Parametric representation of analytic and synthetic curves, surface manipulation, Design and engineering applications.

UNIT IV

Solid Modelling: Boundary representation, constructive solid geometry, boundary representation, Sweep representation, Analytical solid modelling, brief overview of reverse engineering and rapid prototyping. Design and Engineering applications, prototyping

UNIT V

Numerical Methods: Solution of algebraic linear equation, Eigen Value problem, Differential equations, Convergence errors. Introduction to FEM and its application to simple 1-D problem

Text Books:

1. V Ramammurthy, Computer-Aided Mechanical Design and Analysis, McGraw-Hill, 1998
2. Besant and Lui, CAD, East-west Press Pvt Ltd, 1986
3. Ibrahim Zeid, CAD/CAM: Theory & Practical, Tata Mc-Graw Hill, 2012
4. Faut & Pratt, Computational Solid Geometry, Villy storm Ltd, 2002
5. E. Mortenson, Geometric Modelling, Villy storm Ltd, 2002

References Books:

1. Donald Hearn & M. Pauline Balear, Computer Graphics, Prentice Hall, 1997
2. Dean and Taylor, Computer-Aided Design, Addison Wesley, 1992
3. Herrington, S., Computer Graphics, McGraw Hill, 1987
4. K C Jain, Vikas Gohil, CAD/CAM/CIM, Khanna Publishers, 2014

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	1	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	1	3	1
Average	**3**	**2.2**	**2**	–	–	–	–	–	–	–	–	**1**	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46219	Advanced Machine Design	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 26551 and ME 36503.

Course Assessment:
The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Design analysis of rotating ring, disk and curved machine member and their applications in designing of different machine components.
CO2	Design analysis of parts of unsymmetrical section
CO3	Demonstrate reliability based design. Design of machine tool derives for different machines such as lathe, milling and drilling
CO4	Explain optimum design analysis of simple machine members and human factors in design.
CO5	Design analysis of automotive gear box.

COURSE CONTENTS

Unit 1

Rotating ring and disks: Discs of uniform thickness and disc of uniform strength effect of drill hole and extra mass, design of flywheel and pulley, etc.

Unit 2 Design analysis of curved machine members: Crane hooks, chain link, open and close link, m/c frames.

Design of parts of unsymmetrical sections: Defining shear centre, parts subjected to unsymmetrical bending

Unit 3 Limit design analysis: Simple cases of deformations beyond elastic limits.

Reliability based design: Reliability based design of machine elements, design of elements subjected to tension, compression, bending and torsion

Unit 4 Design of machine tool drives: Design of machine tool drives for different machines such as lathe, milling machine, drilling machine, etc.

Experimental method in design: Introduction to experimental stress analysis techniques.

Unit 5 Human factors in design: Introduction to human – machine system, human factors, applications in system design, human physical activities, human control of systems, shapes, coding of control.

Design of automotive gear box-manual and automatic

Text Books:
1. Mechanical Engineering Design, Shigley and Mischke, TMH, 2001
2. Introduction to Machine Design, V. Bhandari, TMH, 2004
3. Strength of Materials, S.S. Ratan, TMH. 2016.
4. Machine Tool Design and Numerical Control, TMH, 2013
5. Advanced Vehicle Technology, H. Heisler, Butterworth-Heinemann, 2e, 2002.

Reference Books:
1. Fundamentals of Machine Component Design, R. C. Juvinall and K. M. Marshek, John Wiley, 2006
2. Engineering Optimization, Rao S.S., John Wiley, 1996

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	1	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	1	3	1
Average	**3**	**2.2**	**2**	–	–	–	–	–	–	–	–	**1**	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 4620B	Design of Air Conditioning Equipment	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 26005 and ME36501.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests andclass attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Distinguish various types of compressors, evaporators and condensers used in refrigeration industry.
2. Explain Kyoto protocol and need for using eco-friendly refrigerants.
3. Classify psychromeric properties and air washer.
4. Analyze the size of air conditioning for a particular commercial application.
5. Design air conditioning and air distribution to maintain indoor air quality.

COURSE CONTENTS

UNIT I

(a) **Compressors:** Hermetic compressors-Reciprocating, Rotary, Scroll Compressors, Open type compressors Reciprocating, Centrifugal, Screw Compressors. Semi-hermetic compressors, Construction, working and Energy Efficiency aspects. Applications of each type.

(b) **Evaporators and condensers:** Different types, capacity control, circuitry, Oil return, Oil separators Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers,Spray ponds.

UNIT II

(a) **Refrigerants:** Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal / Kyoto protocols-Eco Friendly Refrigerants.

(b) **Psychrometry:** Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation.

UNIT III

(a) **Summer and Winter Air Conditioning:** Air conditioning processes-RSHF, summer Air conditioning, Winter Air conditioning, Bypass Factor. Applications with specified ventilation air quantity- Use of ERSHF,Application with low latent heat loads and high latent heat loads.

(b) **Load Estimation and Air Conditioning Control:** Solar Radiation-Heat Gain through Glasses, Heat Transfer through Walls and Roofs-Total Cooling Load Estimation. Controls of Temperature, Humidity andAir flow.

UNIT IV

(a) **Air Distribution:** Flow through Ducts, Static & Dynamic Losses, Air outlets, Duct Design–Equal Friction Method, Duct Balancing, Indoor Air Quality, Thermal Insulation, Fans & Duct System Characteristics, Fan Arrangement, Variable Air Volume systems, Air Handling Units and Fan Coil units.

(b) **Water Circuits:** Water piping in Chilled Water Systems, Multiple Fan Coil Units, Condensers-Multiple Condensers and Cooling Towers.

UNIT V

(a) **Testing:** Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests.

(b) **Applications:** Air Conditioning in Automobiles, Railway Wagons, Marine Vessels, Aircraft and Other Commercial Applications.

Text Books:

1. Arora C.P., Refrigeration and Air Conditioning, Tata McGraw Hill Pub. Company, New Delhi - 2000.
2. Carrier Air Conditioning Co., Handbook of Air Conditioning Systems design, McGraw Hill, 1985.

Reference Books:

1. Langley, Billy C. Refrigeration and Air Conditioning Ed. 3, Engie wood Cliffs (N.J) Prentice Hall 1986.
2. Jones, Air Conditioning Engineering, Edward Amold pub. 2001.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	1	–	–	–	–	–	–	1	3	2
CO2	3	2	1	–	1	–	–	–	–	–	–	1	3	2
CO3	3	1	1	–	1	–	–	–	–	–	–	–	3	1
CO4	3	1	2	–	1	–	–	–	–	–	–	–	3	1
CO5	3	2	1	–	1	–	–	–	–	–	–	–	3	2
Average	3	1.6	1.2	–	1	–	–	–	–	–	–	1	3	1.6

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 4620A	Industrial Tribology and Maintenance Engg	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME26008, ME36001 and ME36503

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests andclass attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Demonstrate the origin of tribology, its constituents, microscopic factors involved,surface topography and applications,
2. Explain basics of friction, its laws, theories, mechanism, material andparameter influence.
3. Explain basics of wear phenomenon, its types, wear equations andparameters.
4. Categorize lubrication mechanisms, their mathematical aspects, designfactors, applications and types.
5. Classify maintenance techniques and machine health monitoring

Syllabus Contents

Unit 1:

History of Tribology, Constituents of Tribology, Engineering surfaces, statistical nature of surfaces, surface examination, Tribological properties of surfaces, contact of surfaces. Tribological applications.

Unit 2

Genesis of Friction, static and kinetic friction, laws of Friction, theories of friction, friction control, stick-slip motion, parameters affecting friction behavior, Friction of various materials.

Unit 3:

Definition of wear, various types of wear, mechanism of wear in adhesive, abrasive, erosive, fretting modes, wear equations, parameters affecting wear, wear prevention.

Unit 4:

Lubrication mechanisms, Stribeck curve, Petroff's equation, Hydrodynamic, Hydrostatic,Elastohydrodynamic, Boundary Lubrications, Reynolds's equation and its limitations, idealized bearings, infinitely long and infinitely short (narrow) journal bearings, Types of lubricants.

Unit 5:

Maintenance policies, Role of maintenance, Diagnostic maintenance, Maintenance techniques, Signature analysis, wear particle analysis, Oil analysis, Thermography.

Text Books:

1. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.
2. Principles in Tribology, Edited by J. Halling, 1975.

Reference Books

1. Fundamentals of Fluid Film Lubrication– B. J. Hamrock, McGraw Hill International,1994 Model Curriculum of Engineering & Technology PG Courses [Vol -II].
2. D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.
3. Introduction to Tribology of Bearings– B. C. Majumdar, A. H. Wheeler &co. pvt. ltd 1985.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	1	–	2	–	–	–	–	1	3	2
CO2	3	2	1	–	1	2	2	–	–	–	–	1	3	2
CO3	3	2	2	–	2	2	–	–	–	–	–	–	3	1
CO4	3	1	2	–	1	–	–	–	–	–	–	–	3	1
CO5	3	2	1	–	1	–	–	–	–	–	–	–	3	2
Average	3	1.8	1.4	–	1.2	2	2	–	–	–	–	1	3	1.6

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46218	Mechatronics and Automation	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 36003.

Course Assessment:

The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO 1	Distinguish various control actions and apply the concepts of transfer functions for mathematical modeling mechanical and electrical system
CO 2	Explain system stability criteria, method and application of PID controller
CO 3	Discuss various types of solenoids, relays and electromechanical actuators and Demonstrate various hydraulic and pneumatic systems and their applications
CO 4	Apply different motion control techniques in various engineering applications.
CO 5	Explain signal conditioning and data acquisition process.

COURSE CONTENTS

Unit 1:

Control system and types: Open loop and closed loop control systems. Block Diagrams representation of control system. Laplace Transform and Transfer Function. Mathematical modeling of mechanical and electrical system. Poles and zeros. Zero order, first order and second order systems and their dynamic response.

Unit 2:

Routh Hurwitz stability criteria, Introduction to bode plot and root locus method. Basic control actions. Proportional, integral and derivative control. Op Amp based PID controller, PID control using MATLAB. Combinatorial and sequential logic. Simple logic networks.

Unit 3:

Electro-Mechanical Actuators: Electro-mechanical actuators, solenoids and relays, types of electric motors and their characteristics, electrical drives and control of electric motor.

Hydraulic &Pneumatic Systems: Hydraulic & Pneumatic cylinders and Actuators, Pressure and Flow Control Valves, Direction Control Valves, Basic circuit, Reference circuit, Meter-in, Meter-out and Bleed off circuit, Accumulator circuit, Circuit Diagram representation,

Unit 4:

Motion Control: Trajectory planning, motion controllers, point to point motion, co-ordinated multi-axis motion, electronic gearing,

Feedback devices: linear and rotary encoders, resolvers, tachometers and tacho-generators.

Unit 5:

Signal Conditioning & Data Acquisition: Amplification. Filters. Operational amplifier and its applications. Analog to digital conversion. Data acquisition. Introduction of microcontrollers interfacing with micro-controller and micro-processor.

References:

1. K. Ogata, Modern Control Theory, PHI, 2004
2. Nakra & Choudhary, Instrumentation, Measurement and Analysis, TMH, 2004
3. Bolton, Mechatronics, Pearson Education India, 2004
4. Norman S. Nice, Control System engineering, John Wiley & Sons, Inc.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	–	2	–	–	–	–	–	–	2	2	2
CO2	2	3	3	2	2	–	–	–	–	–	–	1	3	2
CO3	2	1	–	–	–	–	–	–	–	–	–	1	3	–
CO4	2	2	2	–	–	–	–	–	–	–	–	2	2	–
CO5	2	–	–	–	–	–	–	–	–	–	–	1	2	–
Average	**2**	**2**	**2.333**	**2**	**2**	–	–	–	–	–	–	**1.4**	**2.4**	**2**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46671	Artificial Intelligence	3	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course students will be able to answer

CO1	Build intelligent agents for search and games
CO2	Solve AI problems through programming with Python
CO3	Compute optimization and inference algorithms for model learning
CO4	Design and develop programs for an agent to learn and act in a structured environment
CO5	Apply the principle of reinforcement learning

COURSE CONTENTS

Unit 1

Introduction: Concept of AI, history, current status, scope, agents, environments, Problem Formulations,Review of tree and graph structures, State space representation, Search graph and Search tree.

Unit 2

Search Algorithms: Random search, Search with closed and open list, Depth first and Breadth firstsearch, Heuristic search, Best first search, A* algorithm, Game Search.

Unit 3

Probabilistic Reasoning: Probability, conditional probability, Bayes Rule, Bayesian Networks-representation, construction and inference, temporal model, hidden Markov model.

Unit 4

Markov Decision process: MDP formulation, utility theory, utility functions, value iteration, policyiteration and partially observable MDPs.

Unit 5

Reinforcement Learning: Passive reinforcement learning, direct utility estimation, adaptive dynamicprogramming, temporal difference learning, active reinforcement learning- Q learning.

Books:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill
3. Trivedi, M.C., “A Classical Approach to Artificial Intelligence”, Khanna Publishing House, Delhi.
4. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2011
5. David Poole and Alan Mackworth, “Artificial Intelligence: Foundations for Computational Agents”, Cambridge University Press 2010.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	1	2	–	–	–	–	1	3	2
CO2	3	2	1	2	2	2	2	–	–	–	–	1	3	2
CO3	3	2	1	–	2	2	–	–	–	–	–	–	3	1
CO4	3	2	1	–	1	1	–	–	–	–	–	–	3	1
CO5	3	2	1	–	1	–	–	–	–	–	–	–	3	2
Average	**3**	**2**	**1**	–	**1.4**	**1.5**	**2**	–	–	–	–	**1**	**3**	**1.6**

Department of Industrial and Production Engineering
B. TECH Mechanical Engg IV Year (4YDC)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
IP 46316	Operations Research	3	0	0	3	-	70	30	-	-	100

COURSE OUTCOMES: At the end of the course students will be able to answer

1. Analyze any real life system with limited constraints and depict it in a model form and convert theproblem into a mathematical model
2. Analyze and Simulate different real life probabilistic situations using Monte Carlo simulation technique.
3. Analyze variety of problems such as linear programming, assignment, transportation, Gametheory and Dynamic programming etc.
4. Explain different queuing situations and find the optimal solutions using models for differentsituations

COURSE CONTENTS

1. Introduction: History and Development of O.R. present trend, Types of models, Effect of data availability on modelling, Computations and steps in tackling of problems. Linear Programming:
   (a) Formulation of LPP, Simple LP model and its graphical solution, Development of simplex algorithm, Duality in LP and its interpretation, Sensitivity Analysis.
   (b) Assignment models and applications.
   (c) Transportation Models: finding initial basic feasible solution through North-West corner rule, Row minima method, column minima method, Vogel's approximation method, Finding optimal solution through MODI method.
2. Competitive Strategy: Game theory and its applications, concept and terminology, Pure and mixed strategies, 2x2 matrix game, 2xn game (graphical solution), mxn game solution through linear programming.
3. Waiting Line Models & Their Applications: Concepts, Definitions and notations, Single channel poissonarrivals with exponential service rate (M/M/1), multi-server model (M/M/s)
4. Dynamic Programming : Concept, Principles of optimality, Stage Coach problem, Optimum route problem, Allocation of salesmen to territories, Maximizing Reliability with budget constraints, Application to inventory control.
5. Introduction to Integer Programming. Branch and Bound Algorithm. Simulation: Need for simulation, Monte Carlo method, Random Number Generation, Application to waiting line and Inventory control, Advantages and limitations.

Books & References Recommended :

1. Taha, Operations Research.
2. Hira & Gupta, Operation Research, S. Chand.
3. Philips, Ravindran and Solburg, Operations Research.
4. Sharma S. D. , Operations Research

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	–	1	1	–	–	–	–	1	1	2	2	1
CO2	2	3	–	1	1	–	–	–	1	1	1	1	2	1
CO3	2	3	–	1	1	–	–	–	1	1	2	2	2	1
CO4	2	3	–	1	1	–	–	–		1	2	1	2	1
CO5	2	3	–	1	1	–	–	–	1	1	1.5	1.5	2	1
Average	**2**	**3**	–	**1**	**1**	–	–	–	**1**	**1**	**1.5**	**1.5**	**2**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46315	Hydraulic, Pneumatic & Fluidic Control	3	-	-	3	-	3	70	30	-	-	100

Prerequisites: ME 26011 and ME 36506.

Course outcomes: At the end of the course students will be able to answer

1. Develop understanding the principles of operation of hydraulic, pneumatic and fluidic control systems.
2. Categorize fluid power symbols; demonstrate knowledge of basic fluid power theory and fluidconditioning.
3. Demonstrate mechanical aptitude to accomplish maintenance, testing and repair of hydraulic andpneumatic components and systems.
4. Compute programmable Logic Controllers, Basic logic operations, and feedback devices and sensors.
5. Explain fluidic components, analogue and digital amplifiers and sensors.

Theory:

Unit 1

Characteristics of hydraulic components, control valves, sources of hydraulic power, hydraulic motors,cylinders,

Unit 2

Elements of circuit design, accumulator, control circuits such as position control and speed controlcircuits, flow control methods, sequence operation, regenerative circuit

Unit 3

Pneumatic systems and components, conditioning of compressed air, air lubricator, pressureregulators, filters, pneumatic cylinders and motors, cylinder cushioning.

Unit 4

Steady state analysis of pneumatic components and circuits, applications in industrial process control,proportional, derivative controllers etc.

Unit 5.

Principles of fluidics, fluidic components, analogue and digital amplifiers and sensors, equivalentelectric circuits, graphical characteristics, logic gates and applications.

Books & References Recommended:

1. Vicker Sparry, *Hand Book - Industrial Hydraulics*.
2. Lewis Stern, *Design of Hydraulic Control Systems, McGraw-Hill.*
3. S R Majumdar, *Oil Hydraulic Systems*, *TMH*.
4. D McCloy, H R Marin, *Control of Fluid Power (Analysis & Design), Ellis Horwood*

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	2	1	-	-	-	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	2	1	-	-	-	-	-	-	-	-	-
CO5	2	2	2	2	1	-	-	-	-	-	-	-	-	-
Average	2.8	1.6	1.6	2	1	–	–	–	–	–	–	-	-	-

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 4630A	Bio Mechanics	3	-	-	3	-	3	70	30	0	0	100

Course Assessment:
The following methods are adopted for the assessment of this course;
1. **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO 1	Explain the mechanical functioning of human body.
CO 2	Discussion of through and expression in the field of biomechanics.
CO 3	Application of biomechanical in biomechanical system of human body.
CO 4	Categorize the biomechanical system for human devil development.
CO 5	Explain the application of force, torque etc. to human body.

COURSE CONTENTS

UNIT I

Overview of Biomechanics, Bone structure and composition mechanical properties of bone visco elastic properties, Maxwell and voight models-anisotropy-electrical properties of bone-fracture mechanism and crack propagation, Bone fractures fixators repairing of bones mechanical properties of collagen rich tissues, teeth.

UNIT II

Structure and function of cartilages, tendon, ligaments-biomechanics of joints, Human locomotiongait analysis, foot pressure measurement, Pedobarograph, force platform, Mechanics of foot, Mechanics of plantar ulcer arthritis, biomechanical treatment.

UNIT III

Biomechanics of human heart and its functioning, its mechanical and electric properties. Artificial heart valves, biological mechanical valves development, hetro graft, homograft-testing of valves. Total Hip Prosthesis requirements-different types of components-stress analysis and instrumentation, knee prosthesis.

UNIT IV

Biomechanics of spines, Scoliosis-measurements-biomechanical treatment-instrumentation Muscle mechanic-Exoskeletal system for paraplegics-powered wheel chair-crutches and canes.

UNIT V

Monitoring device, Catheter mathematical model, responses to a sinusoidal input. Tonometry different type's respiratory sound measurement.

Text Books:

1. Alexander R. Mc Neil, Biomechanics, Chapman & Hall, 1975
2. V. C. Hayes, Basic Orthopedics Biomechanics, Lippincott-raven publ.

Reference Books:

1. D.N. Ghista, Biomechanics of medical devices, Macel Dekker, 1982
2. A. Z. Tohen & C. T. Thomas, Manual of Mechanical Orthopedics
3. D. N. Ghista and Roaf, Orthopedic Mechanics, Academic Press

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	-	-	-	-	-	-	-	3	2
CO2	3	2	2	2	1	-	-	-	-	-	-	-	3	2
CO3	3	1	1	-	-	-	-	-	-	-	-	-	3	1
CO4	3	2	2	2	1	-	-	-	-	-	-	-	3	1
CO5	2	2	2	2	1	-	-	-	-	-	-	-	3	1
Average	2.8	1.6	1.6	1.75	1	-	-	-	-	-	-	-	3	1.4

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46327	Data Sciences	3	-	-	3	-	3	70	30	-	-	100

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Demonstrate understanding of the mathematical foundations needed for data science.
CO2	Collect, explore, clean, munge and manipulate data.
CO3	Implement models such as k-nearest Neighbors, Naive Bayes, linear and logistic regression, decision trees, neural networks and clustering.
CO4	Build data science applications using Python based toolkits.

COURSE CONTENTS

Unit 1

Introduction to Data Science: Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting.

Unit 2

Introduction to Programming Tools for Data Science: (a) Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK

Unit 3

(b) Visualizing Data: Bar Charts, Line Charts, Scatterplots (c) Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction

Unit 4

Mathematical Foundations: (a) Linear Algebra: Vectors, Matrices, (b) Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation (c) Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem (d) Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Phacking, Bayesian Inference.

Unit 5

Machine Learning: Overview of Machine learning concepts, Over fitting and train/ test splits, Types of Machine learning, Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks Learning and Generalization, Overview of Deep Learning.

Case Studies of Data Science Application: Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

Suggested Book:

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media
2. Aurelien Geron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
3. Jain V.K., "Data Sciences", Khanna Publishing House, Delhi.
4. Jain V.K., "Big Data and Hadoop", Khanna Publishing House, Delhi.
5. Jeeva Jose, "Machine Learning", Khanna Publishing House, Delhi.
6. Chopra Rajiv, "Machine Learning", Khanna Publishing House, Delhi.
7. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press
8. Jiawei Han and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	–	–	1	–	–	–	–	–	–	1	1	1
CO2	3	2	–	–	1	–	–	–	–	–	–	1	1	1
CO3	3	2	–	2	1	–	–	–	–	–	–	1	1	1
CO4	3	2	2	–	1	–	–	–	–	–	–	1	2	1
CO5	3	2	1	–	1	–	–	–	–	–	–	1	2	1
Average	**3**	**2**	**1.5**	**2**	**1**	–	–	–	–	–	–	**1**	**1.4**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 4630C	Power Plant & Energy Management	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 26005 and ME 36007.

Course Assessment: The following methods are adopted for the assessment of this course;
1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1	Enhancement of power plant & energy management
CO2	Analyze problem in domain of power plant.
CO3	Exposure to application oriented problem solving and building capabilities to formulate and solve such problems.
CO4	Inculcation of sense of social responsibility
CO5	Explain the importance of sustainable development and evolving approaches for it.

COURSE CONTENTS

Unit 1

(a) Introduction to Various Energy Conversion System: Conventional and commercial power plants, e.g. principles of energy conversion in thermal, hydro, nuclear and Internal Combustion Engine Plants.Principle of Direct Energy Conversion Systems including Materials Processes, and applications, of Thermoelectric Converter, Thermion convertors, Photovoltaic Cells, Magneto-Hydro Dynamic Generators and Fuel Cells, properties of semiconductor material and plasma. Introduction to RenewableEnergy Conversion Systems like solar energy, wind energy, geothermal energy tidal energy etc.

(b) Selection: Economic and other considerations in the selection of site for thermal, hydro, nuclear andother types of power plant.

(c) Thermodynamic Cycles of Steam Power Plant. Analysis and calculation of reheat. Regenerative & Binary Cycles.

Unit 2

(a) Thermal Power Plant: Description of the principle and the working of the units of Fossil, Fuel Fire Thermal Power Plant e.g. Boilers, Coal Firing Systems, Turbines, Condensers, Draft Pump Water Treatment Plant, Coal And Ash Handling System, cooling towers, Dust Collection etc. Introduction to Super Critical Pressure Plants.

(b) Design of Components of Thermal Power Plants: To calculate capacity and major dimensions of boiler, fuel firing system, water treatment plants, economics of super-heaters feed water heaters, reheaters, condensers, pumps, cooling towers etc.

Unit 3

(a) Hydro Power Plants: Estimation of power available from hydrological data, selection of water turbines, layout of different types of plants. Introduction to pumped storage plants. Principles of economic consideration of hydro and steam power plant.

(b) Internal Combustion Engine Power Plant: Introduction to various systems and components of DieselEngine Power Plant e.g. Engine, Air, Intake and Exhaust gas systems, Fuel and lube oil systems, coolingwater system etc. calculations of capacity of engine, fuel and lube oil requirements, efficiencies, coolingwater quantities etc.

Unit 4

(a) Principles of working of gas turbines cycles. Efficiencies and output of gas turbines, Reheating regenerative and multistage compression.

(b) Introduction to Stationary Gas Turbine Power Plant and their components, combined cycles and cogeneration plants.

Unit 5

(a) Nuclear Power Plants: nuclear reactions used for power generation elements of a slow and a fast reactor, Different types of power reactors, calculations of fuel feed rate, cooling water rate, quantity of steam supplied etc.

(b) Power Station Economics: Definitions and application of load curves, load factor, plant capacity factor, plant utilization factor, diversity factor and demand factor. Introduction to energy audit. Elementsof fixed and operating costs, power and various tariff.

Text Book:

1. Yadav, R., Steam & Gas Turbine, Standard Publishers, 2007
2. Cohen, Rogers, & Saravanamuttoo, Gas Turbine Theory, Prentice Hall, 2001
3. Domkundwar & Arora, A Course in Power Plant Engineering, Dhanpat Rai and Sons, 2005
4. Rajput R.K., A textbook of Power Plant Engineering, Laxmi Publications, 2005
5. Nag P.K., Power Plant Engineering, Tata McGraw-Hill Education, 2002

Reference Books:

1. Noeb Hussain, Steam turbine theory and Design, Tata McGraw-Hill, 1984
2. Yahaya S.M., Turbine Compressors & Fans, Tata McGraw Hill, 2005
3. Khajuria & Dubey, Gras Turbine & Propulsive System, Dhanpat Rai and Sons, 1984
4. Black & Veatch,Power Plant Engineering, Springer, 1996
5. Angrist, S.W., Direct Energy Conversion, Allyn and Bacon, 1976
6. Skrotzki and Vopat, Power stations engineering and economy, Tata McGraw-Hill Education, 1960

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	–	1	1	–	–	–	–	–	–	2	2	1
CO2	3	2	–	1	1	–	–	–	–	–	–	2	2	1
CO3	3	2	–	2	1	–	–	–	–	–	–	1	2	1
CO4	3	2	2	–	1	–	–	–	–	–	–	1	2	1
CO5	3	2	1	–	1	–	–	–	–	–	–	1	2	1
Average	**3**	**2**	**1.5**	**1.33**	**1**	–	–	–	–	–	–	**1.4**	**2**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46667	Composite Materials	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME26008, ME26002

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Discuss the development of composite materials, their importance, its engineering potential and classification of composites.
2. Identify constituents of composites with their types, role, development, selection and theirinfluence on mechanical properties.
3. Describe fundamentals of manufacturing processes used for development of composites, their types,methods, parameter to be controlled, relative advantages and limitations.
4. Categorize micro-mechanical concepts of composites, stress-strain characteristics of FRP composites, anisotropic/orthotropic materials, and their transformation.
5. Discuss the strength and failure concept in composites, failure mechanics of composites, and knowabout composite codes & standards and testing.

COURSE CONTENTS

UNIT I

Introduction to Composites: General Introduction and Concept, Historical development of composites, Concept of Composite materials, importance of composite material & its engineering applications, Comparison with traditional materials, Advantages & Limitations of Composites. Classification of Composites on the Basis of matrix and reinforcement.

UNIT II

Basic constituents of Composites: Types of Reinforcements, Role and Selection of reinforcement materials, Mechanical properties of fibres and whiskers, Manufacturing of various fibers, comparisonof reinforcements, Functions of a Matrix, Desired Properties of a Matrix, Types of matrix materials.

UNIT III

Manufacturing Processes of composites: Fundamentals of Manufacturing, Manufacturing of Polymer, Metal, Ceramic and Carbon Composites, Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method, Autoclave method, Filamentwinding method, Compression moulding , Reaction injection moulding . Properties and applications.

UNIT IV

Mechanics of composites: Micromechanical analysis of composites, volume and weight fractions, Longitudinal and transverse modulus, Shear modulus, Elastic Properties of Lamina, Stress-Strain relationship of composite materials, Isotropic materials. Orthotropic materials, Compliance and stiffness matrices, Fiber reinforced composites, Transformation of stress-strain.

UNIT V

Strength and failure concept in composites: Strength of laminates, Failure Mechanics of composites, Macro-mechanical failure theories. Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai-Wu theory. Composite codes & standards. Testing of Composites.

Text Books:

1. Fiber Reinforced composites, Materials, Manufacturing and Design, P K Mallick, CRC Press
2. Mechanics of composite materials, Auter Jaw
3. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.

Reference Books:

1. Mechanics of composite materials, R. Jones, Taylor & Francis
2. Hand Book of Composite Materials-ed-Lubin.
3. Composite Materials – K.K.Chawla.
4. Composite Materials Science and Applications – Deborah D.L. Chung.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	–	–	–	–	–	–	1	2	1
CO2	3	2	1	1	1	–	–	–	–	–	–	1	2	1
CO3	3	2	1	1	1	–	–	–	–	–	–	1	2	1
CO4	3	2	1	–	–	–	–	–	–	–	–	1	2	1
CO5	3	2	1	–	–	–	–	–	–	–	–	1	2	1
Average	**3**	**2**	**1**	**1**	**1**	–	–	–	–	–	–	**1**	**2**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46668	Renewable Energy Sources	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 26005 and ME 36007.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Discuss the potential impacts of harnessing energy sources.
2. Measure solar radiation and understand methods of utilizing solar energy.
3. Classify of wind turbines and its subsystems.
4. Classify of biomass and bio-energy.
5. Distinguish the methods of harnessing ocean, geothermal and hydel energy.

COURSE CONTENTS

UNIT I

Energy and Environment: Primary energy sources, world energy resources, Indian energy scenario, energy cycle of the earth, environmental aspects of energy utilisation, CO2 emissions and Global warming, renewable energy resources and their importance. Potential impacts of harnessing the different renewable energy resources.

UNIT II

Solar Energy: Principles of solar energy collection, solar radiation, measurements, instruments, data and estimation, types of collectors, characteristics and design principles of different type of collectors,performance of collectors, testing of collectors. Solar thermal applications, water heaters and air heaters, performance and applications, simple calculations, solar cooling, solar drying, solar ponds, solar tower concept, solar furnace.

UNIT III

Wind energy Systems: Orientation systems and regulating devices, design of blades, Aerodynamic configuration of rotor and determination of blade structure, Description and performance of Vertical axis wind mills. Use of wind energy for water pumping and generation of electricity, Installation operation and maintenance of small wind energy conversion systems.

UNIT IV

(a) Ocean Energy: Energy from tides and waves, working principles of tidal plants and ocean thermalenergy conversion plants,

(b) Geothermal Energy: Introduction to geothermal power, principle of working of geothermal powerplants.

(c) Hydel Energy: Small, mini and Micro hydro system, concepts, types of turbine, hydrologicalanalysis.

UNIT V

Bio Energy: Energy from bio mass and bio gas plants, various types, design principles of biogas plants,applications. Energy from wastes, waste burning power plants, utilization of industrial and municipal wastes, energy from the agricultural wastes.

Text Books:

1. Rai G.D, Non-conventional Energy sources, Khanna Publishers, New Delhi, 1999.
2. Ashok V Desai, Non-conventional Energy, Wiley Eastern Ltd, New Delhi, 1990.
3. Khan B.H., Non-Conventional Energy Resources,Tata McGraw-Hill Education, 2006.
4. Sawhney, G.S., Non-Conventional Energy Resources, PHI Learning

References Books:

1. Loulou, Waaub & Zaccour, Energy and Environment, Springer.
2. Sukhatme & Nayak,Solar Energy: Principles of Thermal Collection and Storage, McGraw-Hill Education.
3. Tiwari G. N., Solar Energy: Fundamentals, Design, Modelling and Applications, CRC Press.
4. Jain Pramod, Wind Energy Engineering, McGraw Hill Professional.
5. Lee & Shah, Biofuels and Bioenergy: Processes and Technologies, CRC Press.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	–	–	2	2	–	–	–	–	–	3	1
CO2	3	2	2	2	1	–	–	–	–	–	–	–	3	1
CO3	3	1	1	–	2	2	–	–	–	–	–	–	3	1
CO4	3	1	–	–	2	2	2	–	–	–	–	–	3	1
CO5	3	–	–	–	–	1	1	–	–	–	–	–	3	1
Average	**3.00**	**1.25**	**1.67**	**2.00**	**1.67**	**1.75**	**1.67**	–	–	–	–	–	**3**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46670	Finite Element Methods	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 26002 and ME36011

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

CO1 Evaluate of problems by approximate methods over the whole domain.
CO2 Apply FEM to formulate and solve 1-D problems.
CO3 Solve truss, beam and frame problems by finite element method
CO4 Write shape functions two dimensional and quadrilateral elements and solve two dimensional problems.
CO5 Solve problems of bars for free vibration, forced vibration and transient vibration

UNIT 1

Solution to engineering problems, mathematical modeling, discrete and continuum modeling, need fornumerical methods of solution, relevance and scope of finite element methods, engineering applicationsof FEA, Initial value and boundary value problems.
Weighted residual methods, weak formulation of the weighted residual statement, principle of stationary total potential, Rayleigh Ritz method.

UNIT II

1-D Elements: Formulation for 1-D applications, linear bar element, quadratic element, shape functions. Application to thermal and fluid flow problems
Unit III

Beam element, thin beam approximation, Euler Bernoulli's beam element, Shear locking, Timoshenkobeam element for thick beam, shape functions, Applications to truss and frame problems.

UNIT IV

2-D Analysis: triangular, rectangular and quadrilateral elements, higher order elements, natural coordinates and coordinate transformations, iso-parametric formulation, plane stress and plane strain problems, axi-symmetric problems, Gausss quadrature formula, natural coordinates,

UNIT V

DYNAMIC ANALYSIS: vibration problems, equations of motion, longitudinal vibration of bars, consistent mass matrices, eigenvalue problems, normal modes, forced vibration, transient vibrations, modeling of damping, mode superposition technique.

Text Book:

1. P. Seshu, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Ed., Prentice-Hall of India.

Reference Books:

1. J.N. Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International Editions, 1993.
3. David V. Hutton,, 'Fundamentals of Finite Element Analysis', Tata McGraw-Hill Edition, 2005.
4. Cook, Robert. D., Plesha, Michael. E & Witt, Robert. J., "Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 2004.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	–	–	–	–	–	–	1	1
CO2	3	2	1	1	1	1	–	–	–	–	–	–	1	1
CO3	3	2	1	1	1	1	–	–	–	–	–	–	1	1
CO4	3	2	1	–	–	–	–	–	–	–	–	–	1	1
CO5	3	2	1	1	–	–	–	–	–	–	–	–	1	1
Average	3	2	1	1	1	1	–	–	–	–	–	–	1	1

Department of Industrial and Production Engineering

B. TECH Mechanical Engg IV Year (4YDC)

Subject Code	Subject Name	L	T	P	Th. Credit	Pr. Credit	Maximum Marks				
							TH	CW	SW	Pr	Total
IP 46669	**Industrial Inspection And Quality Control**	**3**	**0**	**0**	**3**	**-**	70	30	-	-	**100**

Theory:

A. Industrial Inspection:

1. Principles of Measurement: Limit gauging, various systems of limits, Fits and tolerance, ISI andISO system.
Basic principles of design of gauges, types of gauges and their design.
Optical instruments like projector, autocolimeter, use of interferometry for linear measurement.

2. Angular measurement, angle gauges, sine-bar, clinometers, measurement of straightness, flatnessand squareness.
Surface topography - primary & secondary texture, measurement of surface roughness.Inspection of screw threads and gears.

B. Quality Control:

3. Place of quality control in industries, quality control organization, difference between inspectionand quality control. Application of quality control.

4. Theory of control charts, sample size and frequency of sampling, out of control criteria.
Variable control charts, control charts for X, and R, process capability studies.
Control charts for fraction defective and number of defects.

5. Acceptance sampling, single sampling plans, double sampling and sequential sampling plans,Sampling plans continuous production.
Selection of sampling plans for different situations. Economics of acceptance sampling.

Books & References Recommended :

1. Hume, Engineering Metrology.
2. Judge, Engineering Precision Measurement.
3. Jain R.K., Engineering Metrology.
4. Sharp K.W.P., Engineering Metrology.
5. Grant, Statistical Quality Control.
6. Hanson, Quality Control.
7. Duncon, Quality Control.
8. Juran, Quality Planning & Analysis.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	–	1	1
CO2	3	2	1	–	–	–	–	–	–	–	–	–	1	1
CO3	3	1	1	–	–	–	–	–	–	–	–	–	1	1
CO4	3	1	1	–	–	–	–	–	–	–	–	–	1	1
CO5	3	1	1	–	–	–	–	–	–	–	–	–	1	1
Average	**3**	**1.4**	**1**	–	–	–	–	–	–	–	–	–	**1**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 4660A	Robotics	3	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course students will be able to answer

CO1	Classify basic terminologies and concepts associated with Robotics and Automation.
CO2	Categorize robot kinematics and dynamics to explain motion and force analysis in robotics.
CO3	Application of different types of sensors and actuating system in robotics.
CO4	Apply concept of control system in robotics
CO5	Application of AI and Embedded systems in Robotics

COURSE CONTENTS

Unit 1

Introduction to Robotics

Introduction to Robotics, Types and components of a robot, Classification of robots, Kinematics systems; Definition of mechanisms and manipulators, Degrees of Freedom. Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Robotics and Automation for Industry 4.0.

Unit 2

Robot Kinematics and Dynamics

Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Singularity, and Statics.

Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrangeformulation, Newton Euler formulation.

Unit 3

Robot Sensors and Actuating systems

Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Cameracalibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations Vision applications in robotics.

Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

Unit 4

Control Systems

Basics of control: open loop- closed loop, Transfer functions, block diagram, Laplace Transformation, Mathematical modelling of mechanical and electrical system and Control laws: P, PD, PID Linear and Non-linear controls.

Unit 5

AI and Embedded systems in Robotics

Applications in unmanned systems, defense, medical, industries, etc. Microcontroller Architecture and integration with sensors, actuators, components, Programming Applications for Industrial robot - programming in – VAL II

Books:

1. Saha, S.K., “Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Industrial Robotics: M. P. Groover, Ashish Dutta, McGraw Hill
3. Craig, J.J., “Introduction to Robotics: Mechanics and Control”, Pearson, New Delhi.
4. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modelling and Control”, John Wiley
5. Robotics Engineering: R. Klafter, PHI

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	–	1	1	–	–	–	–	–	2	1
CO2	3	2	1	1	–	–	–	–	–	–	–	–	2	1
CO3	3	1	1	–	–	–	–	–	–	–	–	–	1	1
CO4	3	1	1	–	–	–	–	–	–	–	–	–	1	1
CO5	3	1	1	–	–	–	–	–	–	–	–	–	1	1
Average	**3**	**1.4**	**1**	**1**	–	**1**	**1**	–	–	–	–	–	**1.4**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46705	Engineering Optimization	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: NIL

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Evaluate complex engineering problems into mathematical models to solve for optimize solutions.
2. Apply various optimization techniques for single and multi-variable problems.
3. Analyze various methods of solving the unconstrained optimization problems.
4. Analyze various methods of solving the constrained optimization problems.
5. Analyze various non-traditional and neural network based optimizations methods.

Unit I

Introduction and Classical Optimization Techniques, Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems. Optimization Techniques.

Unit II

Classical Optimization Techniques. Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariableOptimization with equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints. Kuhn-Tucker Conditions, Constraint Qualification.

Unit III

Unconstrained optimization Techniques, Introduction; Standard form of the problem and basic terminology; Direct search method- Simplex method, Random search method, Univariate and pattern search method Indirect search method-Steepest Descent (Cauchy) method, Conjugate gradient method, Newton's method, Application to engineering problems

Unit IV

Constrained Optimization Introduction; Standard form of the problem and basic terminology; Direct method: Sequential Linear Programming; Generalized Reduced gradient method, Methods of feasible direction Indirect method: Penalty function method Interior and exterior penalty function method, Convex programming problem, Check for convergence Application to engineering problems

Unit V

Introduction to non-traditional methods, Genetic Algorithm: Introduction, Representation of design variables, objective function and constraints, Genetic operators and numerical results. Introduction to Neural network based optimization.

TEXT BOOK:

1. Engineering Optimization (Theory and Practice) by S. S. Rao, New Age Int. (P) Ltd, 2002.

REFERENCE BOOKS:

1. Optimization Methods in Operations Research and systems Analysis – by K.V. Mital and C.Mohan, New Age Int. Publishers, 1996.
2. Operations Research: An Introduction by H.A. Taha, PHI Pvt. Ltd.
3. Introductory Operations Research by H.S. Kasene & K.D. Kumar, Springer (India).

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	–	1	1	–	–	–	–	–	2	1
CO2	3	2	1	2	–	1	1	–	–	–	–	–	2	1
CO3	3	1	1	1	–	1	1	–	–	–	–	–	2	1
CO4	3	1	1	1	–	–	–	–	–	–	–	–	2	1
CO5	3	1	1	1	–	–	–	–	–	–	–	–	2	1
Average	3	1.4	1	1.4	–	1	1	–	–	–	–	–	2	1

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46707	Computational Fluid Dynamics	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME26011 and ME 36506

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Discuss different methods and techniques to analysis of fluid mechanics and heat transfer problems.
2. Distinguish the interaction of physical processes and numerical techniques. Contemporary methodsfor boundary layers, incompressible viscous flows, and inviscid compressible flows.
3. Apply Finite differences and finite volume techniques

COURSE CONTENTS

UNIT I

Governing Equations And Boundary Conditions: Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II

Finite Difference Method: Derivation of finite difference equations – Simple Methods – GeneralMethods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations.

UNIT III

Finite Volume Method (FVM) For Diffusion: Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank –Nicolson and fully implicit schemes.

UNIT IV

Finite Volume Method For Convection Diffusion: Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT V

Calculation Flow Field By FVM: Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models –High and low Reynolds number models.

Text Books :

1. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002.
2. Versteeg, H. K., & Malalasekera, W., An Introduction to Computational Fluid Dynamics, The finitevolume Method, Longman, 1998.
3. Ghoshdastidar , P. S., Computer Simulation of Flow and Heat Transfer, Tata McGraw Hill PublishingCompany Ltd., 1998.

Reference Books:

1. Patankar, S.V., Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004.
2. Muralidhar, K., and Sundararajan, T., Computationsl Fluid Flow and Heat Transfer, NarosaPublishing House, New Delhi, 1995.
3. Ghoshdastidar P.S., Heat Transfer, OxfordUniversity Press, 2005.
4. Prodip Niyogi, Chakrabarty .S.K., Laha .M.K., Introduction to Computational Fluid Dynamics,Pearson Education, 2005.
5. Introduction to Computational Fluid Dynamics, Anil W. Date, Cambridge University Press, 2005.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2	1	1	–	–	–	–	–	2	1
CO2	3	2	1	2	2	1	1	–	–	–	–	–	2	1
CO3	3	1	1	2	1	1	1	–	–	–	–	–	2	1
CO4	3	1	1	1	1	–	–	–	–	–	–	–	2	1
CO5	3	1	1	1	–	–	–	–	–	–	–	–	2	1
Average	**3**	**1.4**	**1**	**1.6**	**1.5**	**1**	**1**	–	–	–	–	–	**2**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46704	Design of Thermal Systems	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 26005 and ME 36006

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Distinguish various types of heat exchangers and terminologies related to them.
2. Design shell and tube type heat exchanger for particular industrial applications.
3. Design evaporator, cooling towers and condensers.
4. Discuss the fouling phenomenon, prevention and mitigation.
5. Design a heat exchanger using different software.

COURSE CONTENTS

UNIT I

Introduction: Types of heat exchangers, heat transfer laws applied to heat exchangers, convection Coefficients, resistance caused by the walls and by fouling, overall heat transfer coefficient.

UNIT II

Thermal & hydraulic design of commonly used heat exchangers: LMTD & NTU Methods, correction factors, Double pipe heat exchangers, shell and tube heat exchangers, condensers, Evaporators ,Cooling and dehumidifying coils ,cooling towers, evaporative condensers ,design ofair washers, desert coolers.

UNIT III

TEMA standard: Tubular heat exchangers TEMA standard heat-exchanger nomenclature, selection criteria for different types of shells and front and rear head ends; geometrical characteristics of TEMA heat exchangers.

UNIT IV

Review of mechanical Design, Materials of Construction, corrosion damage, testing andinspection.

UNIT V

Heat Pipe: Basics & its mathematical model, micro Heat Exchangers, Use of Software in heatexchanger design.

Text Books:

1. Kern D Q, Kraus A D; Extended Surface Heat Transfer, McGraw Hill Education Pvt. Ltd.
2. Kokac, Heat Exchangers- Thermal Hydraulic fundamentals and design, McGraw Hill Pvt. Ltd.
3. Kays, Compact Heat Exchangers, McGraw Hill Education Pvt. Ltd.
4. Shah and Sekulic, Fundamentals of Heat Exchanger Design, John Wiley & Sons.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2	1	-	-	-	-	-	-	-	3	2
CO2	3	3	2	1	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	3	-	-	-	-	-	-	-	-	3	2
CO4	3	3	2	2	-	-	-	-	-	-	-	-	3	2
CO5	3	1	1	1	1	2	1	-	-	-	-	-	3	2
Average	**3**	**2.6**	**1.6**	**1.8**	**1**	**2**	**1**	-	-	-	-	-	**3**	**2**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 4670A	Gas Dynamics & Fluid Flow	3	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 26011 and ME 36506.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of the course students will be able to answer

1. Discuss the types of flows through the nozzle and diffusers and factors affecting them.
2. Classify the boundary layer theory including drag and lift.
3. Classify the hydrodynamics lubrication and selection of lubrications for specific purpose.

COURSE CONTENTS

UNIT I

Fundamental Aspects of Gas Dynamics: Introduction and review of thermodynamics; Differences between compressible and incompressible flow; Ideal gas, speed of sound, Mach number, Mach Cone.

UNIT II

1-D, adiabatic, isentropic duct flow of an ideal gas: Isentropic relations; One-D compressible adiabatic duct flow, critical properties; Converging nozzles, choking, converging-diverging nozzles and diffuser

UNIT III

Normal shocks: Normal shocks in converging-diverging nozzles, property changes across shocks,Fanno Rayleigh curves, Pitot probes, moving normal shocks

UNIT IV

1-D duct flow with heat transfer: Rayleigh flow and equations, T-s diagrams, choked Rayleighflow, 1-D duct flow with friction: Fanno flow, choked Fanno flow; Comparison/summary of 1- Dflows

UNIT V

Fluid Flow: Boundary Layer Theory, Physical Concept of Laminar and Turbulent boundary layer.Friction drag, pressure drag and profile drag. Determination of drag. Separation of boundary layerand its prevention, Kutta-Joukawsky Law, Prandtl Boundary layer Equation. Von-Karman IntegralMomentum Equation.

Text Books:

1 Yahya S.M, Fundamentals of Compressible Flow: Aircraft and Rocket Propulsion, New Age Science.2 Shapiro A.H., The Dynamics and Thermodynamics of Compressible Fluid Flow, Krieger Pub. Co.

Reference Books/ Material:

1. H. W. Liepmann, and A. Roshko, Elements of Gas Dynamics, Dover Pub, 2001
2. L.D.Landau and E..M.Lifshitz, Fluid Mechanics. 2nd ed., Butterworth-Heinemann, 1995
3. P. H. Oosthuizen and W. E. Carscallen. Compressible Fluid Flow. NY, Mc Graw-Hill, 1997
4. M.A.Saad, Compressible Fluid Flow. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 1993

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	-	-	-	-	-	-	-	2	1
CO2	3	2	2	1	-	-	-	-	-	-	-	-	2	1
CO3	3	2	1	2	-	-	-	-	-	-	-	-	2	1
CO4	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO5	3	2	1	1	1	2	1	-	-	-	-	-	2	1
Average	**3**	**2**	**1.2**	**1.4**	**1**	**2**	**1**	-	-	-	-	-	**2**	**1**

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46706	3D Printing And Design	3	-	-	3	-	3	70	30	-	-	100

Course Outcomes: At the end of the course students will be able to answer

CO1	Analyze CAD data formats, assess the importance of STL files, and differentiate between additive and conventional manufacturing processes.
CO2	Select and apply additive manufacturing processes and parameters for diverse applications in aerospace, electronics, healthcare, defense, automotive, construction, and food processing.
CO3	Classify materials, including polymers, metals, non-metals, and ceramics, and evaluate their properties for additive manufacturing.
CO4	Design additive manufacturing equipment, understand bonding mechanisms, troubleshoot faults, and comprehend the role of lasers in additive manufacturing
CO5	Implement post-processing techniques, inspect and test products for defects, ensuring adherence to quality requirements in additive manufacturing.

COURSE CONTENTS

Unit 1

CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL file format & its importance

3D Printing (Additive Manufacturing): Introduction, Process, Classification, Advantages, Additive v/s Conventional Manufacturing processes, Applications.

Unit 2

Additive Manufacturing Techniques:

- Process, Process parameter, Process Selection for various applications.
- Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools
- Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

Unit 3

Materials

- Polymers, Metals, Non-Metals, Ceramics
- Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
- Support Materials

Unit 4

Additive Manufacturing Equipment

- Process Equipment- Design and process parameters, Laser in additive manufacturing.
- Governing Bonding Mechanism
- Common faults and troubleshooting
- Process Design

Unit 5

Post Processing: Requirement and Techniques
Product Quality

- Inspection and testing
- Defects and their causes

Books:

1. Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.
3. Khanna Editorial, “3D Printing and Design”, Khanna Publishing House, Delhi.
4. CK Chua, Kai Fai Leong, “3D Printing and Rapid Prototyping- Principles and Applications”, World Scientific, 2017.
5. J.D. Majumdar and I. Manna, “Laser-Assisted Fabrication of Materials”, Springer Series in Material Science, 2013.
6. L. Lu, J. Fuh and Y.S. Wong, “Laser-Induced Materials and Processes for Rapid Prototyping”, Kulwer Academic Press, 2001.

CO-PO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	3	–	–	–	–	–	–	1	3	2
CO2	3	2	3	–	–	–	–	–	–	–	–	1	3	2
CO3	3	2	3	–	–	–	1	–	–	–	–	1	3	2
CO4	3	3	2	–	–	–	–	–	–	–	–	1	3	2
CO5	3	2	2	–	3	–	–	–	–	–	–	1	3	2
Average	**3**	**2.2**	**2.4**	**–**	**3**	**–**	**1**	**–**	**–**	**–**	**–**	**1**	**3**	**2**