Department of Mechanical Engineering

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

ME10652: FUNDAMENTALS OF MECHANICAL ENGG.

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		-		Total
		L	T	-	T	-	Total	Th.	CW	-	-	
ME 10652	FUNDAMENTALS OF MECHANICAL ENGINEERING	4	-	-	3	-	3	70	30	-	-	100

Course Objectives:

1. Gain fundamental knowledge of Thermodynamics, Fluid Mechanics and I.C. Engines.
2. Develop skills for material selection for different devices/ components.
3. Gain knowledge of steam formation and properties of steam.

Course Outcomes:

CO 1	Enhancement of fundamental knowledge of Thermodynamics.
CO 2	Enhancement of fundamental knowledge of Fluid Mechanics and I.C. Engines.
CO 3	Acquiring knowledge of materials and their properties for engineering applications
CO 4	Enhancement of analytical skills by Learning different mechanism of machines.
CO 5	Evaluate properties of steam. Demonstrate various types of boilers and their relative merits and demerits. Learning problem solving in particular domain.

COURSE CONTENTS

UNIT 1

Thermodynamics: Thermodynamics properties and processes, heat and work. Zeroth law and First law of thermodynamics. Steady flow energy equation, basic concepts of Second law of thermodynamics.

UNIT 2

Fluid Mechanics: Introduction to fluid properties, Newton's law of viscosity, Pascal's law, Hydrostatic law, types of fluid flow. Euler's equation, Bernoulli's equation & its application.

Introduction to I. C. Engine: Classification of IC engines, terminology used in I C engine; Otto, Diesel& Dual cycles; their air standard efficiencies. Principal parts of IC engine, their functions and working.

UNIT 3

Materials: Introduction, properties, crystal structures types, normal tensile shear and thermal stress andtheir variation in different section of beams, stress-strain diagrams for ductile and brittle materials, elastic constants and relationship between elastic constant.

UNIT 4

Mechanism and Machines: Types of motion, links, kinematic pair, types of joints, degree of freedom, classification of kinematic pairs, kinematic chain, linkage, mechanism and structure, inversions of four- bar and slider crank mechanism.

UNIT 5

(a) Boilers: Classification of boilers, boiler mountings & accessories: function, their construction and working, boiler efficiency, equivalent evaporation, chimney height.

(b) Properties of Steam: Types of steam; enthalpy, volume and internal energy of steam; critical pointand triple point of steam; measurement of dryness fraction of steam.

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

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

Books Recommended:

1. Nag, P.K., *Engineering Thermodynamics*, Tata McGraw Hill.
2. Bansal R K, *Strength of Materials*, Laxmi Publication
3. Yadav, R., *Thermodynamics*, Standard Publishers.
4. Rattan S S, *Theory of Machine*

Department of Mechanical Engineering
B. E. 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:

Course Objectives

1. To familiarize with the drawing instruments, scales and engineering curves.
2. To familiarize with the projection of 1D, 2D and 3D elements.
3. To familiarize with the sectioning of solids and development of surfaces.
4. To familiarize with the conversion of orthographic to isometric views and vice versa.
5. To familiarize with the software for drawing and modern drafting technologies.

Course Outcomes: After completion of this course students will be able to

CO 1	Understand standards drawing conventions, draw curve and scale, use of drawing instruments
CO 2	Apply the concept of projection on lines, planes and solids
CO 3	Draw development of surface and section of solids
CO 4	Draw isometric and orthographic projections
CO 5	Use drafting tools 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 and Vernier Scales, Conic sections including the Rectangular Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

Unit 2

Projections of Line, Planes and solids: Principles of Orthographic Projections- Conventions , Projection of points and lines inclined to both planes; Projections of planes, inclined Planes -Auxiliary Planes; Solids inclined to both the planes- Auxiliary Views.

Unit 3

Sections of Solids: Section planes- AIP, AVP; Sections of geometrical solids, True shape.

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

Unit 4

Isometric Projections: Principles of isometric projection- isometric Scale, isometric Views, Conventions, Isometric Views of Lines, Planes, Simple and compound Solids: Conversion of Orthographic Views to isometric Views.

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

Unit 5

Introduction to Drafting Software: Demonstrating knowledge of the theory of CAD software, Ribbon tabs, Menu system, toolbars, Drawing Area, Dialog boxes and windows, Shortcut menus, Command Line, Status bar; Different method of zoom; Select and erase objects; Setting up the drawing page and the printer; Setting up of units and drawing limits; Orthographic Constraints; Snap to objects manually and automatically ; Producing drawings by using various coordinate input entry methods to draw straight lines; Applying various ways of drawing circles; Applying dimensions to objects to objects, applying annotations to drawings; Setting up and use of layers; Computer aided Design (CAD) software modelling of parts and assemblies; Demonstration of a simple team design project.

ASSESSMENT:

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

1. **Theory of Examination** (70 marks) on the basis of end term theory paper examination (from Units 1 to 4)
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.

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 User Manuals.

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	Enhancement of fundamental knowledge of particular engineering discipline
CO 2	Learning of particular engineering skills
CO 3	Enhancement of analytical skills
CO 4	Learning problem solving in particular domain
CO 5	Have knowledge of steady and unsteady flow

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

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

Pre-requisites: CE10003, 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:

CO1	Understand 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 and able 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 and their 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, modulus of 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 to shear. 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 Falling loads, 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

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
MA 26004	MATHEMATICS-III	4	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:

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. To understand the concept of solving differentiation and integration using approximation methods.
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 nth order 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 Laplace Transform 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.

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

Pre-requisites: CE1001, ME1055, CH1058, PE1091 and IM1059

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

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

Course Outcomes:

CO1	Understand the significance of different crystal structures of different materials.
CO2	Select the material based on their mechanical properties for suitable applications.
CO3	Describe phase diagrams and iron-carbon equilibrium diagram, and choose particular heat treatment cycle based on TTT diagram.
CO4	Explain the behavior of material upon heat treatment from iron-carbon equilibrium diagram and predict the behavior of materials upon impact, fracture.
CO5	Describe various non-destructive tests and basics of Nano-materials.

COURSE CONTENTS

Unit 1

Basic crystallography and properties of engineering materials: Seven crystal systems. Bravais lattice. Symmetry and properties of the simple crystal structure. Miller indices. Direction and Plane indices.

Techniques of Crystal growing. Growth of single crystals from melt. Lattice vacancies, Schottky and Frenkel defects. Diffusion in solid, Fick's law.

Dislocation, Edge dislocation, Screw dislocations, Slip planes. Stress fields of dislocations. Grain boundaries, Dislocation densities, Strength of alloys, Dislocation and crystal growth.

Unit 2

Stress-strain diagrams for engineering materials and Mechanical working of metals: Various mechanical properties like strength, stiffness, elasticity, plasticity, ductility, hardness, impact strength, malleability, brittleness, toughness, resilience, etc. Hot and cold working of metals and their effects on properties.

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

Unit 3

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

Unit 4

Ferrous and Non-ferrous metals and alloys: Properties and application of various steels and cast irons. Effect of impurities in ferrous metal. Effect of common alloying elements on the steels, High-speed steels, Stainless steel, Other steels. Corrosion and its prevention. Composition Microstructure, Properties and application of aluminium and its principle alloys, Copper and its principle alloys. Metallurgical aspects of metal joining, plastics and polymers.

Powder Metallurgy: Manufacturing of metal powders. Sintering and secondary operations. Projects of finished parts. Design considerations and applications. Composite materials. Shape memory alloy metallic glasses.

Unit 5

Failure Analysis of machine parts based on metallurgical aspects like crystal structure variations, crack propagation, the inclusion of impurities, machining effects on normalizing and quenching process of heat treatment surface materials. Non-destructive Testing. Basics of Nano-materials.

A brief discussion of the properties and applications of the rare metals. Composite materials type and their characteristics.

Textbooks Recommended:

1. Abdul Mubeen, Material Science, Galgotia Publications, 2003
2. Raghvan V., Material Science, and Engineering, PHI Learning Pvt. Lt, 2006
3. Callister, William D. Fundamentals of materials science and engineering. Wiley, 2000.

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

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: ME 10055, PH 10005, CH 10058, ME 10007 and MA 2604.

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:

CO1	Define first and second laws of thermodynamics 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	Understand 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.

(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 4

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

Unit 5

(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

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 26555	Mathematics-IV	4	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: The outcomes of this course are

- to obtain the series solution of Bessel's and Legendre's differential equations.
- to understand the concept of vector calculus and its applications.
- to understand the various concepts of function of complex variables and its applications.
- to 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 and Legendre's function.

Unit 2

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

Unit 3

Functions of Complex Variables-I : Analytic Functions, Cauchy-Continuity, Analytic Functions, Cauchy Riemann 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, method of 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:

Ramana B V, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.

Das H. K, Higher Engineering Mathematics, S. Chand New Delhi, 2011.

Balaguruswamy E., Numerical Methods, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1999.

Reference Books:

Jain, R.K. and. Iyengar S.K, Advanced Engineering Mathematics, Narosa Publishing House, New-Delhi , 2006

Sastry S.S., Engineering Mathematics, Prentice Hall of India private limited, New Delhi.

Vedamurthy V.N. and Iyengar S.N., Numerical Methods, Vikas Publishing, 2008.

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 10149 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: Students will be able to-

CO1	Understand machine component behaviour 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 bolted 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

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 2

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.

Unit 3

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

Pipe and pipe joints: design of different types of pipe joints for high pressure

Design of cotter joint and knuckle joint,

Unit 4

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

Unit 5

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, Introduction to Machine Design, Tata McGraw-Hill, 2004

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

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 1007, ME 1055, CE 1001, EE 1002 and PH 1005.

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: Students will be able to-

CO 1	Learn basic mechanisms for motion transmission and number synthesis
CO 2	Determine kinematic analysis (Velocity, acceleration, Inertia forces) for a given mechanism using analytically and graphically method.
CO 3	Construct different types of cam profile for a given data.
CO 4	Learn different types of gears and gear trains
CO 5	Gyroscopic analysis and synthesis of basic four link mechanisms

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's and 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's joint, 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 centre method, Keneddy's theorem and its applications.

Analytical method: Velocity and acceleration of single slider crank chain. Complex algebra approach to various 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 acceleration and retardation motion and cycloidal motion. Cam with specified contours, Displacement, velocity and acceleration of followers.

Unit 4

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

Gear trains, Simple, Compound, Reverted and Epicyclic Gear trains and their applications, Tabular and algebraic 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

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
EC 26563	BASIC ELECTRONICS ENGG	4	-	2	3	1	4	70	30	40	60	200

Pre-requisites: Mathematics-I, Physics

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: Student should be capable of:

1. Design and analyze diode based electronics circuits and subsystem which can perform logical and arithmetic operation.
2. Analyze BJT based electronic circuits.
3. Understand 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. Understand basic internal logic and design of microprocessor and its programming.

COURSE CONTENTS

Unit 1

General principles, working and characteristics of semiconductor diodes, transistors, introduction to rectifiers 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

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
IP 26009	Manufacturing Processes-I	4	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 1007, ME 1055, CE 1001, EE 1002 and PH 1005.

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

Theory paper:

(1) End Semester Exam: 70% weightage,
(2) Continuous assessment: 30% weightage (Two midterm tests: 67% weightage, assignment: 16.5% weightage, regularity 16.5% weightage)
Practical:
(1) Sessional: 40% Weightage (Continuous assessment of experiments and lab manual 50% weightage, final viva 25% weightage, regularity 25% weightage.)
(2) End semester practical viva: 60% weightage.

Student Learning Outcomes:

Upon successful completion of course, Students should be able to

1. Gain thorough knowledge of welding processes and their classifications.
2. Know about forming process and force analysis in metal forming
3. Know about various welding equipment's.
4. Gain knowledge of robotic welding
5. Know about the measuring tools and different welding positions and welding joints.

1. Understand the underlying principles and process of common casting processes
2. Understand 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
6. Understand casting solidification phenomenon and influencing thermal parameters
7. Apply the modulus approach for identifying the last solidifying region

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 arc welding 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 working of 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, screw thread and gear measurement, measurement of straightness, flatness & squareness.

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, and alignment 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

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 10149

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:

CO1	Develop the skill of drafting using CAD software
CO2	Understand 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 packages for 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 etc.

Unit 3

Types of assembly drawings, norms and sequences of preparing assembly drawings
Orthographic projections of Nut-Bolt-Washer assembly, Riveted joints, cotter joint, knuckle joint, flanged coupling, universal coupling, Oldham's coupling. Pipe joints.

Unit 4

Bearings: Bushed 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

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36001	Dynamics of Machines	4	1	2	4	1	5	70	30	40	60	200

Pre-requisites: MA 2604, ME2606, PE2609, MA 2655, ME 2660, ME 2661 and ME2662

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	Learning of thrust and radial load bearings, power screw
CO 2	Learning friction devices
CO 3	Dynamics of governors
CO 4	Dynamic analysis of mechanisms
CO 5	Learning balancing of 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 dynamometer propulsion 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

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

Pre-requisites: ME2601, MA2604, ME2608, PE2609, MA2655, ME2660, ME2661, ME2662, ME2664 and EC2663

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	Learning of engineering skills required for understanding measurement & control systems
CO 2	Enhancement of analytical skills for modeling & analyses of measurement& control system
CO 3	Learning problem solving in domain of measurement & control
CO 4	Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

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 resistance thermometry: 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; Torque measurement: 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, block diagram of closed loop system, block diagram reduction, modeling of mechanical systems, modeling of electrical systems, signal flow graphs, modeling of fluid systems, liquid level systems, hydraulic systems, modeling of thermal systems.

Unit 5

Transient and steady state response analyses: First order systems, unit step and unit impulse response of 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

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

PRE-REQUISITES: MA 2604, ME 2601, ME 2608, MA 2655, ME 2661, ME 2664 and EC 2663.

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:

CO1	Explain basic modes of heat transfer. Application of Fourier's law in different applications like plane and composite wall, 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 and for 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. Effects of variable thermal conductivity on temperature distribution and heat flux.

Unit 2

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

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

Unit 3

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

Unit 4

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.

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

Unit 5

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

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36xxx	Power Plant & Energy Management	4	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 3606, ME3608, ME3603, IM3621, ME3659, ME3656 and IM3661

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:

CO1	Enhancement of fundamental knowledge of power plant & energy management
CO2	Learning problem solving 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	Understanding 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 Renewable Energy 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 and other 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 Diesel Engine Power Plant e.g. Engine, Air, Intake and Exhaust gas systems, Fuel and lube oil systems, cooling water system etc. calculations of capacity of engine, fuel and lube oil requirements, efficiencies, cooling water 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. Elements of 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

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

Pre-requisites: ME 3606, ME3608, ME3603, IM3621, ME3607, ME3607, ME3656, PE3662, and IM3661

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:

CO1	Illustrate the basic concepts of refrigeration system explain various types of refrigerants and their properties
CO2	Explain and analyze vapour compression systems
CO3	Analyse vapour absorption systems. Discuss low temperature and unconventional refrigeration systems
CO4	Analyze air-conditioning processes using the principles of psychometry
CO5	Discuss the theory of 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.

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

Unit 2

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.

Unconventional Refrigeration System: Steam jet and thermo-electric refrigeration systems, their principle of working and application.

Unit 4

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, & Trott,Welch Refrigeration and Air Conditioning, Butterworth-Heinemann, 2008
4. Althouse, Willcox Publisher, 1982-Refrigeration and Air Conditioning. Goodheart Turnquist & Bracciano, Modern

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36xxx	Machine Design – II	4	-	4	3	2	5	70	30	40	60	200

Pre-requisites: ME 26002, ME26008, ME26551, ME36001

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:

CO1	Understand and 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 in stresses, 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-high cycle 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 of spur, 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, spiral etc. 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 different tensions, 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., Introduction to Machine Design, Tata McGraw Publication, 2001
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

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

Pre-requisites: ME 2601, MA2604, PE2609, MA2655, ME2660, ME2662 and ME2664.

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 this course the student is expected to-

CO1	Understand fundamentals of working of hydraulic turbines, reciprocating pumps, centrifugal pumps.
CO2	Have knowledge of steady and unsteady flow characteristics in hydraulic machinery and conduit systems connected to the machinery
CO3	Develop an ability to apply knowledge of mathematics, science and engineering, to understand effect of hydrodynamic force on various types of vanes
CO4	Be able to design a system, component or process to meet desired needs with in realistic constraints
CO5	Learning problem solving in particular domain such as hydraulic turbines, reciprocating pumps & centrifugal pumps

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 pumps and 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.

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

Pre-requisites: ME2601, MA2604, MA2655, ME2661, ME2662, ME2664 and EC2663.

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:

CO1	Analyze various air standard and actual cycles. Classify internal combustion engines based on different parameters.
CO2	List various qualities of engine fuels. Discuss carburetor fundamentals, design 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	Illustrate various mechanisms of lubrication and cooling systems in IC engines. List types of lubricants and additives and Evaluate the performance of engines by understanding its operating characteristics.

COURSE CONTENTS

UNIT I

Air-Standard cycle and their analysis, Comparison of cycles. Classification of engine and their application, Engine Design and operating parameters. Fuel-air cycles and their analysis. Thermochemistry of fuel air mixture. Properties of working fluids 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 heating values. 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, factors influencing 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 Improvements performance 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

ME 46051 : Vibration & Noise Control

Pre-requisites: Mechanics of Solids, Kinematics of Machine, Dynamics of Machine.

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	Mathematical Modeling of SDOF Systems and estimation of natural frequencies, damping factors.
CO 2	Forced Vibration Analysis of SDOF Systems, Vibration isolation and vibration measuring instruments
CO 3	Mathematical modeling of 2DOF systems, design of undamped dynamic vibration absorber, fundamentals of modal analysis.
CO 4	Learning techniques of vibration monitoring and fundamentals of sound/noise
CO 5	Learning techniques of noise control for welfare of human being.

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. Harmonic analysis

System having single degree of freedom, free vibration of systems without damping, Equilibrium and Energy Method for determining natural frequency. Reyleigh's Method, Equivalent Systems (systems with compound 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 viscous damping, 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 with and without damping, discussion of the speeds above and below the critical speed, uniform shaft with and without 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 measuring instruments

UNIT III

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

Modal Analysis, Orthogonality of Eigenvectors, Decoupling of Equations of Motion, Modal Mass, Modal Stiffness 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. Standards of 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

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
XX 46xxx	Artificial Intelligence	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

After undergoing this course, the students will be able to:

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

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 first search, 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, policy iteration and partially observable MDPs.

Unit 5

Reinforcement Learning: Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, 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.

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46xxx	Robotics	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

After undergoing this course, the students will be able to:

CO1	Understand basic terminologies and concepts associated with Robotics and Automation.
CO2	Understand 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	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-Lagrange formulation, Newton Euler formulation.

Unit 3

Robot Sensors and Actuating systems

Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, 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

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
XX 46xxx	3D Printing And Design	4	-	-	3	-	3	70	30	-	-	100

Course Outcomes:

After undergoing this course, the students will be able to:

CO1	Develop CAD models for 3D printing
CO2	Import and Export CAD data and generate .stl file.
CO3	Select a specific material for the given application
CO4	Select a 3D printing process for an application.
CO5	Build a product using 3D Printing or Additive Manufacturing (AM).

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.

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46xxx	Advanced Machine Design	4	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 36001, ME26002, Machine Design I. Machine Design II

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:

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.

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

Unit 2

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

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

Unit 3

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

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

Unit 4

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

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.

Unit 5

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.

Reference Books:

1. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M. Marshek, John Wiley, 2006
2. Engineering Optimization, Rao S.S., John Wiley, 1996

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 46218	Mechatronics and Automation	4	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 3606, ME3601, ME3603, ME3607, PE3662 and IM3661

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:

CO 1	List various control actions and apply the concepts of transfer functions for mathematical modelling 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.