**Department of Mechanical Engineering**

**B.E. (4 Year Degree Course)**

# SYLLABUS

**2016**


**Shri G. S. Institute of Technology & Science, Indore**
**23, Park Road, Indore-03**

**(An Autonomous Institution, Established in 1952)**

| Class | Subject code | Nomenclature | Remarks |
|---|---|---|---|
| BE (Mech)2nd Yr Sem A | ME2601 | Fluid Mechanics | |
| | ME2606 | Mechanics of Solids | |
| | ME2608 | Material Science | |
| BE (Mech)2nd Yr Sem B | ME2660 | Design of Machine Elements | |
| | ME2661 | Machine Drawing | |
| | ME2662 | Kinematics of Machines | |
| | ME2664 | Thermodynamics | |
| BE (Mech)3rd Yr Sem A | ME3606 | Heat & Mass Transfer | |
| | ME3608 | Steam &Gas Turbines | |
| | ME3601 | Dynamics of Machine | |
| | ME3603 | Measurement & Automatic Control | |
| BE (Mech)3rd Yr Sem B | ME3659 | Internal Combustion Engines | |
| | ME3607 | Machine Design – I | |
| | ME3656 | Fluid Machinery | |
| | ME3691 | Minor Project | |
| BE (Mech)4th Yr Sem A | ME4608 | Automobile Engineering | |
| | ME4609 | Refrigeration &Air Conditioning | |
| | ME4607 | Machine Design – II | |
| | ME4610 | Computer Aided Design | |
| | ME46** | Elective – I | |
| | ME4643 | Major Project (phase – I) | |
| BE (Mech)4th Yr SemB | ME4658 | Mechatronics | |
| | ME4661 | Vibration & Noise Control | |
| | ME4657 | Power Plant & Energy Management | |
| | ME46** | Elective – II | |
| | ME46** | Elective – III | |
| | ME4693 | Major Project (phase – II) | |

| Class | Subject code | Nomenclature | Remarks |
|---|---|---|---|
| Elective-I | ME4622 | Design of Air conditioning equipments | |
| | ME4625 | Hydraulic Pneumatic & Fluidic Control | |
| | ME4627 | Tribology & Maintenance Engg | |
| | ME4628 | Engineering Optimization | |
| Elective-II | ME46** | Solar Energy Utilization | |

| | | | |
|---|---|---|---|
| | **ME4678** | **Finite Element Methods** | |
| | **ME46**** | **Biomechanics** | |
| | **ME46**** | **Computational Fluid Dynamics** | |
| **Elective – III** | **ME4624** | **Gas Dynamics & Fluid Flow** | |
| | **ME46**** | **Renewable Energy Sources** | |
| | **ME46**** | **Design of Thermal systems** | |
| | **ME46**** | **Robotics** | |
| | **ME4677** | **Composite Materials** | |
| | **ME46**** | **Computational Mechanics** | |
| | **ME46**** | **Product Development** | |

## LIST OF SUBJECTS TAUGHT TO THE OTHER DEPARMTENTS

| | | |
|---|---|---|
| 1 | ME2304 | Mechanics of Solid |
| 2 | ME2305 | Mechanical Metallurgy |
| 3 | ME2355 | Theory of machine |
| 4 | ME2356 | Fluid Mechanics and Thermal Engineering |
| 5 | ME3305 | Design Of machine Element |
| 6 | ME3306 | Prime movers and pumps |
| 7 | ME3752 | Mechanical Measurements |
| 8 | ME3308 | Design Of machine elements |
| 9 | ME3309 | Mechatronics |

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 2601 | Fluid Mechanics | 3 | - | 2 | 3 | 1 | 4 | 70 | 30 | 40 | 60 | 200 |

**Pre-requisites:** ME10505, PH1005, MA1006, MA1056 and IM1059

**Course Assessment:**

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

- **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
- **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
- **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
- **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

## COURSE CONTENTS

**Unit I**

**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.

**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**

**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 conective acceleration, continuity equation.

**Unit III**

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

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

**Unit IV**

**Flow Through Pipes** : Reynold Number, Laminar and Turbulent flow, Viscous flow through parallel plates and pipes, Navier Stoke's equation, Pressure gradient, Head loss in Turbulent Flow (Darcey's Equation), Friction factor, Minor losses, Hydraulic and Energy gradient.

**Unit V**

**Boundary Layer Theory** : Introduction, Description of Boundary Layer. Boundary Layer Parameters, Von Karman Momentum Equation, Laminar Boundary Layer, Turbulent Boundary Layer, Boundary Layer Separation.

**Compressible Flow** : Introduction, Mach Number, Isentropic Flow, Stagnation Properties.

**Text Books:**


- Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005
- Modi and Seth, Hydraulics & Fluid Mechanics, Standard Book House, 1991

**Reference Books:**


- Shames, Fluid Mechanics, Tata McGraw-Hill, 1962
- Massey, B.S., Mechanics of Fluids, Routledge Publication, 2006
- 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 2608 | 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;

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 Material Science
CO 2 Learning of experimental skills in Material Science
CO 3 Enhancement of analytical skills for Material Science
CO 4 Learning problem solving in the domain of Material Science

## COURSE CONTENTS

**UNIT I**

Techniques of Crystal Growing. Growth of single crystals from melt, Czocharalski crystal pulling. Crystal Growth and Refining by zone melting technique. Lattice Vacancies, Schottky and Frenkel defects. Diffusion in solid, Fick's Law, Color Centers.

Dislocation, Edge dislocation, Screw Dislocations, Slip Planes. Stress Fields of Dislocations. Grain Boundaries, Dislocation densities, Strength of Alloys, Dislocation and crystal growth.

Description of crystal structure: Seven crystal systems. Bravais lattice. Symmetry and properties of simple crystal structure. Miller Indices. Direction and Plane Indices.

**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 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 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.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 IV**

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 Micro structure, 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 V**

Failure Analysis of machine parts based on metallurgical aspects like crystal structure variations, crack propagation, inclusion of impurities, machining effects on surface materials, load capacity of different phases.

Non-destructive Testing: Ultrasonic, Magnetic, Eddy Current, Radiography test etc. Metallography. Introduction to instrumental methods of analysis.

A brief discussion of the properties and applications of the rare metals like Titanium, Uranium, Beryllium and Zirconium. Composite materials type 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

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME _ _ _ _ | Strength of Materials | 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;
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 3 Enhancement of fundamental knowledge of particular engineering discipline
CO 4 Learning of particular engineering skills
CO 5 Enhancement of analytical skills
CO 6 Learning problem solving in particular domain

**COURSE CONTENTS**

**UNIT I**
(a) Stress and Strain : Tension, compression and shear, Complementary shear stresses. Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus, Poisson's Ratio. Relation among the moduli. Stress due to temperature.
(b) Statically indeterminate system,.

**UNIT II**
(a) Bending Moment and Shear Forces : Diagrams of Shear Forces and Bending Moment for Cantilever beams, Fixed End Beams and Simply Supported Beams with or without overhanging ends. Relation between loads, shearing forces and bending moments.
(b) Bending Stress : Theory of bending, bending and shear stresses in beams and their distributions, modulus of section, beams of varying cross section, beams of uniform strength, composite beams.

**UNIT III**
(a) Shear stress in a circular member due to Torsion.
(b) Stress on oblique section of a bar subjected to axial stress, compound stress. Principal stress and strain, Mohr's Circle. Combined stresses.

**UNIT IV**
(a) Deflection : Uniform curvature, Relation between curvature and deflection, cantilevers and simply supported beams of varying cross section. Macaulay's method. Propped beam.
(b) Parts subjected to column action with and without lateral loading.

**UNIT V**
(a) 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.
(b) Thin walled pressure vessels

**Text Books:**
1. Ramamrutham S., Mechanics of Solids,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

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-3606 | Heat and Mass Transfer | 4 | - | 2 | 4 | 2 | 6 | 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:**

CO 1 Learning of engineering skills necessary for heat & mass transfersystems

CO 2 Enhancement of analytical skills for formulation & understanding of HMT system

CO 3 Learning problem solving in domain of HMT

CO 4 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

CO 5 Solution of problems of particular domain through modeling and simulation using software tools

## COURSE CONTENTS

**Unit I**

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 II**

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

Brief introduction toUnsteady State Heat Conduction:

**Unit III**

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 IV**

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 V**

Radiation: Thermal Radiation. Monochromatic and total emissive power, absorptivity, reflectivity and transmitivity, 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:**

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-3608 | Steam and Gas Turbines | 4 | - | 2 | 4 | 2 | 6 | 70 | 30 | 40 | 60 | 200 |

**Pre-requisites:** MA 2604, ME 2601, ME 2608, MA 2655, ME 2661, ME 2664.

**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 problem solving indomain of steam & gas turbine systems
CO 2 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems
CO 3 Inculcation of sense of social responsibility through fundamentals of energy conversion
CO 4 Understanding the importance of sustainable development and evolving approaches for it

## COURSE CONTENTS

**UNIT I**

Thermodynamic Cycles of Steam Plant. Analysis and calculation of reheat. Regenerative & Binary Cycles. Combined cycles of steam and gas.

**UNIT II**

Nozzle flow analysis conditions for maximum flow. Effect of friction. Performance of nozzle & its efficiencies. Theory of steam injectors.

Impulse and Reaction turbines. Basic types and elements of these turbines. Flow through turbines and stages. Power developed degree of reactions. Efficiency of Impulse and reaction turbine stages.velocity diagram, governing, losses in turbine

**UNIT III**

Steam condensers. Types of condensers, Efficiency of Air and methods of its extraction & calculation of pump capacity. Cooling water calculations.

Axial & centrifugal compressors, equation of energy transfer, power inputs and losses, axial flow turbines, combustion chambers requirements and types, application of gas turbines for aircraft, surface vehicle and power plant.

**UNIT IV**

Principles of working of gas turbines cycles. Efficiencies and out put of gas turbines, Reheating regenerative and multistage compression. Total head, polytropic and stage efficiencies.

**UNIT V**

Jet Propulsion.: Essential elements and principle of operation of turbo prop, turbojet and ramjet, pulse jet engines, their operating cycles, calculation of thrust, power and efficiencies, jet propulsion systems. Rocket propulsion. Principle of operation, calculation of thrust and efficiency.

**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

**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 ofengineering skillsnecessary for understanding dynamic Systems
CO 2 Enhancement of analytical skills for formulation & modeling dynamic systems
CO 3 Learning problem solving indomain of machine dynamics
CO 4 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

## COURSE CONTENTS

**UNIT I**

**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 II**

**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 III**

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

**UNIT IV**

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

**UNIT V**

**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.

**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-3603 | Measurement and Automatic Control | 4 | - | 2 | 4 | 2 | 6 | 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 ofengineering 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 I**

**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 II**

**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 III**

**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 IV**

**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 V**

**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:

**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
4

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-4608 | Automobile Engineering | 4 | - | 2 | 4 | 2 | 6 | 70 | 30 | 40 | 60 | 200 |

**Pre-requisites:** ME 3601,ME3603, IM3621, ME3659, ME3607, ME3656, PE3662, andIM3661.

**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 understanding & knowledge ofautomotive systems
CO 2 Learning ofengineering skills for understanding & analyses of automotive systems
CO 3 Learning problem solving in domain of automobiles and equipments
CO 4 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

## 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 .Steering gear 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 automatic transmission 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, four wheel 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

**Reference 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

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 4609 | Refrigeration and Air Conditioning | 4 | - | 2 | 4 | 2 | 6 | 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:**

CO 1 Enhancement of analytical skills necessary for formulation & modeling RAC systems
CO 2 Learning problem solving in domain of RAC applications & systems
CO 3 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems
CO 4 Solution of problems through modeling and simulation using software tools
CO 5 Inculcation of sense of social responsibility through development & section of appropriate RAC equipments
CO 6 Understanding the importance of sustainable development and evolving approaches for it

## COURSE CONTENTS

**UNIT I**

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 II**

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 III**

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 IV**

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 V**

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

Air conditioning equipments : 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, Turnquist & Bracciano, Modern Refrigeration and Air Conditioning. Goodheart-Willcox Publisher, 1982

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-4607 | Machine Design – II | 4 | - | 4 | 4 | 4 | 8 | 70 | 30 | 40 | 60 | 200 |

**Pre-requisites:** ME 3606,ME3601, ME3603, ME3659, 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. **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 analytical skills for understanding & formulation of system design problems
CO 2 Learning problem solving in domain of system design
CO 3 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems
CO 4 Solution of problems through modeling and simulation using software tools
CO 5 Inculcation of sense of social responsibility through optimized and under friendly design.
CO 6 Understanding the importance of sustainable development and evolving approaches for it

**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, design and selection of hooks and wire ropes.

**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**

Optimum design analysis: Introduction to optimum design analysis of simple machine members.

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 reciprocating machine parts: Design of reciprocating machine parts such as – cylinder, piston, connecting rod, crank and crank shaft, etc.

**Text Books:**

1. Mechanical Engineering Design, Shigley and Mischke, TMH, 2001
2. Introduction to Machine Design, V. Bhandari, TMH, 2004

**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-4610 | Computer Aided Design | 4 | - | 2 | 4 | 2 | 6 | 70 | 30 | 40 | 60 | 200 |

**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. **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 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

CO 2 Solution of problems of particular domain through modeling and simulation using software tools

**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.

**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, Sweep representation, Analytical solid modelling, 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: Theary & Practical, Tata Mc-Graw Hill, 2012


**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

| CODE | SUBJECT NAME | L | T | P | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Th. | CW | SW | Pr. | Total |
| ME 4622 | Design of Air-Conditioning Equipment | 4 | - | - | 100 | 25 | - | - | 125 |

**Prerequisite:** ME3606, ME3608, ME4609

**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 Outcome:**
At the end of this course the student is expected to be:

1. Familiar with various types of compressors, evaporators and condensers used in refrigeration industry.
2. Understand Kyoto protocol and need for using eco-friendly refrigerants.
3. Familiar with psychromeric properties and air washer.
4. Estimate 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 and Air 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:**

5. Arora C.P., Refrigeration and Air Conditioning, Tata McGraw Hill Pub. Company, New Delhi - 2000.

6. 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.

**ELECTIVE – I**

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 4625 | Hydraulic, Pneumatic & Fluidic Control | 4 | 1 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:** ME 3656, ME2601

**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 this course the student is expected to:

1. Develop understanding the principles of operation of hydraulic, pneumatic and fluidic control systems.
2. Beable to draw fluid power symbols; demonstrate knowledge of basic fluid power theory and fluid conditioning.
3. Demonstrate mechanical aptitude to accomplish maintenance, testing and repair of hydraulic and pneumatic components and systems.
4. Handle Programmable Logic Controllers, Basic logic operations, and feedback devices and sensors.

**COURSE CONTENTS**

**Unit I**

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

**Unit II**

Elements of circuit design, accumulators, control circuits such as position control and speed control circuits.

**Unit III**

Pneumatic systems, conditioning compressed air, pressure regulators, filters.

**Unit IV**

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

**Unit V**

Principles of fluidic components, analog digital amplifiers and sensors Equivalent electric circuits, graphical characteristics, logic gates applications.

**Text Books & References Recommended :**

1. Vicker Sparry, Hand Book - Industrial Hydraulics.
2. Lewis Stern, Design of Hydraulic Control Systems.

**ELECTIVE – I**

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 4627 | Tribology & Maintenance Engineering | 4 | 1 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:**

**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 this course the student is expected to:

1. describe surface topography, physico-chemical aspects of solid surfaces, and surface interactions.
2. recognize the laws of friction, mechanisms of friction, friction space, stiction, stick slip, and surface temperature.
3. appreciate the various modes of wear: adhesive, delamination, fretting, abrasive, erosive, corrosive, oxidational (mild and severe), melt, and the wear-mechanism maps.
4. identify types of lubrication: boundary, solid-film, hydrodynamic, and hydrostatic lubrication.
5. examine applications/case studies: sliding contacts, rolling contacts, bearing design, coating selection, and lubrication.
6. explore the design of tribological surfaces and how to troubleshoot tribology problems.

**COURSE CONTENTS**

**UNIT I**

Failure analysis and Repair: Failure Analysis and Trouble Shooting, Metallurgical failure analysis, Machinery problem solving Sequences, Sneak analysis.

**UNIT II**

Industrial Tribology : Introduction to triblogy, Friction, types, laws, mechanism, friction instabilities, wear, classifications, theories, abrasive, adhesive, surface fatigue, corrosion, lubrication theories, viscous flow and viscometers, hydrodynamic, hydrostatic theories, boundary lubrication.

**UNIT III**

Diagnostic Maintenance: Condition based maintenance, online and off line techniques, thermography, wear particle and oil analysis, Noise and vibration signature analysis, Non destructive analysis.

**UNIT IV**

Lubrication theory and Practices

**UNIT V**

Maintenance Planning and Control

**Books & References Recommended :**


1. Bloch H P and Geiners F K, Machinary Failure Analysis and Trouble Shooting
2. I M Hutching, Tribology, CRC Press.
3. Eillis E G, Fundamentals of Lubrication
4. Kelly A, Maintenance, Planning and Control, Butterworth-Heinemann
5. R.A. Collcatt, Mechanical Fault diagnosis & condition Monitoring, Wiley.

**ELECTIVE – I**

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 4628 | ENGINEERING OPTIMIZATION | 4 | 1 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:**

**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 this course the student is expected to:

**COURSE CONTENTS**

**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 – multivariable Optimization 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 Singiresu 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).

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-2304 | Mechanics of solids | 4 | - | 2 | 4 | 2 | 6 | 70 | 30 | 60 | 40 | 200 |

**COURSE CONTENTS**

**UNIT I**

Stress and Strain : Tension, compression and shear, Complementary shear stresses. Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus, Poisson's Ratio, Relations among the moduli, Stress due to temperature, Statically indeterminate system, Shear stress in a circular member due to Torsion.

**UNIT II**

(a) Bending Moment and Shear Forces: Diagrams of Shear Forces and Bending Moment for cantilevers beams and simply supported beams with or without over hanging ends. Relation between Loads and Shearing Forces and Bending Moments.

(b) Bending Stress : Theory of Bending, bending and shearing Stress in beams and their distribution with varied load, modulus of section and modulus of rupture, beams of varying cross section, beams of uniform strength.

(c) Introduction to Composite Beams

**UNIT III**

Stress on oblique section of a bar subjected to axial stress, Complex Stresses, Principal stress and strain, Mohr's Circle, Combined direct and bending stress

**UNIT IV**

(a) Deflection : Uniform Curvature, Relation between curvature and deflection, cantilevers and simply supported beams of varying cross-section, MaCauley's Method, Deflection due to Shear. Propped Beam,

(b) Parts subjected to column action with and without lateral loadings, Euler's theory of columns.

**UNIT V**

(a) Elastic strain energy: Resilience, Proof Resilience. Materials under tension, Static, Sudden and Falling Loads, Strain Energy due to Direct Shear, bending and torsion, Castigliano's theorem.

(b) Introduction to thin and thick cylinder.

**Sessional Work :**

Each candidate will be required to undergo a laboratory course based on the theoretical course prescribed above and will hand over a journal containing full record of his laboratory work and this shall constitute Sessional Work.

**Book & References Recommended :**


1. Popov, E.P., *Mechanics of Solids*, Prentice-Hall India.
2. Ryder, G.H., *Strength of Materials,* Macmillan India.
3. Beer & Johnston, *Mechanics of Material.* Tata McGraw-Hill.
4. Ramamrutham, *Mechanics of Solids,*Dhanpat Rai.

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-2305 | Mechanical metallurgy | 4 | - | 2 | 4 | 2 | 6 | 70 | 30 | 60 | 40 | 200 |

**COURSE CONTENTS**

**UNIT I**

Metal Structures and Crystallization: Atoms Structure, Atomic binding, Crystal Structure, Allotropy Structure of Alloys. Equilibriums, Lever Rule, Phase Rule, Iron, Iron Carbide Equilibrium Diagram.

**UNIT II**

Mechanical Properties and Mechanical Working of Metals : Strength, Stiffness, Elasticity, Plasticity, Ductility, Hardness, Impact Strength, Malleability, Brittleness, Toughness, Resilience etc. Hot and Cold Working of Metals and their Effects on Properties and Microstructure of Metals.

**UNIT III**

Heat Treatment of Metals and Alloys : TTT Diagram, Continuous Cooling Curves, Annealing, Normalizing, Spheriodizing, Hardening, Tempering, Austempering, Martempering, Case Carburizing, Nitriding, Cynading, Carbontriding, Induction Hardening, Flame Hardening, Age Hardening and Hardenability.

**UNIT IV**

Ferrous and Non-Ferrous Metals and Alloys: Modern Trends in the Manufacture of Iron and Steel, Cast Steel Composition, Micro Structure, Properties and Applications of Plain Carbon Steels and Cast Irons. Effect of Impurities in Ferrous Metal. Effect of Common Alloying Elements on properties of plan Carbon the Steels. Common Alloy Steels. High Speed Steel. Hard Field Mn Steel, Stainless Steel. Corrosion and its Prevention. Composition Micro Structure, Properties and Application of Aluminium and its Principle Alloys, Copper and its Principle Alloys. Bearing Metals.

Rare Metals: A Brief Discussion of the Properties and Application of Rare Metals, Viz. Platinum, Uranium, Beryllium and Zirconium.

**UNIT V**

Destructive and Non-destructive Testing : Tensile test, Hardness Compression, Impact test Shear, Torsion Fatigue test, Radiography Impact, and Hardness Tests. Ultrasonic, Magnetic, Eddy Current Testing, Penetration Testing and Magnetic Particles Inspection Testing Radiographic Test Etc.

Power Metallurgy: Theory of Power Metallurgy, Manufacturing of Metal Powers, Sintering and Secondary Operations, Properties of Finished Parts, Design Consideration and Application.

**Sessional Work :**

Each candidate will be required to undergo a laboratory course based on the course prescribed above. Each student shall maintain a Journal containing full record of his laboratory work.

**Books & References Recommended :**

1. Nayak S. P., *Metallurgy for Engineers*, Chatotar Publication.
2. Lakhtin, *Engineering Physical Metallurgy*, MIR.

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-3306 | Prime movers and pumps | 4 | - | | 4 | | 4 | 70 | 30 | | | 100 |

**COURSE CONTENTS**

**Unit 1** Internal Combustion Engines : Introduction, Classification of I.C. Engines, Constructional details of two-stroke & four-stroke engines and rotary engines, Important parameters of design of engines, Volumetric efficiency and scavenging, Fuel-air cycle analysis.

Carburation and ignition systems of spark ignition engines. Carburettor details, TCI & CDI ignition systems, Air fuel mixture & requirement, combustion process and detonation, compression ignition engines, injection systems for single and multi-cylinder engines, combustion and knocking.

Fuel rating, alternative fuels, Supercharging and turbo-charging,

**Unit 2**

Steam Engineering : Rankine cycle, Reheat and regenerative cycles, Fuel and combustion, Industrial boilers, draught.

Steam turbines : Impulse and reaction turbines, Velocity diagrams, reheat factors, condensers and cooling, Elementary idea of governing.

**Unit 3**

Gas Turbines and Gas Propulsion : Turbine cycles with intercooler and comparative studies constructional details of axial-flow and centrifugal compressors. Elementary of Jet-propulsion and calculation of force, work and efficiency.

**Unit 4**

Theory of Fluid Machinery : Classification of rotor-dynamic turbines and pumps, Velocity triangles, Euler's equation of work done and efficiencies. Constructional details of Pelton, Francis and Kaplan turbines. Characteristics and specific speed.

**Unit 5**

Pumps, Compressors and Blowers : Positive displacement pumps, rotary compressors and blowers their constructional details, characteristics and efficiencies,

**Books & References Recommended :**


1. K. L. Kumar, *Engineering Fluid Mechanics*.
2. S. M. Yahya, *Pumps, Compressors and Fans*.
3. H. R. Kapoor, *Thermal Engineering, Vol.I & II.*
4. M. L. Mathur & F. S. *Mehta, Thermal Engineering, Vol. I & I*

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 3308 | DESIGN OF MACHINE ELEMENTS | 4 | 0 | 3 | 4 | 2 | 6 | 70 | 30 | 40 | 60 | 200 |

**PRE-REQUISITES:**ME1007 Engineering Drawing, ME1055 GME

## COURSE OBJECTIVES:

The Course having following Objectives-

1. To formulate and analyze stresses and strains in machine elements and structures subjected to various loads,
2. To apply fatigue failure criteria in the analysis and design of mechanical components,
3. To analyze and design structural joints (Knuckle, Cotter etc.)
4. To analyze and design power transmission shafts carrying various elements with geometrical features,
5. To understand standards, safety, reliability, importance of dimensional parameters and manufacturing aspects in mechanical design.

## THEORY

1 Machine Drawing: Orthographic projections of machine components and assemblies viz Knuckle
joints, cotter joints, flange couplings, bushed bearings (Plummer blocks foot-step bearing).
2 Introduction to machine design; Design and drawing of parts subjected to compressive, bending, and
shear stresses such as pins, keys, cotters, levers.
3. Design of fastening elements under direct and eccentric loading
   a. Riveted joints: Lap joint, butt joint, diamond joint
   b. Welded joints
   c. Threaded and bolted joints
4. Theories of failure. Design of machine elements subjected to combined loading Design of shafts.
5. Design of machine components subjected to stress concentration and dynamic loading.

## SESSIONAL WORK

Drawing and journal based on above course will constitute the Sessional work.
Drawings on Imperial size drawing sheets (04 to 06 sheets) to be prepared based on above e course work.

## COURSE OUTCOMES:

The course prerequisites are Engineering Drawing, General Mechanical Engineering, Engineering Materials, Mechanics of Solids, and Kinematics of Machines.

This course is designed to help students achieve the following outcomes.

1. To familiarize with the mechanical engineering design and develop an understanding of importance of an engineer's role in society as a designer.
2. Ability to utilize the knowledge of prerequisite subjects in design.
3. To develop understanding of material selection, F.O.S. selection.
4. Ability to estimate magnitude, nature and direction of load in static and dynamic loading condition.
5. Ability to formulate and analyze stresses and strains in machine elements and use of theories of failure.
6. Ability to apply multidimensional static failure criteria in the analysis and design of mechanical components.
7. Ability to understand and use of design data hand book.
8. Ability to determine dimensions of simple machine components empirically and rationally.
9. Able to design bolted, welded and riveted joints.

## COURSE ASSESSMENT:

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

**1.Class Work (CW) - 30 marks**
Class work consists of assignments and two mid semester tests.

2**. Sessional Work (SW) - 40 marks**
Sessional work consists of internal viva and work done in design lab (design problems based on above course).

**3. Practical Examination Marks – 60**
Practical examination is conducted at the end of semester to evaluate practical knowledge of students.

**4. Theory Examination Marks – 70**
Theory examination is conducted for the evaluation of theoretical knowledge.

## BOOKS & REFERENCE:


1. Shigley and Misehke, Mechanical Engineering Design
2. Bhandari, Machine Design
3. Juvinall. Machine Design
4. N.D. Bhatt, Machine Drawings

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 3309 | Mechatronics | 4 | 0 | 2 | 4 | 2 | 6 | 70 | 30 | 40 | 60 | 200 |

**PRE-REQUISITES:**Me-1055: General Mechanical Engg., Me 2601: Fluid Mechanics, Ma 2604: Maths-III,

## COURSE OBJECTIVES:

To understand the theory of Measurement of various properties by mechanical devices

To analyze hydraulic and Pneumatic control valves and actuators,

To understand System modeling using MAT LAB,

Effective Integration of multiple mechanical & electrical systems.

## THEORY:

1. Open loop and closed loop control systems: Dynamic modeling of simple mechanical, electrical, electromechanical, thermal and fluid systems. Transfer function and block diagram representation of control system. Zero order, first order and second order systems and their dynamic response, Routh Hurwitz stability criteria, Introduction to bode plot and root locus method. System modeling using MAT LAB.
2. Measurement Systems: Generalized measurement system. Sensors and transducers, intermediate elements, indicating and recording elements indicating and recording elements. Static and dynamic characteristics of measuring instruments. Amplitude linearity, phase linearity, bandwidth, frequency response. Proximity sensors and switches, potentiometers, optical encoders, electrical strain gauges, load cells, thermocouples, piezoelectric accelerometers, pressure and flow sensors, semiconductor sensors.
3. Signal Conditioning & Data Acquisition: Amplification. Filters. Operational amplifier and its applications. Analogue to digital conversion. Data acquisition. Interfacing with micro-controller and micro-processor.
4. Actuators: Electro- mechanical actuators, solenoids and relays, types of electric motors and their characteristics, speed control of electric motors. Stepper motors and their control.
   Electro- hydraulic and electro- pneumatic actuators, Servomotor.
5. Controllers: Basic control actions. Proportional, integral and derivative control. Op Amp based PID controller. Combinatorial and sequential logic. Simple logic networks. Introduction of micro controllers.

## SESSIONAL WORK:

Each candidate will be required to undergo a laboratory course based on the theoretical course based on the theoretical course prescribed above and will hand over a journal
containing full record of his laboratory work and this shall constitute Sessional Work. Such SW will be awarded marks maximum up to 50.

## COURSE OUTCOMES:

Select and apply the knowledge, techniques, skills and modern tools in mechatronics engineering technology,

Use appropriate computer languages and application software that pertain to mechatronics engineering technology systems,

Apply problem solving skills, including the ability to identify problems, conduct experiments, gather data, analyze data, and produce results,

Students will be conversant with measurement techniques and the use of measuring instruments,

Will have working knowledge for dealing with problems involving control system fundamentals,

Students can design and implement state space based controller designs to regulate and control various processes and systems.

## COURSE ASSESSMENT:

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

**1.Class Work (CW) - 30 marks**
Class work consists of assignments and two mid semester tests.

2**. Sessional Work (SW) - 40 marks**
Sessional work consists of internal viva and work done in design lab (design problems based on above course).

**3. Practical Examination Marks – 60**
Practical examination is conducted at the end of semester to evaluate practical knowledge of students.

**4. Theory Examination Marks – 70**
Theory examination is conducted for the evaluation of theoretical knowledge.

## Books & References Recommended:


1. Beckwith and Buck, Mechanical Measurements
2. K. Ogata, Modern Control Theory
3. Nakra & Choudhary, Instrumentation, Measurement and Analysis
4. Alciatore and Histand, Introduction to Mechatronics & Measurement Systems
5. *Bolton, Mechatronics*

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME_____ | Design of Machine Elements | 3 | - | 2 | 3 | 1 | 4 | 70 | 30 | 40 | 60 | 200 |

**Pre-requisites:** ME 1007 and ME 2609

**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 3 Enhancement of fundamental knowledge of particular engineering discipline
CO 4 Learning of particular engineering skills
CO 5 Enhancement of analytical skills

## COURSE CONTENTS

**Unit 1**

Selection criteria for factor of safety, degree of uncertainty about loading, material strength, human safety and economy, Fracture mechanics: Crack- initiation, growth, propagation & fracture, ductile and brittle fracture. Residual stresses: Causes and effect, Stress relaxation, effect on stress distribution. Various methods of strengthening of Materials. Various types of loads and stresses, statistical nature of loading, preliminary stress calculations

**Unit 2**

Theories of failure and application to the design problems: Different theories of failure – normal stress theory, maximum shear stress theory, maximum strain energy theory, maximum distortion energy theory, etc, modified Mohr theory.

Contact stress and deformation: Contact surfaces - their geometries and deformations. Rolling resistance theory of elasticity and plasticity applicable to contact stresses, contact stress distributions

**Unit 3**

Design of joints like cotter joint and knuckle joint and flanged coupling
Levers and handles: Design of different types of levers, proper material selection and fittings, lubrication, design of handles for various applications.

**Unit 4**

Pressure vessels and cover plates: Analysis of thin and thick cylindrical and spherical shells, compound cylinders, joints for steam and hydraulic piping, parts of press fit and shrink fit, design considerations for pressure vessels, and cover plates

**Unit 5**

Threaded fasteners, Power screws: Material selection, load analysis, stress distribution, standard specifications, effect of initial tension, eccentric loading, static and dynamic load, failure studies, various types of nut – bolt – washers, etc, thread profiles of power screws, stress analysis, design of power screws.
Welded joint, riveted joint : Load and stress analysis, dimension calculations, design of welded joints, riveted joints, direct and eccentric loading.

**Text Books:**

1. Shigley and Mischke, Mechanical Engineering Design, Tata McGraw-Hill, 2001
2. V. Bhandari, Introduction to Machine Design, Tata McGraw-Hill, 2004

**Reference Books:**

1. Robert C. Juvinall and Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley, 1991

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-2661 | Machine Drawing | - | - | 4 | 0 | 4 | 4 | 0 | 0 | 40 | 60 | 100 |

**Pre-requisites:** ME 1007 and ME 2609

**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:**
CO 2 Imparting a particular skill
CO 8 Solution of problems of particular domain through modelling and simulation using software tools

## COURSE CONTENTS

**Unit I**

Introduction to computer aided drafting. Basic commands of common computer aided drafting packages for 2-D & 3-D.

**Unit II**

Sectioning and drawing conventions for types of threads, welded joints, surface finish. Fits and tolerances. Dimensioning.

Orthographic projections of simple machine parts like, threaded fasteners, pulleys, keys, cotters, pins etc.

**Unit III**

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 IV**

Bearings: Bushed bearing, Plummer block, foot step bearing.

Engine parts like piston, connecting rod, crankshaft, valves.

**Unit V**

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

**Text Books:**
1. Bhatt N.D. and Panchal V.M., Machine Drawing, Charotar Publishing House, 2000
2. Laxminarayan and Mathur, Machine Drawing, Jain Bros, New Delhi, 1983

**References Books:**
1. Gill P.S., Machine Drawing, S K Kataria and Sons, 2001

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 2662 | Kinematics of Machine | 2 | 1 | 2 | 3 | 1 | 4 | 70 | 30 | 40 | 60 | 200 |

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

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

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

**Course Outcomes:**
CO 3 Enhancement of fundamental knowledge of kinematics
CO 4 Learning of engineering skills for formulation of kinematic problems
CO 5 Enhancement of analytical skills for handling kinematic chassis& mechanism
CO 6 Learning problem solving in the domain of kinematics & mechanisms

## COURSE CONTENTS

**UNIT I**

Degree of freedom, Grubler's criterion, Grubler's theory for listing all combinations of component members of linkages with number of links less than or equal to 8. Quadric cycle chain and its inversions, link motions, Quick return motion. Pantograph, Motor Vehicle steering gear, hooke's joint and engine indicators. Direct acting engine mechanism.

**UNIT II**

Velocity and acceleration diagrams of various mechanisms. Klien's construction, Coriolis components. Determination of velocity and acceleration by analytical and/or graphical methods

Synthesis of 4 bar mechanism.

**UNIT III**

Cams : Types of cams and followers, Cam profiles with specified follower motion e.g. simple harmonic, constant velocity and acceleration types, Cam with specified contours, Displacement, velocity and acceleration of followers.

**UNIT IV**

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, Wheel trains and Epicyclic wheel trains and their applications.

**UNIT V**

Gyroscopes : Products of Inertia, Principle Axis, Gyroscopic Motion, Gyroscopic Torque, Gyrostabilizer, Gyrocompass, Application to Ships and Aeroplanes.

**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 |
| ME 2664 | Applied Thermodynamics | 2 | 1 | 2 | 3 | 1 | 4 | 70 | 30 | 40 | 60 | 200 |

**Pre-requisites:** ME 1055, PH 1005, CH 1058, ME 1007 and MA 2604.

**Course 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.
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 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:**

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 Inculcation of sense of social responsibility
CO 6 Understanding the importance of sustainable development and evolving approaches for it

**CONTENTS**

**UNIT I**

(a) First Law of thermodynamics: Work and Heat Transfer, Joule's Experiment, 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, Absolute Thermodynamic Temperature Scale.

**UNIT II**

(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 Compressors: Types of air compressor, Construction and working of Reciprocating Compressors, Work requirement (actual, adiabatic and isothermal), Volumetric Efficiency, Isothermal Efficiency, Adiabatic efficiency, Multistage compression, Condition for minimum work.

**UNIT III**

(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 IV**

(a) Draught: Types of draught systems. Natural Draught, Determination of the height and diameter of chimney, condition for maximum discharge, efficiency of chimney, Mechanical draught (Forced, Induced and Balanced), Steam Jet Draught.

(b) Boiler Performance: Evaporation, Equivalent Evaporation, Boiler efficiency, Factors affecting Performance of Boilers, Boiler Trials. Heat Balance.

**UNIT V**

(a) Fuels: Solid, liquid and gaseous fuels, Properties of liquid fuel such as density, specific gravity, viscosity, flash point, pour point, specific heat, calorific value. Sulphur, ash content, Water Content, Removal of contaminants.

(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., *Thermal Science and Engineering*, SK Kataria & Sons Publication.
2. Nag P.K., *Engineering Thermodynamics*, Tata McGraw-Hill.
3. R Yadav, *Fundamentals of Thermodynamics*, Central Publishing House.

**Reference Books Recommended :**

1. Sonntag, Borgnakke and Van Wylen, *Fundamentals of Thermodynamics*, Wiley Publication.
2. Cengel and Boles, Thermodynamics: An Engineering Approach, McGraw-Hill Education.

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-2355 | Theory of machines | 4 | - | | 4 | | 4 | 70 | 30 | | | 100 |

**COURSE CONTENTS**

**UNIT I**

(a) Motion and Force Analysis : Plane motion, Kinematic concept of links, Basic terminology and definitions, Inversion of kinematic chains, Absolute and relative motion, Vector diagram, Instantaneous centre, Velocity and Acceleration Polygons, Special Graphical Methods for Slider Crank Mechanism.

(b) Concept of Free Body and its Equilibrium, Kinematic and dynamic quantities and their relationships, Static Force Analysis, Piston Effort, Dynamic Force Analysis, Equivalent Dynamical Systems.

**UNIT II**

Power Transmission : The Kinematic design of pulleys, Flat belts and V-belt, Transmission of power by belts, Conditions for maximum power transmission, Efficiency of power transmission.

**UNIT III**

Friction Devices, Coulomb friction, Pivot and Collars, Power screw, Plate clutch and Cone clutch, Band and Block Brakes.

**UNIT IV**

Gears : Fundamental laws of gearing, Classification and basic terminology, Involute tooth profile and Kinematic consideration, Spur gears, other types of Gears, Standards in tooth forms, Gear trains, Simple, Compound and Epicyclic Gear Trains.

**UNIT V**

(a) Balancing : Static and Dynamic Balancing or Rotating Masses in Same and Different Planes.

(b) Vibrations : Degree of Freedom, Natural Frequency of Single Degree of Freedom Systems, Damped and un-damped systems, Forced Vibration, Whirling of Shafts and Critical Speeds.

**Books Recommended :**


1. Bevan T., *Theory of Machines*, CBS Publication.
2. Ambekar A. G., *Mechanism & Machine Theory*, Prentice Hall of India.
3. Myszka David H., *Machines and Mechanism*, Prentice hall of India.

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-2356 | Fluid mechanics and thermal engg. | 3 | - | 2 | 3 | 1 | 4 | 70 | 30 | 40 | 60 | 200 |

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

- **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
- **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
- **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
- **Theory Examinati2n** (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

## ME 2356: FLUID MECHANICS AND THERMAL ENGG.

**Theory:**

### A. Fluid Mechanics:

1. Fundamentals: Types of Flows, One and Two Dimensional Flows, Irrotational and Rotational Flows, Stream and Potential Functions.Basic Laws of Fluid Flow : Continuity, Momentum and Energy Equations as Applied to System and Control Volume. Euler's and Bernoulli's Equations. Application to Flow through Office, Venturimeter, Pitot Tube.
2. Dimensional Analysis: Buckingham's Theorems, Similarities, Physical Significance of Reynold's, Mach and Froude Numbers etc.
3. Viscous Flow: Concept of Boundary, Drag, Lift, Flow through Pipes, Hydraulic Gradient and Losses due to Friction and Sudden Enlargement/Contraction, Pipes in Series and Parallel.

### B. Thermodynamics:

4. Fundamentals: Application of Mass and Energy Equation to Steady Flow System, Heat and Work Transfer in Flow and Non-Flow Processes. Second flow, Kelvin Planck's and Clausius Statement, Concept of Entropy, Clausius Inequality, Entropy Changes in Non-Flow processes, Properties of Gases and Vapours, Rankine Cycle.
5. Conduction in Parallel, Radial and Composites Walls, Connective Heat Transfer with Laminar and Turbulent Flows, Overall Heat Transfer Coefficient, Thermal Boundary Layer, Important Correlation's, Flow Through Heat Exchanger, *Refrigeration and Air Conditioning :* Principles of Refrigeration, A/C Cycles, Coefficient of Performance and Properties of Refrigerants.

**Books & References Recommended :**


1. K. L. Kumar, *Engineering Fluid Mechanics*.
2. Irwing Shames, *Fluid Mechanics*.
3. H. R. Kapoor, *Thermal Engineering*, Vol.1 and II.
4. M. L. Mathur and F. S. Mehta, *Thermal Engineering*, Vol.1 and II.

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-3659 | Internal Combustion Engines | 4 | - | 2 | 4 | 2 | 6 | 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:**
CO 1 Enhancement of analytical skills for study and understanding IC Engines
CO 2 Learning problem solving indomain of IC Engines
CO 3 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems
CO 4 Inculcation of sense of social responsibility towards design & development of efficient
CO 5 Understanding the importance of sustainable development and evolving approaches for it

## 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. Themochemistry 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 Carburetions: 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 behaviour, 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

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-3607 | Machine Design – I | 4 | - | 4 | 4 | 4 | 8 | 70 | 30 | 40 | 60 | 200 |

**pre-requisites:** MA2604, ME2606, MA2608, PE2609, MA2655, ME2660, ME2661and 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 Enhancement of analytical skills for formulation of problems in m/c design
CO 2 Learning problem solving indomain of machine component design and analysis
CO 3 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems
CO 4 Solution of problems through modeling and simulation using software tools

## COURSE CONTENTS

**Unit 1**

Dynamic loading, fatigue and endurance limits, creep: Stress concentration factors: Effect of abrupt changes in the geometries and changes in stresses suitable applications of data and various graphs for calculation of design stresses, notch sensitivity, different stress conc. values for different materials.

Various types of dynamic loading, S – N curves, fatigue life fatigue strength, Bauschinger effects, low cycle, high cycle fatigue, effect of various factors like- size, surface, stress concentration, temperature, reliability etc. Different criterion for design of parts subjected to fatigue.

**Unit 2**

Gears: Material selection for different types of gears, reviews of kinematic considerations, design of spur, bevel, worm, helical and other types of 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.

Axle and Shafts: Transmission by shafts through the rigid and flexible couplings, comparison of torque carrying capacity, stress distribution and angle of twist, design of overhung crank.

**Unit 4**

Design of journal bearings: Specifying bearing modulus, minimum oil film thickness, flow of oil and bearing dimensions, types of antifriction bearings, life and load criteria of bearings, different applications and selection procedure of bearings.

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

**Unit 5**

Clutches: Standard specifications of different types of clutches, design of different parts of clutches and as assembly, friction material's selection, collection and comparison of performance data for suitable designs.

Brakes: Design of different types of brakes-band, block, disc and combinations, etc, selection of friction materials for brakes

**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-3656 | Fluid Machinery | 4 | - | 2 | 4 | 2 | 6 | 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:**
CO 1 Enhancement of analytical skillsfor understanding fluid machinery systems
CO 2 Learning problem solving indomainof fluid mechanics & prime movers
CO 3 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

## COURSE CONTENTS

**Unit I**

F**low in Open Channels**: notches and weirs, introduction, classification and comparison of notches, classification of flow in channels, most economical section of channel, specific energy and specific energy curve, hydraulic jump, gradually varied flow

**Unit II**

**Theory of Fluid Machinery** : Classifications velocity triangles, Euler's Equation for work done, efficiencies.

**Hydraulic Turbines** : Pelton, Francis, Propeller, Kaplan, Bulb Turbine, their constructional details, characteristics of turbines, unit quantities, specific speed, governing of turbines.

**Unit III**

**Pumps, Compressor and Blowers** : positive displacement pumps, Rotodynamics pumps, rotary compressors and blowers, their constructional details, characteristics and efficiencies, NPSH, Specific Speed, Multistaging.

**Unit IV**

**Water Hammer, Surge Tank and Cavitation**: Phenomenon of water hammer, fundamental equation, arithmetic integration, type of surge tank , types of cavitation, cavitation effects, Thoma cavitation factor, apparatus for cavitation tests, effects of cavitation in pumps and turbine, prevention of cavitation..

**Unit V**

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

**Text Books:**

3. Yahya, S.M., Turbines, Compressor & Fans, Tata McGraw Hill, 2005
4. Jagdish Lal, Hydraulic Machine, Metropolitan book co. 1963
5. Kumar, D.S., Fluid mechanics and Hydraulic Machines, S K Kataria & Sons Publication, 1998

**Reference Books:**

3. GovindaRao, N.S., Fluid Flow Machines, Tata McGraw Hill, 1983

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-4658 | Mechatronics | 4 | - | 2 | 4 | 2 | 6 | 70 | 30 | 40 | 60 | 200 |

**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. **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 analytical skills for modeling & simulation of automated systems
CO 2 Learning problem solving indomain of automation
CO 3 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems
CO 4 Solution of problems through modeling and simulation using software tools

## COURSE CONTENTS

**Unit I**

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

**Unit II**

**Controllers:** Basic control actions. Proportional, integral and derivative control. Op Amp based PID controller, PID control using MATLAB. Combinatorial and sequential logic. Simple logic networks. Introduction of micro-controllers, Pneumatic controllers.

**Unit III**

**Electro-MechanicalActuators:** Electro-mechanical actuators, solenoids and relays, types of electric motors and their characteristics, electrical drives and control of electric motors

**Unit IV**

**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 V**

**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. Motion control using LabVIEW.

**Text Books:**

1. Beckwith and Buck, Mechanical Measurement, 1982
2. K. Ogata, Modern Control Theory, PHI, 2004
3. Nakra & Choudhary, Instrumentation, Measurement and Analysis, TMH, 2004

**References Books:**

1. Alciatore and Histand, Introduction to Mechatronics & Measurement Systems, TMH, 2011
2. Bolton, Mechatronics, Pearson Education India, 2004
3. Jovitha Jerome, Virtual Instrumentation, PHI, 2010

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 4661 | Vibration & Noise Control | 4 | - | 2 | 4 | 2 | 6 | 70 | 30 | 40 | 60 | 200 |

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

**Course Outcomes:**

CO 1 Learning of engineering skills for understanding Vibration& Noise Control
CO 2 Enhancement of analytical skills for formulation & solution of Vibration & Noise Control problem
CO 3 Learning problem solving in domain of Vibration & Noise Control
CO 4 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems
CO 5 Solution of problems through modeling and simulation using software tools
CO 6 Inculcation of sense of social responsibility
CO 7 Understanding the importance of sustainable development and evolving approaches for it

## 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.

Electrical Analogies : Electric circuit principles, equivalent circuits.

**UNIT II**

Forced vibrations of systems with and without damping (viscous and coulomb), Method of complex algebra, equivalent viscous damping, impressed force due to unbalance, inadmissibility, support motion, Vibration isolation, commercial isolators.

**UNIT III**

System with two-degree of freedom : Normal mode vibrations, Torsional systems, Coupled vibrations, General solution in terms of normal mode, vehicle suspension, Undamped dynamic vibration absorber, Centrifugal absorber, friction damper.

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 Rayleigh Method) for simply supported and fixed ends.

**UNIT IV**

Noise Control : Noise and its causes, sound pressure / intensity / power level and their inter-relation, Decibel scale, Loudness and equal loudness contours, Effect of machine / process noise on operators, employees and local residents. Standards of noise level and exposure limits. Methods of industrial noise control.

**UNIT V**

Vibration & Noise Measurement : Principle of frequency, amplitude, velocity and acceleration measuring instruments, frequency response plots, phase shift plots, analysis of vibration records.

Sound spectra and octave band analysis. Background noise, Weighted networks, Measurement of noise

**Text Books:**

1. Grover, Mechanical Vibrations, Nem Chand & Brothers, 2003
2. Ambekar A.G., Mechanical Vibrations & Noise Engineering, Prentice Hall of India, 2006

**References Books:**

1. TseMorse & Hinkle, Mechanical Vibrations, CBS Publication, 2002
2. Thomson, Theory of Mechanical Vibration, 5th Ed., Prentice Hall, 1998

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME-4657 | Power Plant & Energy Management | 4 | - | - | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 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:**

CO 1 Enhancement of fundamental knowledge of power plant&energy management

CO 2 Learning problem solving in domain of power plant

CO 3 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

CO 4 Inculcation of sense of social responsibility

CO 5 Understanding the importance of sustainable development and evolving approaches for it

## COURSE CONTENTS

**UNIT I**

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.

**UNIT II**

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.

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 III**

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

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

**UNIT IV**

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.

Introduction to Stationary Gas Turbine Power Plant and their components, combined cycles and co-generation plants.

**UNIT V**

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.

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 Books:**


1. Domkundwar & Arora, *A Course in Power Plant Engineering*, Dhanpat Rai and Sons,2005
2. Rajput R.K., *A textbook of Power Plant Engineering*, Laxmi Publications, 2005
3. Nag P.K., *Power Plant Engineering*, Tata McGraw-Hill Education, 2002


**References Books:**


1. Black & Veatch,*Power Plant Engineering*, Springer, 1996
2. Angrist, S.W., *Direct Energy Conversion*, Allyn and Bacon, 1976
3. Skrotzki and Vopat, *Power stations engineering and economy*, Tata McGraw-Hill Education, 1960

## ELECTIVES – II

| CODE | SUBJECT NAME | L | T | P | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Th. | CW | SW | Pr. | Total |
| ME 46** | Solar Energy and Its Utilisation | 4 | - | - | 100 | 25 | - | - | 125 |

**Prerequisite:** ME3606, ME3608, ME3659, ME4660

**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 Outcome:**
At the end of this course the student is expected to:

1. Measure and/or estimate solar radiation on a surface.
2. In-depth knowledge of utilizing solar energy using flat plate collectors and calculate collector efficiency.
3. Understand the method of concentrating solar energy for higher power output.
4. Familiar with the methods of storing solar energy for off sunshine hour applications.
5. Basics of photovoltaic solar cells, manufacturing and testing.

### COURSE CONTENTS

**Unit I**

**Introduction:** Energy alternatives, New energy technologies, Solar thermal process Solar Radiation, Solar constant, extra-terrestrial radiation, clear sky irradiation, solar radiation measurement, estimation of average solar radiation, solar radiation on tilted surface.

**Unit II**

**Flat Plate Collectors**: Liquid and air type, Energy balances equation and collectors efficiency, collector performance, collector improvements, effect of incident angle, dust and shading, thermal analysis of flat plate collector and useful heat gained by the fluid, collector design, heat transfer factors.

**Unit III**

**Concentration Collectors and Reflectors**: Parabolic concentrators, non-imaging concentrators, other forms of concentrating collectors. Tracking, receiver shape and orientation, performance analysis, reflectors, reflectors orientation, performance analysis.

**Unit IV**

**Solar Energy Storage:** Stratified storage, well mixed storage, comparison, Hot water system, practical consideration, solar ponds, principle of operation and description of Non-convective solar pond, extraction of thermal energy application of solar ponds.

**Unit V**

**Applications of Solar Energy:** The Photovoltaic effect; Spectral response; p-n junction; different types of photovoltaic cells; PV cell characteristics; Photovoltaic modules. Solar furnace, Solar Chimney, heaters, power generation system. Tower concept, solar refrigeration system, thermo electric refrigeration system.

**Text Books:**


1. John.A. Duffie and Willam A.Beckman., 'Solar Engineering of Thermal Processes', Wiley, 2006.
2. Suhatme, S.P., 'Solar Energy Principle of Thermal Collection and Storage', Tata McGraw Hill, 1996.
3. TiwariG. N., Solar Energy: Fundamentals, Design, Modelling and Applications, CRC Press.


**References Books:**


1. Kriender, J.M., 'Principles of Solar Engineering', McGraw Hill, 1999.
2. Bansal, N.K., 'Renewable Energy Source and Conversion Technology', Tata McGraw Hill, 1989.
3. Peter J. Lunde., 'Solar Thermal Engineering', John Willey and Sons, New York, 1985.

## ELECTIVES – II

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 4678 | Finite Element Methods | 4 | 0 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites: ME 2601, ME 2606, ME 2662, ME 3601, ME 3606, ME 4661,**

**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 this course the student should be able to:

1. have learning to make mathematical models of physical problems.
2. have knowledge of having approximate solution of mathematical models.
3. formulate and solve one dimensional problems of statics e.g. bar and beam etc by finite element method.
4. formulate and solve two dimensional problems e.g. plane stress and plane strain problems by finite element method.
5. formulate and solve problems of dynamics of structures and machines by finite element method.
6. formulate and solve problems of fluid mechanics and heat transfer by finite element method

### COURSE CONTENTS

**UNIT I**

**INTRODUCTION** : Solution to engineering problems – mathematical modeling – discrete and continuum modeling – need for numerical methods of solution – relevance and scope of finite element methods – engineering applications of FEA.

**FINITE ELEMENT FORMULATION OF BOUNDARY VALUE PROBLEMS :** Weighted residual methods –general weighted residual statement – weak formulation of the weighted residual statement – comparisons – piecewise continuous trial functions example of a bar finite element –functional and differential forms – principle of stationary total potential – Rayleigh Ritz method – piecewise continuous trial functions – finite element method – application to bar element

**UNIT II**

**ONE DIMENSIONAL FINITE ELEMENT ANALYSIS :** General form of total potential for 1-D applications – generic form of finite element equations – linear bar element – quadratic element –nodal approximation – development of shape functions – element matrices and vectors – example problems – extension to plane truss– development of element equations – assembly – element connectivity – global equations – solution methods –beam element – nodal approximation – shape functions – element matrices and vectors – assembly – solution – example problems

**UNIT III**

**TWO DIMENSIONAL FINITE ELEMENT ANALYSIS :** Introduction – approximation of geometry and field variable – 3 noded triangular elements – four noded rectangular elements – higher order elements – generalized coordinates approach to nodal approximations – difficulties – natural coordinates and coordinate transformations – triangular and quadrilateral elements – iso-parametric elements – structural mechanics applications in 2-dimensions – elasticity equations – stress strain relations – plane problems of elasticity – element equations – assembly – need for quadrature formule – transformations to natural coordinates – Gaussian quadrature – example problems in plane stress, plane strain and axisymmetric applications.

**UNIT IV**

**DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD:** Introduction – vibrational problems – equations of motion based on weak form – longitudinal vibration of bars – transverse vibration of beams – consistent mass matrices – element equations –solution of eigenvalue problems – vector iteration methods –

normal modes – transient vibrations – modeling of damping – mode superposition technique – direct integration methods.

**UNIT V**

**APPLICATIONS IN HEAT TRANSFER & FLUID MECHANICS :** One dimensional heat transfer element – application to one-dimensional heat transfer problems- scalar variable problems in 2-Dimensions – Applications to heat transfer in 2- Dimension – Application to problems in fluid mechanics in 2-D.

**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.
2. David V. Hutton,, 'Fundamentals of Finite Element Analysis', Tata McGraw-Hill Edition, 2005.
3. Cook,Robert.D., Plesha,Michael.E & Witt,Robert.J., "Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 2004.

## ELECTIVES – II

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 46** | BIO MECHANICS | 4 | 0 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:**

**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 this course the student is expected to:

1. Clarity of thought and expression in the field of biomechanics.
2. Know how biomechanics is applicable to biomechanics of human system.
3. Learn the biomechanical system for human devil development.
4. Understand the application of forces, torque etc. to human.

### COURSE CONTENTS

**UNIT I**

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 locomotion-gait analysis-foot pressure measurement-Pedobarograph-force platform-Mechanics of foot-Mechanics of plantar ulcer arthritis-biomechanical treatment.

**UNIT III**

Artificial heart valves-biological mechanical valves development-hetrograft, 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 types respiratory sound measurement.

**Text Books:**

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

**Reference Books:**

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

## ELECTIVES – II

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 46** | Computational Fluid Dynamics | 4 | 0 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:** ME2601, ME3656

**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:**

1. At the end of this course the student is expected to:
2. Have an in-depth introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems.
3. Understand the interaction of physical processes and numerical techniques. Contemporary methods for boundary layers, incompressible viscous flows, and inviscid compressible flows.
4. Be able to use 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 – General Methods 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-€) models – High and low Reynolds number models.

**Text Books** :


1. T.J. Chung, Computational Fluid Dynamics, CambridgeUniversity Press, 2002.
2. Versteeg, H. K., & Malalasekera, W., An Introduction to Computational Fluid Dynamics, The finite volume Method, Longman, 1998.
3. Ghoshdastidar , P. S., Computer Simulation of Flow and Heat Transfer, Tata McGraw Hill Publishing Company 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, Narosa Publishing 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.

**Electives –III**

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 4624 | Gas Dynamics and Fluid Flow | 4 | 0 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:** ME3606, ME3608 and ME3656

**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 this course the student is expected to have:

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

**COURSE CONTENTS**

**UNIT I**

Gas Dynamics: Adiabatic and isentropic flow, Mach Number, subsonic and super sonic flow, stagnation properties. Flow through nozzles and diffusers.

**UNIT IU**

Normal shock waves, governing equation of Rankine-Hugoniot Relation, Prandtl Equation, Shock Strength, Propagation Shock Wave, Converging and Diverging Nozzles with normal Shock Waves.

**UNIT III**

Flow through a constant area duct with friction under design and off design conditions. Flow through a constant area duct with heat transfer under design and off design conditions. Introductory idea of oblique shocks and expansion waves.

**UNIT IV**

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 layer and its prevention, Kutta – Joukawsky Law, Prandtl Boundary layer Equation. Von - Karman Integral Momentum Equation.

**UNIT V**

Lubrication Mechanics: Hydro – dynamics lubrication of journal bearing, Film Pressure around the Journal, Load Carrying Capacity of Films, and its minimum thickness, Friction Torque in a Journal Bearing, Selection of lubrications.

**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.


**References Books**


1 Schlichting H. and Gersten K., Boundary layer Theory. McGraw-Hill.
2 Liepman H. W. and Roshko A., Elements of gas dynamics, Dover Publications.
3 Zucrow M.J. and Holfman J. D., Gas dynamics, John Wiley and Sons, New York

**Electives –III**

| CODE | SUBJECT NAME | L | T | P | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Th. | CW | SW | Pr. | Total |
| **ME 46**** | **Design of Thermal Systems** | **4** | **-** | **-** | **100** | **25** | **-** | **-** | **125** |

**Prerequisite:** ME3606, ME3608

**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 Outcome:**
At the end of this course the student is expected to:

1. Be familiar with 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. Understand the fouling phenomenon, prevention and mitigation.
5. Use of software for designing a heat exchanger.

**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 of air 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 and inspection.

**UNIT V**

**Heat Pipe:** Basics & its mathematical model, micro Heat Exchangers, Use of Software in heat exchanger 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 Education Pvt. Ltd.
3. Kays, Compact Heat Exchangers, McGraw Hill Education Pvt. Ltd.
4. Shah and Sekulic, Fundamentals of Heat Exchanger Design, John Wiley & Sons.

**Electives –III**

| CODE | SUBJECT NAME | L | T | P | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Th. | CW | SW | Pr. | Total |
| ME 46** | Renewable Energy Sources | 4 | - | - | 100 | 25 | - | - | 125 |

**Prerequisite:** ME3606, ME3608, ME3659, ME4660

**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 Outcome:**
At the end of this course the student is expected to:

1. Be familiar with potential impacts of harnessing energy sources.
2. Measure solar radiation and understand methods of utilizing solar energy.
3. Have adequate knowledge of wind turbines and its subsystems.
4. Have in-depth knowledge of biomass and bio-energy.
5. Understand 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, $CO_2$ 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 thermal energy conversion plants,
(b) **GeothermalEnergy:** Introduction to geothermal power, principle of working of geothermal power plants.
(c) **Hydel Energy:** Small, mini and Micro hydro system, concepts, types of turbine, hydrological analysis.

**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. TiwariG. N., Solar Energy: Fundamentals, Design, Modelling and Applications, CRC Press.
4. JainPramod, Wind Energy Engineering, McGraw Hill Professional.
5. Lee & Shah, Biofuels and Bioenergy: Processes and Technologies, CRC Press.

**Electives –III**

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 46** | ROBOTICS | 4 | 0 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:**

**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 this course the student is expected to:

**COURSE CONTENTS**

**UNIT I**

**FUNDAMENTALS OF ROBOT :** Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types andclassification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, PayLoad – Robot Parts and Functions – Need for Robots – Different Applications

**UNIT II**

**ROBOT DRIVE SYSTEMS AND END EFFECTORS :** Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C.Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications andComparison of Drives End Effectors – Grippers – Mechanical Grippers, Pneumatic andHydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and ThreeFingered Grippers; Internal Grippers and External Grippers; Selection and DesignConsiderations.

**UNIT III**

**SENSORS AND MACHINE VISION :** Requirements of a sensor, Principles and Applications of the following types of sensors– Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured,Lighting Approach, Time of Flight Range Finders, Laser Range Meters), ProximitySensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors),Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors,Slip Sensors. Camera, Frame Grabber, Sensing and Digitizing Image Data – SignalConversion, Image Storage, Lighting Techniques. Image Processing and Analysis –Data Reduction: Edge detection, Feature Extraction and Object Recognition -Algorithms. Applications – Inspection, Identification, Visual Serving and Navigation.

**UNIT IV**

**ROBOT KINEMATICS AND ROBOT PROGRAMMING :** Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics andReverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems.Teach Pendant Programming, Lead through programming, Robot programmingLanguages – VAL Programming – Motion Commands, Sensor Commands, End effectercommands, and Simple programs

**UNIT V**

**IMPLEMENTATION AND ROBOT ECONOMICS :** RGV, AGV; Implementation of Robots in Industries – Various Steps; SafetyConsiderations for Robot Operations; Economic Analysis of Robots – Pay back Method,EUAC Method, Rate of Return Method.

**Text book:**

1. M.P.Groover, "Industrial Robotics – Technology, Programming and Applications",McGraw-Hill, 2001.

**Reference books :**


1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., “Robotics Control, Sensing, Vision andIntelligence”, McGraw-Hill Book Co., 1987
2. Yoram Koren, “Robotics for Engineers”, McGraw-Hill Book Co., 1992
3. Janakiraman.P.A., “Robotics and Image Processing”, Tata McGraw-Hill, 1995

**Electives –III**

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 4677 | COMPOSITE MATERIAL | 4 | 0 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:** ME2608, ME2606, ME3607, ME4607

**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 this course the student is expected to:

1. know general Introduction, concept, historical development of composite materials.
2. understand importance of composite material & its engineering potential as compared to metals with their advantages & limitations along with basic definitions and classification of composites.
3. know basic constituents involved in composites with theirtypes, role and selection and their influence on mechanical properties.
4. understand mechanics of composites and to calculate isotropic elasticity & plane stress concept in 3-D.
5. understand stress-strain characteristics of FRP composites and also stress and strain components in 3-D with Generalized Hooke's Law in 3-D.
6. know anisotropic/orthotropic elasticity, stress-strain relations for isotropic and orthotropic cases.
7. understand mechanics of plates involving **c**oncept of laminates, laminate strain-Displacement relationship based on Kirchhoff's hypothesis.
8. calculate problems on mechanical behavior of unidirectional, cross-ply and angle lamina. structural mechanics of laminates. laminates stiffness.
9. understand strength and failure concept in composites and do the calculations for strength of laminates, failure mechanics of composites.
10. know various theories for composite structures based on structure and failure modes.
11. know about composite codes & standards and testing.
12. know manufacturing processes used for development of composites.

**COURSE CONTENTS**

**UNIT I**

**Introduction to Composites**: General Introduction and Concept, Historical development, Concept of Composite materials, importance of composite material & its engineering potential, Comparison with Metals, Advantages & limitations of Composites. Basic Definitions and Classification of Composites. Various types of composites, Basic constituents materials in Composites: Types of Reinforcements/Fibers, Role and Selection or reinforcement materials, Mechanical properties of fibres, Functions of a Matrix, Desired Properties of a Matrix, Types of matrix materials.

**UNIT II**

**Mechanics of composites**: Isotropic Elasticity & Plane stress concept in 3-D, Linear Elastic Stress-Strain Characteristics of FRP Composites, Stress and Strain components in 3-D, Generalized Hooke's Law in 3-D, Stress-Strain relations in 3-D for Isotropic case. Anisotropic/Orthotropic Elasticity, Stress-Strain relations for isotropic and orthotropic cases.

**UNIT III**

**Mechanics of Plates/Kirchhoff's Plate theory:** Concept of laminates, laminate strain-Displacement relationship based on Kirchhoff's Hypothesis, Mechanical behavior of unidirectional, cross-ply and angle lamina. Structural mechanics of laminates. Laminates stiffness and ABD-Matrices, special classification of laminates, symmetric, anti-symmetric and non-symmetric laminates.

**UNIT IV**

**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.

**UNIT V**

**Manufacturing Processes of composites**: Processing of Composite Materials, Overall considerations, Autoclave curing, Other Manufacturing Processes, Fiber-only performs, Combined Fiber-Matrix performs. Testing of Composites.

**Text Books:**

1. Fiber Reinforced composites, P K Mallick, CRC Press
2. Mechanics of composite materials, Auter Jaw

**Reference Books:**

1. Mechanics of composite materials, R. Jones, Taylor & Francis

**Electives –III**

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 46** | Computational Mechanics | 4 | 0 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:**

**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 this course the student is expected to:

1. Have an in-depth introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems.
2. Understand the interaction of physical processes and numerical techniques. Contemporary methods for boundary layers, incompressible viscous flows, and inviscid compressible flows.
3. Be able to use Finite differences and finite volume techniques.

**COURSE CONTENTS**

**UNIT I**

Numerical methods in kinematics, evaluation of constraints equation and Jacobean, assembly of system, linear equation solution and matrix factorization, Gaussian method and L-U factorization, detect ion and elimination of redundant constraints.

**UNIT II**

Numerical methods in dynamics, solution of mixed differential-algebraic equations, dynamics analysis of slider crank mechanism, four bar mechanism, quick return mechanics.

**UNIT III**

Introduction: Conservation equations, mass, momentum and energy equations, convective forms of the equations and general description. Clarification into various types of equations, parabolic, elliptic, boundary and initial conditions, overview of numerical methods.

**UNIT IV**

Finite difference methods: different means of formulating finite difference equations, Taylor series expansion, integration over element, local function method, finite volume methods, central, upwind and hybrid formulation and comparison for convective-diffusion problem, treatment of boundary conditions, boundary layer treatment, variable property, interface and free surface treatment, accuracy of finite difference method.

**UNIT V**

Solution of finite difference equations: iterative methods, matrix inversion methods, ADI methods, operator splitting, Fast Fourier transform, applications.

**Books & References Recommended :**


1. Edward J Haug, Computer Aided Kinematics and Dynamics of Mechanical Systems: Basic methods, 1989.
2. Anderson D.A., Computational Fluid Mechnaics, Hemisphere, N.Y.
3. Roache P.I., Computational Fluid Dynamics, Hermosan, New Mexico
4. Patankar S.V., Numerical Heat Transfer and Fluid Flow, Hemisphere, WashingtonD.C.
5. Zienkiewicz O.C., The finite element method in Engineering Science, Mc Graw Hill

**Electives –III**

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 46** | Product Development | 4 | 0 | 0 | 4 | 0 | 4 | 70 | 30 | 0 | 0 | 100 |

**Pre-requisites:**

**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 this course the student is expected to:

**COURSE CONTENTS**

**UNIT I**

**Introduction:** Nature and scope of product engineering - creative thinking and organizing for product innovation criteria for product success in life cycle of a product.

**UNIT II**

**Modeling & simulation:** Modeling and simulation - the role of models in product design mathematical modeling similitude relations - weighted property index.

**UNIT III**

**Material Selection:** Material selection - problems of material selection-performance characteristics of materials - the materials selection process-economics of materials-cost versus perforamance relations-weighted property index.

**UNIT IV**

**Design considerations:** Functional and production design-form design-influence of basic design, mechanical loading and material on form design - form design of gray castings, malleable iron castings, aluminium castings, pressure die castings, plastic mouldings, welded fabrications, forging and manufacture by machining methods. Influence of space, size, weight, etc., on form design, aesthetic and ergonomic considerations.

**UNIT V**

**Tolerance and Analysis:** Dimensioning and tolerancing a product-functional production and inspection datum-tolerance analysis.

**Text and References Books:**

1. Jones J.C., "Design Methods", interscience, 1970.
2. Buhl, H.R., "Creative Engineering Design", Iowa State University Press, 1960.
3. Dieter, G.E., "Engineering Design", McGraw Hill, 1983.
4. Robert Matouseek, "Engineering Design", Blackie & Sons Ltd., 1963.
5. Niebel, B.W. & Draper, A.B., "Product Design and Process Engineering, McGraw Hill, 1974.
6. Harry Peck, "Designing for Manufacturing", Sir Issac Pitman and Sons Ltd., 1973.
7. Gladman, C.A., "Manual for Geometric Analysis of Engineering Designs", Austrlian Trade Publications Ltd.
8. Wade, Or., "Tolerance Control in Design and Manufacture", Industrial Press, Inc.

| CODE | SUBJECT NAME | L | T | P | Credits | | | Maximum Marks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T | P | Total | Th. | CW | SW | Pr. | Total |
| ME 3752 | MECHANICAL MEASUREMENTS | 4 | 0 | 2 | 4 | 2 | 6 | 70 | 30 | 60 | 40 | 200 |

**Theory :**

**1.** Theory of Measurement : Static and dynamic characteristic of instruments. Standards and calibration. Systematic and random errors. Error analysis. Reduction of errors. Null balance, ratio metric and averaging techniques.

**2.** Metrology : Design principles of measurement instruments, Principles of Mechanical measuring instruments, Electrical measuring instruments, Optical measuring instruments and pneumatic instruments Linear and angular measurements. Measurement of flatness, Straightness, and roundness, Sine bars and slip gauges, Angle gauges and autocollimators.

**3.** Mechanical Measurement : Measurement of displacement, Velocity, Acceleration, Force, Torque, Strain, Shock, Vibration and Sound.

**4.** Hydraulic and Pneumatic control valves and actuators. Measurement and control of Pressure, Flow Level, Temperature and Humidity.

**5.** Mechanical Elements : Energy storing elements, suspension systems and dampers, pivots, bearings, gears locks and stops, coupling and clutches, levers and linkages.

**Books & References Recommended :**


1. Hume, K. J., *Engineering Metrology*, Kalyan Pub.
2. Nakra & Choudhary, *Instrumentation, Measurements and Analysis*, TMH.
3. Raman, R., *Elements of Precision Engineering*, Oxford IBH.
4. *Buck and Beckwith, Mechanical Measurements.*