**B.E. (Mechanical Engineering)**

**SEMESTER-VI**

| S. No. | Code No. | Subject | Scheme of Instruction | | | | Scheme of Examination | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Duration in Hrs | CIE | SEE | |
| **Theory Courses** | | | | | | | | | |
| 1 | 6PC611ME | Dynamics of Machines | 3 | 1 | - | 4 | 40 | 60 | 4 |
| 2 | 6PC612ME | Heat Transfer | 3 | - | - | 3 | 40 | 60 | 3 |
| 3 | 6PC613ME | Design of Machine Elements- II | 3 | 1 | - | 4 | 40 | 60 | 4 |
| 4 | OE | Open Elective II** | 3 | - | - | 3 | 40 | 60 | 3 |
| 5 | PE | Professional Elective II / MOOC's | 3 | - | - | 3 | 40 | 60 | 3 |
| 6 | PE | Professional Elective III / MOOC's | 3 | - | - | 3 | 40 | 60 | 3 |
| 7 | 6MC603HS | Indian Constitution | 2 | - | - | 2 | 40 | 60 | - |
| **Practical / Laboratory** | | | | | | | | | |
| 8 | 6HS653HS | Soft Skills Lab | - | - | 2 | 2 | 40 | 60 | 1 |
| 9 | 6PC658ME | Theory of Machines Lab | - | - | 2 | 2 | 40 | 60 | 1 |
| 10 | 6PC659ME | Heat Transfer Lab | - | - | 2 | 2 | 40 | 60 | 1 |
| **Total** | | | **20** | **2** | **6** | **28** | **400** | **600** | **23** |

**O.E.II→1.** 6OE602ME 3D Printing Technologies

** Subject is not offered to the students of Mech. Engg. Department

**P.E.II →**

1. 6PE605ME Power Plant Engineering (MOOC's-2C)
2. 6PE606ME Industrial Tribology
3. 6PE607ME Introduction to Composites (MOOC's-3C)
4. 6PE608ME Entrepreneurship (MOOC's-3C)

**P.E.III →**

1. 6PE609ME Turbo Machinery
2. 6PE610ME Introduction to Mechanical Vibrations (MOOC's-2C)
3. 6PE611ME Fundamentals of Additive Manufacturing Technologies (MOOC's-3C)
4. 6PE612ME Industrial Engineering.

*Note :* Students have to undergo summer internship of 4 weeks at the end of semester VI and credits will be awarded after evaluation in VII semester.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PC611ME | DYNAMICS OF MACHINES | | | | | | Core |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| Engineering Mechanics, Strength of Materials& Kinematics of Machinery. | 3 | 1 | - | - | 40 | 60 | 4 |

## COURSE OBJECTIVES:

1. To understand the forces, torques and energy involved in different machine members.
2. To understand theory involved in the analysis of clutches, brakes, dynamometers and flywheels.
3. Aware of situations like speed fluctuations, rotor imbalance and machine vibration which appears in industry.
4. To understand the modes of vibrations, two degree of Freedom and Torsional Vibrations.
5. To determine natural frequencies of undamped, damped and forced vibrating systems of single degree freedom systems.

## COURSE OUTCOMES:

**After the completion of course the students will be able to:**

1. Recall the gyroscopic effects in ships, aero planes and road vehicles, function of governors, flywheels and basic concepts on vibrations, brakes, rotating and reciprocating machinery.
2. Demonstrate the ability to apply the fundamentals of gyroscopic couple, Governors, Brakes, Balancing of rotating, reciprocating masses and Vibrations.
3. Analyze gyroscopic couple, Height of Governor, Angular velocity of Flywheels, Balancing of forces in Reciprocating machinery, Rotating machinery, fundamental frequencies of free, forced and Torsional Vibrations.
4. Evaluate gyroscopic couple, Height of Governor, Angular velocity of Flywheels, Balancing of forces in Reciprocating machinery, Rotating machinery, Fundamental frequencies of free, forced and Torsional Vibrations.
5. Formulate Gyroscopic couple, Height of Governor, Angular velocity of Flywheels, Balancing of forces in Reciprocating machinery Rotating machinery, fundamental frequencies of free, forced and Torsional Vibrations

**UNIT-I:**

**Force analysis:** Dynamic force analysis of single slider crank mechanism and four bar mechanism concept of dynamically equivalent link. Static force analysis of single slider crank mechanism and four bar mechanism.

**Gyroscope:** Principle of gyroscope, rolls, yaw and pitch motions, gyroscopic effect in a two- wheeler, car, ship and aeroplane, practical problems.

**UNIT - II :**

**Governors:** Necessity of governor, different types of governors, working principle of centrifugal governors, characteristics of Watt governor, Porter governor, Proell governor, Hartnell governor & Hartung governor. Hunting of governors, concept of control force, control force diagram, definition of stability of governor, condition for stability, concept of isochronisms, sensitivity of governor, energy of governor.

Brakes: Simple block brakes, internal expanding brake, band brake of vehicle, Dynamic force analysis on braking system.

**UNIT - III :**

**Flywheels & Turning moment diagrams:** Working principle of flywheel, turning moment on the crank shaft, turning moment diagrams, maximum fluctuation of energy and its determination, coefficient of fluctuation of speed, design of flywheels, rim type flywheel versus solid type flywheel. Flywheel analysis for I.C. Engines and shearing/punching/riveting machines.

**UNIT – IV :**

**Balancing of Rotating masses:** Balancing and its types, rotor balancing, single plane and two plane balancing, unbalanced forces and couples, static and dynamic balancing, balancing of rotors by analytical and graphical methods.

Balancing of reciprocating machines: Primary and secondary unbalanced forces, balancing of in line and radial engines.

**UNIT – V :**

**Vibrations:** Free Vibrations of mass attached to vertical spring – Transverse loads – vibrations of beams with concentrated and distributed loads. Dunkerly's method – Raleigh's method. Whirling of shafts – critical speed – torsional vibrations – one, two and three rotor systems.

**TEXT BOOKS:**

1. S.S. Rattan, "Theory of Machines", Fourth edition, Tata-Mc Graw Hill.

**REFERENCE BOOKS:**

1. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, "Theory of Machines & Mechanisms", Oxford University press.
2. William T.Thomson , "Theory of Vibration with Application", 5th edition, Pearson education.
3. Ghosh and Mallick, "Theory of mechanisms and machines", Affiliated to E-W Press.
4. J.S. Rao and Gupta, "Theory and Practice of Mechanical Vibrations", PHI.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PC612ME | HEAT TRANSFER | | | | | | Core |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| TD | - | 3 | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES :**

1. To understand the basic concepts of heat transfer.
2. To study the concepts of conduction, convection and radiation.
3. To study and solve problems on different modes of heat transfer.
4. To study the basic concepts of Boiling and condensation.
5. To understand the basic concepts of Heat Exchangers and applications.

**COURSE OUTCOMES :**

After the completion of course the students will be able to:

1. Understand the basic modes of heat transfer.
2. Compute temperature distribution in steady-state and unsteady-state heat conduction.
3. Interpret forced and free convection heat transfer.
4. Understand the principles of boiling, condensation and radiation heat transfer.
5. Design of heat exchangers using LMTD and NTU methods.

**UNIT - I**

**Conduction:** Modes of Heat Transfer, Laws of Heat Transfer - Fourier, Newton, Stefan- Boltzmann General conduction equation in Cartesian, cylindrical and spherical coordinates, One dimensional steady state conduction through slabs, hollow cylinders and spheres with and without heat generation, Effects of variable thermal conductivity in heat transfer of one dimensional steady state conduction of plate, cylinders and spheres, Steady state heat transfer through composite slabs, cylinders and spheres, Critical radius of insulation.

**UNIT - II**

**Fins:** Heat transfer analysis of tips with heat dissipation environment - rectangular straight pin fins, Application of fin to temperature measurement, unsteady state conduction, Lumped parameter analysis of a body with negligible internal temperature

gradients, Transient heat transfer analysis of finite slab with specified temperature and convective boundary conditions, Use of Grober and Heisler charts for solving problems of infinite slabs, cylinders and spheres.

**UNIT – III**

**Free and forced convection:** Dimensional analysis and its use in free and forced convection, Buckingham theorem, Physical significance of different dimensionless numbers, Application of Von-Karman integral equation for the analysis of thermal boundary layer in forced convection of flat plate, Reynold's analogy for flow over plane surfaces, calculation of heat transfer for flow over plates, cylinders, spheres and flow through tubes in free and forced convection using empirical formulae.

**UNIT – IV**

**Radiation:** Definition of absorptivity, reflectivity and transmissivity, Concept of black-body and emissivity. Kirchoff's law, Planck's black body spectral distribution, Wien's and Stefan Boltzmann law, Monochromatic and total emissive power, radiant heat exchange between two gray surfaces, Shape factor, Thermal circuit for radiant heat exchange between infinite parallel plates and between concentric cylinders, Enclosures with black and grey surfaces, Radiation shields and re-radiation surfaces.

**UNIT – V**

**Heat Exchangers:** Classification and applications of heat exchangers in industry, Analysis and design of counter flow and parallel flow heat exchanger, Fouling factors, problems on multi pass heat exchanger using non dimensional parameter plots.

**Change of Phase:** Boiling-pool boiling regimes nucleate pool boiling, effect of surface wettability on bubble contact angle, Critical heat flux, boiling in forced convection, Condensation: Film condensation, Drop wise condensation, Condensation film thickness, Heat transfer coefficient in film condensation.

**TEXT BOOKS:**


1. Rajput R.K., "Heat and Mass Transfer", S. Chand & Company Ltd, New Delhi.
2. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", New Age International (P) Ltd Publishers, New Delhi.


**REFERENCE BOOKS:**


1. Holman J.P. , "Heat Transfer", McGraw Hill Publication, New Delhi.
2. Yadav R, Sanjay. and Rajay. "Heat and Mass Transfer", Central Publishing House, Allahabad.
3. Arora S.C. and Domkandwar, "A course in Heat and Mass Transfer", Dhanpat Rai & Sons, New Delhi.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PC613ME | DESIGN OF MACHINE ELEMENTS - II | | | | | | Core |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| Strength of Materials & Design of Machine Elements- I | 3 | 1 | - | - | 40 | 60 | 4 |

## COURSE OBJECTIVES:

1. To acquire knowledge how to analyse, design, and choose commonly used machine components using the principles of stress analysis, failure theories and material science.
2. To acquire knowledge about the numerous mechanical components that are available and to utilise mechanical engineering design theory to identify and quantify machine parts in the design of regularly used mechanical systems.
3. To gain knowledge about designing the essential mechanical gears and its design principles.
4. To gain knowledge about design principles of IC engine piston, connecting rod, crank shaft, C- clamp and crane hooks.
5. To acquire knowledge about using the data available in design data books to design the various engine components.

## COURSE OUTCOMES:

**After the completion of course the students will be able to:**

1. State the function of springs, gears, Bearings, IC Engine parts and bending theory of members with initial curvature.
2. Summarize the Materials for springs, Gears, Bearings, IC Engine components and curved beams.
3. Select various types of Springs, Bearing, Gear drives and curved beams for specific application.
4. Analyze the design of Helical coil springs, leaf springs Gear drives, IC Engine components and curved beams for mechanical systems.
5. Design various types Springs, Gear drives, Bearings, IC Engine components and curved beams.

**Note:** Design Data Book is permitted.

**UNIT - I**

**Mechanical Springs:** Introduction, types of springs, Materials used for springs. Helical Springs: Wahl's factor, calculation of stresses, deflection and energy stored in spring. Design for static and fluctuating loads.

**Leaf Springs:** Stresses and deflection, nipping of Leaf springs. Design for static loads.

**UNIT - II**

**Bearings:** Introduction, classification of bearings, materials used for bearings, properties and types of lubricants. Design of Sliding Contact Bearings: Hydrodynamic bearings.

**Selection of Rolling Contact Bearings:** Types of rolling elements and their constructional details, Static and dynamic load carrying capacity, Load-life relationship, selection of bearing for cyclic loads and speeds.

**UNIT - III**

**Gears:** - Force Analysis, Spur, Helical Gears, Bevel and Worm Gears, Selection of Gears– Design of gears using AGMA procedure involving Lewis and Buckingham equations. Check for wear. Types of gear tooth failure and preventive measures

**Design of Belts & Pulleys:** Transmission of power by Belt and Rope Drives, Transmission efficiencies, Belts – Flat and V types – Ropes – pulleys for belt and rope.

**UNIT - IV**

**I.C. Engine Parts:** Introduction, Materials used, Design of piston, connecting rod and overhang crank shaft.

**UNIT-V**

**Design of Curved Beams:** Introduction, stresses in curved beams, expression for radius of curvature of neutral axis for rectangular, circular and trapezoidal sections, Design of C-clamp and crane hook.

**Design for manufacturing:** Design considerations for Welding, Forging & Casting. Design process for non metallic parts, Plastics, Rubber, Ceramic, Wood, Glass parts. Material selection in machine design.

**TEXT BOOKS:**


1. Design of Machine Elements / V. Bhandari / Mc Graw Hill.
2. Machine design/RS Khurmi.


**REFERENCE BOOKS:**


1. Machine Design / Jindal / Pearson.
2. Design of Machine Elements / V. M. Faires / Macmillan.
3. Design of Machine Elements-I / Kannaiah, M.H / New Age.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PE605ME | POWER PLANT ENGINEERING | | | | | | Elective |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| ATD | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES:**

1. To understand operation of steam turbine power plant.
2. To understand about gas turbine power plants.
3. To understand hydraulic power plant and various types of nuclear power plants.
4. To understand working knowledge of basic design principles of Solar, wind, geothermal and alternative power plants.
5. To understand the power plant economics, environmental and safety aspects of power plant operation.

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. List out the various components in power plant.
2. Illustrate the working principle of gas turbine power plant.
3. Demonstrate the hydro power plant dams and spillways.
4. Explain the basic principles of thermal-fission and fast-breeder nuclear power plants, such as pressurized- water, boiling-water and heavy-water reactors.
5. Explain economic feasibility and the control methods of major pollutants emitted from fossil-fuel power plants.

**UNIT-I**

**Introduction to Sources of Energy**- Resources and Development of Power in India.

**Steam Power Plant:** Plant layout, working of different circuits, Fuel handling equipment, coal handling and choice of handling equipment, coal storage and ash handling systems.

**UNIT-II**

**Combustion Process:** Types of coal. Properties of coal- overfeed and underfeed fuel beds, travelling grate stokers, spreader stokers, retort stokers, pulverized fuel

burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, Dust collectors, cooling towers and heat rejection, corrosion and feed water treatment.

**UNIT - III**

**Gas Turbine Power Plant:** Introduction -Classification-Layout with Auxiliaries-Principles of working of closed and open cycle gas turbines.

Hydro Electric Power Plant: Water Power, Classification of dams and spill ways, Hydrological cycle, flow measurement- drainage area Characteristics-Hydrographs-storage and pondage.

**UNIT-IV**

**Nuclear Power Plant:** Nuclear fuel-breeding and fertile materials -Nuclear reactor-reactor Operation- Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas-cooled reactor. Radiation hazards and shielding - Radioactive waste disposal.

**UNIT-V**

**Power Plant Economics:** Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Load curves, average load and load factor, delivery factor-related exercises.

Environmental Considerations: Effluents from power plants and impact on environment - Pollutants and Pollution Standards -Methods of pollution control.

**TEXT BOOKS:**


1. Power Plant Engineering, P. K. Nag, McGraw Hill Publications, Fourth edition.
2. Power Plant Engineering, R. K. Rajput, Laxmi Publications, Fourth edition.


**REFERENCE BOOKS:**


1. Power Plant Engineering, RK Hegde, Pearson India publications, First edition.
2. Power Plant Technology, M.M.El-Wakil, McGraw Hill, Indian.
3. Power Plant Engineering, Arora & Domkundwar, Dhanpathi Rai & Sons, Tenth edition.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PE606ME | INDUSTRIAL TRIBOLOGY | | | | | | Elective |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| Applied Mechanics, Material Science | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES:**

1. To understand the application of Tribology in modern machinery for designing, manufacturing and exploration for new and better products.
2. To understand the principles of theories of lubrication, lubricants and their chemistry.
3. To understand the principles of theories of wear and friction.
4. To familiarize various types of bearings for different applications.
5. The most important types of coatings and surface modifications for protection of surfaces.

**COURSE OUTCOMES :**

**After the completion of course the students will be able to:**

1. Understand the fundamentals of Tribology and associated parameters.
2. Apply the concepts of Tribology for the performance analysis and design of components experiencing relative motion and apply the principles of surface engineering for different applications of Tribology.
3. Select proper bearing materials and lubricants for a given tribological application.
4. Analyze the requirements and design hydrodynamic journal and plane slider bearings for a given application.
5. Design hydrodynamic journal and plane slider bearings for wear and Corrosion resistance.

**UNIT - I**

**Introduction to Tribology:** Historical background, practical importance, and subsequent use in the field.

**Lubricants:**Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.

**UNIT - II**

**Friction:** Origin, friction theories, measurement methods, friction of metals and non-metals.

**Wear:** Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.

**UNIT - III**

**Hydrodynamic journal bearings:** Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reinhold's equation in 2D. Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Somerfield's number and its significance; partial bearings, end leakages in journal bearing, numerical examples.

**UNIT - IV**

**Plane slider bearings with fixed/pivoted shoe:** Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a fixed/pivoted shoe bearing, centre of pressure, numerical examples.

**Hydrostatic Lubrication:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. Introduction to Hydrostatic journal bearings.

**UNIT - V**

**Bearing Materials:** Commonly used bearings materials and properties of typical bearing materials. Advantages and disadvantages of bearing materials.

**Introduction to Surface engineering:** Concept and scope of surface engineering.

**Surface modification :** Transformation hardening, surface melting, thermo chemical processes.

**Surface Coating :** Plating, fusion processes, vapour phase processes. Selection of coating for wear and corrosion resistance.

**TEXT BOOKS:**


1. Introduction to Tribology B. Bhushan John Wiley & Sons, Inc., New York.
2. Engineering Tribology Prasanta Sahoo PHI Learning Private Ltd, New Delhi.


**REFERENCE BOOKS:**


1. Engineering Tribology J. A. Williams Oxford Univ. Press.
2. Introduction to Tribology in bearings B. C. Majumdar Wheeler Publishing.
3. Engineering Tribology G. W. Stachowiak and A.W.Batchelor Butterworth-Heinemann.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PE607ME | INTRODUCTION TO COMPOSITES | | | | | | PE-II |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES :**

1. To learn the concept of composite materials
2. To learn the polymer matrix composite.
3. To gain the knowledge of metal matrix composite and laminate composite
4. To understand the manufacturing methods of various composite materials.
5. To interpret the mechanical behaviour of composite materials

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Explain the advantages and applications of various types composite materials.
2. Describe the properties of polymer metal matrix of composite materials.
3. Summarize the metal matrix composite materials and importance.
4. Describe the manufacture of metal matrix and polymer matrix composites.
5. Formulate the mechanical behaviour of composite materials and theories of laminated composite materials.

**UNIT - I**

**COMPOSITE MATERIALS :** Fundamentals of composites – need for composites – classification of composites – Matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – particle reinforced composites, Fibre reinforced composites. Applications of various types of composites.

**UNIT - II**

**POLYMER MATRIX COMPOSITES :** Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – rovings – woven fabrics – non woven random mats – various types of fibres. PMC processes – hand lay up processes – spray up processes – compression moulding.

**UNIT - III**

**METAL MATRIX COMPOSITES :** Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, spray process.

**UNIT - IV**

**LAMINATED COMPOSITES :** Laminates Plate Stiffness and Compliance, Assumptions, Strains, Stress Resultants, Types of Laminates, Symmetric Laminates, Anti symmetric Laminate, Balanced Laminate, Quasi- isotropic Laminates.

**UNIT - V**

**MECHANICAL BEHAVIOR OF COMPOSITES :** Mechanical Properties: Material axes in unidirectional composites, composite density. Thermal properties. predictive models – strength, stiffness and Elastic constants.

**TEXT BOOKS:**


1. Chawla K. K., "Composite materials", Second Edition, Springer – Verlag.
2. M.Balasubramanian, Composite materials processing, 1st edition, CRC press.


**REFERENCE BOOKS:**


1. Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England.
2. Chung, Deborah D.L., "Composite Materials: Science and Applications", Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint.
3. Clyne, T. W. and Withers, P. J., "Introduction to Metal Matrix Composites", Cambridge University Press.
4. Mechanics of Composite Materials, Jones, R. M., Mc-Graw Hill.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PE608ME | ENTREPRENEURSHIP | | | | | | PE-II |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES:**

1. To motivate students to take up entrepreneurship in future
2. To learn nuances of starting an enterprise & project management
3. To understand project formulation and choice technology in enterprise
4. To understand the behavioural aspects of entrepreneurs and time management

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Understand Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques
5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches of time management, their strengths and weakness. The urgency addiction and time management matrix.

**UNIT-1**

**Entrepreneurship:** Definition, functions of entrepreneurship, Characteristics and qualities of entrepreneurs, Entrepreneur vs. intrapreneur, need of innovation, Economic growth. Small Scale Industry in India, Linkage among small, medium and heavy industries.

**UNIT – II**

**Indian Industrial Environment:** Competence, Opportunities and Challenges, Emergence of First generation entrepreneurs, women entrepreneurs. Conception and evaluation of ideas and their sources. Types of enterprises. Collaborative interaction for Technology development. Corporate Social Responsibility

**UNIT – III**

**Project formulation:** Introduction, Elements of Business Plan and its salient features, Analysis of market demand, Financial and profitability analysis and Technical analysis.

**UNIT - IV**

**Project Management:** During construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management.

**UNIT - V**

**Behavioural aspects of entrepreneurs:** Personality - Determinants, Attributes and Models. Leadership concepts and Models. Values and Attitudes.

**Time Management:** Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

**TEXT BOOKS:**


1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing
2. Prasanna Chandra, "Project-Planning, Analysis, Selection, Implementation and Review", House, Tata McGraw-Hill Publishing Company Ltd.


**REFERENCE BOOKS:**


1. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster Publication,
2. Robert D. Hisrich, Michael P. Peters, "Entrepreneurship", Tata Me Graw Hill Publishing Company Ltd.,
3. G.S. Sudha, "Organizational Behaviour".

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PE609ME | TURBO MACHINERY | | | | | | Elective |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| ATD | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES:**

1. Understand isentropic flow for variable areas and relations
2. Understand and apply fanno flow, Rayleigh flow and shock flow.
3. Understand centrifugal and axial flow compressor with velocity triangles
4. Understand and analyze impulse and reaction steam turbines with velocity triangles
5. Understand and analyze gas turbines and rocket propulsion

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Analyze situations of Thermal gradients in Turbo machines and apply the situation of fluid flow analysis with energy conversion principles for work transfer.
2. Develop knowledge about working principles of work absorption and work producing situations
3. Understand applications of Thermodynamics with fluid flow behavior and compressibility effects
4. Attain knowledge of Power production using external combustion engines, with methods of improving efficiencies
5. Establish and compute one dimensional thermodynamic analysis of Compressors, Turbines (both for air & vapour working fluids) and analyzing using velocity triangles for single and multi stages.

**UNIT - I**

**Introduction to compressible flows:** Speed of propagation of pressure waves, Mach number, Acoustic velocity and Mach cone, limits of compressibility, pressure field due to a moving source of disturbance, one dimensional compressible flow. Isentropic flow with variable area, Mach number variation, Area ratio as function of Mach

number, flow through nozzles and diffusers. Flow in constant area ducts with friction- Fanno flow, variation of flow properties, variation of Mach number with duct length, isothermal flow with friction.

**UNIT - II**

**Flow in constant area duct with Heat Transfer,** -The Rayleigh liner, Rayleigh flow relations, variation of flow properties, Maximum heat transfer. Flow with Shock Waves- Development of Normal Shock waves, governing equations, Prandtl -Meyer relation, Rankine-Hugoniot equations, Stagnation pressure ratio across shock.

**UNIT - III**

**Blade nomenclature of an aerofoil, Rotodynamic compressors:** Introduction and general classification, comparison of Reciprocating and Rotary compressors, Positive displacement Rotary compressors, Flow through rotary compressors. Static and total head quantities, Thermodynamic cycles and work done, calculation of various efficiencies. Velocity diagrams and pre-whirl. Euler equation for energy transfer between fluid and rotor, Analysis of Centrifugal compressors and analysis of axial flow compressors, Chocking, Surging and Stalling.

**UNIT - IV**

**Steam Turbines:** Classification, flow over blades, pressure velocity variations, Compounding of steam turbines- pressure compounding, velocity compounding and pressure- velocity compounding, Impulse turbine with several blade rings, Nozzle efficiency, Blade efficiency and Gross stage efficiency of Impulse turbine, Velocity diagrams for Impulse turbine-De Laval Turbine, blade efficiency of Impulse turbine, Optimum blade speed ratio, Maximum work done and blade efficiency of Impulse turbine, Degree of reaction of Reaction turbine, Parson Reaction turbine, Velocity diagram for Parson Reaction turbine, blade efficiency of Parson Reaction turbine, Maximum work done and blade efficiency of Parson Reaction turbine, Height of blades of Reaction turbine, Balancing of End thrust.

**UNIT - V**

**Gas Turbines:** Classification of Gas Turbines - constant pressure and constant volume gas turbines, Joule cycle-configuration diagram and temp-entropy diagram, Thermal efficiency of Joules cycle, Maximum pressure ratio in terms of temperature ratio, optimum pressure ratio for maximum work output with and without considering machine efficiencies, Improvement of gas turbine plant performance- Inter-cooling, Reheating and Regeneration. Simple problems on Joule cycle.

**Air Craft Propulsion:** Air craft engine types, air craft propulsion theory, Turbo jet engines, Ramjet engines, Pulse jet engines, Rocket Propulsion: Types of Propellants, Types of Rocket engines, Rocket propulsion theory-Rocket applications

**TEXT BOOKS:**


1. Yahya S M, Fundamentals of Compressible Flow, New Age International Publishers, Third Edition Mathur ML, & Mehta F S, Thermal Engineering, Jain Brothers, New Delhi.
2. Ganeshan V, Gas Turbines, Tata Me Graw Hills, New Delhi.


**REFERENCE BOOKS:**


1. Dennis G Shepherd, Aerospace Propulsion, Elsevier Publishing Company, New York.
2. Power Plant Technology, M.M.El-Wakil, Mc Graw Hill, Indian
3. CohenH Rogers G F C, Saravana Mutto H I H, Gas Turbine Theory, Longman 5th Edition, New York.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PE610ME | INTRODUCTION TO MECHANICAL VIBRATIONS | | | | | | Elective |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| Kinematics of Machines & Dynamics of Machines | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES:**

1. Explain the concept of vibrations, with single degree of freedom systems.
2. Discuss the numerical methods involved in vibrations.
3. Demonstrate the concept of Transient vibrations.

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Understand the concepts related to vibrations and its motion in one, two and multi degree of freedom systems.
2. Demonstrate the ability to apply the fundamentals of Undamped, damped free & forced vibrations.
3. Analyze the vibration respond from Undamped and damped in free, forced excitation with various excitation and Vibration Measuring instruments for engineering applications
4. Evaluate Free, Forced, Damped, and Undamped, one, two and multi degrees of Freedom.
5. Formulate the solution of engineering problem in mechanical system by considering economy, safety & environment energy conservation.

**UNIT - I**

**Introduction:** Types of vibrations, Definitions, Simple Harmonic Motion (S.H.M.), Work done by harmonic force, Principle of super position applied to SHM, Beats, Fourier theorem and problems.

**Undamped (Single Degree of Freedom) Free Vibrations:** Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs

in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and Problems.

**UNIT - II**

**Damped free vibrations (Single Degree of Freedom):** Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and Problems.

**UNIT - III**

**Forced Vibrations (Single Degree of Freedom):** Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, Energy dissipated due to damping and Problems.

**UNIT - IV**

**Vibrations (Two degrees of Freedom Systems):** Principle modes of vibrations, Normal mode and natural frequencies of systems (without damping) Simple spring mass systems, masses on tightly stretched strings, double pendulum, torsional systems, combined rectilinear and angular systems, geared systems and Problems, undamped dynamic vibration absorber and Problems.

**UNIT - V**

**Numerical Methods for multi degree freedom of systems:** Introduction, Maxwell's reciprocal theorem, Influence coefficients, Rayleigh's method, Dunkerley's method, Stodola method, Holzer's method, Orthogonality of principal modes, method of matrix iteration and Problems.

**Vibration Measuring Instruments and Whirling of shafts:** Seismic Instruments Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Whirling of shafts with and without damping, discussion of speeds above and below critical speeds and Problems.

**TEXT BOOKS:**


1. Rao, Singiresu S., "Mechanical Vibrations", 5th Edition, Prentice Hall.
2. Inman, D. J. "Engineering Vibration", 3rd Edition, Pearson Prentice Hall.


**REFERENCE BOOKS:**


1. Kelly, S. Graham, "Mechanical Vibrations: Theory and Applications", SI Edition, Cengage Learning.
2. Timoshenko, S. "Vibration Problems in Engineering", Fifth Edition, John Wiley & Sons, Inc.
3. Leonard Meirovitch, "Elements of Vibration Analysis", International Edition, McGrawHill.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PE611ME | FUNDAMENTALS OF ADDITIVE MANUFACTURING TECHNOLOGIES | | | | | | PE-III |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES:**

1. To introduce and make students understand the basics of additive manufacturing/rapid prototyping, its advantages & limitations.
2. To know the various types of STL file errors and other data formats used in additive manufacturing Technology.
3. To know the features of various software used in additive manufacturing.
4. To know the working principle, advantages, disadvantages and applications of liquid, solid and Powder based Technologies.
5. To know diversified applications of additive manufacturing Technologies and to explore the potential of AMT in different industrial sectors.

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Interpret and describe the fundamentals and features of additive manufacturing.
2. Select suitable CAD data formats and software for different additive manufacturing technologies.
3. Describe the operating principles and capabilities of liquid, solid & powder based additive manufacturing systems.
4. Understand the advantages and limitations of liquid, solid & powder based additive manufacturing systems.
5. Explore the applications of AMT in different industrial sectors.

**UNIT - I**

**Prototyping fundamentals:** Need for time compression in product development, Historical development, Fundamentals of Rapid Prototyping, rapid prototyping process chain, Advantages Limitations of rapid prototyping, rapid prototyping wheel, Commonly used Terms, Classification of processes.

**UNIT - II**

**Liquid-based Systems:** Stereo Lithography Apparatus (SLA): Models and Specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser, laser scanning, Applications, Advantages and Disadvantages, Case studies. Poly jet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

**Solid-based System:** Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case Studies. Fused.

**Deposition Modelling (FDM):** Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Wire Arc Additive Manufacturing (WAAM& WLAM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

**UNIT - III**

**Powder Based Systems:** Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following Technologies like Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM).

**Three dimensional Printing (3DP):** Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

Rapid Tooling: Introduction to Rapid Tooling (RT),Conventional Tooling v/s RT, Need for RT. Rapid Tooling Classification; Direct & Indirect tooling methods.

**UNIT - IV**

**Data Formats &Software:** STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL files Repairs, Newly Proposed Formats.

**Software's Features:** Magics, Mimics, Solid View, View Expert, 3D Rhino, 3D doctor, Flash Print, Object Studio, Cura, ITK Snap, 3-matic, Simplant, Mesh Lab, Ansys for Additive Manufacturing.

**UNIT - V**

**Applications of Additive Manufacturing:** Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, construction

field, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customised Implants Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization Bio molecules. Biopolymers, Packaging, Disaster Management, Entertainment and Sports industry.

**TEXT BOOKS:**


1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications", Fifth Edition, World scientific.
2. 3DPrinting, Rapid Prototyping, and Direct Digital Manufacturing" Springer, Second Edition.


**REFERENCE BOOKS**


1. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies.
2. Frank W. Liou, "Rapid Prototyping & Engineering Applications", CRC Press, Taylor & Francis Group.
3. Rafiq Noorani, "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PE612ME | INDUSTRIAL ENGINEERING | | | | | | Elective |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| - | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES:**

1. To learn the concept of Management.
2. To understand the role of Production Planning and Control in Industry.
3. To learn various material procurement policies.
4. To understand importance of quality control and various methods.
5. To interpret the role of Decision theory in Industry.

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Explain various approaches for industrial management. Able to infer concept of management in human resource domain
2. Apply the Philosophy of Production Planning and Control in Industry and control the activities in delivering the products in time
3. Determine the optimum requirement of inventory by developing the various quantitative models.
4. Develop the various models or methods for ensuring the required quality of the products or process
5. Elaborate the role of Decision theory and apply various approaches under Uncertainty and Risk conditions

**UNIT - I**

**Management:** Introduction to Management, Scientific Management, Systems approach to Management, MBO and Decision Making Process.

**Personnel Management-** Functions of personnel management, types of training, Job evaluation and Merit rating, Collective bargaining and labour participation in management.

**UNIT - II**

**Production Planning & Control :** Definition, Objectives, Importance and Functions

of Production Planning & Control. Planning, Routing, Scheduling, Dispatching, Follow-up and progress Report. Introduction to Forecasting.

**UNIT - III**

**Inventory Control:** Importance of inventory control, types of inventory models, Inventory costs deterministic inventory models, Basic EOQ models, ABC analysis, production model without shortages, Purchase model with instantaneous replenishment and with shortages, production model without shortages. Inventory model with price breaks, Fixed order quality system, periodic review system, Inventory model with probabilistic demand model.

**UNIT - IV**

**Quality Control:** Concept of quality, evaluation of quality control, assignable and chance causes of variation, Variable Control charts (X and R charts), Attributes control charts: P chart and C chart

**Acceptance Sampling**–Single Sampling, Double Sampling and Multi sampling plans–OC curves of single sampling plans

**UNIT - V**

**Decision Making:** Decision Theory, Types of Decision making Environment. Decision making under Uncertainty- Criterion of Optimism or Maxi max, Criterion of Pessimism or Maxi min, Mini max decision criteria, Decision making under Risk – Expected Monetary Value (EMV), Expected Opportunity Loss (EOL) Criterion & Expected Value of Perfect Information (EVPI) Criterion, Decision Trees.

**TEXT BOOKS:**


1. M.Mahajan, Industrial Engineering and Production Management", Dhanpatrai & sons, New Delhi.
2. S.K. Sharma and Savita sarma, "Industrial Engineering and Organization Management ", S.K. Kataria & Sons, New Delhi.


**REFERENCE BOOKS:**


1. S.D.Sharma, "Operations Research", Kedarnnath, Ramnath & Co., Meerut.
2. S Kalavathi, "Operations Research", Vikas Publishing House Pvt. Ltd.
3. V.K.Kapoor,"Operations Research", S.Chand, New Delhi.
4. S K Sharma & Savita Sharma,"Acourse in Industrial Engineering & Operations Management ", S.K. Kataria & Sons.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6MC603HS | INDIAN CONSTITUTION | | | | | | MC |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| Elementary Civics-School level | 2 | - | - | - | 40 | 60 | - |

## COURSE OBJECTIVES:

**The objective of this course is:-**

1. To create awareness and relevance of the Indian Constitution, its directive principles.
2. To impart understanding of the role, powers and functions of administration at the Central, State and local levels.
3. To create awareness and understanding of Fundamental Rights, State Policy and Duties of Ideal citizen
4. To expose students to the relations between Central/Federal, State and Provincial units, divisions of executive, legislative and judiciary in them.
5. To impart knowledge about the statutory institutions and their role.

## COURSE OUTCOMES:

After completion of the course, the student will be able to:-

1. Have a general knowledge and back ground about the Constitution of India and its importance.
2. Will distinguish and understand the working of the Central, state and provincial levels of administration.
3. Will be conscious about the fundamental duties, responsibilities and rights as an ideal citizen of India
4. Will be able to perceive and interpret the functioning and distribution of resources between centre and state.
5. Have an awareness and relate to the existing hierarchy of the social structure, election process and Grievance redressal in a democracy

**UNIT-I**

**Introduction to Constitution**- Meaning, reasons for having a constitution.

**Evolution of the Indian Constitution:** History, 1909 Act,1919 Act and 1935 Act and Premeable.

**Constituent Assembly:** Composition and Functions.

**UNIT - II**

**Government vs. Governance:**

**Union Government:** Political Executive-President, Prime Minister, Council of Ministers, Bureaucratic Executive.

**State Government:** Executive: Governor, Chief Minister, Council of Ministers

**Local Government:** Panchayat Raj Institutions, Rural and Urban local bodies-composition.

**UNIT - III**

**Rights and Duties:** Fundamental Rights, Directive principles of State Policy, Fundamental Duties of a good citizen Public Interest Litigation.

**UNIT - IV**

**Relation between Federal and Provincial units**:

**Union-State relations:** Administrative, Legislative and Financial, Inter-State council, NITI Ayog, Finance Commission of India.

**UNIT - V**

**Constitutional and Statutory Bodies:** Election Commission and Electoral Reforms, National Human Rights Commission, National Commission for Women, National Commission for Minorities, National Commission for Protection of Child Rights.

**TEXT BOOKS:**


1. Durga Das Basu, "Introduction to the Constitution of India", English-Hardcover –Lexis Nexis, New Delhi.
2. Dr. B.L. Fadia, Dr. Kuldeep Fadia , "Indian Government and Politics", Sahithya Bhavan Publications, Agra.
3. M . Lakshmikanth, "Indian polity', Tata McGraw Hill.


**REFERENCE BOOKS:**


1. M.V. Pylee, " Indian Constitution".
2. Khattar, "Indian Political System".
3. Constitution of India, Telugu Academy.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6HS653HS | SOFT SKILLS LAB | | | | | | HS |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | - | - | - | 2 | 40 | 60 | 1 |

**COURSE OBJECTIVES:**

1. To enable the students to listen to different speakers in different contexts for various purposes and learn target language expressions.
2. To enable the students to develop confidence and interactive skills to speak professionally in different situations.
3. To enable students to learn and develop various reading skills and strategies.
4. To enable the students to develop written expression of thought and provide opportunities to explore ideas by utilizing various techniques.
5. To equip the students to develop needed confidence and interactive skills to speak professionally and acquire skills to face any Interview.

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Listen to a variety of speakers and texts and will be able to comprehend and perform the required tasks.
2. Interact in a group professionally and communicate confidently in terms of both the spoken and written communication.
3. Develop the skills and strategies of reading and writing.
4. Face any Interview confidently by managing time, making decisions by speaking appropriately according to the context.
5. Demonstrate right attitude and right skills to cope with team and communicate professionally.

**LIST OF EXPERIMENTS**

**I. Listening Skills**

- Listening to different situations by Native Speakers.
- Listening to Conversations.
- Listening to Motivational Speeches.

**II. Speaking Skills**

- Describing a person or a place or a thing using relevant adjectives.
- Picture Perception
- Oral Presentations.
- Etiquette in different situations.

**III. Reading Skills**

**IV. Writing Skills**

**V. Interview Skills**

- Reading different Texts
- Reading Comprehension Passages.
- Skimming and Scanning
- Paraphrasing.
- Writing Slogans related to the image.
- Communicating on Social Media.
- Skills required to attend an Interview
- Soft Skills to be demonstrated in a Job Interview.
- Debates and Group discussions.

**TEXT BOOKS:**

1. Andrea J. Rutherford.Basic Communication Skills for Technology. Pearson Education. Inc. New Delhi.
2. Antony Jay and Ros Jay. Effective Presentation. How to be a Top Class Presenter. Universities Press. (India) Limited.

**REFERENCE BOOKS:**

1. Robert M Sherfield and etal. "Developing Soft Skills" 4th edition, New Delhi: Pearson Education.
2. M.Ashraf Rizvi Effective Technical Communication, Tata McGraw-Hill Publishing Company Limited. New Delhi.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PC658ME | THEORY OF MACHINES LAB | | | | | | Core |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| Theory of Machines lab. | - | - | - | 2 | 40 | 60 | 1 |

**COURSE OBJECTIVES:**

1. To impart practical knowledge on design and analysis of mechanisms in the automobiles.
2. To understand the kinematics and dynamics of mechanical elements such as linkages, cams, Governors and learn to design such elements to accomplish desired motions or tasks.
3. To acquire the knowledge in evaluating the stability of vehicles.
4. To demonstrate the importance of static and dynamic balancing.
5. Frequency response of spring mass system with damping and without damping - Undamped torsional vibrations of single and double rotor systems.

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Understand the function of Governors, Gyroscope, Various types of vibrations and kinematic mechanisms.
2. Summarize various types of governors, vibrations and kinematic mechanisms.
3. Select Various types of governors, kinematic mechanisms and vibrations based on industrial applications.
4. Analyze forces acting on governors, vibrations and kinematic mechanisms.
5. Evaluate the balancing of forces in rotating masses, gyroscopic couple due to centrifugal force, Height of governor with respect to speed, Natural frequencies of free and forced vibrations.

**List of Experiments**

1. To study various types of cam and cam follower arrangements.
2. To study various types of kinematics links, pairs, chains & mechanisms.
3. To study inversions of 4 bar Mechanisms and slider crank mechanisms.

4. Centrifugal Governors: Experiment on Performance Characteristic Curves.
5. Estimation of Gyroscopic Couple & Understanding of Gyroscopic Effects on a rotating disc.
6. Static and Dynamic Balancing of Rotating Masses.
7. Damped and Undamped Torsional Vibrations of Single and Double Rotor System.
8. Single DOF (Degrees of Freedom) of Spring Mass Damper System. (Damped and Undamped Systems).
9. Free and Forced Vibration of Simply Supported Cantilever Beam.
10. Dunkerley Method to Find Fundamental Frequencies.
11. Critical Speed of Shaft.
12. To find the coefficient of friction between belt and pulley.

**Note:** Minimum ten experiments should be conducted in the semester.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6PC659ME | HEAT TRANSFER LAB | | | | | | Core |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | - | - | - | 2 | 40 | 60 | 1 |

**COURSE OBJECTIVES:**

1. To enable the student to apply conduction, convection and radiation heat transfer concepts to practical applications.
2. To demonstrate knowledge in evaluating thermal conductivity and heat transfer coefficient under natural convection phenomena and forced convection phenomena.
3. To understand the basic concepts of radiation heat transfer.
4. To understand the basic working principle of Heat Exchangers.

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Analyze the effective thermal resistance in composite slabs and thermal conductivity of metal bar.
2. Evaluate the heat transfer coefficient in free and forced convection.
3 Evaluate the overall heat transfer coefficient of Parallel and counter flow heat exchanger.
4 Evaluate emissivity of test plate and Stefan Boltzman constant.
5 Analyze overall efficiency of Axial flow fan and Centrifugal blower.

**LIST OF EXPERIMENTS**

1. Determination of overall and individual plate thermal conductivity for a composite wall.
2. Determination of thermal conductivity of metal Rod.
3. Determine heat transfer in pin-fin and its efficiency.
4. Determination of radiation emissivity of a test plate
5. Determination of Stefan-Boltzmann constant for radiation.

6. Determine overall heat transfer coefficient of Parallel and counter flow heat exchanger.
7. Heat transfer in Natural convection.
8. Heat transfer in Forced convection.
9. Determination of overall efficiency of centrifugal blower
10. Determination of overall efficiency of axial flow fan.
11. Determination of COP of Refrigeration system using capillary tube and thermostatic expansion valve.
12. Measurement of Lift and Drag force models in Wind tunnel section.

**Note:** At least ten experiments should be conducted in the Semester

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| 6OE602ME | 3D PRINTING TECHNOLOGIES | | | | | | Open Elective-II |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| NIL | 3 | - | - | - | 40 | 60 | 3 |

**COURSE OBJECTIVES:**

1. To understand the fundamental concepts of 3D Printing, its advantages & limitations.
2. To know the various types of STL file errors and other data formats used in additive manufacturing Technology.
3. To know the working principle, advantages, disadvantages & applications of liquid, solid and powder based 3D Printing technologies.
4. To know the diversified applications of 3D Printing technologies and explore them in different industrial sectors.

**COURSE OUTCOMES:**

**After the completion of course the students will be able to:**

1. Describe the fundamentals of 3D printing, classify and explain advantages and disadvantages of 3D Printing technologies.
2. Select thesuitable CAD data formats and software used in 3D Printing technology.
3. Describe the operating principles, capabilities and limitations of liquid, solid & powder based 3D Printing Technologies.
4. Compare different 3D printing technologies based on their process capabilities and applications.
5. Apply the capabilities and knowledge of 3D printing in different industrial sectors.

**UNIT-I**

**Prototyping Fundamentals:** Historical Development, Fundamentals of 3D Printing, Advantages and Limitations of 3D Printing, commonly used terms, 3D Printing Process Chain, 3D Modelling, Data conversion and transmission, Checking &

Preparing, Building, Post processing, Classification of 3D Printing processes, Fundamental Automated Processes, Distinction between 3D Printing and Conventional Machining Processes.

**Data Formats & Software:** Data formats; conversion and transmission, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs, Newly Proposed Formats. Software's Features: Magics, Mimics, Solid View, Cura, ITK Snap.

**UNIT-II**

**Liquid based Systems:** Stereo Lithography Apparatus (SLA): Models and Specifications, Process, working principle, photopolymers, photo polymerization, Layering Technology, laser and laser scanning, Applications, Advantages and Disadvantages. **Poly jet:** Models and Specifications, Process, working principle, Applications, Advantages and Disadvantages. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

**UNIT-III**

**Solid-based Systems:** Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Fused Deposition Modelling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Multi Jet Modelling (MJM): Models and specifications, Process, Working principle, Applications, Advantages and Disadvantages.

**UNIT-IV**

**Powder Based Systems:** Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Three Dimensional Printing (3DP): Models and Specifications, Process, working principle, Applications, Advantages and Disadvantages. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

**UNIT-V**

**Applications of 3D Printing :** Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, Construction field,

Arts and Architecture, Pattern for investment and vacuum casting, Medical Models and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production Medical Devices, Forensic Science and Anthropology and Web Based Rapid Prototyping Systems.

**TEXT BOOKS :**


1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific
2. 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" Springer, Second Edition.


**REFERENCE BOOKS:**


1. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies:
2. Frank W. Liou, "Rapid Prototyping & Engineering Applications"- CRC Press, Taylor & Francis Group.
3. Rafiq Noorani, "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons.