# ANNA UNIVERSITY, CHENNAI – 600 025

## UNIVERSITY DEPARTMENTS

**R - 2023**

**B.E. MECHANICAL ENGINEERING (PART-TIME)**

**I - VIII SEMESTER CURRICULA AND SYLLABI**

## SEMESTER I

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**TOTAL** | **11** | **0** | **3** | **14** | **12.5** |

Attested,

DIRECTOR

Centre for Academic Courses
Anna University, Chennai-600 025
### SEMESTER VII

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PROFESSIONAL ELECTIVES COURSES
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UNIT I MATRICES
Eigen values and Eigen vectors of a real matrix – Properties of Eigen values - Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES

UNIT III INTEGRAL CALCULUS
Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions- Properties – Evaluation of integrals by using Beta and Gamma functions – Error functions.

UNIT IV MULTIPLE INTEGRALS

UNIT V VECTOR CALCULUS
Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green’s theorem, Stoke’s and Gauss divergence theorems – Verification and applications in evaluating line, surface and volume integrals.

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Use the matrix algebra methods for solving practical problems.
CO2: Use differential calculus ideas on several variable functions.
CO3: Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO4: Apply multiple integral ideas in solving areas and volumes problems.
CO5: Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

REFERENCES:

**CO-PO Mapping**

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[Image of Anna University logo]
UNIT I  MECHANICS OF MATERIALS

UNIT II  OSCILLATIONS, SOUND AND THERMAL PHYSICS

UNIT III  OPTICS AND LASERS

UNIT IV  QUANTUM MECHANICS

UNIT V  CRYSTAL PHYSICS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion of this course, the students shall be

CO1: Understand the important mechanical properties of materials

CO2: Express the knowledge of oscillations, sound and applications of Thermal Physics

CO3: Know the basics of optics and lasers and its applications

CO4: Understand the basics and importance of quantum physics.

CO5: Understand the significance of crystal physics.

TEXT BOOKS:
REFERENCES:


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PTCY3151 ENGINEERING CHEMISTRY L T P C 3 0 0 3

UNIT I POLYMER CHEMISTRY

Engineering Plastics: Polyamides, Polycarbonates and Polyurethanes. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendering

UNIT II NANOCHEMISTRY

UNIT III CORROSION SCIENCE

UNIT IV ENERGY SOURCES
Batteries - Characteristics - types of batteries – primary battery (dry cell), secondary battery (lead acid, lithium-ion-battery)- emerging batteries – nickel-metal hydride battery, aluminum air battery, batteries for automobiles and satellites - Fuel cells (Types) – H₂-O₂ fuel cell - Supercapacitors- Types and Applications, Renewable Energy: Solar- solar cells, DSSC

UNIT V WATER TECHNOLOGY

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: To recognize and apply basic knowledge on different types of polymeric materials, their general preparation methods and applications to futuristic material fabrication needs.
CO2: To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
CO3: To recognize and apply basic knowledge on suitable corrosion protection technique for practical problems.
CO4: To recognize different storage devices and apply them for suitable applications in energy sectors.
CO5: To demonstrate the knowledge of water and their quality in using at different industries.
TEXT BOOKS:

REFERENCES:

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. determining the resultant forces acting on a particle in 2D and 3D and for applying methods of equilibrium on a particle in 2D and 3D.
2. evaluating the reaction forces for bodies under equilibrium, for determining the moment of a force, moment of a couple, for resolving force into a force-couple system and for analyzing trusses.
3. assessing the centroids of 2D sections / center of gravity of volumes and for calculating area moments of inertia for the sections and mass moment of inertia of solids.
4. evaluating the frictional forces acting at the contact surfaces of various engineering systems and for applying the work-energy principles on a particle.
5. determining kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I  STATIC OF PARTICLES  9+3

UNIT II  EQUILIBRIUM OF RIGID BODIES AND TRUSSES  9+3

UNIT III  DISTRIBUTED FORCES  9+3
Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration.
Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV  FRICTION AND WORK PRINCIPLES  9+3
UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES


TOTAL : 60 PERIODS

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

CO1 To determine the resultant forces acting on a particle in 2D and 3D and to apply methods of equilibrium on a particle in 2D and 3D.

CO2 Evaluate the reaction forces for bodies under equilibrium, to determine moment of a force, moment of a couple, to resolve force into a force-couple system and to analyze trusses.

CO3 Assess the centroids of 2D sections / center of gravity of volumes and to calculate area moments of inertia for the sections and mass moment of inertia of solids.

CO4 Evaluate the frictional forces acting at the contact surfaces of various engineering systems and apply the work-energy principles on a particle. evaluate the kinetic and kinematic parameters of a particle.

CO5 Determine kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

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DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
UNIT I  ORDINARY DIFFERENTIAL EQUATIONS  (9+3)

UNIT II  LAPLACE TRANSFORMS  (9+3)

UNIT III  FOURIER SERIES  (9+3)

UNIT IV  FOURIER TRANSFORMS  (9+3)
Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions - Convolution theorem (without proof) – Parseval’s identity.

UNIT V  Z – TRANSFORM AND DIFFERENCE EQUATIONS  (9+3)

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Solve higher order ordinary differential equations which arise in engineering applications.
CO2: Apply Laplace transform techniques in solving linear differential equations.
CO3: Apply Fourier series techniques in engineering applications.
CO4: Understand the Fourier transforms techniques in solving engineering problems.
CO5: Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

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UNIT – I  ELECTRICAL CIRCUITS

UNIT – II  ELECTRICAL MACHINES

UNIT – III  ANALOG AND DIGITAL ELECTRONICS

UNIT – IV  SENSORS AND TRANSDUCERS
Solenoids, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors, Strain gauge, LVDT, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT – V  MEASUREMENTS AND INSTRUMENTATION

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO 1: Compute and demonstrate the electric circuit parameters for simple problems.
CO 2: Explain the working principles and characteristics of electrical machines, electronic devices and measuring instruments.
CO 3: Identify general applications of electrical machines, electronic devices and measuring instruments.
CO 4: Analyze and demonstrate the basic electrical and electronic circuits and characteristics of electrical machines.
CO 5: Explain the types and operating principles of sensors and transducers.
## Mapping of COs with POs and PSOs

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### TEXT BOOKS:

### REFERENCES:
COURSE OBJECTIVE:
To impart the importance of design in today’s context of global competition.

UNIT I DESIGN THINKING FOR NEED IDENTIFICATION 9

UNIT II PRODUCT DEVELOPMENT PROCESS 9

UNIT III PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN FOR ENVIRONMENT 9

UNIT IV ROBUST DESIGN FOR MANUFACTURING AND SUPPLY CHAIN 9
Robust design through the design of experiments (DOE)–Design for X (DFX)–Iteration of DFM method–Failure Mode and Effect Analysis (FMEA)–Quality Function Deployment (QFD)–Partial disassembly, folding, or compression– Delayed final packaging.

UNIT V DESIGN THINKING IN COST-CUTTING AND INTELLECTUAL PROPERTY 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course, the student will be able to
CO1 Apply design concepts for manufacturing, assembly and environment.
CO2 Make economically sound decisions.
CO3 Design methodologies on industrial ecology.
CO4 Analyze the design for its manufacturability using modern quality control concepts and Approaches.
CO5 Learn the value of design and how it impacts society, industry, and the environment.
TEXT BOOKS:

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UNIT I  FLUID PROPERTIES AND FLOW CHARACTERISTICS  10

UNIT II  FLOW THROUGH PIPES AND BOUNDARY LAYER  9

UNIT III  DIMENSIONAL ANALYSIS AND MODEL STUDIES  7
Fundamental dimensions - Dimensional homogeneity - Rayleigh’s method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV  TURBINES  10
Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines – Pelton wheel, Francis turbine (inward and outward) and Kaplan turbine- Working principles - Work done by water on the runner - Efficiencies – Draft tube - Specific speed - Performance curves for turbines.

UNIT V  PUMPS  9
Classification of pumps - Centrifugal pumps – NPSH – Minimum speed to start the pump - working principle - Heads and efficiencies– Velocity triangles- Work done by the impeller - performance curves - Reciprocating pump working principle – indicator diagram and it’s variations – work saved by fitting air vessels.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the student is expected to be able to

CO1  Understand the difference between solid and fluid, its properties and behaviour in static conditions along with the conservation laws applicable to fluid flow and its application through fluid kinematics and dynamics.

CO2  Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel and to understand the concept of boundary layer theory.

CO3  Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies.

CO4  Design of Pelton wheel, Francis and Kaplan turbines and explain the working principles of each turbine with draft tube theory for reaction turbines.

CO5  Differentiate pumps and explain the working principle with characteristic curves and design centrifugal and reciprocating pumps.

TEXT BOOKS:
REFERENCES:
1. K.L. Kumar, Engineering Fluid Mechanics, (8\textsuperscript{th} Ed.) S. Chand Publishing (India) Pvt. Ltd., New Delhi, 2016.

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UNIT I ENVIRONMENT AND BIODIVERSITY 6

UNIT II ENVIRONMENTAL POLLUTION 6

UNIT III RENEWABLE SOURCES OF ENERGY 6
Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6
Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability–from unsustainability to sustainability-millennium development goals, and protocols Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES 6

COURSE OUTCOMES:
CO1 To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
CO2 To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
CO3 To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
CO4 To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
CO5 To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXT BOOKS:

REFERENCES:

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COURSE OBJECTIVES:
1. To develop the understanding of the principle concepts of stress, strain and deformation of solids for various engineering applications.
2. To analyse the flexural and shear stresses induced in beams due to different loading conditions.
3. To analyse the effect of torsion on shafts and springs.
4. To understand and analyse the deflection of beams for different support and loading conditions.
5. To examine the stresses induced in thin and thick shells.

UNIT I  STRESS, STRAIN AND DEFORMATION OF SOLIDS  9

UNIT II  TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM  9
Beams – Types - Transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over hanging beams - Theory of simple bending – Bending stress distribution - Load carrying capacity - Proportioning of sections – Flitched beams – Carriage springs – Shear stress distribution - Shear Centre.

UNIT III  TORSION  9
Theory of Pure Torsion- Stresses and deformation in circular and hollows shafts – Transmission of power through hollow & solid shafts – Stepped shafts – Shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs.

UNIT IV  DEFLECTION OF BEAMS  9
Double Integration method – Macaulay’s method – Area moment method - Conjugate beam method - Strain energy method - computation of slopes and deflections in beams- Maxwell’s reciprocal theorem.

UNIT V  THIN &THICK SHELLS, THEORIES OF FAILURE  9
Stresses and deformations in thin cylindrical shells and spherical shells subjected to internal pressure – Stresses in thick cylinders – Lame’s theory – Application of theories of failure- Euler’s buckling theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Have thorough understanding of the fundamental concepts of stress and strains.
CO2 Understand the bending and shear stress distribution in beams.
CO3 Have sufficient knowledge on designing shafts to transmit power.
CO4 Have the ability to determine the deflection of beams.
CO5 Have the knowledge of behaviour of cylindrical and spherical shells.

TEXT BOOKS:
2. Rajput, R.K., Strength of Materials, S Chand And Company Ltd., New Delhi, 2018
REFERENCES:

CO-PO-PSO MAPPING: MECHANICS OF MATERIALS

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COURSE OBJECTIVE:
Students will understand and acquire knowledge on the fundamentals of the theory of kinematics.

UNIT I  MECHANISMS

UNIT II  KINEMATICS & PLANE MOTION OF BODY
Velocity and acceleration – Motion of a link in machine – Determination of Velocity and acceleration diagrams – Graphical method – Application of relative velocity method four bar chain. Velocity and acceleration analysis of a given mechanism, determination of Coriolis component of acceleration. determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

UNIT III  FRICTION IN MACHINE ELEMENTS
Introduction, Screw friction, Belt drives, types of belt drives, materials used for belt, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt, Friction aspects in clutches.

UNIT IV  CAMS

UNIT V  GEARs & GEAR TRAINS

TOTAL :45 PERIODS
COURSE OUTCOMES:
Upon successful completion of this course, the students would be able to:
CO1 Interpret the mechanisms from the basic concepts for kinematic pairs, joints and mechanisms
CO2 Evaluate velocity and acceleration for various mechanisms
CO3 Analyze the effects of friction in machine elements.
CO4 Design cams for producing a desired motion.
CO5 Evaluate gear parameters and gear ratios for different types of gear trains for automobile and machine tools

TEXT BOOKS:
2. Theory of Machines – S. S Rattan- TMH Publishers

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COURSE OBJECTIVE:
To impart knowledge on metal casting, joining, and forming processes

UNIT I
METAL CASTING PROCESSES

UNIT II
METAL JOINING PROCESSES

UNIT III
BULK DEFORMATION PROCESSES

UNIT IV
SHEET METAL PROCESSES

UNIT V
MANUFACTURE OF PLASTIC COMPONENTS

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course the students will be able to:
1. Explain the working principles of various metal casting processes.
2. Categorize and select the appropriate metal joining process.
3. Compare the working principles of bulk deformation of metals.
5. Explain the manufacturing of plastic components.

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVE:
To impart knowledge on application of thermodynamic concepts on work producing and consuming thermal systems.

UNIT I AIR STANDARD CYCLES

UNIT II VAPOUR POWER CYCLES
Rankine Cycle, modified reheat and regenerative cycles, Binary Vapour cycle, comparison.

UNIT III STEAM NOZZLES AND STEAM TURBINES

UNIT IV INTERNAL COMBUSTION ENGINES – FEATURES AND COMBUSTION
IC engine – Classification, working, components and their functions. Ideal and actual: Valve timing, port timing and p-v diagrams, two stroke & four stroke engines – comparison. Fuel requirements for IC engines, stoichiometric air-fuel ratio calculation for different fuels. Fuel Injection and Ignition systems, Charging, lubrication and cooling systems of IC engines, Normal and abnormal combustion in SI & CI Engines. Performance and emission testing of IC Engines.

UNIT V REFRIGERATION AND AIR CONDITIONING
Carnot Cycles on Refrigerator, Heat Pump and Heat Transformers - Refrigerants and their properties - Compression based Refrigeration Cycles & Systems

Air-Water Properties, Psychometric Charts & Process, Thermal Comfort in Built environment, Types of Air Conditioning Systems, Indoor Air Quality

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Analyze the different thermodynamic cycles and deduce their maximum thermodynamic efficiency
CO2 Assess the performance of Steam power cycle
CO3 Evaluate the performance of steam nozzles and steam turbines
CO4 Identify and understand the function of each IC engine components
CO5 Understand and apply refrigeration cycles and air-conditioning systems for various applications
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COURSE OBJECTIVE:
To impart knowledge on various forms of energy, energy transfer and energy interactions.

UNIT I  FIRST LAW OF THERMODYNAMICS  9

UNIT II  SECOND LAW AND CONCEPT OF ENTROPY  9

UNIT III  EXERGY ANALYSIS  9
High and low grade energy, Exergy and Anergy, Availability and Irreversibility for open and closed system processes - I and II law Efficiency, Applications of II Law.

UNIT IV  PROPERTIES OF PURE SUBSTANCES AND REAL GASES  9
Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction of wet and very wet steam, Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

Real Gas, Vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states - Generalized Compressibility Chart.

UNIT V  GAS MIXTURES AND THERMODYNAMIC RELATIONS  9
Gas mixtures, Maxwell relations - Tds Equations - heat capacities relations - Energy equation, Joule-Thomson experiment - Clausius- Clapeyron equation.

COURSE OUTCOMES:
At the end of the course the students would be able to
CO1: Understand and carry out various thermodynamic system analysis
CO2: Apply the second law of thermodynamics to various thermal systems
CO3: Determine the availability and perform the exergy analysis of thermal systems
CO4: Evaluate the properties of pure substance and real gases.
CO5: Explain the thermodynamic relations and compute properties of gas mixtures

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COURSE OBJECTIVE:
Students will acquire knowledge on force analysis of machine components, control mechanisms, the significance of unbalanced forces and its consequences in terms of vibrations.

UNIT I PRECESSION AND GOVERNERS 9
Gyrosopes, effect of precession motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and ships. Watt, Porter and Proell governors, spring loaded governors – Hartnell and Hartung with auxiliary springs. sensitiveness, isochronism and hunting.

UNIT II STATIC AND INERTIA FORCE ANALYSIS 9
static force analysis of planar mechanisms, Dynamic force analysis of slider crank mechanism, inertia torque, angular velocity and acceleration of connecting rod, crank effort and turning moment diagrams – fluctuation of energy – fly wheels and their design

UNIT III BALANCING 9
Balancing of rotating masses single and multiple – single and different planes, use analytical and graphical methods. Primary, secondary, and higher balancing of reciprocating masses. analytical and graphical methods, unbalanced forces and couples – Balancing of Multi-cylinder inline engines, V-engines – Partial balancing in engines

UNIT IV FREE VIBRATION 9

UNIT V FORCED VIBRATION 9

TOTAL:45 PERIODS

COURSE OUTCOMES:
Upon successful completion of this course the student should be able to:
CO1: Implement the stabilization knowledge in sea vehicles, aircrafts and automobile vehicles
CO2: Assess the force-motion relationship in components subjected to external forces in standard mechanisms and to design flywheel
CO3: Determine the undesirable effects of unbalances resulting from prescribed motions in mechanism
CO4: Calculate the natural frequencies, and amplitudes of mechanical systems subjected to free vibration.
CO5: Estimate the effect of dynamics of undesirable forced vibrations.
TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVE:
To impart knowledge on phase diagram constructions, Heat treatments of metals and alloys, and selection of ferrous & non-ferrous materials for suitable engineering applications

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9

UNIT II HEAT TREATMENT 9
Phase transformation- Pearlite, bainite and martensite formation mechanism; Diffusion-Fick’s first and second Law-Homogenous and heterogeneous nucleation-critical radius of Nucleation-Full annealing, stress relief, spheroidising –normalizing, hardening and tempering of steel. TTT diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test—recrystallisation.

UNIT III FERROUS AND NON-FERROUS ALLOYS 9

UNIT IV POWDER METALLURGY 9
PM process- Powder preparation, powder characterization, powder compaction, sintering-stages of sintering-mechanism of sintering, different sintering techniques-case studies on cemented carbide and cermet tool making.

UNIT V MECHANICAL BEHAVIOUR OF MATERIALS 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Construct the iron-iron carbide phase diagram and estimate the phases present in the micro-structure.
CO2 Design a suitable heat treatment process for ferrous alloys based on the requirements
CO3 Suggest suitable ferrous and non-ferrous alloys for specific engineering applications
CO4 Use the PM techniques to produce Engineering components
CO5 Describe testing procedures and failure mechanisms
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PTME3403 METAL CUTTING AND MACHINE TOOLS L T P C

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COURSE OBJECTIVE:
To Impart Knowledge on science of metal cutting through the application of mechanics of machining, material properties, and other relevant engineering knowledge.

UNIT I THEORY OF METAL CUTTING
Need for metal cutting, Classification of metal cutting processes, Mechanics of orthogonal and oblique cutting, forces in machining, Shear stress and shear strain in metal cutting, Types of chip, Nomenclature of single point cutting tool, Material factors – work piece materials and cutting tool materials, Tribological aspects in metal cutting - friction at the tool-chip interface, cutting fluids, thermal aspects - cutting temperatures, their measurement and heat transfer models, effect of process parameters, tool wear and mechanisms, tool life, surface integrity - surface roughness, machining induced microstructural changes, Machinability

UNIT II TURNING MACHINES

UNIT III ROTATING CUTTING TOOLS, GEAR CUTTING AND BROACHING
Drilling - geometry of helical drills, special modifications to improve drill performance, Allied operations - reaming, boring, taping, Milling - Classification - Horizontal vs Vertical and Conventional vs Climb milling - types of milling cutters - Surface finish in milling – machining time calculations - Gear cutting, gear hobbing and gear shaping – gear finishing methods; broaching machines: broach construction – push, pull, surface broaching.

UNIT IV ABRASIVE PROCESSES
Grinding - Mechanics of grinding and specific energy in grinding, grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding; Surface integrity in grinding - Traditional micro-/nano-finishing methods - Honing, Lapping, Superfinishing - Typical applications, Hybrid mass finishing of AM parts.

UNIT V COMPUTER NUMERICAL CONTROL MACHINE TOOLS
Computer Numerical Control (NC) machine tools – Need, types, constructional details, special features - ball screws, ATC, sensors, machining centre, part programming fundamentals – G-codes and M-codes, manual part programming and computer assisted part programming.

TOTAL 45 PERIODS

COURSE OUTCOMES:
CO1 Analyze the variables governing metal cutting process and the mechanics behind metal cutting.
CO2 Determine the machining parameters of turning process and select appropriate automates.
CO3 Explain the need for milling & hole making processes and various gear cutting methods.
CO4  Analyze the process parameters and the physics of grinding, and explain the commonly used abrasive finishing processes.

CO5  Develop CNC part programs for machining and turning centers.

TEXT BOOKS:

REFERENCES:
OBJECTIVE:
To understand the working of different power plants, analyse their performance and compute/compare their respective cost of power generation.

UNIT I HYDRO POWER PLANTS

UNIT II COAL, OIL AND GAS TURBINE POWER PLANTS

UNIT III NUCLEAR POWER PLANTS

UNIT IV RENEWABLE ENERGY POWER PLANTS

UNIT V ECONOMICS OF POWER GENERATION

COURSE OUTCOMES:
Upon completion of this course the students will be able to:
1. Describe the working of a hydro-electric power plant and select appropriate turbine
2. Compare the pro's and con's of coal, diesel and gas turbine power plants
3. Enumerate components associated with the nuclear power plants
4. Apply suitable technologies for harnessing renewable energy
5. Understand the cost of power generation from different fuel sources

TOTAL: 45 PERIODS

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COURSE OBJECTIVES:
To impart and give exposure to performance testing of various engine categories, components and fuel characterization

PART I IC ENGINE LABORATORY
LIST OF EXPERIMENTS
2. Actual p-v diagrams of IC engines.
3. Performance Test on four – stroke Diesel Engine.
5. Morse Test on Multi-Cylinder Petrol Engine.
6. Retardation Test on a Diesel Engine.
7. Determination of p-θ diagram and heat release characteristics of an IC engine.
8. Determination of Flash Point and Fire Point of various fuels / lubricants
9. Performance test on a two stage Reciprocating Air compressor

PART II STEAM LABORATORY
List of Experiments:
1. Study of Steam Generators and Turbines.

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Examine the performance of IC engines
2. Determine the valve overlap and scavenging periods
3. Evaluate the performance of boilers and steam turbines
4. Performance prediction of air compressors
5. Quantify the flash and fire point of any given fuel/lubricant
OPERATIONS RESEARCH

COURSE OBJECTIVE:
To impart the knowledge on Linear programming, Transportation, Inventory control, Queuing system, Project and Maintenance Management.

UNIT – I  LINEAR PROGRAMMING PROBLEMS  9
OR-Definition - Phases - models, LP problem formulation – Graphical solution, GLPP, Standard and Canonical forms of LPP- simplex methods- Big M, Two phase methods, Alternate optimal solutions, Duality in LP and Revised Simplex method

UNIT – II  TRANSPORTATION  9
Transportation problems- Basic feasible solution, Optimal solution By MODI method, Balanced and Unbalanced TP, Degeneracy, Production problems. Assignment problems – Hungarian method - Traveling salesman problems - Sheduling and Sequencing models-Johnson algorithm, n job 2 machines, n job 3 machines and n job m machines.

UNIT – III  INVENTORY CONTROL  9
Types of inventory- Inventory cost - EOQ - Deterministic inventory problems – Purchase and Production models with and without shortages-EOQ with price breaks - Stochastic inventory problems - Multi product problems - Systems of inventory control (P and Q Systems)-Determination of buffer stock and re-order levels -Selective inventory control techniques (ABC, VED, SDE, etc.)

UNIT – IV  QUEUING THEORY  9
Queuing system - Characteristics - symbols - Poisson process and exponential distribution –Single server queuing models - Multiserver queuing models, Simulation Monte Carlo technique- Inventory & Queuing problems.

UNIT – V  PROJECT MANAGEMENT AND REPLACEMENT MODELS  9
Project management: Network logic – Ford-Fulkerson's rule - AON diagram - CPM and PERT techniques, Critical path and float calculations. Replacement models -types of failures – Gradual failures:- replacement of items: with and without change in money values, sudden failures- individual and group replacement policies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon the completion of this course the student will be able to

CO1  Select the constraints on the availability of resources, develop a model and render an optimal solution during the given circumstances

CO2  Analyze the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits

CO3  Determine the purchase/ manufacturing policies to manage the safety stocks and meet the customer demands.

CO4  Categorize the different queue discipline and explore the avenues for better customer service

CO5  Evaluate the nature of the project/ failure and offer methodical assistance towards decision making.
TEXT BOOKS:

REFERENCES:
5. Prem kumar Gupta and D.S.Hira, “Problems in Operations research”, 2009 S.Chand

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COURSE OBJECTIVE:
The main learning objectives of this course is to provide knowledge on Geometric modelling and CNC part programming.

UNIT I COMPUTER AIDED DESIGN 9
Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates-Line drawing -Clipping- viewing transformation-visual realism.

UNIT II GEOMETRIC MODELLING 9
Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B spline surfaces. Solid modeling techniques- CSG and B-rep – Introduction to model storage –Data structures for interactive modeling- integration of design analysis and CAD-customization and design automation.

UNIT III CAD STANDARDS and CAD CAM INTERFACE 9

UNIT IV COMPUTER NUMERICAL CONTROL 9

UNIT V INFORMATION AND INTEGRATION OF MANUFACTURING SYSTEMS 9

TOTAL : 45 PERIODS

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

CO1 Apply the fundamental concepts of computer graphics and its tools in a generic framework.

CO2 Create and manipulating geometric models using curves, surfaces and solids.

CO3 Apply standard CAD practices in engineering design and to understand the need for integration of CAD and CAM

CO4 Apply CNC manual and computer assisted part programming for various manufacturing process
CO5  Discriminate the problems in Production Planning and Control.

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for familiarizing the various steps involved in the design process using standard practices and standard data, evaluating the design parameters of a component to satisfy functional and strength requirements.

UNIT I  FUNDAMENTAL CONCEPTS IN DESIGN  9
Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending, and torsional loading- Modes of failure - Factor of safety – Combined loads – Principal stresses curved beams – crane hook and ‘C’ frame-theories of failure – Design based on strength and stiffness – stress concentration – Fluctuating stresses – Endurance limit –Design for finite and infinite life under variable loading - Exposure to standards.

UNIT II  DESIGN OF SHAFTS AND COUPLINGS  9
Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity, and critical speed – Keys and splines – Rigid and flexible couplings.

UNIT III  DESIGN OF JOINTSAND POWER SCREWS  9

UNIT IV  DESIGN OF SPRINGSAND PIPE JOINTS  9
Types of springs, design of helical and concentric springs–Surge in springs, Design of laminated springs Introduction to pipe joints and fittings- soldered fittings-screwed connections - pipe connections- oval type flanged pipe joint

UNIT V  DESIGN OF BEARINGS  9
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs - Selection of Rolling Contact bearings - Seals and Gaskets.

Note: Use of approved design data book is permitted.

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1    Design machine members subjected to static and variable loads.
CO2    Design shafts and couplings for various applications.
CO3    Design bolted, welded joints and power screws for various kinds of loads.
CO4    Design helical, leaf springs, and pipe joints for various applications.
CO5    Design sliding and rolling contact bearings

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COURSE OBJECTIVE:
To apply the concepts of the finite element analysis to solve multi-dimensional problems in engineering.

UNIT I INTRODUCTION

UNIT II ONE-DIMENSIONAL PROBLEMS

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS

UNIT V ISOPARAMETRIC FORMULATION AND ADVANCED TOPICS

TOTAL:45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Develop mathematical models for Boundary Value Problems and their numerical solution
CO2 Formulate the Finite Element methodology to solve the one-dimensional problems
CO3 Estimate field variables for two-dimensional scalar variable problems
CO4 Determine field variables for two-dimensional vector variable problems
CO5 Apply the Iso-parametric transformation and use the numerical integration technique engineering problems.
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COURSE OBJECTIVES:

1. To make students conversant with the fluid power principles, and different types of hydraulic pumps.
2. To impart knowledge about the various types of hydraulic actuators and control components.
3. To inculcate the skills to design and develop hydraulic circuits and systems.
4. To familiarize the students with the design of pneumatic circuits.
5. To provide the knowledge of trouble shooting methods in fluid power systems.

UNIT – I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 9

UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

UNIT – III HYDRAULIC CIRCUITS AND SYSTEMS 9
Accumulators, Pressure Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits – Servo and Proportional valves – Applications – Mechanical, hydraulic servo systems, Case Studies.

UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

UNIT – V TROUBLE SHOOTING AND APPLICATIONS 9

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course the students would be able to
1. Apply the principles of fluid power systems, and select relevant hydraulic pumps for the fluid power applications.
2. Select necessary control components and hydraulic actuators for the fluid power applications.
3. Design and develop hydraulic circuits and systems.
4. Design and develop pneumatic circuits and systems.
5. Solve problems and troubles in fluid power systems.

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COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for designing mechanical power transmission elements.

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9
Motor power capacity for various applications - Design of Flat belts and pulleys - Selection of V belts and sheaves – Selection of wire ropes and pulleys – Design of Transmission Chains and Sprocket.

UNIT II SPUR AND HELICAL GEARS 9
Gear materials - Design of straight tooth spur & helical gears based on speed ratios, number of teeth, Fatigue strength, Factor of safety, strength, and wear considerations. Force analysis –Tooth stresses - Dynamic effects - Helical gears – Module - normal and transverse, Equivalent number of teeth – forces.

UNIT III BEVEL AND WORM GEARS 9

UNIT IV GEARBOXES 9

UNIT V CLUTCHES AND BRAKES 9
Design of single and multi-plate clutches, cone clutches, internal expanding rim clutches, and Electromagnetic clutches. Design of brakes: External shoe brakes - Single and Double Shoe, Internal expanding shoe brakes, and Band brakes.

TOTAL : 45 PERIODS
Note: Use of approved design data book is permitted.

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

CO1 Design flexible elements like belts, ropes, and chain drives for engineering applications.
CO2 Design spur and helical gear drives for power transmission.
CO3 Design bevel and worm drives for power transmission.
CO4 Design multi-speed gearbox for machine tools and automotive applications.
CO5 Design clutch and brake systems for engineering applications.
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COURSE OBJECTIVE:
To impart knowledge on dimensional, form and surface finish measurement in manufacturing

UNIT I  BASICS OF METROLOGY

UNIT II  MEASUREMENT OF LINEAR AND ANGULAR DIMENSIONS

UNIT III  TOLERANCE ANALYSIS

UNIT IV  METROLOGY OF SURFACES

UNIT V  ADVANCES IN METROLOGY

TOTAL: 45 PERIODS
COURSE OUTCOMES:

CO1 To describe the importance of measurements in engineering and the factors affecting measurements and to estimate measurement uncertainty.

CO2 To describe the working principle and applications of various linear and angular contact and non-contact measuring instruments.

CO3 To analyse the effect of tolerance in manufacturing, interpret the various tolerance symbols given in engineering drawings to choose the appropriate manufacturing process.

CO4 To describe the principles and methods of form and surface metrology.

CO5 To describe the advances in measurements for quality control in manufacturing Industries.

TEXT BOOKS:

REFERENCES:
5. NPL Measurement good practice guides relevant to the syllabus – No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131.

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COURSE DESCRIPTION
This course aims to provide a broad understanding about the modern values and ethical principles that have evolved and are enshrined in the Constitution of India with regard to the democratic, secular and scientific aspects. The course is designed for undergraduate students so that they could study, understand and apply these values in their day to day life.

COURSE OBJECTIVES:
- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitise students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students’ minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

UNIT I  DEMOCRATIC VALUES
6
Reading Text: Excerpts from John Stuart Mills’ On Liberty

UNIT II  SECULAR VALUES
6
Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.
Reading Text: Excerpt from Secularism in India: Concept and Practice by Ram Puniyani

UNIT III  SCIENTIFIC VALUES
6
Reading Text: Excerpt from The Scientific Temper by Antony Michaelis

UNIT IV  SOCIAL ETHICS
6
Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.
Reading Text: Excerpt from 21 Lessons for the 21st Century by Yuval Noah Harari

UNIT V  SCIENTIFIC ETHICS
6
Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.

TOTAL: 30 PERIODS
COURSE OUTCOMES
Students will be able to
CO1 : Identify the importance of democratic, secular and scientific values in harmonious functioning of social life
CO2 : Practice democratic and scientific values in both their personal and professional life.
CO3 : Find rational solutions to social problems.
CO4 : Behave in an ethical manner in society
CO5 : Practice critical thinking and the pursuit of truth.

REFERENCES:
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022
COURSE OBJECTIVE:
The main objective of this course is to prepare the students for learning the basics of simulation and analysis tools.

SIMULATION

1. Introduction to MATLAB, MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Simulation of Spring-mass system using MATLAB
3. Solving the simple problems in vibration
4. Simulation of the working principle of air conditioning system
5. Simulation of the working principle of hydraulic and pneumatic cylinder
6. Simulation of the working principle of cam and follower mechanism
7. Simulation of quick return mechanism

ANALYSIS

LIST OF EXPERIMENTS
Use of any finite element analysis software for following problems:

1. Force and Stress analysis using link elements in Trusses, cables and bars.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
5. Thermal stress and heat transfer analysis of fins, plates and cylinders.
6. Vibration analysis of spring-mass systems.
7. Modal analysis of Beams.
8. Harmonic, transient and spectrum analysis of simple systems

TOTAL:45 PERIODS

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

CO1 Simulate and analyze the response of mechanical systems.
CO2 Analyze structural and thermal problems.
CO3 Perform dynamic analysis of mechanical components
PTME3701 MECHATRONICS AND IoT

COURSE OBJECTIVE:
To impart knowledge on the principles of sensors, actuators, micro-controllers, Programmable Logic control, Arduino and Raspberry Pi and IOT.

UNIT – I SENSORS AND ACTUATORS

UNIT – II SIGNAL CONDITIONING CIRCUITS AND PLC

UNIT – III FUNDAMENTALS OF IoT AND EMBEDDED SYSTEMS

UNIT – IV ARDUINO AND RASPBERRY PI

UNIT – V MECHATRONICS AND IoT CASE STUDIES

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course the students would be able to
1. Select suitable sensors and actuators to develop mechatronics systems
2. Devise proper signal conditioning circuit for mechatronics systems, and also able to implement PLC as a controller for an automated system.
3. Elucidate the fundamentals of IoT and Embedded Systems.
4. Implement Arduino and Raspberry Pi as controllers for automated systems.
5. Design and develop an apt mechatronics/IoT based system for the given real-time application.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
Textbooks:

References:
COURSE OBJECTIVE:
To impart knowledge on production planning & control, cellular manufacturing, flexible manufacturing system and role of robots in industrial automation.

UNIT – I  FUNDAMENTALS OF CIM

UNIT – II  PRODUCTION PLANNING & CONTROL AND COMPUTER AIDED PROCESS PLANNING

UNIT – III  AUTOMATION IN MANUFACTURING SYSTEMS

UNIT – IV  CELLULAR MANUFACTURING AND FMS

UNIT – V  INDUSTRIAL ROBOTICS AND AGVs

COURSE OUTCOMES:
At the end of the course the students would be able to:
1. Explain the fundamentals of CIM.
2. Identify and solve the problems in Production Planning and Control.
3. Apply the automation techniques in manufacturing systems.
4. Implement Cellular Manufacturing Processes and FMS.
5. Select and apply the suitable Robots and AGVs for industrial applications.
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COURSE OBJECTIVE:
To impart knowledge on principles of operations in different Refrigeration & Air conditioning systems and components.

UNIT – I INTRODUCTION 9
Introduction to Refrigeration - Unit of Refrigeration and C.O.P.- Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT – II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

UNIT – III OTHER REFRIGERATION SYSTEMS 9
Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - MagneticVortex and Pulse tube refrigeration systems.

UNIT – IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9
Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT – V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9
Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system.

TOTAL:45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:
1. Understand the basic concepts of Refrigeration
2. Analyse the performance of Vapor compression Refrigeration systems
3. Demonstrate the various types of Refrigeration systems
4. Predict the Psychrometric properties and its use in psychrometric processes
5. Know the concepts of Air conditioning and to able solve problems

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COURSE OBJECTIVE
To impart knowledge on the recent advancement in vehicle engineering technologies

UNIT – I  ELECTRIC VEHICLES

UNIT – II  ELECTRIC VEHICLE MOTORS

UNIT – III  AUTONOMOUS AND CONNECTED VEHICLES

UNIT – IV  AUTOMOTIVE NETWORKING
Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

UNIT – V  ON-BOARD TESTING
Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course the students would be able to

1. Acquire an overview of electric vehicles and their importance in automotive.
2. Discuss the characteristics and the selection of traction motor.
3. Comprehend the vehicle-to-vehicle and autonomous technology.
4. Explain the networking of various modules in automotive systems, communication protocols and diagnostics of the sub systems.
5. Be familiar with on-board diagnostics systems.

TEXT BOOKS:
1 John G Hayes and G AbaasGoodarzi, Electric Powertrain -, 1st Edition, John Wiley & Sons Ltd., 2018
REFERENCES:
1 Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.
3 Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures) by Andrew M Wright and Harrison R Scott | 5 September 2012
4 Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002
5 Advanced Motorsport Engineering: Units for Study at Level 3 by Andrew Livesey | 1 September 2011

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COURSE OBJECTIVE:
To impart knowledge on fundamentals of heat and mass transfer and develop problem solving skills in its applications.

UNIT I CONDUCTION 12
Heat Conduction Equation — Cartesian, Cylindrical and Spherical Coordinates with and without heat generation, Boundary Conditions, Thermal Contact Resistance, Critical radius of insulation.

UNIT II CONVECTION 12
Classification of fluid flows, Energy & Momentum equations, Velocity & Thermal Boundary layers
Free convection – Vertical, Horizontal, Inclined plates, Cylinders and Spheres.

UNIT III HEAT TRANSFER APPLICATIONS 12
Fin Design – Uniform and non-uniform cross sectional area, fin performance, overall surface efficiency.
Heat Exchangers – Overall heat transfer coefficient, LMTD, \( \varepsilon \)-NTU method, TEMA classification.
Boiling and Condensation — Physical mechanisms, Regimes and heat transfer calculations.

UNIT IV RADIATION 12
Fundamental concepts — Radiation intensity, Black body radiation, View factor, Surface emission.
Kirchhoff’s law, Radiation heat transfer between two surfaces. Radiation shields, Thermal radiation network

UNIT V SIMULTANEOUS HEAT & MASS TRANSFER 12
Boundary conditions, Fick’s law of diffusion, Rate equations, Convective Mass Transfer, Analogy between Friction, Heat and Mass transfer coefficients.

TOTAL :60 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to
CO1 Apply the conduction equations for steady and transient conditions.
CO2 Solve problems involving free and forced convection heat transfer.
CO3 Estimate heat transfer in systems involving radiation heat transfer.
CO4 Analyse the heat transfer problems in real systems.
CO5 Relate heat and mass transfer processes.

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COURSE OBJECTIVE:

To test the acquired engineering knowledge of students through design, fabrication, and computational skills.

A project topic must be selected by the students in consultation with their guides. The ultimate aim of the project work is to deepen comprehension of mechanical principles by applying them to a new problem which may be the simulation, analysis, design and fabrication of mechanical systems for a specific application. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

If the student opts for semester long internship, the student shall undergo the internship in the Government Organizations/Reputed Industries with the due approval of Centre for Academic Course, Anna University. The student should submit the report after the report according the guidelines given by CAC.

TOTAL 90 PERIODS

COURSE OUTCOMES:

CO1 Manage the selection and initiation of individual projects and of portfolios of sustainable projects in the enterprise.
CO2 Identify the concepts to relevant research problems and societal practical applications.
CO3 Demonstrate a strong working knowledge of ethics and professional responsibility.
CO4 Implement processes for successful resource, communication, and risk and change management.
CO5 Demonstrate effective organizational leadership and change management skills for projects and project teams.
PTME3001 ADDITIVE MANUFACTURING

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COURSE OBJECTIVES:
- To introduce the development of Additive Manufacturing (AM), various software tools, processes, and techniques to create physical objects that satisfy product development/prototyping requirements.

UNIT I INTRODUCTION 6

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM) 6

UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION 6

UNIT IV POWDER BED FUSION AND MATERIAL EXTRUSION 6

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 6
ADDITIVE MANUFACTURING LABORATORY

Experiments
1. Modelling and converting CAD models into STL file.
3. Design and fabrication of parts by varying part orientation and support structures.
4. Fabrication of parts with material extrusion AM process.
5. Fabrication of parts with vat polymerization AM process.

Design and fabrication of topology optimized parts.

Equipment required - lab
1. Extrusion based AM machine
2. Resin based AM machine
3. Mechanical design software
4. Open-source AM software for STL editing manipulation and slicing.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of this course students shall be able to:
CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
CO2: Acquire knowledge on process of transforming a concept into the final product in AM technology.
CO3: Elaborate the vat polymerization and direct energy deposition processes and its applications.
CO4: Acquire knowledge on process and applications of powder bed fusion and material extrusion.
CO5: Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

TEXT BOOKS:

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COURSE OBJECTIVE
To impart knowledge on both conventional and futuristic vehicle technologies.

UNIT – I ADVANCED ENGINE TECHNOLOGY

UNIT – II COMBUSTION TECHNOLOGY
Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low-Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT – III LOW CARBON FUEL TECHNOLOGY
Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)
Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

UNIT – V FUEL CELL TECHNOLOGY
Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

TOTAL :45 PERIODS

OUTCOMES:
At the end of the course the students would be able to
1. Understand the latest trends in engine technology
2. Explain the need for advanced combustion technologies and their impact on reducing carbon footprint on the environment.
3. Analyze the basic characteristics of low carbon fuels, their impact over conventional fuels, and in achieving sustainable development goals.
4. Understand the working and energy flow in various hybrid and electric configurations.
5. Analyze the need for fuel cell technology in automotive applications.

TEXT BOOKS:
2. Rakesh Kumar Maurya, Characteristics and Control of Low-Temperature Combustion Engines. ISBN 978-3-319-68507-6, SPRINGER
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COURSE OBJECTIVES:

To study the various aspects of digital manufacturing, importance of DM in Product Life-cycle Management and Supply Chain Management in the digital work environment.

UNIT – I INTRODUCTION 6

UNIT – II DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT 6

UNIT – III SMART FACTORY 6
Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity

UNIT – IV INDUSTRY 4.0 6

UNIT – V STUDY OF DIGITAL TWIN 6

DIGITAL MANUFACTURING AND IoT LABORATORY

Experiments
1. Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino
2. Detect the Vibration of an Object Using Arduino
3. Sense a Finger When it is Placed on Board Using Arduino
4. Temperature Notification Using Arduino
5. Switch Light On and Off Based on the Input of User Using Raspberry Pi
6. Connect with the Available Wi-Fi Using Arduino

OUTCOMES:
At the end of the course the students would be able to
1. Impart knowledge to use various elements in the digital manufacturing.
2. Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.
3. Select the proper procedure of validating practical work through digital validation in Factories.
4. Implementation the concepts of IoT and its role in digital manufacturing.
5. Analyse and optimize various practical manufacturing process through digital twin.

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PTME3004 LEAN MANUFACTURING L T P C
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COURSE OBJECTIVES:
To introduce the basics of 6 SIGMA, methodologies of lean manufacturing & its tools

UNIT – I BASICS OF 6 SIGMA 9
Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.

UNIT – II INTRODUCTION TO LEAN MANUFACTURING TOOLS 9

UNIT – III DEEPER UNDERSTANDING METHODOLOGIES 9
What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.

UNIT – IV LEAN ELEMENTS 9
Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects

UNIT – V IMPLEMENTATION AND CHALLENGES 9
Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.

TOTAL :45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:
1. Discuss the basics of 6 SIGMA
2. Elaborate the lean manufacturing tools.
3. Illustrate about the deeper understanding methodologies of Lean manufacturing.
4. Discuss lean concepts and its elements.
5. Describe the implementation and challenges of lean manufacturing.

TEXT BOOKS:
2. Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile SouthAsia
3. The Toyota Way: 14 Management Principles
REFERENCES:

2. International Society of Six Sigma Professionals: https://isssp.org/about-us/
4. Older / Previous editions of AIAG manuals on APQP, FMEA and PPAP. These are great sources of information on Quality Planning and have basics of Project Management and required skills.
5. Quality Management for Organizations Using Lean Six Sigma Techniques- Erick C Jones

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PTME3005 MODERN ROBOTICS

COURSE OBJECTIVE:

To impart knowledge on anatomy of robots, kinematics, different end effector, mobile robots and its societal applications

UNIT – I INTRODUCTION
Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.

UNIT – II SIMULATION OF ROBOT KINEMATICS
Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation, and rotation matrices D-H transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system.

UNIT – III GRASPING AND MANIPULATION OF ROBOTS
Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.

UNIT – IV MOBILE ROBOTS
Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control

UNIT – V APPLICATIONS OF ROBOTS
Application of robotic: industrial robots, Service robots, domestic and household robots, medical robots, defence robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare

TOTAL :45

OUTCOMES:
At the end of the course the students would be able to
1. Explain the definition, history of robotics and robot anatomy.
2. Develop the solutions for robot kinematics
3. Describe the grasping and manipulation of robots.
4. Explain mobile robot and manipulation.
5. Summarise the applications of robots in industry, Defence, domestic & household and medical field.
**TEXT BOOKS:**


**REFERENCES:**

5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10: 16397873732

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COURSE OBJECTIVES:
To familiarize the students with the environment for Green Manufacturing, concept of green manufacturing, green supply chain and green concepts in industries.

UNIT I  ENVIRONMENT FOR GREEN MANUFACTURING AND LIFE CYCLE ASSESSMENT

UNIT II  GREEN MANUFACTURING SUPPLY

UNIT III  GREEN MANUFACTURING IN INDUSTRIES

UNIT IV  DESIGN FOR SUSTAINABILITY
Introduction to Sustainability, Principles and its effect on Design and Manufacturing – Green Design Methods and Tools – Industrial Ecology and Sustainability – Economics of Sustainable Engineering

UNIT V  ANALYSIS AND DEVELOPMENT TECHNIQUES AND GREEN CO-RATING

TOTAL : 45 PERIODS

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

CO1 Perceive the Concept of a Green Manufacturing Environment
CO2 Conceptualize Green Supply Chain
CO3 Understand the current green trends in industries
CO4 Make sustainable choices for industrial production
CO5 To describe techniques of modelling and analysis of green manufacturing

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COURSE OBJECTIVES:

To make students understand the concepts of environmental impact assessment and life cycle assessment

UNIT I  CONCEPTS OF ENVIRONMENTAL IMPACT ASSESSMENT  9

UNIT II  DETAILED CONTENTS OF EIA  9
Introduction-Project Description-Description of The Environment-Anticipated Environmental Impacts and Mitigation Measures-Analysis of Alternatives-Environmental Monitoring Programme-Additional studies-Project Benefits-Environmental Cost Benefit Analysis.

UNIT III  SUSTAINABILITY ASSESSMENT  9

UNIT IV  LIFE CYCLE ASSESSMENT  9

UNIT V  ENVIRONMENTAL IMPACT ASSESSMENT AMENDMENTS  9
Spatial economics- EIA notification September 2006 and amendments- Categorization of projects-Procedure for getting environmental clearance-Public participation in environmental decision-making process-Case studies on EIA for Industries and Infrastructure projects.

TOTAL : 45 PERIODS

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

CO1 Explain the concepts of Environmental Impact analysis
CO2 Examine different environmental attributes and select the environmental parameters affecting the project
CO3  Apply various methods to Predict the Environmental impacts of the project after deciding various environmental attributes
CO4  Perform life cycle assessment and assess environmental impacts of manufacturing processes
CO5  Understand the EIA report for getting Environmental Clearance

TEXTBOOKS:

REFERENCES:
3. Asefa, “The economics of sustainable development”, WE Upjohn institute for employment research, 2005
PTME3008 GREEN SUPPLY CHAIN MANAGEMENT L T P C
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COURSE OBJECTIVE:
To familiar with the modern lead free electronic manufacturing processes, recycling of
electronics, and reliability assessment.

UNIT – I INTRODUCTION TO GREEN ELECTRONICS
Environmental concerns of the modern society- Overview of electronics industry and their
relevant regulations in China, European Union and other key countries- global and regional
strategy and policy on green electronics industry. Restriction of Hazardous substances
(RoHS) - Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and
Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH).

UNIT – II GREEN ELECTRONICS MATERIALS AND PRODUCTS
Basics of IC manufacturing and its process – Electronics with Lead (Pb) -free solder pastes,
conductive adhesives, Introduction to green electronic materials and products - halogen-free
substrates and components. Substitution of non-recyclable thermosetting polymer based
composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous
substances in electronic products

UNIT – III GREEN ELECTRONICS ASSEMBLY AND RECYCLING
Various processes in assembling electronics components - the life-cycle environmental
impacts of the materials used in the processes - substrate interconnects. Components and
process equipments - Technology and management on e-waste recycle system construction,
global collaboration, and product disassembles technology.

UNIT – IV PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN
Stages of product development process in green design: Materials- Manufacturing -
Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment
(LCA), and Eco-design tools - Environmental management systems, and International
standards - Eco-design in electronics industry.

UNIT – V CASE STUDIES
Reliability of green electronics systems, Reuse and recycle of End-of-Life(EOL) electrical and
electronic equipment for effective waste management – Introduction of Green Supply Chain,
and Modeling green products from Supply Chain point of view - A life-cycle assessment for
eco-design of Cathode Ray Tube Recycling.

TOTAL:45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:

1. Get concise awareness of standards and legislation of modern electronic
   manufacturing for green environment.
2. Explain the conventional electronic processing and lead free electronic
   manufacturing techniques.
3. Realize the assembly process and the need of recycle of electronics
5. Validate the green electronic manufacturing procedures in applications.

TEXT BOOKS:
1. Green Supply Chain Management, by CharisiosAchillas , Dionysis D. Bochtis ,
   DimitriosAidonis, Routledge; 1st edition (16 November 2018), ISBN-10 :
   1138644617
2. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill,
   2008.
REFERENCES:

COURSE OBJECTIVES:
To study the casting of ferrous and non-ferrous alloys casting and their metallurgy and its applications.

UNIT – I FERROUS CAST ALLOYS

UNIT – II NON-FERROUS CAST ALLOYS

UNIT – III PHYSICAL METALLURGY OF WELDING

UNIT – IV WELDING OF ALLOY STEELS AND NON-FERROUS METALS
Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions.

UNIT – V DEFECTS, WELDABILITY AND STANDARDS
Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:
1. Explain the ferrous casting metallurgy and its applications.
2. Explain the non-ferrous casting metallurgy and its applications.
3. Explain the ferrous welding metallurgy and its applications.
4. Explain the welding metallurgy of alloy steels and non ferrous metals and its applications.
5. Identify the causes and remedies of various welding defects; apply welding
standards and codes.

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PROGRESS THROUGH KNOWLEDGE

**Attest**

Director

Centre for Academic Courses
Anna University, Chennai-600 025

89
COURSE OBJECTIVES:
To study the processing of different types of composite material and mechanics approach to design a laminate

UNIT – I  INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING

UNIT – II  FLAT PLATE LAMINATE CONSTITUTE EQUATIONS

UNIT – III  LAMINA STRENGTH ANALYSIS

UNIT – IV  THERMAL ANALYSIS

UNIT – V  ANALYSIS OF LAMINATED FLAT PLATES

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:
1. Summarize the various types of Fibers, Equations and manufacturing methods
2. Derive Flat plate Laminate equations
3. Analyze Lamina strength
4. Analyze the thermal behavior of Composite laminates
5. Analyze Laminate flat plates

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COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER

COURSE OBJECTIVES:

1. To impart the knowledge on the basics of CFD and its significance of solving capability of the industrial oriented problems.
2. To understand the use of FDM and FVM discretization techniques for solving steady and transient diffusion problems.
3. To study the concept of use of FVM for solving convection diffusion problems.
4. To provide insights of CFD concept for incompressible flow analysis.
5. To understand the significance of various types of turbulence modelling.

UNIT I  GOVERNING EQUATIONS AND BOUNDARY CONDITIONS  9

UNIT II  FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION PROBLEMS  9

UNIT III  FINITE VOLUME METHOD FOR CONVECTION DIFFUSION PROBLEMS  9
Introduction to convection diffusion problems - Central, upwind differencing schemes, Hybrid and Power-law schemes - Analysis of properties of discretization schemes - Conservativeness, Boundedness, Transportiveness.

UNIT IV  INCOMPRESSIBLE FLOW ANALYSIS  9

UNIT V  TURBULENCE MODELS AND MESH GENERATION  9
Reynolds Averaging – RANS - Turbulence models, mixing length model, Two equation (k-€) models – High and low Reynolds number models, Mesh Generation and refinement Techniques – Introduction to use of simulation software tools.

TOTAL :  45

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Understand the need of CFD for solving industrial problems
CO2 Apply the concept of FDM and FVM for diffusion problems
CO3 Analytical skills to solve convection diffusion problems by using various discretization schemes
CO4 Familiarize the role of various algorithm used for incompressible flow analysis.
CO5 Assess the different turbulence models as well as the simulation software tools.
TEXT BOOKS:

REFERENCES:

*Each course must contain only five units with equal distribution of hours.

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COURSE OBJECTIVE:
The main learning objective of this course is to
1. Understanding the importance of failure analysis and causes of failures, principles of NDT methods, its applications and limitations.

UNIT I  INTRODUCTION TO FAILURE ANALYSIS  9
Need and scope of failure analysis. Engineering Disasters in history and their failure analysis. Sources of failures. Description & origin of Processing defects. Types of failures-Ductile & Brittle, Fracture Analysis, FMEA. Application of fracture mechanics concepts to design for safety. NDT for failure analysis- an overview.

UNIT II  DYE PENETRANT & MAGNETIC PARTICLE INSPECTION  9
Importance of NDT, Visual Inspection: Tools, applications and limitations,
Liquid Penetrant Inspection (LPI): Principles, Requisites of a good penetrant and developer, Types of penetrants and developers, Techniques, procedures, interpretation and evaluation of penetrant test indications, advantages and limitations, case study.
Magnetic Particle Inspection (MPI): Principles, Magnetization Methods, techniques. Continuous & Residual testing of MPI, System sensitivity, Interpretation of MPI indications, Advantage and limitations, case study.

UNIT III  ULTRASONIC TESTING  9
Principle, type of Ultrasonic waves, mode conversion in ultrasonics, Principle, UT testing methods: Contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, Ultrasonic Testing Techniques: Resonance testing, Through transmission technique, Pulse echo testing technique, Instruments used in UT, Transducer types, Reference blocks with artificially created defects, Calibration of equipment, A-Scan, B-scan & C-scan, case study.

UNIT IV  EDDY CURRENT TESTING & THERMOGRAPHY  9
Eddy current Testing: Principles, Physics aspects of ECT- conductivity, permeability, resistivity, inductance, inductive reactance, impedance, Filed factor and lift off effect, edge effect, end affect, Depth of penetration of ECT, Instrumentation, application of ECT, advantages, limitations, case study.
Thermography: Principles, Contact and non-contact inspection methods, Heat sensitive paints and papers, thermally quenched phosphors, Liquid crystals, techniques for applying liquid crystals, advantage and limitations, Infrared radiation and infrared detectors, applications, case study.

UNIT V  RADIOGRAPHY TESTING  9
Principle, electromagnetic radiation sources, X-ray sources, Production of X-rays, High energy X-ray source, Gama ray source, Properties of X-rays and gamma rays, Inspection techniques, Exposure, Real time radiography, Films and screens used in radiography, Quality of radiographic film processing, interpretation, evaluation of test results, Computed Tomography, Safety aspects required in radiography, Applications, advantages and limitations, case study.
COURSE OUTCOMES:
Upon completion of the Course, the students will be able to:
CO1 Discuss on the various failures, their analysis and their importance
CO2 Adapt the Penetrant testing procedures for evaluating the surface defects.
CO3 Interpret the images and the results obtained from the Thermographic technique and the Eddy current testing
CO4 Describe the testing procedure and analyze the results obtained in the Ultrasonic inspection
CO5 Explain the techniques involved in the Radiographic testing and the various advancements in Radiography.

TEXT BOOKS:

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COURSE OBJECTIVES:
To study the Codes and Standards used in different industries and government norms and regulations

UNIT – I  INTRODUCTION
Introduction to Codes and Standards. What is code? What is Standard Need for codes and standards. Objective of Codes and Standards. Codes, Standards and Good Engineering Practices.

UNIT – II  CODES

UNIT – III  STANDARDS

UNIT – IV  REGULATIONS

UNIT – V  DESIGN CODES

TOTAL :45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:
1. Explain the need for codes and Standards in Industry.
2. Discuss the different codes and standards used in different industry.
3. Discuss the sources of different codes and standards and the societies that publish them and how these are evolved
4. Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International
5. Discuss knowledge of codes and standards used in Process equipment design for Oil and Gas Industry.
TEXTBOOKS:
2. Perrys Chemical Engg Handbook

REFERENCES:
1. ASME
2. API
3. ISO, IBR, OISD
4. AWS
5. ISHRAE

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COURSE OBJECTIVE:
The main learning objective of this course is to prepare the students for designing the components with the considerations of quality, reliability, safety, cost, environment, manufacturing and assembly.

UNIT I DESIGN FOR QUALITY
Quality Function Deployment - House of Quality - Objectives and Functions - Targets - Stakeholders - Measures and Matrices - Design of Experiments - design Process - Identification of control factors, noise factors, and performance metrics - developing the experimental plan - experimental design - testing noise factors - Running the experiments - Conducting the Analysis - Selecting and conforming factor - Set points - reflecting and repeating

UNIT II DESIGN FOR RELIABILITY AND SAFETY
Reliability - Definitions - Constant failure Rate - Weibull Frequency distribution - Reliability with variable failure rate - System reliability - Design strategy - Causes of unreliability - Minimizing Failure - Sources of reliability data - Cost of reliability - Failure Mode Effect Analysis - Defects and Failure Modes - Importance of Failure - Safety - Safe product - Design aspects of safety - Fail safe design - Potential dangers and safety hazards - Guidelines for design for safety - Warning Labels

UNIT III DESIGN FOR MANUFACTURE AND ASSEMBLY
Role of Manufacturing in design - Manufacturing functions - types of manufacturing process, process systems - Manufacturing process selection - Design for Manufacturability (DFM) - Design for Assembly (DFA) - Role of standardization in DFMA - Mistake Proofing.

UNIT IV DESIGN FOR ENVIRONMENT AND SERVICEABILITY

UNIT V DESIGN FOR COSTING
Categories of costing - Overhead cost - methods of developing cost estimates - Manufacturing cost - Product profit model - refinements to cost analysis methods - Design to cost - Value Analysis in costing - Life cycle costing

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1 Apply the quality concepts to develop a robust product.
CO2 Enforce methods to improve the reliability of a product and to ensure the safety of the product by use of standards and guidelines
CO3 Apply the principles of process selection and to design the components by considering the manufacturing and assembly guidelines.

CO4 Design the product for its environment and to improve its re-pairability.

CO5 Predict the product cost using strategies and to refine the cost by performing cost analysis.

TEXTBOOKS:

REFERENCES:
COURSE OBJECTIVE:
To acquire the Mathematical knowledge to design and analysis of pressure vessels and piping

UNIT – I INTRODUCTION
Methods for determining stresses – Terminology and Ligament Efficiency – Applications

UNIT – II STRESSES IN PRESSURE VESSELS

UNIT – III DESIGN OF VESSELS
Design of Tall cylindrical self-supporting process columns – Supports for short vertical vessels – Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – Pressure Vessel Design.

UNIT – IV BUCKLING AND FRACTURE ANALYSIS IN VESSELS
Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT – V PIPING

OUTCOMES:
At the end of the course the students would be able to:
1. Understand the working principle and applications of pressure vessels.
2. Determine the stresses in pressure vessels.
3. Design and analyse the pressure vessels.
4. Perform buckling and fracture analysis in vessels
5. Design and analyse piping layout.

TEXT BOOKS:
2. Theory And Design Of Pressure Vessels (Pb 2001) by HARVEY J.F. | 1 January 2001

REFERENCES:
5. Theory and design of Pressure Vessels (Pb 2001) by HARVEY J.F. | 1 January 2001

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PTME3016  BIOENERGY CONVERSION TECHNIQUES  L  T  P  C  
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COURSE OBJECTIVES:

To elucidate on biomass, types, availability, and characteristics

UNIT – I  INTRODUCTION  

UNIT – II  BIOMETHANATION  
Biomethanation process – influencing parameters – typical feed stocks – Biogas plants: types and design, Biogas appliances – burner, luminaries and power generation systems – Industrial effluent based biogas plants.

UNIT – III  COMBUSTION  
Perfect, complete and incomplete combustion – stoichiometric air requirement for biofuels - equivalence ratio – fixed Bed and fluid Bed combustion

UNIT – IV  GASIFICATION, PYROLYSIS AND CARBONISATION  

UNIT – V  LIQUIFIED BIOFUELS  
Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry - Biodiesel Vs. Diesel – comparison on emission and performance fronts. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications

TOTAL :45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:
1. Estimate the surplus biomass availability of any given area.
2. Design a biogas plant for a variety of biofuels.
3. Determine and compare the cost of steam generation from biofuels with that of coal and petroleum fuels.
4. Analyse the influence of process governing parameters in thermochemical conversion of biomass.
5. Synthesize liquid biofuels for power generation from biomass.

TEXTBOOKS:
REFERENCES:
1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester, 1984.
2. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
5. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981

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COURSE OBJECTIVE:
To learn quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign

UNIT – I  INTRODUCTION

UNIT – II  ELECTRICAL SUPPLY SYSTEMS
Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers – Harmonics

UNIT – III  ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES

UNIT – IV  ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES
Energy conservation in: Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems

UNIT – V  ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS

OUTCOMES:
At the end of the course the students would be able to:
1. Discuss Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign
2. Analyse factors behind energy billing and apply the concept of demand side management for lowering energy costs
3. Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries
4. Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency
5. Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

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PTME3018  ERGONOMICS IN DESIGN  L  T  P  C  3  0  0  3

COURSE OBJECTIVE:
To introduce to industrial design with considerations of ergonomics, aesthetics and environmental aspects.

UNIT – I  INTRODUCTION  9
An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT – II  ERGONOMICS AND PRODUCTION  9
Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt’s perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT – III  DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS  9
Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

UNIT – IV  VISUAL ASPECTS  9
Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipment, Colour coding, Psychological effects, colour and machine form, colour and style

UNIT – V  AESTHETIC CONCEPTS  9
Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software’s, total layout design.

TOTAL: 45 periods

COURSE OUTCOMES:
At the end of the course the students would be able to
1. Appreciate ergonomics need in the industrial design.
2. Apply ergonomics in creation of manufacturing system
3. Discuss on design of controls and display.
4. Consider environmental factors in ergonomics design.
5. Report on importance of aesthetics to manufacturing system and product

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Director
COURSE OBJECTIVE: The main objective of this course is to prepare the students on generic development processes and new product development.

UNIT I  INTRODUCTION TO PRODUCT DEVELOPMENT  9

UNIT II  PRODUCT PLANNING, CUSTOMER NEEDS IDENTIFICATION & PRODUCT SPECIFICATION  9

UNIT III  PRODUCT CONCEPT GENERATION, SELECTION & TESTING  9
Activity of Concept Generation – Concept Selection – Concept Screening – Concept Scoring – Caveats – Concept Testing.

UNIT IV  PRODUCT ARCHITECTURE & INDUSTRIAL DESIGN,  9

UNIT V  DESIGN FOR MANUFACTURING & PROTOTYPING  9

TOTAL: 45 PERIODS

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

CO1  Apply the principles of generic development process; and understanding the organization structure for new product development. identify the opportunity and planning for new product development.

CO2  Conduct customer need analysis; and to design and set product specification for new product development.

CO3  Generate, select, and test the concepts for new product development

CO4  Apply principles of product architecture and industrial design for new product development.

CO5  Apply the principles in design for manufacturing and prototyping for new product development.
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PTME3020  PRODUCT LIFE CYCLE MANAGEMENT  L  T  P  C

COURSE OBJECTIVE:
The main objective of the course is to prepare the students for understanding and applying the fundamental concepts and principles behind PLM in Product Design & Development.

UNIT I  INTRODUCTION TO PLM

UNIT II  PLM ENVIRONMENT: BUSINESS PROCESS

UNIT III  PLM ENVIRONMENT: PRODUCT DATA

UNIT IV  PLM ENVIRONMENT: INFORMATION SYSTEMS

UNIT V  PLM ENVIRONMENT: PROJECT MANAGEMENT

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1  Apply the fundamental concepts and principles behind PLM in Product Design & Development.
CO2  Apply the business process concept of PLM in Product Design & Development.
CO3  Apply the product data concept of PLM in Product Design & Development.
CO4  Apply the information systems concept of PLM in Product Design & Development.
CO5  Apply the project management concept of PLM in Product Design & Development.
**TEXT BOOKS:**

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# PTME3021 ENERGY EFFICIENT BUILDINGS

**COURSE OBJECTIVE:**

1. To learn energy saving concepts in buildings through incorporation of renewable energy systems

## UNIT – I INTRODUCTION

Climate and Building, Historical perspective, Aspects of Net Zero building design – Sustainable Site, Water, Energy, Materials and IGBC, LEED, GRIHA, IEQ and ECBC Standards

## UNIT – II LANDSCAPE AND BUILDING ENVELOPES

Energy efficient landscape design – Micro climates – various methods – Shading, water bodies – Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, insulation, Design methods and tools

## UNIT – III THERMAL COMFORT, PASSIVE HEATING AND COOLING


## UNIT – IV ENERGY CONSERVATION IN BUILDING UTILITIES


## UNIT – V RENEWABLE ENERGY IN BUILDINGS


**TOTAL:45 PERIODS**

**OUTCOMES:**

At the end of the course the students would be able to:

1. Familiar with climate responsive building design and basic concepts
2. Explain the basic terminologies related to buildings
3. Discuss the energy efficient air conditioning techniques
4. Evaluate the performance of buildings
5. Gets acquainted with Renewable energy systems in buildings

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COURSE OBJECTIVES:
To learn the various renewable energy technologies and its applications.

UNIT – I ENERGY SCENARIO 9
Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status - Potential of various renewable energy sources - Global energy status - Per capita energy consumption - Future energy plans

UNIT – II SOLAR ENERGY 9

UNIT – III WIND ENERGY 9

UNIT – IV BIO-ENERGY 9

UNIT – V OCEAN AND GEOTHERMAL ENERGY 9

TOTAL: 45 PERIODS

OUTCOMES: At the end of the course the students would be able to
1. Discuss the Indian and global energy scenario.
2. Describe the various solar energy technologies and its applications.
3. Explain the various wind energy technologies.
4. Explore the various bio-energy technologies.
5. Discuss the ocean and geothermal technologies.

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COURSE OBJECTIVES:
To study the various types of energy storage devices, their performance and its technological applications

UNIT – I  INTRODUCTION TO ENERGY STORAGE  9

UNIT – II  ENERGY STORAGE SYSTEMS  9

UNIT – III  MOBILE AND HYBRID ENERGY STORAGE SYSTEMS  9
Batteries for electric vehicles – Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS.

UNIT – IV  RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT  9

UNIT – V  OTHER ENERGY DEVICES  9

TOTAL: 45

OUTCOMES:
At the end of the course the students would be able to:
1. Discuss the need and identify the suitable energy storage devices for applications.
2. Explain the working of various energy storage devices and their importance.
3. Explain the basic characteristics of batteries for mobile and hybrid systems.
4. Discuss the storage of renewable energies and management systems.
5. Explain the need for other energy devices and their scope for applications.

TEXT BOOKS:

REFERENCES:
2. Ibrahim Dincer and Mark A Rosen, “Thermal Energy Storage Systems and..."

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**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students to understand metallurgical changes that occur during surface modification.

**UNIT I SURFACES & FRICTION**

- Basics of surfaces features – Roughness parameters – surface measurement - Cause of friction
- Contact mechanics.

**UNIT II WEAR & CORROSION**

- Types of Wear, Adhesive, Abrasive, Oxidative, Corrosive, Erosive and Fretting Wear, Roles of Friction and Lubrication, Wear-debris analysis, Theoretical wear models, Standards,

**UNIT III CORROSION OF INDUSTRIAL COMPONENTS & TESTING**


**UNIT IV PLATING & THIN FILM COATINGS**

- Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy,
- Fundamentals of electroplating, Electrodeposition from plating baths, Electroless plating, Metalliding, Selective plating, CLC, Hard anodizing, Thermal evaporation, PVD and CVD, Sputter coating, Ion plating, Thinfilm for wear application, Coating specifications.

**UNIT V HARD FACING PROCESSES AND APPLICATIONS**


**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to:

- **CO1** Explain the different failures that occur on the surface of the engineering components.
- **CO2** Discuss on the kinetic aspects and the effect of various parameters on the rate of corrosion.
- **CO3** Interpret the corrosion failures that occur in different industrial components and articulate the results obtained from the corrosion testing.
- **CO4** Discuss on the various plating techniques and thin film coatings.
- **CO5** Implement suitable corrosion protection methods in critical engineering components.

**TOTAL : 45**
TEXT BOOKS:

REFERENCES:
4. Stand Grainger Engineering Coatings – Design and Application Jaico Publishing House,

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COURSE OBJECTIVES
To provide knowledge on the various hybrid electric powertrain configurations, electric vehicle controls, drives, and energy storage technologies.

UNIT – I  INTRODUCTION  9
Basics of vehicle performance, vehicle power source characterization, transmission characteristics. History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, the impact of modern drive-trains on energy supplies.

UNIT – II  HYBRID ELECTRIC DRIVE TRAINS  9
Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT – III  CONTROL OF AC & DC DRIVES  9
Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switch Reluctance Motor drives, drive system efficiency.

UNIT – IV  ENERGY STORAGE  9

UNIT – V  DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES  9
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting of appropriate energy storage technology; Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
  At the end of the course the students would be able to
  1. Discuss Characterize and configure hybrid drivetrains requirement for a vehicle
  2. Design and apply appropriate hybrid and electric drive trains in a vehicle
  3. Design and install suitable AC and DC drives for electric vehicles.
  4. Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle
  5. Apply energy management strategies to ensure better economy and efficiency

TEXT BOOKS:
REFERENCES:
2 Rand D.A.J, Woods, R &amp; Dell RM Batteries for Electric vehicles, John Wiley &amp; Sons, 1998
4 Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar | 11 February 2011
5 Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December 2013

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COURSE OBJECTIVE:
To impart knowledge on the significance of battery thermal management and its impact on performance and safety

UNIT – I ADVANCED BATTERIES
Li-ion Batteries- chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S- 18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Supercapacitors Vs batteries. Diamond battery concepts.

UNIT – II THERMAL MANAGEMENT IN BATTERIES

UNIT – III BATTERY THERMAL MANAGEMENT CASE STUDIES

UNIT – IV THERMAL MANAGEMENT IN FUEL CELLS
Fuel Cells- operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.

UNIT – V FUEL CELL THERMAL MANAGEMENT CASE STUDIES

TOTAL: 45PERIODS

COURSE OUTCOMES:
At the end of the course the students would be able to
1 Discuss the different Li-ion Batteries and Fuel Cell performances.
2 Design a Battery Pack with appropriate PCM.
3 Apply Cooling Models using Simulation
4 Estimate fuel economy.
5 Utilize different Thermal Management System approaches during real world usage.

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COURSE OBJECTIVE:
To understand the basics of drone concepts, fundamentals of design, fabrication and programming of drone

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9
Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9
Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9
Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone Controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9
Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9
The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Know about a various type of drone technology, drone fabrication and programming.
CO2: Execute the suitable operating procedures for functioning a drone
CO3: Select appropriate sensors and actuators for Drones
CO4: Develop a drone mechanism for specific applications
CO5: Create the programs for various drones

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PTME3028 INTEGRATED PRODUCT DESIGN AND MANUFACTURING USING GD&T

COURSE OBJECTIVES:
To impart the knowledge on GD&T to interpret engineering drawings from the manufacturing perspective, and for cost effective manufacturing of products.

UNIT I Need for GD&T and basic concepts
Engineering drawings and tolerancing - Dimensioning, dimensioning standards and rules, Geometric properties of a surface - Coordinate tolerancing system and its shortcomings, Geometric dimensioning and tolerancing system - benefits, Symbols & terms as per ASME Y14.5M, rules and concepts, virtual condition and bonus tolerance

UNIT II Form, Datums, and Orientation controls
Flatness, Straightness, Circularity and Cylindricity control; Datums - Implied datums, Planar datums, datum targets, FOS datum features, FOS datum features applications RFS, at MMC and LMC, Orientation controls - Perpendicularity, Angularity and parallelism control of axis / midplane

UNIT III Position, Concentricity, Symmetry, Runout and Profile controls
Tolerance of position - Position vs Coordinate conversion, Tolerance of position RFS, at MMC and LMC, TOP calculations, fixed and floating fastener calculations; Runout control - circular, total and runout calculations, Profile control - surface, line, Profile modifiers, Derived element controls - Straightness derived median line, Flatness derived median plane, Concentricity control, Symmetry control.

UNIT IV GD&T for Integrated product design and manufacturing
Concurrent engineering in Y14.5M, Datum reference frames, Foundation of geometric control: interrelated features, the boundary concept, Taylor's principle, and refinement of controls; Application considerations, Product and process design - The six step methodology, Developing the tooling and gaging designs needed to create a producible product

UNIT V GD&T for Integrated product design and manufacturing
Producibility design cycle, datum - specification, selection, qualification, and identification; Phantom gage dimensioning, Dimensional measurements, Inspection and verification, functional gaging, functional gage tolerancing, functional inspection techniques, functional workholding and fixturing, Implementation and process improvement.

TOTAL : 45

COURSE OUTCOMES:

CO1 Explain why geometric tolerancing is superior to coordinate tolerancing
CO2 Interpret the symbols and material modifiers used in GD&T
CO3 Define the key terms used in GD&T
CO4 Interpret applications of datum targets, size datum features, and size datum
features

**COS** Interpret the various types of tolerance (flatness, circularity, cylindricity, straightness, perpendicularity, parallelism, angularity, position, runout, and profile)

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PTME3029 NON-TRADITIONAL MACHINING PROCESSES  L  T  P  C

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COURSE OBJECTIVE:
To impart knowledge on working principles, process characteristics and applications of various nontraditional machining processes

UNIT I  INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES
Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Mechanical energy based non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining - working principle, equipment, effect of process parameters, applications, advantages and limitations.

UNIT II  CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES
Principles, equipment, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring

UNIT III  THERMO-ELECTRIC ENERGY BASED PROCESSES
Electric discharge machining - Principle, equipment, effect of process parameters, workpiece and electrode materials, applications, advantages and limitations, Improvements - Powder mixed EDM, cryogenic assisted EDM, magnetic field assisted EDM, Wire electric discharge machining, Electro-discharge grinding, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT IV  NANO FINISHING PROCESSES
Abrasive flow machining - Principle, equipment, effect of process parameters, applications, advantages and limitations – Chemo-mechanical polishing, Drag finishing of cutting tools and biomedical implants, Magnetic field assisted nanofinishing processes - Magnetic abrasive finishing, Magnetorheological finishing, Magnetorheological abrasive flow finishing

UNIT V  HYBRID NON-TRADITIONAL MACHINING PROCESSES
Assisted hybrid machining processes their working principles, equipment, effect of process parameters, applications, advantages and limitations - Vibration assisted conventional processes - turning, drilling, milling and grinding, Vibration assisted non-traditional processes - ECM, EDM; Thermal assisted machining - Laser assisted conventional machining, Plasma assisted conventional machining, Laser assisted ECM, EDM

TOTAL : 45 PERIODS

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

CO1  Classify different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.

CO2  Explain the principle and applications of chemical and electro chemical energy based processes.
CO3 Explain the principle of thermo-electric energy based processes and analyse the effect of process parameters on EDM.

CO4 Select a suitable nano-finishing process for the given application.

CO5 Explain the need and principle of assisted / hybrid conventional and non-traditional machining processes.

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Attested

Director
Centre for Academic Courses
Anna University, Chennai-600 025
COURSE OBJECTIVE:
To impart knowledge on the measurement of various physical parameters using Data Acquisition system.

UNIT – I INTRODUCTION

UNIT – II MOTION, PROXIMITY AND RANGING SENSORS

UNIT – III FORCE, MAGNETIC AND HEADING SENSORS

UNIT – IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS

UNIT – V SIGNAL CONDITIONING AND DAQ SYSTEMS

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course the students would be able to
1. Recognize with various calibration techniques and signal types for sensors.
2. Explain the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.
3. Apply the various sensors and transducers in various applications.
4. Select the appropriate sensor for different applications.
5. Acquire the signals from different sensors using Data acquisition systems.

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![Progress Through Knowledge Logo](image)
PTME3031 PROCEDURE PLANNING AND COST ESTIMATION

COURSE OBJECTIVE:
To impart knowledge on creation of process plan and estimation of cost for various manufacturing operations.

UNIT – I INTRODUCTION TO PROCESS PLANNING

UNIT – II PROCESS PLANNING STEPS

UNIT – III INTRODUCTION TO COST ESTIMATION

UNIT – IV PRODUCTION COST ESTIMATION
Estimation of production cost for - Casting processes, Welding processes, and Forging processes.

UNIT – V ESTIMATION OF MACHINING TIME AND COST
Estimation of Machining time – Lathe operations, Drilling, Milling, Shaping and Planning, and Grinding, Cost estimation for machining processes.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course the students would be able to
1. Explain the process flow for a given Product.
2. Create a process plan for manufacturing a component.
3. Estimate the overhead cost and breakeven associated with manufacturing.
4. Evaluate the total cost for the Cast, welded and Forged products.
5. Analyze the machining time and estimate the cost of machined product.

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COURSE OBJECTIVES:
To learn the basic concepts of different types of electrical machines and their performance.

UNIT – I  INTRODUCTION
Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives– heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors

UNIT – II  DRIVE MOTOR CHARACTERISTICS
Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors– Braking of Electrical motors – DC motors: Shunt, series, and compound - single phase and three phase induction motors.

UNIT – III  STARTING METHODS
Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phasesquirrel cage and slip ring induction motors.

UNIT – IV  CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF D.C. DRIVES
Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers – applications.

UNIT – V  CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF A.C. DRIVES
Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course the students would be able to:
1. Discuss the basic concepts of different types of electrical machines and their performance.
2. Explain the different methods of starting D.C motors and induction motors.
3. Discuss the conventional and solid-state drives.
4. Describe the conventional and solid-state speed control of D.C. drives.
5. Explain the conventional and solid-state speed control of A.C. drives.

TEXT BOOKS:

REFERENCES:
4. Fundamentals Of Electric Drives And Control by B.R. Gupta and V. Singhal | 1 January 2013
5. Advanced Electrical Drives - Analysis ModelingControl by Rik De Doncker, Andre Veltman, et al. | 1 January 2014

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**Fundamentals Of Electric Drives And Control by B.R. Gupta and V. Singhal | 1 January 2013**

**Advanced Electrical Drives - Analysis ModelingControl by Rik De Doncker, Andre Veltman, et al. | 1 January 2014**
COURSE OBJECTIVE:
The main learning objective of this course is to prepare the students for analyzing the various design requirements and get acquainted with the processes involved in product development.

UNIT I DESIGN TERMINOLOGY
Definition- various methods and forms of design-importance of product design-static and dynamic products- various design projects- morphology of design- requirements of a good design- concurrent engineering- computer aided engineering- codes and standards- product and process cycles- benchmark marking.

UNIT II DESIGN PROCESSES AND DESIGN FOR QUALITY
Basic modules in design process- scientific method and design method- Need identification, importance of problem definition- real life problem- information gathering- customer requirements- Quality Function Deployment (QFD)- product design specifications- generation of alternative solutions- Analysis and selection- Detail design and drawings- Prototype, modeling, simulation, testing and evaluation- Design of Experiments

UNIT III CREATIVITY IN DESIGN AND RELIABILITY
Creativity and problem solving- vertical and lateral thinking- invention- psychological view, mental blocks- Creativity methods- brainstorming, synectics, force fitting methods, mind map, concept map- Theory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts.
Reliability- Survival and Failure- Series and parallel systems- Mean time between failure- Weibull distribution

UNIT IV HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT
Human factors in design, ergonomics, user friendly design- Aesthetics and visual aspects- environmental aspects- marketing aspects- team aspects- legal aspects- presentation aspects

UNIT V MATERIAL AND PROCESSES IN DESIGN
Material selection for performance characteristics of materials- selection for new design substitution for existing design- economics of materials- selection methods- recycling and material selection- types of manufacturing process, process systems- Design for Manufacturability (DFM) - Design for Assembly (DFA).

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

CO1 Articulate the various design requirements and get acquainted with the processes involved in product development.
CO2 Design the processes to develop a successful and a quality product.
CO3 Implement the scientific approaches to provide reliable design solutions.
CO4 Integrate human and societal aspects in design.
CO5 Select materials and manufacturing processes in design.
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PTME3034  TURBO MACHINES  

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**COURSE OBJECTIVES:**
To study the energy transfer in rotor and stator parts of the turbo machines, centrifugal fans, blowers, compressors and turbines.

**UNIT – I  WORKING PRINCIPLES**

**UNIT – II  CENTRIFUGAL FANS AND BLOWERS**

**UNIT – III  CENTRIFUGAL COMPRESSOR**
Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.

**UNIT – IV  AXIAL FLOW COMPRESSOR**

**UNIT – V  AXIAL AND RADIAL FLOW TURBINES**

**TOTAL : 45 PERIODS**

**OUTCOMES:**
At the end of the course the students would be able to:
1. Explain the energy transfer in rotor and stator parts of the turbo machines.
2. Explain the function of various elements of centrifugal fans and blowers.
3. Evaluate the working and performance of centrifugal compressor.
4. Analyze flow behavior and flow losses in axial flow compressor.
5. Explain the types and working of axial and radial flow turbines.

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