Course Code | 17ME35 A /45A | CIE Marks | 40
Number of Lecture Hours/Week | 04 | SEE Marks | 60
Total Number of Lecture Hours | 50(10 Hours per Module) | Exam Hours | 03
Credits – 04

Course Objectives:

- To provide detailed information about the moulding processes.
- To provide knowledge of various casting process in manufacturing.
- To impart knowledge of various joining process used in manufacturing.
- To provide adequate knowledge of quality test methods conducted on welded and casted components.

Module - 1

INTRODUCTION & BASIC MATERIALS USED IN FOUNDRY

Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy.

Introduction to casting process & steps involved. Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.

Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types

Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger. Study of important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold. Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line, horn gate) and rise ring (open, blind) Functions and types

Module - 2

MELTING & METAL MOLD CASTING METHODS

Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace,
constructional features & working principle of cupola furnace.

**Casting using metal molds:** Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes

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**Module - 3**

**SOLIDIFICATION & NON FERROUS FOUNDRY PRACTICE**
Solidification: Definition, Nucleation, solidification variables, Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods.

Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process

Nonferrous foundry practice: Aluminum castings - Advantages, limitations, melting of aluminum using lift-out type crucible furnace. Hardeners used, drossing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations.

Module - 4

WELDING PROCESS


Module - 5

SOLDERING, BRAZING AND METALLURGICAL ASPECTS IN WELDING

Structure of welds, Formation of different zones during welding, Heat Affected Zone (HAZ), Parameters affecting HAZ. Effect of carbon content on structure and properties of steel, Shrinkage in welds & Residual stresses, Concept of electrodes, filler rod and fluxes. Welding defects- Detection, causes & remedy.


Course outcomes:

- Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investment and plaster molds.
- Explain the Pattern, Core, Gating, Riser system and Jolt, Squeeze, Sand Slinger Molding Machines.
- Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.
- Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.
- Explain the Solidification process and Casting of Non-Ferrous Metals.
- Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes used in manufacturing.
- Explain the Resistance spot, Seam, Butt, Projection, Friction, Explosive, Thermit, Laser and Electron Beam Special type of welding.
Describe the Metallurgical aspects in Welding and inspection methods for the quality assurance of components made of casting and joining process.

TEXT BOOKS:

MACHINE TOOLS AND OPERATIONS

B.E, III/IV Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code 17ME35 B / 45B CIE Marks 40 SEE Marks 60 Exam Hours 03

Credits – 04

Course Objectives:

- To introduce students to different machine tools in order to produce components having different shapes and sizes.
- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To develop the knowledge on mechanics of machining process and effect of various parameters on economics of machining.

Module - 1

MACHINE TOOLS
Introduction, Classification, construction and specifications of lathe, drilling machine, milling machine, boring machine, broaching machine, shaping machine, planning machine, grinding machine [Simple sketches showing major parts of the machines]

Module - 2

MACHINING PROCESSES
Introduction, Types of motions in machining, turning and Boring, Shaping, Planning and Slotting, Thread cutting, Drilling and reaming, Milling, Broaching, Gear cutting and Grinding, Machining parameters and related quantities.
### Module - 3

**CUTTING TOOL MATERIALS, GEOMETRY AND SURFACE FINISH**

Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish.

**Machining equations for cutting operations:** Turning, Shaping, Planing, slab milling, cylindrical grinding and internal grinding, Numerical
### Module - 4

**MECHANICS OF MACHINING PROCESSES**

### Module - 5

**TOOL WEAR, TOOL LIFE:** Introduction, tool wear mechanism, tool wear equations, tool life equations, effect of process parameters on tool life, machinability, Numerical problems

**ECONOMICS OF MACHINING PROCESSES:** Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, machining at maximum efficiency, Numerical problems

### Course outcomes:

- Explain the construction & specification of various machine tools.
- Describe various machining processes pertaining to relative motions between tool & work piece.
- Discuss different cutting tool materials, tool nomenclature & surface finish.
- Apply mechanics of machining process to evaluate machining time.
- Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.

### TEXT BOOKS:

### REFERENCE BOOKS
REFRIGERATION AND AIR-CONDITIONING
(Professional Elective-I)

[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]

SEMESTER - V

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CREDITS - 03

Pre-requisites: Basic and Applied Thermodynamics

Course objectives

1. Study the basic definition, ASHRAE Nomenclature for refrigerating systems
2. Understand the working principles and applications of different types of refrigeration systems
3. Study the working of air conditioning systems and their applications
4. Identify the performance parameters and their relations of an air conditioning system

Course Outcomes

At the end of the course, the student will be able to:

1. Illustrate the principles, nomenclature and applications of refrigeration systems.
2. Explain vapour compression refrigeration system and identify methods for performance improvement
3. Study the working principles of air, vapour absorption, thermoelectric and steam-jet and thermo-acoustic refrigeration systems
4. Estimate the performance of air-conditioning systems using the principles of psychrometry.
5. Compute and Interpret cooling and heating loads in an air-conditioning system
6. Identify suitable refrigerant for various refrigerating systems
Module - I


Industrial Refrigeration- Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous 8 Hours

Module - II

Vapour Compression Refrigeration System (VCRS): Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle

- liquid-suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP - Ewing's construction and Gosney's method. Actual cycles with pressure drops,

Complete Vapour Compression Refrigeration System, Multi-Pressure, Multi-evaporator systems or Compound Vapour Compression Refrigeration Systems - Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.

Module - III


Other types of Refrigeration systems: Brief Discussion on (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration, pulse tube refrigeration, thermo acoustic refrigeration systems 8 Hours

Module - IV
Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures - zeotropic and azeotropic mixtures

Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators,

A brief look at other components of the system. 8 Hours

Module - V


Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.),

Air conditioning systems for trains, Air conditioning systems for ships. 8 Hours

TEXT BOOKS

2. Roy J. Dossat, Principles of Refrigeration, Wiley Limited

REFERENCE BOOKS
3. PITA, Air conditioning 4th edition, pearson-2005
4. Refrigeration and Air-Conditioning' by Manohar prasad
5. S C Arora & S Domkundwar, Refrigeration and Air-Conditioning Dhanpat Rai Publication
6. http://nptel.ac.in/courses/112105128/#

Data Book:


E- Learning

- VTU, E-learning, MOOCS, Open courseware

THEORY OF ELASTICITY

(Professional Elective-I)
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]

SEMESTER - V

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CREDITS - 03

Course objectives

1. To gain knowledge of stresses and strains in 3D and their relations and thermal stresses.
2. To understand the 2D analysis of elastic structural members.
3. To gain knowledge of thermal stresses and stability of columns
4. To analyse elastic members for the stresses and strains induced under direct loading conditions.
5. To analyse the axisymmetric and torsional members.
6. To analyse the thermal stresses induced in disks and cylinders.
7. To analyse the stability of columns

Course outcomes

At the end of course student able to:

1. Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads and thermal loads.
2. Analyse the structural members: beam, rotating disks, columns
3. Analyse the torsional rigidity of circular and non-circular sections.
4. Analyse the stability of columns

Module - 1

Analysis of Stress: Definition and notation of stress, equations of equilibrium in differential form, stress components on an arbitrary plane, equality of cross shear, stress invariants,
principal stresses, octahedral stress, planes of maximum shear, stress transformation, plane state of stress,

**Numerical problems**

**8 Hours**

**Module - 2**

**Analysis of Strain:** Displacement field, strains in term of displacement field, infinitesimal strain at a point, engineering shear strains, strain invariants, principal strains, octahedral strains, plane state of strain, compatibility equations, strain transformation, Numerical Problems.

**8 Hours**

**Module - 3**

**Two-Dimensional classical elasticity Problems:** Cartesian co-ordinates - Relation between plane stress and plane strain, stress functions for plane stress and plane strain state, Airy’s stress functions, Investigation of Airy’s stress function for simple beams, bending of a narrow cantilever beam of rectangular cross section under edge load. Bending of simply supported beam under UDL. General equations in polar coordinates, stress distribution symmetrical about an axis, Thick wall cylinder subjected to internal and external pressures, Numerical Problems.

**10 Hours**

**Module - 4**

**Axisymmetric and Torsion problems:** Stresses in rotating discs of uniform thickness and cylinders. Torsion of circular, elliptical and triangular bars, Prandtl’s membrane analogy, torsion of thin walled thin tubes, torsion of thin walled multiple cell closed sections. Numerical Problems

**8 Hours**

**Module -5**

**Thermal stress and Elastic stability:** Thermo elastic stress strain relations, equations of equilibrium, thermal stresses in thin circular discs and in long circular cylinders. Euler’s column buckling load: clamped-free, clamped-hinged, clamped-clamped and pin-ended, Numerical Problems

**8 Hours**
HUMAN RESOURCE MANAGEMENT

(Professional Elective-I)

[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]

SEMESTER - V

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CREDITS - 03

Objectives:

1. To develop a meaningful understanding of HRM theory, functions and practices.
2. To apply HRM concepts and skills across various types of organizations.

Course Outcomes

On completion of the course the student will be able to
1. Understand the importance, functions and principles Human Resource Management and process of Job analysis

2. Summarize the objectives of Human Resource planning, Recruitment and selection process

3. Understand the process involved in Placement, Training and development activities.

4. Understand the characteristics of an effective appraisal system and compensation planning.

5. Understand the issues related to employee welfare, grievances and discipline.

Module – 1

Human Resource Management

Introduction, meaning, nature, scope of HRM. Importance and Evolution of the concept of HRM. Major functions of HRM, Principles of HRM, Organization of Personnel department, Role of HR Manager.

Job Analysis: Meaning, process of job analysis, methods of collecting job analysis data,

Job Description and Specification, Role Analysis. 08 hours

Module – 2

Human Resource Planning: Objectives, Importance and process of Human Resource planning, Effective HRP

Recruitment: Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment.

Selection: Definition and Process of Selection. 08 hours

Module – 3

Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation.

Training and development: Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods, Executive Development,
Methods and Development of Management Development, Career and Succession Planning.

**Module - 4**

**Performance Appraisal:** Concept of Performance Appraisal, the Performance Appraisal process, Methods of Performance Appraisal, Essential Characteristic of an Effective Appraisal System.

**Compensation:** Objectives of Compensation Planning, Job Evaluation, Compensation Pay Structure in India, Wage and Salary Administration, Factors Influencing Compensation Levels, Executive Compensation.

**Module - 5**


**Discipline:** Meaning, approaches to discipline, essential of a good disciplinary system, managing difficult employees.

**TEXT BOOKS**


**REFERENCE BOOKS**

NON TRADITIONAL MACHINING
(Professional Elective-I)

[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]

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CREDITS - 03

Course Outcomes

On completion of the course, the students will be able to

1. Understand the compare traditional and non-traditional machining process and recognize the need for Non-traditional machining process.

2. Understand the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.

3. Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.

4. Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.

5. Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM.

MODULE 1
INTRODUCTION

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

MODULE 2

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.


Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.

MODULE 3

ELECTROCHEMICAL MACHINING (ECM)


Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process.

Advantages, disadvantages and application of ECG, ECH.

CHEMICAL MACHINING (CHM)
Elements of the process: Resists (maskants), Etchants. Types of chemical machining process—chemical blanking process, chemical milling process.

Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.  

10 hours

MODULE 4

ELECTRICAL DISCHARGE MACHINING (EDM)

Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium—its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.

PLASMA ARC MACHINING (PAM)

Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.  

08 hours

MODULE 5

LASER BEAM MACHINING (LBM)

Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM)

Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.  

08 hours
Text Books:


Reference Books

1. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000

OPTIMIZATION TECHNIQUES

(OPEN ELECTIVE – I)

[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]

SEMESTER – V

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CREDITS – 03

COURSE OBJECTIVES

Course Objective:

The general objectives of the course is to

1. Introduce the fundamental concepts of Optimization Techniques;
2. Make the learners aware of the importance of optimizations in real scenarios;
3. Provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

**COURSE OUTCOMES**

Upon successful completion of this course, students will be able to

1. Understand the overview of optimization techniques, concepts of design space, constraint surfaces and objective function.
2. Review differential calculus in finding the maxima and minima of functions of several variables.
3. Formulate real-life problems with Linear Programming.
4. Solve the Linear Programming models using graphical and simplex methods.
5. Formulate real-life transportation, assignment and travelling salesman problems to find the optimum solution using transportation algorithms.
6. Analyze the Queuing model for effective customer satisfaction.
7. Apply dynamic programming to optimize multi stage decision problems.
8. Determine the level of inventory that a business must maintain to ensure smooth operation.
9. Construct precedence diagram for series of activities in a huge project to find out probability of expected completion time using PERT-CPM networks. Also reduce the duration of project by method of crashing.

**MODULE I**

**Introduction to Classical Optimization Techniques**


**Classical Optimization Techniques**

Single variable Optimization, Multi variable Optimization with and without constraints, Multivariable Optimization with equality constraints - solution by method of Lagrange multipliers, Multivariable Optimization with inequality constraints - Kuhn - Tucker conditions.

(8Hours)

**MODULE II**

**Linear Programming**
Various definitions, statements of basic theorems and properties, Advantages, Limitations and Application areas of Linear Programming, Graphical method of Linear Programming problem.

Simplex Method - Phase I and Phase II of the Simplex Method, The Revised Simplex method, Primal and Dual Simplex Method, Big - M method.  

(10 Hours)

MODULE III

Transportation Problem

Finding initial basic feasible solution by north - west corner rule, least cost method and Vogel's approximation method - testing for optimality of balanced transportation problems. (Including assignment and travelling salesman problems) (No degeneracy problems)

Queuing

Queuing Models: Essential features of queuing systems, operating characteristics of queuing system, probability distribution in queuing systems, classification of queuing models, solution of queuing M/M/1 : ∞ /FCFS, M/M/1 : N/FCFS, M/M/C : ∞/FCFS, M/M/C : N/FCFS.

(8 Hours)

MODULE IV

Dynamic Programming

**Integer Programming**

Pure and mixed integer programming problems, Solution of Integer programming problems – Gomory’s all integer cutting plane method and mixed integer method, branch and bound method, Zero-one programming. (8 Hours)

**MODULE V**

**Simulation Modeling**

Introduction, Definition and types, Limitations, Various phases of modeling, Monte Carlo method, Applications, advantages and limitations of simulation

**Inventory Models**

Role of demand in the development of inventory models, objectives, inventory costs, quantity discount, Economic Order Quantity (EOQ), EOQ when stock replenishment is not instantaneous, Economic lot size when shortages are allowed, economic lot size with different rate of demand in different cycles (Instantaneous replenishment). (No Dynamic EOQ Models) (8 Hours)

**TEXT BOOKS**


**REFERENCE BOOKS**

- Operations Research - by S.D. Sharma, Kedarnath Ramanath & Co

- Industrial Engineering and Production Management, M. Mahajan, Dhanpat Rai & co
ENERGY AND ENVIRONMENT

(OPEN ELECTIVE - I)

[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]

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Course Objectives

- Understand energy scenario, energy sources and their utilization
- Learn about methods of energy storage, energy management and economic analysis
- Have proper awareness about environment and eco system.
- Understand the environment pollution along with social issues and acts.

Course Outcomes

At the end of the course, the student will be able to:

1. Summarize the basic concepts of energy, its distribution and general Scenario.
2. Explain different energy storage systems, energy management, audit and economic analysis.
3. Summarize the environment eco system and its need for awareness.
4. Identify the various types of environment pollution and their effects.
5. Discuss the social issues of the environment with associated acts.

Module - I

Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India’s energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment.

8 Hours
Module - II

**Energy storage systems:** Thermal energy storage methods, Energy saving, Thermal energy storage systems

**Energy Management:** Principles of Energy Management, Energy demand estimation, Energy pricing

**Energy Audit:** Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries

**Economic Analysis:** Scope, Characterization of an Investment Project

10 Hours

Module - III

**Environment:** Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness.

**Ecosystem:** Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.

8 Hours

Module - IV

**Environmental Pollution:** Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies.

8 Hours

Module - V


8 Hours
TEXT BOOKS:

1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education by University grant commission and Bharathi Vidyapeeth Institute of environment education and Research ,Pune


REFERENCE BOOKS:


E- Learning

2. Open courseware

AUTOMATION AND ROBOTICS

(OPEN ELECTIVE - I)
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]

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Course Outcomes

On completion of the course student will be able to

- Classify various types of automation & manufacturing systems
- Discuss different robot configurations, motions, drive systems and its performance parameters.
- Describe the basic concepts of control systems, feedback components, actuators and power transmission systems used in robots.
- Explain the working of transducers, sensors and machine vision systems.
- Discuss the future capabilities of sensors, mobility systems and Artificial Intelligence in the field of robotics.

Module - 1

Automation

History of Automation, Reasons for automation, Disadvantages of automation, Automation systems, Types of automation - Fixed, Programmable and Flexible automation, Automation strategies


Module - 2

Robotics
Definition of Robot, History of robotics, Robotics market and the future prospects, Robot Anatomy, Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration.

Robot motions, Joints, Work volume, Robot drive systems, Precision of movement - Spatial resolution, Accuracy, Repeatability, End effectors - Tools and grippers.

08 Hours

Module - 3

Controllers and Actuators

Basic Control System concepts and Models, Transfer functions, Block diagrams, characteristic equation, Types of Controllers: on-off, Proportional, Integral, Differential, P-I, P-D, P-I-D controllers. Control system and analysis.

Robot actuation and feedback components


09 Hours

Module - 4

Robot Sensors and Machine vision system

Sensors in Robotics - Tactile sensors, Proximity and Range sensors, use of sensors in robotics.

Machine Vision System: Introduction to Machine vision, the sensing and digitizing function in Machine vision, Image processing and analysis, Training and Vision systems. 08 Hours

Module - 5
Robots Technology of the future: Robot Intelligence, Advanced Sensor capabilities, Telepresence and related technologies, Mechanical design features, Mobility, locomotion and navigation, the universal hand, system integration and networking.

Artificial Intelligence: Goals of AI research, AI techniques – Knowledge representation, Problem representation and problem solving, LISP programming, AI and Robotics, LISP in the factory. 09 Hours

Text Books


Reference Books


PROJECT MANAGEMENT

(OPEN ELECTIVE - I)
Course Outcomes

On completion of the course the student will be able to

2. Understand the selection, prioritization and initiation of individual projects and strategic role of project management.
3. Understand the work breakdown structure by integrating it with organization.
4. Understand the scheduling and uncertainty in projects.
5. Students will be able to understand risk management planning using project quality tools.
6. Understand the activities like purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.
7. Determine project progress and results through balanced scorecard approach
8. Draw the network diagram to calculate the duration of the project and reduce it using crashing.

MODULE - 1

Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles
Project Selection And Prioritization – Strategic planning process, strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects. 08 Hours

MODULE - 2

Planning Projects: Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system.

Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart. 08 Hours

MODULE - 3

Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control.

Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kickoff: Development of quality concepts, project quality management plan, project quality tools, kickoff project, baseline and communicate project management plan, using Microsoft Project for project baselines. 08 Hours

MODULE - 4

Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management.
**Project Progress and Results**: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.  

**08 Hours**

**MODULE - 5**

**Network Analysis**

Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.  

**10 Hours**

**TEXT BOOKS**

- Project Management, A systems approach to planning scheduling and controlling by Harold kerzner, CBS publication.

**REFERENCE BOOKS**

- Project Management, Pennington Lawrence, Mc Graw hill
- Project Management, Bhavesh M. Patal, Vikas publishing House,

**Computational Fluid Dynamics**

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam duration</th>
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</thead>
<tbody>
<tr>
<td>Computational Fluid Dynamics</td>
<td>15ME651</td>
<td>03</td>
<td>3-0-0</td>
<td>80</td>
<td>20</td>
</tr>
</tbody>
</table>
Pre-requisites: Fluid Mechanics, Vector Calculus, Linear Algebra.

Course learning objectives:

- Study the governing equations of fluid dynamics
- Learn how to formulate and solve Euler’s equation of motion.
- Become skilled at Representation of Functions on Computer
- Solve computational problems related to fluid flows

Module – I

Introduction to CFD and Governing Equations

Need of CFD as tool, role in R&D, continuum, material or substantial derivative or total derivative, gradient, divergence and curl operators, Linearity, Principle of Superposition. Derivation of Navier-Stokes equations in control volume (integral form) and partial differential form, Euler equations (governing inviscid equations). Mathematical classification of PDE (Hyperbolic, Parabolic, Elliptic). Method of characteristics, Introduction to Riemann Problem and Solution Techniques.  

9 Hours

Module – II

One-dimensional Euler's equation


Introduction to Turbulence Modeling: Derivation of RANS equations and k-epsilon model.  

8 Hours

Module – III

Representation of Functions on Computer

Module – IV

**Finite difference method** – Applied to Linear Convection equation, Laplace Equations, Convection Diffusion equations, Burgers equations, modified equations • Explicit methods and Implicit methods – as applied to linear convection equation, Laplace equations, convection-diffusion equation• FTCS,FTFS,FTBS,CTCS • Jacobi Method, Gauss-Siedel, Successive Over Relaxation Method, TDMA. • VonNauman n stability (linear stability) analysis.

Upwind Method in Finite Difference method.

Module – V

**Finite volume method**

Finite volume method. Finding the flux at interface.

**Central schemes** - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and Mac Cormack Method


Course Outcomes

At the end of the course, the student will be able to:

- Understand mathematical characteristics of partial differential equations.
- Explain how to classify and computationally solve Euler and Navier-Stokes equations.
- Make use of the concepts like accuracy, stability, consistency of numerical methods for the governing equations.
- Identify and implement numerical techniques for space and time integration of partial differential equations.
- Conduct numerical experiments and carry out data analysis.
- Acquire basic skills on programming of numerical methods used to solve the Governing equations.

Text Books


6. T.j.chung, Computational Fluid Dynamics, , Cambridge University Press


7. Leveque, r., Numerical methods for conservation laws, lectures in mathematics, eth Zurich, birkhauser,199

8. Riemann Solvers and Numerical methods for Fluid Dynamics – A


MOOCs:

6. Introduction to CFD by Prof M. Ramakrishna, Aerospace Engineering, IIT Madras.

7. Computational fluid dynamics by Prof Suman Chakraborty, Mechanical Engineering, IIT Kharagpur


Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

MECHANICS OF COMPOSITE MATERIALS

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
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<tr>
<td>Mechanics of Composite</td>
<td>15ME652</td>
<td>03</td>
<td>3-0-0</td>
<td>80 SEE, 20 CIA</td>
<td>3 Hrs</td>
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<tr>
<td>Materials</td>
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</table>
Course objectives:

The course is intended to provide basic understanding of Composite Materials to engineering students with following aspects:

- To acquire basic understanding of composites and its manufacturing
- To develop an understanding of the linear elastic analysis of composite materials, which include concepts such as anisotropic material behavior and the analysis of laminated plates.
- Provides a methodology for stress analysis and progressive failure analysis of laminated composite structures for aerospace, automobile, marine and other engineering applications
- The students will undertake a design project involving application of fiber reinforced laminates.

MODULE -1


Manufacturing Techniques of Composites:

Fiber Reinforced Plastic (FRP) Processing: Layup and curing, fabricating process, open and closed mould process, Hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

Fabrication Process for Metal Matrix Composites (MMC's): Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques. 10 Hrs

MODULE -2

Micromechanics of Composites: Density, Mechanical Properties; Prediction of Elastic Constants, Micromechanical Approach, Halpin-Tsai Equations, Transverse Stresses. Thermal

**MODULE -3**

**Macromechanics of Composites:** Elastic Constants of an Isotropic Material, Elastic Constants of a Lamina, Relationship between Engineering Constants and Reduced Stiffnesses and Compliances, Variation of Lamina Properties with Orientation, Analysis of Laminated Composites, Stresses and Strains in Laminate Composites, Inter-laminar Stresses and Edge Effects. Numerical Problems. 10 Hrs

**MODULE -4**

**Monotonic Strength, Fracture, Fatigue and Creep:** Tensile and Compressive strength of Unidirectional Fiber Composites. Fracture Modes in Composites; Single and Multiple Fracture, Debonding, Fiber Pullout and Delamination Fracture. Strength of an Orthotropic Lamina; Maximum Stress Theory, Maximum Strain Criterion, Tsai-Hill Criterion, Quadratic Interaction Criterion, Comparison of Failure Theories. Fatigue; S-N Curves, Fatigue Crack Propagation Tests, Damage Mechanics of Fatigue, Thermal Fatigue. Creep behavior of Composites. 10 Hrs

**MODULE -5**

**Failure Analysis and Design of Laminates:** Special cases of Laminates; Symmetric Laminates, Cross-ply laminates, Angle ply Laminates, Antisymmetric Laminates, Balanced Laminate. Failure Criterion for a Laminate. Design of a Laminated Composite. Numerical Problems. 10 Hrs

**Course outcomes:**

**On completion of this subject students will be able to:**

3. To identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.

4. To predict the failure strength of a laminated composite plate

5. Understand the linear elasticity with emphasis on the difference between isotropic and anisotropic material behaviour.
6. Acquire the knowledge for the analysis, design, optimization and test simulation of advanced composite structures and Components.

**TEXT BOOKS:**


**REFERENCE BOOKS:**


10. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993
11. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

**E- Learning**

- VTU, E- learning

**Scheme of Examination:**

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
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<th>Assessment</th>
<th>Exam Duration</th>
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<td>Metal Forming</td>
<td>15ME653</td>
<td>3</td>
<td>3-0-0</td>
<td>80 20</td>
<td>3 Hrs</td>
</tr>
</tbody>
</table>

**Course objectives:**

The course is intended to provide basic understanding of Metal Forming with following aspects:

- To acquaint with the basic knowledge on fundamentals of metal forming processes
- To study various metal forming processes
- Understanding plastic deformation during forming processes

**MODULE -1**

**Introduction to Metal Forming:** Classification of metal forming processes, advantages and limitations, stress-strain relations in elastic and plastic deformation. Concepts of true stress, true strain, triaxial & biaxial stresses. Determination of flow stress, principal stresses, yield criteria and their significance, Tresca & Von-Mises yield criteria, concepts of plane stress & plane strain.

Deformation mechanisms, Hot and Cold working processes and its effect on mechanical properties. 10 Hrs

**MODULE -2**

**Effects of Parameters:** Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, Effects of Temperature, strain rate, friction and lubrication, hydrostatic pressure in metalworking. Deformation zone geometry, workability of materials, Residual stresses in wrought products. 10 Hrs

**Forging:** Classification of forging processes. Forging machines equipment. Expressions for forging pressures & load in open die forging and closed die forging by slab analysis, concepts and factors affecting it. Die-design parameters. Material flow lines in forging, forging defects, residual stresses in forging. Simple problems.
MODULE -3


**Drawing:** Drawing equipment & dies, expression for drawing load by slab analysis, power requirement. Redundant work and its estimation, optimal cone angle & dead zone formation, drawing variables, Tube drawing, classification of tube drawing. Simple problems. 10 Hrs

MODULE -4

**Extrusion:** Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion. Extrusion dies, extrusion of seamless tubes. Extrusion variables. Simple problems.

**Sheet Metal Forming:** Forming methods, dies & punches, progressive die, compound die, combination die. Rubber forming. Open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, LDR in drawing, Forming limit criterion, defects of drawn products, stretch forming. Roll bending & contouring. Simple problems. 10 Hrs

MODULE -5


**Powder Metallurgy:** Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations. 10 Hrs
Course outcomes:

On completion of this subject, students will be:

1. Able to understand the concept of different metal forming process.
2. Able to approach metal forming processes both analytically and numerically
3. Able to design metal forming processes
4. Able to develop approaches and solutions to analyze metal forming processes and the associated problems and flaws.

TEXT BOOKS:


REFERENCE BOOKS:

3. Fundamentals of Manufacturing Processes by Lal G K , Narosa

E- Learning

- VTU, E- learning

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
AUTOMOBILE ENGINEERING

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
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<tbody>
<tr>
<td>Automobile</td>
<td>15ME655</td>
<td>3</td>
<td>3-0-0</td>
<td>SEE 80 CIA 20</td>
<td>3 Hrs</td>
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</table>

Course learning objectives: The student will be able to learn

- The layout and arrangement of principal parts of an automobile
- The working of transmission and brake systems
- The operation and working of steering and suspension systems
- To know the Injection system and its advancements
- To know the automobile emissions and its effects on environment

MODULE 1


COOLING AND LUBRICATION: cooling requirements, types of cooling- thermo siphon system, forced circulation water cooling system, water pump, Radiator, thermostat valves. Significance of lubrication, splash and forced feed system.

10 Hours

MODULE 2

TRANSMISSION SYSTEMS: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

BRAKES: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes,
drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock & Numerical

MODULE 3

STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.

IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

MODULE 4

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.

FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, types of carburetors, C.D.& C.C. carburetors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection System.

MODULE 5

AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter.

EMISSION STANDARDS: Euro I, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act

08 Hours
Course Outcomes: Student will be able

- To identify the different parts of an automobile and it’s working
- To understand the working of transmission and braking systems
- To comprehend the working of steering and suspension systems
- To learn various types of fuels and injection systems
- To know the cause of automobile emissions, its effects on environment and methods to reduce the emissions.

TEXT BOOKS:


REFERENCE BOOKS:

Energy Auditing

<table>
<thead>
<tr>
<th>Course</th>
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<th>L-T-P</th>
<th>Assessment</th>
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<td>Energy Auditing</td>
<td>15ME661</td>
<td>03</td>
<td>3-0-0</td>
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Course learning objectives is to

- Understand energy scenario and general aspects of energy audit.
- Learn about methods and concept of energy audit
- Understand the energy utilization pattern including wastage and its management

**Module – I**

**General Aspects:** Review of energy scenario in India, General Philosophy and need of Energy Audit and Management, Basic elements and measurements - Mass and energy balances – Scope of energy auditing industries - Evaluation of energy conserving opportunities, Energy performance contracts, Fuel and Energy substitution, Need for Energy Policy for Industries,

National & State level energy Policies

8 Hours

**Module – II**

**Energy Audit Concepts:** Need of Energy audit - Types of energy audit – Energy management (audit) approach - understanding energy costs - Benchmarking – Energy performance - Matching energy use to requirement - Maximizing system efficiencies - Optimizing the input energy requirements - Duties and responsibilities of energy auditors - Energy audit instruments - Procedures and Techniques.

8 Hours

**Module – III**

**Principles and Objectives of Energy Management:** Design of Energy Management Programmes - Development of energy management systems – Importance - Indian need of Energy Management - Duties of Energy Manager - Preparation and presentation of energy audit reports - Monitoring and targeting, some case study and potential energy savings.

8 Hours
Module – IV


8 Hours

Module – V

**Electrical Energy Management:** Supply side Methods to minimize supply-demand gap - Renovation and modernization of power plants - Reactive power management - HVDC - FACTS - Demand side - Conservation in motors - Pumps and fan systems – Energy efficient motors.

8 Hours

Note: A case study involving energy audit may be taken up with suggestion for energy improvements as a part of assignment.

Course Outcomes

At the end of the course, the student will be able to:

- Understand the basic concepts of energy audit and energy management
- Explain different types of energy audit, maximizing and optimizing system efficiency.
- Summarize energy management systems, prepare and present energy audit report
- Identify energy saving potential of thermal and electrical systems
- Discuss Energy audit instruments, Procedures and Techniques.

TEXT BOOKS:

REFERENCE BOOKS:


E- Learning

https://beeindia.gov.in/content/energy-auditors

Scheme of Examination: Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
INDUSTRIAL SAFETY

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
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<th>Assessment</th>
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<tr>
<td>INDUSTRIAL</td>
<td>15ME662</td>
<td>03</td>
<td>3-0-0</td>
<td>80 20</td>
<td>3 Hrs</td>
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</table>

Prerequisites:

- Elements of Mechanical Engineering
- Electrical Engineering
- Elements of Civil Engineering
- Engineering Chemistry lab
- Workshop Practice
- Other labs of various courses

Overview:

Accidents lead to human tragedy, economical loss to individual, company and the nation. Safe acts lead to increase in productivity. The present course highlights the importance of general safety and its prevention, extended to mechanical, electrical and chemical safety. The Industrial safety course helps in motivating the staff and students to understand the reason for fire, its prevention. Controlling of fire by various means are highlighted. Importance of chemical safety, labeling of chemicals, hand signals during forklift operations in industrial and aerodromes will help in to understand and apply the techniques in practical field. A visit to campus, various labs, workshops, local industries and fire stations helps in analyzing the importance of safety and corrective measures through case studies.

MODULE-1 : INTRODUCTION TO SAFETY

Terms used: accident, safety, hazard, safe, safety devices, safety guard, security, precaution, caution, appliance, slip, trip, fall.
Ladders and scaffolding. Unsafe acts, reason for accidents, MSDS (material safety data sheet), OSHA, WHO.

Lockout and tag out procedures. Safe material handling and storage.

Case studies: Student should identify the unsafe acts near their surroundings like housekeeping,

lab layouts, road safety, campus layout, safety signs. 12 hours

MODULE-2 : FIRE SAFETY


Case studies: demonstration of fire extinguishers, visit to local fire fighting stations. Visit to fire accident sites to analyze the cause of fire and its prevention for future. 10 hours

MODULE-3 : MECHANICAL SAFETY

PPE, safety guards, Safety while working with machine tools like lathe, drill press, power and band saws, grinding machines. Safety during welding, forging and pressing. Safety while handling Material, compressed gas cylinders, corrosive substance, waste drum and containers. Case studies: Visit to machine shop, workshops, foundry lab and local industries to record the practical observation and report the same with relevant figures and comments.

12 hours

MODULE-4 : ELECTRICAL SAFETY

Introduction to electrical safety, Electric hazards, effect of electric current on human body, causes of electrical accidents, prevention of electric accidents, PPE used.

Electric shock. Primary and secondary electric shocks, AC and DC current shocks.

Safety precautions against shocks. Safety precautions in small and residential building installations. Safety procedures in electric plant.

Case studies: To visit electrical sub stations, local distribution systems, observe and share the experience and report.

12 hours

MODULE-5: CHEMICAL SAFETY AND OTHER SAFETY CHECKS
Introduction to Chemical safety, Labeling of chemicals, acid hoods. Handling of acids, eye washers and showers. Safety thinking, accident investigation, safety policy of the company, safety, loss prevention and control, check list for LPG installations, safety precautions using CNG, fire prevention and safety audit, confined space entry, risk assessment. Case studies: To visit chemical laboratory of the college and other chemical industries like LPG, CNG facilities and report. 10 hours

Course Outcomes:

At the end of the course, student is able to:

1- Understand the basic safety terms.

2- Identify the hazards around the work environment and industries.

3- Use the safe measures while performing work in and around the work area of the available laboratories.

4- Able to recognize the sign boards and its application.

5- Able to demonstrate the portable extinguishers used for different class of fires.

6- Able to write the case studies by sharing experience of the employees working in housekeeping, laboratories like workshops, electrical labs, machine shops, electronics and computer laboratories.

7- Able to understand and report the case studies from various references (text books, news report, journals, visiting industries like power stations, manufacturing and maintenance).

Text Books:


Reference books:


VISITS:
1- To visit respective Institution: stores, office, housekeeping area, laboratories.
2- To visit local industries, workshops, district fire fighting system facility and local electrical power

**Maintenance Engineering**

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<tr>
<th>Course</th>
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<th>L-T-P</th>
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<tr>
<td>Maintenance Engineering</td>
<td>15ME663</td>
<td>3</td>
<td>3-0-0</td>
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</table>

**Course objectives:**

The course is intended to provide basic concepts of maintenance engineering to engineering students with following aspects:

- To acquire basic understanding of Maintenance systems
- To develop an understanding of the principles of Preventive Maintenance & Predictive Maintenance
- Provides a methodology for reliability & probability concepts applied to maintenance engineering
- The students will concepts and procedures for Condition Monitoring in Mechanical and Electrical systems along with the analysis and processing techniques for machine fault identification

**MODULE -1**
**Maintenance systems:** Maintenance objectives and scopes; Maintenance strategies & organizations; Maintenance works; life cycle costs Preventive Maintenance: Principles of preventive maintenance, procedures & selection; Preventive Maintenance planning, scheduling and control; Forms & resources; Maintenance work measurement; Modeling and analysis techniques in PM and inspections; Predictive maintenance.

**Computerized Maintenance Management systems:** Benefits and applications; Work order systems & plant registers; Maintenance reports, analysis and monitoring; Introduction to commercial packages Equipment maintenance: Installation, commissioning and testing of plant equipment, checking for alignment, lubrication and lubrication schedule; maintenance of typical rotating and process equipment systems like turbines, pumps and fans, centrifuges, heat exchangers, boilers and pressure vessels etc.

10 hrs

**MODULE -2**

**Reliability & probability Concepts:** Basic concepts of probability theory and distributions, definition of reliability, failure probability, reliability and hazard rate function, MTBF and MTTR, System reliability, series and parallel system, redundancy.

10 hrs

**MODULE -3**


10 hrs

**MODULE -4**

**Total Productive Maintenance:** Goals of TPM and methodology, TPM improvement plan & procedures. The modern role of care and asset management through TPM The use of TPM concepts consisting of Pareto ABC analysis, Fishbone diagrams, OEE and 5S. Fault analysis.

10 hrs
MODULE -5

Condition Monitoring:

Measurable phenomena from different Plant Items:

Measurable phenomena associated with degradation from a range of plant items including motors/generators, transformers, cables, bushings, connectors, capacitors and circuit breakers.

Fault diagnosis of Rotational Machines:

Unbalance, shaft and coupling misalignments, bent shafts, gear and bearing wear, oil whirls and shaft eccentricity.

Measurement Strategies and Techniques:

A wide range of strategies and associated technologies will be discussed including light emission (photo multipliers, fiber optic techniques etc.), heat emissions (IR, cameras, direct temperature measurement, etc.), electrical charges (tan δ, electrical particle discharge, etc.), force, power and vibration.

Data Processing and Analysis:

For each of the approaches, options with respect to data processing and analysis will be discussed including digital signal processing and computational techniques. Close attention will be paid through examples of the cost benefits and the reliability which can be placed on data with respect to formulating a view on the condition of a given item of plant.

10 hrs

Course outcomes:

On completion of this subject students will be able to:

1. Understand maintenance objectives and evaluate various maintenance strategies for process plant application, Develop necessary planning and scheduling and control of preventive maintenance activities.
2. Evaluate reliability of a simple plant component and system.
3. Understand and apply the advanced concepts such as RCM and advantages for a company employing them.
4. Understand and apply the advanced concepts such as TPM and advantages for a company employing

5. Apply the principles of condition monitoring systems.

6. Apply the mechanical condition monitoring techniques and analyze the data used in condition monitoring

TEXT BOOKS:


REFERENCE BOOKS:

2. Reliability Engineering, Srinath L S,
3. Maintenance Replacement and Reliability, Jardine AKS,
4. Practical reliability engineering, Oconnor, Patrick D T
5. , Reliability and Maintainability Engineering, Charles E Ebeling
6. Introduction to Reliability Engineering Lewis E,

E- Learning

- VTU, E-learning

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
TOTAL QUALITY MANAGEMENT

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam</th>
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<tr>
<td>Total Quality Management</td>
<td>15ME664</td>
<td>03</td>
<td>3-0-0</td>
<td>80</td>
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**Course Learning Objectives:**

This course enables students to

1. Understand various approaches to TQM
2. Understand the characteristics of quality leader and his role.
3. Develop feedback and suggestion systems for quality management.
4. Enhance the knowledge in Tools and Techniques of quality management

**Module - 1**

**Principles and Practice:** Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM.

**Quality Management Systems:** Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.

08 Hours

**Module - 2**

**Leadership:** Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making.

08 Hours
Module - 3

**Customer Satisfaction and Customer Involvement:**

Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies.

Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.

Module - 4

**Continuous Process Improvement:** process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.

**Statistical Process Control:** Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies

Module - 5

**Tools and Techniques:** Bench marking, information technology, quality management systems, environmental management system, and quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance.

---

COURSE OUTCOMES:

**Student will be able to**

1. Explain the various approaches of TQM and infer the customer perception of quality
2. Analyze customer needs and perceptions to design feedback systems.
3. Apply statistical tools for continuous improvement of systems.
4. Apply the tools and technique for effective implementation of TQM.
TEXT BOOKS:


REFERENCE BOOKS:


Reference Books:


Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
DESIGN OF THERMAL EQUIPMENTS

Course Code Credits L-T-P Assessment Exam Duration
Design of thermal Equipments 15ME741 03 3-0-0 SEE 80 20 CIA 3 Hrs

Course objectives :

2. To understand types of heat exchanger
3. To study the design shell and tube heat exchanger
4. To study types and design of steam heat condenser and compact heat exchanger
5. To comprehend and design air cooled heat exchanger
6. To understand and to design air cooled heat exchanger, furnaces

Module I

**Introduction To Heat Exchanger Design**: Types of heat exchangers and their applications. Flow arrangements and temperature distributions in transfer type of heat exchangers. Overall heat transfer coefficient;- Clean overall heat transfer coefficient, dirt factor dirt overall heat transfer coefficient, dirt factors for various process services.

**Double Pipe Heat Exchangers**: Film coefficients for tubes and annuli, equivalent diameter of annuli, fouling factors, caloric or average fluid temperature, true temperature difference; Design calculation of double pipe heat exchanger, double pipe exchangers in series-parallel arrangements.
Module II

**Shell and tube heat exchangers** - tube layouts, baffle spacing, classification of shell and tube exchangers, Design calculation of shell and tube heat exchangers, flow assignments: tube side flow area calculations; viscosity correction factor, shell side equivalent diameter, calculation of shell side heat transfer coefficient, evaluation for wall temperature, evaluation of overall heat transfer coefficient, Calculation of surface area. Calculations of tube side and shell side pressure drops.

Module III

**Steam Condensers**: Specifications of other details as per TEMA standards. Flow arrangement for increased heat recovery: - lack of heat recovery in 1-2 exchangers true temperature difference in a 2-4 exchanger. Calculation procedure for steam condensers.

**Compact Heat Exchangers**: Introduction; definition of Geometric Terms: plate fin surface geometries and surface performance data; correlation of heat transfer and friction data; Goodness factor comparisons; specification of rating and sizing problems; calculation procedure for a rating problem.

Module IV

**Air-Cooled Heat Exchangers**: Air as coolant for industrial processes; custom-built units; fin-tube systems for air coolers; fin-tube bundles; thermal rating; tube side flow arrangements; cooling air supply by fans; cooling air supply in natural draft towers.

**Furnaces And Combustion Chambers**: Introduction; process heaters and boiler; heat transfer in furnaces: - Heat source; Heat sink; refractory surfaces; heat transfer to the sink; Design methods: - Method of Lobo and Evans:Method of Wilson, Lobo and Hottel; The Orrok-Hudson equation;Wallenberg simplified method.

Module V

**Heat pipes** - types and applications, operating principles, working fluids, wick structures, control techniques, pressure balance, maximum capillary pressure, liquid and vapor pressure drops, effective thermal conductivity of wick structures, capillary limitation on heat transport capability, sonic, entrainment, and boiling limitations, determination of operating conditions; Heat pipe design – fluid selection, wick selection, material selection, preliminary design considerations, heat pipe design procedure, determination of heat pipe diameter, design of heat pipe containers, wick design, entertainment and boiling limitations, design problems.
Course outcomes:

1. To have complete knowledge of heat exchanger and its applications
2. To be able to design shell and tube heat exchanger
3. To be able to select and design of steam heat condenser and compact heat exchanger condenser and heat pipes for various application

TEXT BOOKS:


REFERENCE BOOKS:

3. Heat exchanger- Kokac Thermal- hydraulic and design analysis.
## TRIBOLOGY

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
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<th>Assessment</th>
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<td>Tribology</td>
<td>15ME742</td>
<td>03</td>
<td>3-0-0</td>
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### Course objectives:

**CLO1** To educate the students on the importance of friction, the related theories/laws of sliding and rolling friction and the effect of viscosity of lubricants.

**CLO2** To expose the students to the consequences of wear, wear mechanisms, wear theories and analysis of wear problems.

**CLO3** To make the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.

**CLO4** To expose the students to the factors influencing the selection of bearing materials for different sliding applications.

**CLO5** To introduce the concepts of surface engineering and its importance in tribology.

### Module 1

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

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

8 hours
Module 2

**Friction:** Origin, friction theories, measurement methods, friction of metals and non-metals.
**Wear:** Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.

8 hours

Module 3

**Hydrodynamic journal bearings:** Friction forces and power loss in a lightly loaded journal bearing, Petroff’s equation, mechanism of pressure development in an oil film, and Reynold’s equation in 2D.

Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld’s number and it’s significance; partial bearings, end leakages in journal bearing, numerical examples on full journal bearings only.

10 hours

Module 4

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

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

8 hours

Module 5

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

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

Surface modification – transformation hardening, surface melting, thermo chemical processes.

Surface Coating – plating, fusion processes, vapor phase processes.

Selection of coating for wear and corrosion resistance.

8 hours
COURSE OUTCOMES:

After studying this course, students will be able to:

| CO1 | Understand the fundamentals of tribology and associated parameters. |
| CO2 | Apply concepts of tribology for the performance analysis and design of components experiencing relative motion. |
| CO3 | Analyse the requirements and design hydrodynamic journal and plane slider bearings for a given application. |
| CO4 | Select proper bearing materials and lubricants for a given tribological application. |
| CO5 | Apply the principles of surface engineering for different applications of tribology. |

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Use of approved Design Data Handbook/charts can be permitted during the examination.

TEXTBOOKS:


REFERENCES:


5. “Basic Lubrication Theory”, A. Cameron, Ellis Hardwoods Ltd., UK.

FinanciaL Management

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<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
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<th>Assessment</th>
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<td>03</td>
<td>3-0-0</td>
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Subject Overview: Finance is the lifeblood of any enterprise. Financial Management is imperative for efficient utilization and generation of monetary resources and funds. The subject deals with fundamental books and records of accounts with financial analysis. The subject imparts exposure to statutory levies to strengthen the understanding of government taxed and duties including the general sales tax structure. The subject includes concepts of market risks and returns to efficiently manage the cash and circumvent liquidity problems both at the individual and organizational levels. In the new CBCS scheme, topics on investment decisions and asset management decisions besides the financing decisions. The curriculum also includes costing and budgeting to enable budding engineers to make a comparative study of finance and economics and evaluate costs and revenues of engineering operations.

Module - 1


05 hours Statutory Levies: Forms of organization, direct and indirect taxes. Statutory Registration- excise Duty, central sales tax, VAT, service tax, central and state general Sales tax, international fund availability.

05 hours

Module - 2

Working Capital Management: Definition, need and factors influencing the working capital requirement. Determination of operating cycle, cash cycle and operating cycle analysis. Calculation of gross working capital and net working capital requirement.

06 Hours

Long Term Financing: Raising of finance from primary and secondary markets. Valuation of securities, features of convertible securities and warrants. Features of debt, types of debt instruments, return on investment (ROI) and credit rating of units. Shares, debentures.

06 Hours
MODULE-3

INVESTMENT DECISIONS: Inventory investment, Strategic investment, Ownership investments, lending investment, cash equivalent investment, factors affecting investment decisions, Capital Budgeting, disinvestment methods - public offer, sale of equity, cross holding

06 Hours

ASSET MANAGEMENT DECISIONS: Current Asset Management, Fixed Asset Management, Wealth management, engineering asset management (EAM) - asset maintenance technologies, asset reliability management, project management

06 Hours

MODULE -4

RISK AND REQUIRED RETURN: Risk and return relationship, methods of measuring the risk, Business risk, financial risk, calculation of expected rate of return to the portfolio, financial theories - portfolio theory, capital asset pricing model, arbitrage pricing theory numerical problems. 06 Hours

RATIO ANALYSIS / ACCOUNTING RATIO: Liquidity ratio – Current ratio, quick ratio, turnover ratio, capital structure ratio- Debt – equity ratio, Coverage ratio, Profitability ratio, Profit margin, Return on assets, Activity ratios – Inventory turnover ratio, Debtor Turnover ratio. Preparation of the balance sheet from various ratios. Analysis of any one published balanced sheet. 07 Hours

MODULE - 5

COSTING: Classification of costs, preparation of cost sheet, absorption and variable costing, standard costing, job costing, process costing. Classification of the variances analysis – material, labor and overhead variances.

06 Hours

BUDGETING: Types of budgets – Flexible budgets, preparation of cash budgets, purchase and production budgets and master budget, Budgetary control, advantages & limitations of budgeting. 8 Hours
**Course Outcomes:** Upon successful completion of the course, students will be able to:

1. Measure the returns from engineering projects of differing risks and present a risk-return tradeoff relationship (PO 4, 12)
2. Determine the financial ratios and profitability margins of projects to evaluate economic viability to accept or reject the project. (PO 11)
3. Evaluate cost break ups of engineering projects and processes to determine and control the prohibitive cost components (PO 11)
4. Apply a Engineering Asset Management techniques to evaluate the economic value of physical assets. (PO 1, 11, 12)

**TEXT BOOKS:**

2. **Financial Accounting, Costing and Management Accounting,** S. M. Maheshwari, 2000

**REFERENCE BOOKS:**

4. **Financial Decision Making,** Humpton. 2000
Course Outcomes: Upon successful completion of the course, students will be able to:

1. Measure the returns from engineering projects of differing risks and present a risk-return tradeoff relationship (PO 4, 12)
2. Determine the financial ratios and profitability margins of projects to evaluate economic viability to accept or reject the project. (PO 11)
3. Evaluate cost break ups of engineering projects and processes to determine and control the prohibitive cost components (PO 11)
4. Apply a Engineering Asset Management techniques to evaluate the economic value of physical assets. (PO 1, 11, 12)
Course objectives:

CLO1 To educate students on factors to be considered in designing parts and components with focus on manufacturability.

CLO2 To expose the students to dimensional tolerances, geometric tolerances and true position tolerance techniques in manufacture.

CLO3 To impart the knowledge on design considerations for designing components produced using various machining operations like turning, drilling, milling, grinding etc.

CLO4 To educate the students on design rules and recommendations for processes like casting, welding, forgings powder metallurgy and injection moulding.

Module 1:

Major phases of design, effect of material properties on design, effect of manufacturing processes on design. Material selection process- cost per unit property, weighted properties and limits on properties methods. Guidelines for design for manufacturability.

Review of relationship between attainable tolerance grades and different machining processes.

Process capability, mean, variance, skewness, kurtosis, process capability indices- Cp, and Cpk.

Cumulative effect of tolerance- Sure fit law and truncated normal law, problems.
Module 2:

Selective Assembly: Interchangeable part manufacture and selective assembly. Deciding the number of groups -model-1: group tolerance of mating parts equal, model- 2: total and group tolerances of shaft equal. Control of axial play- introducing secondary machining operations, and laminated shims; examples.

True positional theory: Comparison between coordinate and true position method of feature location. True position tolerance- virtual size concept, floating and fixed fasteners, projected tolerance zone and functional gages. Concept of Zero true position tolerance. Simple problems on true position tolerancing.

10 hours

Module3:

Datum Features: Functional datum, datum for manufacturing, changing the datum; examples. Component Design: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility. Design for assembly

8 hours

Module4:

Design of components with casting considerations: Pattern, mould, and parting line. Cored holes and machined holes. Identifying the possible and probable parting lines. Castings requiring special sand cores. Designing to obviate sand cores.

Welding considerations: requirements and rules, redesign of components for welding; case studies.

8 hours
Module 5:

Forging considerations - requirements and rules - redesign of components for forging and case studies.

Design of components for powder metallurgy - requirements and rules - case studies.

Design of components for injection moulding - requirements and rules - case studies.

8 hours

COURSE OUTCOMES:

After studying this course, students will be able to:

<table>
<thead>
<tr>
<th>CO1</th>
<th>Describe the different types of manufacturing systems and compare their suitability for economic production of various components and products.</th>
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<tbody>
<tr>
<td>CO2</td>
<td>Identify factors and causing mechanisms of the defects likely to occur with different manufacturing processes in producing mechanical products and the relevant design approaches to rectify them.</td>
</tr>
<tr>
<td>CO3</td>
<td>Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic production.</td>
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Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.
TEXTBOOKS:


REFERENCES:


SMART MATERIALS and MEMS

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
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<td>Smart Materials and MEMS</td>
<td>15ME745</td>
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**Course Objective:**

This course provides a detailed overview to smart materials, piezoelectric materials structures and its characteristics. The study of Smart structures and modelling helps in Vibration control using smart materials in various applications. Helps to understand the principles and concepts of using MEMS, ER & MR Fluids for various applications.

**MODULE 1**

Unit1: Introduction: Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing and characteristics.

– 5hrs


– 5hrs

**MODULE -2**

Unit-3 Electro rheological and Magneto rheological Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others).

– 5hrs
Unit-4 Fibre Optics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors and shape memory elements.

– 5hrs

MODULE-3


– 6hrs


– 5hrs

MODULE -4


– 5hrs


– 5hrs
MODULE-5


– 6hrs

Unit 10: Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development: Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties, Investment and competition

– 5hrs

TEXT BOOKS:


COURSE OUTCOMES:

1. Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS.

2. Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, Biomimetics and MEMS with principles of working.

3. Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.

4. Summarize the methods and uses of Micro fabrications, Biomimetics, types of polymers used in MEMS, Fibre optics, piezoelectric sensing and actuation.
Automotive Electronics

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<td>03</td>
<td>3-0-0</td>
<td>80 20</td>
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Course Objective

Students will learn

1. Basics of electronic control of internal combustion engines and the drives
2. Understand principle of working of sensors and actuators used in automobiles for control
3. Diagnostics and safety systems in automobiles

Module 1

Automotive Fundamentals Overview – Evolution of Automotive Electronics,
Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control,
Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train - Transmission,
Drive Shaft, Differential, Suspension, Brakes, Steering System, Starter Battery
Operating principle: (  

7 hours

Analysis of intake manifold pressure, Electronic Ignition.

6 hours
Module 2

**Control Systems** - Automotive Control System applications of Sensors and Actuators - Typical Electronic Engine Control System, Variables to be measured

3 hours


5 hours

**Automotive Actuators** - Solenoid, Fuel Injector, EGR Actuator, Ignition System

3 hours
Module 3


6 hours

Control Units - Operating conditions, Design, Data processing, Programming, Digital modules in the Control unit, Control unit software.

3 hours

Module 4

Automotive Networking - Bus Systems - Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles (Text 2: Pg. 85-91), Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, FlexRay, Diagnostic Interfaces.

6 hours

Vehicle Motion Control - Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS)

3 hours
Module 5


4 hours

Future Automotive Electronic Systems – Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display,


6 hours
Course Outcomes

1. Explain the electronics systems used for control of automobiles
2. Select sensors, actuators and control systems used in automobiles
3. Diagnose the faults in the sub systems and systems used automobile

Text Books:

Course Objective:

Fracture mechanics provides a methodology for prediction, prevention and control of fracture in materials, components and structures.

It provides a background for damage tolerant design.

It quantifies toughness as materials resistance to crack propagation.

Course Content:

Module 1.


Module 2.


Module 3.
Tearing modulus. Stability.

**Elastic plastic fracture mechanics:** Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD.

**Module 4.**


Module 5.

Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, Means to provide fail-safety, Paris law, Required information for fracture mechanics approach, 08 Hrs

Course Outcome:

At the end of the course students will:

1. Develop basic fundamental understanding of the effects of cracklike defects on the performance of aerospace, civil, and mechanical Engineering structures.

2. Learn to select appropriate materials for engineering structures to insure damage tolerance.

3. Learn to employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.

4. Gain an appreciation of the status of academic research in field of fracture mechanics.

Text Books


Reference Books

**Course Code Credits L-T-P Assessment Exam Duration**

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<th>Course</th>
<th>Code</th>
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<td>15ME753</td>
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<td>3-0-0</td>
<td>80</td>
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<td>3Hrs</td>
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**Course objectives:**

- To understand the HRM concepts and theory
- To gain overview of analysis of job, Recruitment and selection process
- To obtain an overview of various HRM functions and practices
- To gain an insight into the various statutory provisions

**Module 1:**  
**Human Resource Management:**

Introduction, nature, scope of HRM, Importance and Evolution of the concept of HRM - Major functions of HRM, influencing factors for future of HRM, Business ethics in HRM

**Job Analysis:** Meaning, process of Job Analysis, methods of collecting job analysis data, Job Description and Job Specification, Role Analysis.

09 hours

**Module 2:**

**Human Resource Planning:** Objectives, Importance and process of Human Resource Planning, Effective HRP.

**Recruitment:** Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment.

**Selection:** Definition and Process of Selection.
**Placement:** Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation

08 hours

**Module 3:**

**Training and development:** Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods.

**Performance Appraisal:** Concept of Performance Appraisal, the Performance Appraisal Process, Methods of Performance Appraisal

**Compensation:** Objectives of Compensation Planning, Job Evaluation, Compensation Pay Structure in India.

08 hours

**Module 4:**


**Employee Grievances:** Employee Grievance procedure, Grievances Management in Indian Industry.

**Discipline:** Meaning, approaches to discipline, essential of a good disciplinary system, managing difficult employees.

08 hours

**Module 5:**

**Industrial Relations and labour laws:** Importance, approaches, settlement of industrial disputes, industrial disputes act 1947, payment of wages act, factories act, employees compensation act, minimum wages act 1948, payment of bonus act 1948, ESI act 1948, payment of gratuity act 1972, trade union movement in India


09 hours

**Case studies:** Discussion of HRM cases to make the student aware of case study approach.

(Not for the examination)
Exercise: (this study shall be made in the organisation the student is studying or in a nearby organisation)

- Give a case and ask the students to prepare the recruitment advertisement for a newspaper
-Expose students to standard selection tests followed in various sectors.
-Exploring training and development practices.
-Exploring performance appraisal practices in various sectors.
-Exploring employee separation practices.
-Give a job analysis case and ask the students to prepare job description and job specification.
-Ask the students to prepare an appointment letter for the post of office manager of a company.

Course outcome:

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

- Synthesize information regarding the effectiveness of recruiting methods & selection procedures
- Identify the various training methods and design a training program
- Design a job description and job specification for various levels of employees.
- List out the regulations governing employee benefit practices.

RECOMMENDED BOOKS:


REFERENCE BOOKS:


E-RESOURCRES: NPTEL online resources, VTU e-learning resources
MECHATRONICS

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<td>Mechatronics</td>
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<td>03</td>
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<td>SEE</td>
<td>CIA 3 Hrs</td>
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Course objectives:

5. Understand the evolution and development of Mechatronics as a discipline.
6. Substantiate the need for interdisciplinary study in technology education.
7. Understand the applications of microprocessors in various systems and to know the functions of each element
8. Demonstrate the integration philosophy in view of Mechatronics technology

MODULE -1

Introduction: Definition, Multidisciplinary Scenario, Evolution of Mechatronics, Design of Mechatronics system, Objectives, advantages and disadvantages of Mechatronics.

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, proximity switches and Hall Effect sensors. 10 Hours

MODULE -2

Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers.

Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data, Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel’s 8085A Microprocessor. 10 Hours

MODULE -3

Programmable logic controller: Introduction to PLC’s, basic structure, Principle of operation, Programming and concept of ladder diagram, concept of latching & selection of a PLC.

Integration: Introduction & background, Advanced actuators, Pneumatic actuators, Industrial Robot, different parts of a Robot-Controller, Drive, Arm, End Effectors, Sensor & Functional requirements of robot. 10 Hours
MODULE -4

**Mechanical actuation systems**: Mechanical systems, types of motion, Cams, Gear trains, Ratchet & Pawl, belt and chain drives, mechanical aspects of motor selection.

**Electrical actuation systems**: Electrical systems, Mechanical switches, Solenoids, Relays, DC/AC Motors, Principle of Stepper Motors & servomotors.

10 Hours

MODULE -5

**Pneumatic and hydraulic actuation systems**: Actuating systems, Pneumatic and hydraulic systems, Classifications of Valves, Pressure relief valves, Pressure regulating/reducing valves, Cylinders and rotary actuators.

**DCV & FCV**: Principle & construction details, types of sliding spool valve, solenoid operated, Symbols of hydraulic elements, components of hydraulic system, functions of various units of hydraulic system. Design of simple hydraulic circuits for various applications.

10 Hours

**Course outcomes:**

On completion of this subject, students will be able to:

7. Illustrate various components of Mechatronics systems.

8. Assess various control systems used in automation.

9. Develop mechanical, hydraulic, pneumatic and electrical control systems.

**TEXT BOOKS:**


**REFERENCE BOOKS:**


**E-Learning**

- VTU, E-learning

**Scheme of Examination:**

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
Course Objectives:

Students will be able to:

1. Understand the additive manufacturing process, polymerization and powder metallurgy process.

2. Understand characterisation techniques in additive manufacturing.

3. Acquire knowledge on CNC and Automation.

Module 1

**Introduction to Additive Manufacturing:** Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build, removal and clean up, post processing.

**Classification of AM processes:** Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet system.

**Post processing of AM parts:** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

**Guidelines for process selection:** Introduction, selection methods for a part, challenges of selection.
AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries

Module 2

System Drives and devices: Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features

Actuators: Electrical Actuators; Solenoids, Relays, Diodes, Thyristors, Triacs, Hydraulic 8 Hours and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.

Module 3

POLYMERS & POWDER METALLURGY

Basic Concepts: Introduction to Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc. Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD] Polymer Processing: Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques 12 Hours

General Concepts: Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM

Powder Production Techniques: Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes. Characterization Techniques: Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle
Friction, Compression ability, Powder Structure, Chemical Characterization

**Microstructure Control in Powder:** Importance of Microstructure Study, Microstructures of Powder by Different techniques


**Application of Powder Metallurgy:** Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc.

### Module 4

**NANO MATERIALS & CHARACTERIZATION TECHNIQUES:**

**Introduction:** Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology

**Nano-materials Synthesis and Processing:** Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of Nano-materials- sol-gel process; Gas Phase synthesis of Nano-materials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation(CVC).

**Optical Microscopy** - principles, Imaging Modes, Applications, Limitations.


### Module 5

10 Hours
MANUFACTURING CONTROL AND AUTOMATION


Introduction: Automation in production system principles and strategies of automation, basic Elements of an automated system. Advanced Automation functions. Levels of Automations, introduction to automation productivity


Course Outcomes

1. Understand the different process of Additive Manufacturing, using Polymer, Powder and Nano materials manufacturing.
2. Analyse the different characterization techniques.
3. Describe the various NC, CNC machine programing and Automation techniques.
TEXT BOOKS:


REFERENCE BOOKS:


**CRYOGENICS**

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryogenics</td>
<td>15ME831</td>
<td>03</td>
<td>3-0-0</td>
<td>SEE 80</td>
<td>20 3 Hrs</td>
</tr>
</tbody>
</table>

**Course objectives:**

1. To understand cryogenic system and gas liquefaction system
2. To analyze gas cycle cryogenic refrigeration system
3. To Comprehend gas separation and gas purification system
4. To have detailed knowledge of vacuum technology, insulation, storage of cryogenic liquids
5. To study applications of cryogenics and to embark on cryogenic fluid

**Module 1**

**Introduction to Cryogenic Systems:**

Cryogenic propellants and its applications, liquid hydrogen, liquid nitrogen, and liquid Helium The thermodynamically Ideal system Production of low temperatures – Joule Thompson Effect, Adiabatic expansion.

**Gas Liquefaction Systems:**

Module 2

Gas Cycle Cryogenic Refrigeration Systems:

Classification of Cryo coolers Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt’s analysis of Stirling cycle, Various configurations of Stirling cycle refrigerators, Integral piston Stirling cryo-cooler, Free displacer split type Stirling Cryo coolers, Gifford Mcmahon Cryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators. 10hrs

Module 3

Gas Separation and Gas Purification Systems

Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation, Linde single column air separation. Linde double column air separation, Argon and Neon separation systems.

Ultra Low Temperature Cryo – Refrigerators

Magneto Caloric Refrigerator 3He-4He Dilution refrigerator. Pomeranchuk cooling. Measurement systems for low temperatures, Temperature measurement at low temperatures,

Resistance thermometers, Thermocouples, Thermistors, Gas Thermometry. Liquid level sensors. 10hrs

Module 4

Vacuum Technology

Vacuum Technology: Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level. Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers

Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super
insulation, Composite insulation.

10hrs

Module 5

Cryogenic Fluid Storage And Transfer Systems

Design of cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Fill and drain lines. Cryogenic fluid transfer, External pressurization, Self pressurization, Transfer pump.

Application of Cryogenic Systems

Cryogenic application for food preservation – Instant Quick Freezing techniques Super conductive devices, Cryogenic applications for space technology.

Application of cryogenic systems, super conducting devices, space technology, cryogenic in biology and medicine.

10hrs

Course outcomes:

On completion of this subject students will be able to:

1. To be able to understand the cryogenic system.
2. To have complete knowledge of cryogenic refrigeration system
3. To be able to design gas separation and gas purification system
4. To able to solve the problem in, insulation, storage of cryogenic liquids
5. To be able to apply cryogenic in various areas and to be able take up research in cryogenics

TEXT BOOKS


REFERENCE BOOKS


2. High Vacuum Technology – A. Guthree – New Age International Publication

3. Experimental Techniques in Low Temperature Physics – G.K. White – Oxford University Press,

E- Learning

- VTU, E-learning
- NPTEL

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
# EXPERIMENTAL STRESS ANALYSIS

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Credits</th>
<th>L-T-P</th>
<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Stress Analysis</td>
<td>15ME832</td>
<td>3</td>
<td>3-0-0</td>
<td>SEE 80, CIA 20</td>
<td>3 Hrs</td>
</tr>
</tbody>
</table>

## Course Learning Objectives (CLO’s):

1. To use the method of electrical strain gauges to study and characterize the elastic behavior of solid bodies.
2. To measure displacement and perform stress strain analysis of mechanical systems using electrical resistance strain gauges.
3. To describe the photo elastic method to study and characterize the elastic behavior of solid bodies.
4. To determine stress strain behavior of solid bodies using methods of coating.
5. To conduct stress strain analysis of solid bodies using the methods Holography

## Module - 1

**Introduction:** Definition of terms, Calibration, Standards, Dimension and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause and types of experimental errors. general consideration in data analysis.

03 Hours

**Electrical Resistance Strain Gages:** Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance’ Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone’s bridges, Constant current circuits.
Module -2

**Strain Analysis Methods:** Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage.

04 Hours

**Force, Torque and strain measurements:** Mass balance measurement, Elastic element for force measurements, torque measurement.

02 Hours

Module – 3

**Photoelasticity:** Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinics & Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photoelastic model materials

06 Hours

**Two Dimensional Photoelasticity:** Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photoelastic model materials, Materials for 2D photoelasticity

02 Hours

Module - 4

**Three Dimensional Photoelasticity:** Stress freezing method, Scattered light photoelasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses.

04 Hours

**Photoelastic (Birefringent) Coatings:** Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson's, Stress separation techniques: Oblique incidence, Strip coatings

06 Hours
Module – 5

Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.

05 Hours

Moire Methods: Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, Out of plane displacement measurements, Out of plane slope measurements. Applications and advantages

05 Hours

Course Outcomes (CO’s):

At the end of the course, the student will be able to:

1. Explain characterize the elastic behavior of solid bodies.
2. Describe stress strain analysis of mechanical systems using electrical resistance strain gauges.
3. Discuss skills for experimental investigations an accompanying laboratory course is desirable
4. Discuss experimental investigations by predictions by other methods.
5. Describe various coating techniques.

TEXT BOOKS:


REFERENCES BOOKS:

4. "Motion Measurement and Stress Analysis", Dave and Adams,

**Scheme of Examination:** Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

<table>
<thead>
<tr>
<th>Course</th>
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<th>L-T-P</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory of Plasticity</td>
<td>15ME833</td>
<td>3</td>
<td>3-0-0</td>
<td>SEE: 80</td>
</tr>
</tbody>
</table>

**THEORY OF PLASTICITY**
Pre-requisite: This course requires sufficient solid mechanics and theory of elasticity background and basic knowledge about materials and their mechanical properties.

Course objectives:

<table>
<thead>
<tr>
<th>CLO1</th>
<th>To introduce the concepts of Plasticity and mechanism of plastic deformation in metals.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLO2</td>
<td>To expose the students to elasto-plastic problems involving plastic deformation of beams and bars.</td>
</tr>
<tr>
<td>CLO3</td>
<td>To introduce the concepts of slip line field theory.</td>
</tr>
</tbody>
</table>

Module 1

Brief review of fundamentals of elasticity: Concept of stress, stress invariants, principal Stresses, octahedral normal and shear stresses, spherical and deviatoric stress, stress transformation; concept of strain, engineering and natural strains, octahedral strain, deviator and spherical strain tensors, strain rate and strain rate tensor, cubical dilation, generalized Hooke’s law, numerical problems.

8 Hours

Module 2

Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth, flow figures or Luder’s cubes.

Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca criterion, geometrical representation, yield surface, yield locus (two dimensional stress space), experimental evidence for yield criteria, problems.

9 Hours

Module 3
Stress Strain Relations: Idealised stress-strain diagrams for different material models, empirical equations, Levy-Von Mises equation, Prandtl- Reuss and Saint Venant theory, experimental verification of Saint Venant’s theory of plastic flow. Concept of plastic potential, maximum work hypothesis, mechanical work for deforming a plastic substance.

8 Hours

Module 4

Bending of Beams: Stages of plastic yielding, analysis of stresses, linear and nonlinear stress strain curve, problems.

Torsion of Bars: Introduction, plastic torsion of a circular bar, elastic perfectly plastic material, elastic work hardening of material, problems.

9 Hours

Module 5

Slip Line Field Theory: Introduction, basic equations for incompressible two dimensional flows, continuity equations, stresses in conditions of plain strain, convention for slip lines, geometry of slip line field, properties of the slip lines, construction of slip line nets.

8 Hours

Course outcomes:

At the end of course, student will able to:

<table>
<thead>
<tr>
<th>CLO1</th>
<th>Understand stress, strain, deformations, relation between stress and strain and plastic deformation in solids.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLO2</td>
<td>Understand plastic stress-strain relations and associated flow rules.</td>
</tr>
<tr>
<td>CLO3</td>
<td>Perform stress analysis in beams and bars including Material nonlinearity.</td>
</tr>
<tr>
<td>CLO4</td>
<td>Analyze the yielding of a material according to different yield theory for a given state of stress.</td>
</tr>
<tr>
<td>CLO5</td>
<td>Interpret the importance of plastic deformation of metals in engineering problems.</td>
</tr>
</tbody>
</table>
Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Text Books:


References Books:

COURSE OBJECTIVES

Students will be able to

1. Acquire a broad understanding of sustainable manufacturing, green product and process
2. Understand the analytical tools, techniques in green manufacturing
3. Understand the structures of sustainable manufacturing, environmental and management practice.

Module- 1

Introduction to Green Manufacturing

Why Green Manufacturing, Motivations and Barriers to Green Manufacturing, Environmental Impact of Manufacturing, Strategies for Green Manufacturing.

The Social, Business, and Policy Environment for Green Manufacturing


Module- 2

Metrics for Green Manufacturing

Introduction, Overview of Currently Used Metrics, Overview of LCA Methodologies, Metrics Development Methodologies, Outlook and Research Needs.
Green Supply Chain

Motivation and Introduction, Definition, Issues in Green Supply Chains (GSC), Techniques/Methods of Green Supply Chain, Future of Green Supply Chain.

Principles of Green Manufacturing

Introduction, Background, and Technology Wedges, Principles, Mapping Five Principles to Other Methods and Solutions.

Module -3

Closed-Loop Production Systems


Semiconductor Manufacturing


Module- 4

Environmental Implications of Nano-manufacturing


Green Manufacturing Through Clean Energy Supply

Introduction, Clean Energy Technologies, Application Potential of Clean Energy Supply in Green Manufacturing
Module- 5

Packaging and the Supply Chain: A Look at Transportation

Introduction, Background, Recommended Method to Determine Opportunities for Improved Pallet Utilization, Discussion.

Enabling Technologies for Assuring Green Manufacturing


Concluding Remarks and Observations about the Future


COURSE OUTCOMES

1. Understand the basic design concepts, methods, tools, the key technologies and the operation of sustainable green manufacturing.

2. Apply the principles, techniques and methods to customize the learned generic concepts to meet the needs of a particular industry/enterprise.

3. Identify the strategies for the purpose of satisfying a set of given sustainable green manufacturing requirements.

4. Design the rules and processes to meet the market need and the green manufacturing requirements by selecting and evaluating suitable technical, managerial / project management and supply chain management scheme.
**PRODUCT LIFE CYCLE MANAGEMENT**

<table>
<thead>
<tr>
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<th>Assessment</th>
<th>Exam Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Life Cycle Management</td>
<td>15ME835</td>
<td>3</td>
<td>3-0-0</td>
<td>80 20</td>
<td>3 Hrs</td>
</tr>
</tbody>
</table>

**Course objectives:**

This course enables students to

1. Familiarize with various strategies of PLM
2. Understand the concept of product design and simulation.
3. Develop New product development, product structure and supporting systems
4. Interpret the technology forecasting and product innovation and development in business processes.
5. Understand product building and Product Configuration.

**MODULE 1:**

**INTRODUCTION TO PLM AND PDM**

Introduction to PLM, Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.

**MODULE 2:**

**PRODUCT DESIGN**

Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for ‘X’ and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product
MODULE 3:

PRODUCT DEVELOPMENT


MODULE 4:

TECHNOLOGY FORECASTING

Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies. Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation.

MODULE 5:

PRODUCT BUILDING AND STRUCTURES

Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.

Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
Course Outcomes:

Student will be able to

1. Explain the various strategies of PLM and Product Data Management
2. Describe decomposition of product design and model simulation
3. Apply the concept of New Product Development and its structuring.
4. Analyze the technological forecasting and the tools in the innovation.
5. Apply the virtual product development and model analysis

Text Books:


2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006

Reference Books:
