# C U R R I C U L U M

# A N D

# S Y L L A B U S

FOR

## BACHELOR OF TECHNOLOGY (B. Tech.)

IN

## MECHANICAL ENGINEERING

(**Operative from Session 2020-21**)

**DEPARTMENT OF MECHANICAL & MANUFACTURING ENGINEERING**

**NATIONAL INSTITUTE OF FOUNDRY & FORGE TECHNOLOGY**

**HATIA, RANCHI - 834003**

**Course structure**

| Year | Semester | Code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|---|
| II (42) | III (21) | ME301 | Thermodynamics | 3 | 1 | 0 | 3 |
| | | ME302 | Fluid Mechanics | 3 | 1 | 0 | 3 |
| | | ME303 | Strength Of Materials | 3 | 1 | 0 | 3 |
| | | MT301 | Materials Engineering | 3 | 1 | 0 | 3 |
| | | BSC301 | Mathematics-III | 3 | 1 | 0 | 4 |
| | | BSC302 | Environmental Science | 2 | 0 | 0 | 0 |
| | | **Laboratory/Sessional** | | | | | |
| | | ME301P | Thermodynamics Lab | 0 | 0 | 3 | 1 |
| | | ME302P | Fluid Mechanics Lab | 0 | 0 | 3 | 1 |
| | | ME303P | Strength Of Materials Lab | 0 | 0 | 3 | 1 |
| | | EX301 | Extra Activities (NSO/NSS/NCC/Yoga / Creative Arts/Mini Project) | 0 | 0 | 2 | 1 |
| | | HS301 | Communication Skill Lab | 0 | 0 | 2 | 1 |
| | | **Total Credits** | | **21** | | | |
| | | | | | | | |
| | IV (21) | ME401 | Theory Of Machines | 3 | 1 | 0 | 3 |
| | | ME402 | Fluid Machines | 3 | 1 | 0 | 3 |
| | | ME403 | Applied Thermodynamics | 3 | 1 | 0 | 3 |
| | | PE401 | Manufacturing Process-I | 3 | 1 | 0 | 3 |
| | | EC404 | Electronics & Instrumentation Engg. | 3 | 1 | 0 | 3 |
| | | EN401/ IT402 | Engineering Economics / Cyber Security | 2 | 0 | 0 | 0 |
| | | **Laboratory/Sessional** | | | | | |
| | | ME401P | Theory Of Machines Lab | 0 | 0 | 3 | 1 |
| | | ME403P | Applied Thermodynamics Lab | 0 | 0 | 3 | 1 |
| | | PE401P | Manufacturing Process-I Lab | 0 | 0 | 3 | 1 |
| | | EX401 | Extra Activities (NSO/NSS/NCC/Yoga/ Creative Arts/Mini Project) | 0 | 0 | 2 | 1 |
| | | IN401 | Internship/ Tour & Training/Industrial Training | 0 | 0 | 0 | 2 |
| | | **Total Credits** | | **21** | | | |

| Year | Semester | Code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|---|
| III (44) | V (22) | MEC501 | Heat Transfer | 3 | 1 | 0 | 4 |
| | | MEC502 | Design of Machine Elements | 2 | 1 | 0 | 3 |
| | | MEC503 | Internal Combustion Engines | 2 | 1 | 0 | 3 |
| | | MEP504<br>MEP505<br>MEP506 | Industrial Robotics*<br>Design for Manufacturing*<br>Energy System and Management* | 2 | 1 | 0 | 3 |
| | | MEO507<br>MEO508<br>MEO509 | Project Management**<br>Principles of Management**<br>Total Quality Management** | 2 | 1 | 0 | 3 |
| | | **Laboratory/Sessional** | | | | | |
| | | ME501P | Heat Transfer | 0 | 0 | 2 | 1 |
| | | ME502P | Design of Machine Elements | 0 | 0 | 2 | 1 |
| | | ME503P | Internal Combustion Engines | 0 | 0 | 2 | 1 |
| | | ME504P | Industrial Robotics Lab | 0 | 0 | 2 | 1 |
| | | ME505G | General Proficiency/Seminar | 0 | 0 | 2 | 2 |
| | | **Total Credits** | | **22** | | | |
| | | ***Professional Elective I<br>** Open Elective I** | | | | | |
| | | | | | | | |
| | VI (22) | MEC601 | Solid Mechanics | 3 | 1 | 0 | 4 |
| | | MEC602 | Automobile Engineering | 2 | 1 | 0 | 3 |
| | | MEC603 | Design of Transmission System | 2 | 1 | 0 | 3 |
| | | MEP604<br>MEP605<br>MEP606 | Computer Aided Design*<br>Mechatronic Systems*<br>Microprocessor in Automation* | 2 | 1 | 0 | 3 |
| | | MEO607<br>MEO608<br>MEO609 | Operations Research**<br>Reliability Engineering**<br>Machine Tool Design** | 2 | 1 | 0 | 3 |
| | | **Laboratory/Sessional** | | | | | |
| | | ME601P | Solid Mechanics | 0 | 0 | 2 | 1 |
| | | ME602P | Automobile Engineering | 0 | 0 | 2 | 1 |
| | | ME603P | Manufacturing Lab | 0 | 0 | 2 | 1 |
| | | ME604P | Computer Aided Design | 0 | 0 | 2 | 1 |
| | | ME605I | Internship/Tour & Training/Industrial | 0 | 0 | 0 | 2 |
| | | **Total Credits** | | **22** | | | |
| | | ***Professional Elective II<br>** Open Elective II** | | | | | |

| Year | Semester | Code | Subject | L | T | P | C |
|---|---|---|---|---|---|---|---|
| IV (42) | VII(21) | MEC701 | Automation in Manufacturing | 3 | 0 | 0 | 3 |
| | | MEP702<br>MEP703<br>MEP704 | Refrigeration and Air Conditioning*<br>Cryogenics*<br>Gas Dynamics* | 3 | 0 | 0 | 3 |
| | | MEP705<br>MEP706<br>MEP707 | Power Plant Engineering**<br>Finite Element Analysis**<br>Tool Design** | 3 | 0 | 0 | 3 |
| | | MEO708<br>MEO709<br>MEO710<br>MEO711<br>MEO712 | Mechanical Vibrations#<br>Convective Heat Transfer#<br>Micro and Nano Manufacturing#<br>Energy Systems and Management#<br>Condition Monitoring# | 3 | 0 | 0 | 3 |
| | | MEO713<br>MEO714<br>MEO715<br>MEO716<br>MEO717 | Rapid Prototyping##<br>Industrial Automation##<br>Technology management##<br>Computer Aided Manufacturing##<br>Maintenance Engineering & Maintenance## | 3 | 0 | 0 | 3 |
| | | **Laboratory/Sessional** | | | | | |
| | | ME701P | Lab VII (RAC) | 0 | 0 | 2 | 1 |
| | | ME702D | Project-I | 0 | 0 | 4 | 2 |
| | | ME703I | Internship Assessment | 0 | 0 | 0 | 2 |
| | | **Total Credits** | | **20** | | | |
| | | * **Professional Elective III** (Anyone)<br>** **Professional Elective IV**(Anyone)<br># **Open Elective III** (Anyone)<br>## **Open Elective IV** (Anyone) | | | | | |
| | | | | | | | |
| | VIII (21) | ME801D | Project-II | 0 | 0 | 16 | 8 |
| | | **Total Credits** | | **08** | | | |

# Detailed Syllabus for III$^{rd}$ Semester II$^{nd}$ Year

**MATHEMATICS III (Mechanical)**

**Course Code- BSC301**

**Module -1**

**Laplace Transformation:** Laplace Transformation and its properties, Periodic function, Unit step function and impulse function. Inverse Laplace Transformation, Convolution Theorem, Applications of Laplace transforms in solving certain initial value problems & simultaneous differential equations. **(8L/1.5Q)**

**Module-2**

**Numerical Method:** Finite difference, Symbolic relations, Interpolation and Extrapolation,

Newton - Gregory forward and backward formula, Lagrange's formula, Inverse Interpolation by

Lagrange's formula. Numerical Differentiation and Numerical Integration, Newton Cotes

Quadrature formula, Trapezoidal rule. Simpson's 1/3" rule, Simpson's 3/8" rule. **(10L/1.5Q)**

**Module -3**

**Z-Transform & Inverse Z-Transform-** Properties - Initial and Final value theorems,

Convolution theorem- Difference equations. Solution of difference equations using Z-

Transformation. **(6L/1.5Q)**

**Module –IV Fourier Series & Fourier Transform:** Expansion of - Algebraic, Exponential &Trigonometric functions in Fourier series, Change of interval, Even and odd function, half range sine and cosine series, Complex form of Fourier series.

Fourier Transformation and inverse Fourier Transformation, Fourier sine & cosine transforms.

Convolution theorem for Fourier transforms with simple illustrations. (**8L/1.5Q)**

**Module V**

**Partial Differential Equations:** Formation of partial differential equations, Linear partial differential equations of first order, Lagrange's linear equation, Non-linear equations of first order, Charpit's method Solution of one-dimensional Wave equation & Heat equation by the method of separation of variables and its applications. **(8L/1Q)**

**Note-Question no.1 will be compulsory, objective type with 7 sub-parts comprising of the whole syllabus.**

**Textbooks**


1. Irwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,
2. Ramana R.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi,2010.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition,


**Reference Books**


1. R. J. Beerends.H. G. Ter Morsche, J. C. Van Den Berg. L. M. Van De Vrie, Fourier and Laplace Transforms, Cambridge University Press.
2. Sastry S.S. Introductory Methods of Numerical Analysis, PHI


## THERMODYNAMICS (Mechanical)
**Course code-ME301**

**Objectives:**

- To learn about work and heat interactions, and balance of energy between system and its surroundings.
- To learn about application of I law of various energy conversion devices.
- To evaluate the changes in properties of substances in various processes.
- To understand the difference between high grade and low grade energies and II law limitations on energy conversion.

**Contents:**

**Module -I**

Fundaments- system and control volume; property; state and process; Exact & inexact differentials; Work-thermodynamic definition of work; examples; displacement work; path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. **(5hrs)**

**Module – II**

Temperature, definition of thermal equilibrium and zeroth law; temperature scales; various thermometers-definition of heat; examples of heat/work interaction in systems-first law for cycle & non-cyclic processes; concept of total energy E; Demonstration that E is a property; Various modes of energy; internal energy and enthalpy. **(5hrs)**

**Module – III**

Definition of pure substance, ideal gases and ideal gas mixture, real gases and real gas mixtures, compressibility charts-Properties of tow phase system-const. temperature and const. pressure heating of water; Definitions of standard states; PV-T surface; use of steam tables and R134a tables; saturation tables; superheated tables; identification of states and determination of properties, Mollier's chart. (8hrs)

**Module – IV**

First law of flow processes-Derivation of general energy equation for a control volume; Steady state flow processes including throttling; Examples of steady flow devices; unsteady processes; Examples of steady and unsteady I law applications for system and control volume. **(5hrs)**

**Module -V**

Second law- Definitions of direct and reverse heat engines; Definitions of thermal efficiency andCOP; Kelvin-plank and Clausius statements; Definition of reversible process; internal and external irreversibility; Carnot cycle; Absolute Temperature Scale. **(5hrs)**

**Module-VI**

Clausius inequality; Definition of energy S; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of S from steam tables-Principle of increase of entropy; Illustration of processes in T-S co-ordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and availability, availability function for systems and control volume undergoing different processes, Lost work. Second law analysis for a control volume. Energy balance equation and Energy analysis. **(8hrs)**

**Module -VII**

Thermodynamic cycles- Basic Rankine cycle; Basic Brayton cycle; Basic vapour compression cycle and comparison with Carton cycle. **(4hrs)**

**Course Outcomes:**

1. After completing this course, the students will be able to apply energy balance to systems and control volumes, in situations involving heat and work interactions.
2. Students can evaluate changes in thermodynamic properties of substances.
3. The student will be able to evaluate the performance of energy conversion devices.
4. The students will be able to differentiate between high grade and low-grade energies.

**Textbooks:**


1. Sonntag R.E., Borgnakke C. and Van wylen G. J., 2003- 6th edition, *Fundamentals of thermodynamics*, John Wiley and sons.
2. Jones, J.B. and Duggan R.E., 1996, *Engineering Thermodynamics*, PrenticeHall of India.

3. Morgan, M.J and Shapiro, H.N., 1999, *Fundamentals of Engineering Thermodynamics*, John Wiley and Sons.
4. Nag P.K.,1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd.

## FLUID MECHANICS(Mechanical)

**Course Code-ME302**

**Module I**

Fluids and Their Properties: Introduction of fluid, fluid classifications, hypothesis of continuum, Shear stress in a moving fluid, molecular structure of material, fluid density, viscosity, causes of viscosity in gases and liquids, surface tension, capillary effect, vapor pressure, cavitation, compressibility and the bulk modulus

**Module II**

Pressures and Head: Types of Pressure, Pascal's law of pressure at a point, variation of pressure vertically in a fluid under gravity, equality of pressure at the same level in a static fluid, general equation for the variation of pressure due to gravity from a point to point in a static fluid, pressure and head, the hydrostatic paradox, pressure measurements using Elastic Pressure
Transducers, Force Balance Pressure gauge, Electrical Pressure Transducers

**Module III**

Static Forces on Surface and Buoyancy: Fluid static, action of fluid pressure on surface, resultant force and centre of pressure on a plane surface under uniform pressure, resultant force and centre of pressure on a plane surface immersed in a liquid, pressure diagrams, forces on a curved surface due to hydrostatic pressure, buoyancy, equilibrium of floating bodies, stability of a submerged body, stability of floating bodies, determination of the metacentric height, determination of the position of the metacentre relative to the centre of buoyancy

**Module IV**

The Energy Equation and its Application: Momentum and fluid flow, Momentum equation for 2D and 3-D flow along a stream line, momentum correction factor, Euler's equation of motion along a stream line, Mechanical energy of a flowing fluid – Bernoulli's theorem, kinetic energy correction factor, pitot tube, determination of volumetric flow rate via pitot tube, changes of pressure in tapering pipe, principle of venturi meter, pipe orifices, theory of small orifices discharging to atmosphere, theory of large orifices, Rotameter, elementary theory of notches and weirs, flow in a curved path

**Module V**

Dimensional Analysis and Similarities: Dimension reasoning, dimensional homogeneity, dimensional analysis using Rayleigh's method, Buckingham π-theorem, significance of dimensionless, use of dimensionless numbers in experimental investigation, geometric similarity, dynamic similarity, Kinematic similarity, model testing-Model laws, Undistorted and Distorted models.

**Module VI**

Viscous Flow: Reynolds number and Reynolds experiment, flow of viscous fluid through circular pipe- Hagen Poiseuille formula, Flow of viscous fluid between two parallel fixed plates, power absorbed in viscous flow through - journal, foot step and collar bearing, movement of piston in dash pot, methods of measurement of viscosity Turbulent Flow: Expression for coefficient of friction -Darchy Weishbach Equation, Moody diagram resistance of smooth and rough pipes shear stress and velocity distribution in turbulent flow through pipes.

**Module VII**

Flow through pipes: Major energy losses, Minor energy losses, Hydraulic gradient and total energy lines, Pipes in series and parallel, Equivalent pipes, Siphon, power transmission through
pipe, Flow through nozzle at end of pipe, Water hammer in pipes
Compressible Flow: Basic equations for one dimensional compression, Pressure wave propagation, sound velocity in fluid, Mach number, Stagnation properties

**Reference Books:**

1.Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S.K.Kataria & Sons
2.Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Publications
3. Fluid Mechanics and Hydraulic Machines by R.K. Rajput, S.Chand & Co.
4.Fluid Mechanics by Frank.M. White, McGraw Hill Publishing Company Ltd.
5.Fundamentals of Fluid Mechanics by Munson, Wiley India Pvt. Ltd
6.Fluid Mechanics by A. K. Mohanty, PHI Learning Pvt. Ltd.
7.Laboratory Manual Hydraulics and Hydraulic Machines by R V Raikar

**Course Outcome:** After learning the course the students should be able to: Understand the basic concept of fluid mechanics.

- Understand statics, dynamics and various approaches to fluid mechanics.
- Understand fundamentals of flow through pipes
- Understand basics of compressible flow
- Correlate fundamentals of fluid mechanics with various mechanical systems

## STRENGTH OF MATERIALS(Mechanical)
**Course code -ME 303**

**Objectives:**

- To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts cylinders and spheres for various types of simple loads.
- To calculate the elastic deformation occurring in various simple geometries for different types of loading.

**Contents:**

**Module-1**

Deformation in solids-Hooks law, stress and strain-tension, compression and shear stresses –elastic constants and their relations-volumetric,

linear and shear strains principal stresses and principal planes-mohr's circle **(8hrs)**

**Module-II**

Beams and types of transverse loading on beams-shear force and bending moment diagrams-Types of beam supports, simply supported and over hanging beams, cantilevers. Theory of bending of beam, bending stresses distribution and neutral axis, shear stress distribution, point and distributed loads. **(8hrs)**

**Module-III**

Moment of inertia about the axis and polar moment of inertia, deflection of beam using double integration method, computation of slopes and deflection in beams,

Maxwell's reciprocal theorem. **(8hrs)**

**Module-IV**

Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical spring.
**(8hrs)**

**Module -V**

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure. **(8hrs)**

**Course Outcomes:**

- After completing this course, the students should be able to recognize various type of load applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components.
- The students will be able to evaluate the strains and deformation that will results due to the elastic stresses develop within the material for simple type of loading.

**Test Books:**


1. Egor P. Popov,Engineering Mechanics of solids,Prentice Hall of india,New Delhi,2001.
2. R.Subramanian, Strength of Materials,Oxford University Press,2007.

Ferdinand P.Been, Russel Johnson Jr and Jhon J.Dewole, Mechanism of materials, Tata McGrawHill Publication Co. Ltd., New Delhi 2005.


## MATERIAL ENGINEERING(Mechanical)

**Course code -MT 301**

**Course Objectives:**

To increasing demand of the available materials, coupled with new applications and requirements has brought about many changes in the style of their uses. To develop the basic knowledge of metals, polymers composites and ceramics other than conventional metals and alloys to apply them to advance engineering applications.

**Module - I**

Introduction – Crystalline and Non crystalline solids, Classification of Engineering materials and their selections, Bonding in solids: Ionic, Covalent and Metallic bonding. (5hrs)

**Module – II**

Crystal Structure- Space lattices, Bravais lattices, Crystal system, Unit Cell, Metallic crystal structures: SC, BCC, FCC, HCP structures, Miller notations of planes and directions, Imperfections in crystal: Point defects, Line surface defects.
Dislocations: Edge and Screw dislocation, Burgers vectors. (12 hrs)

**Module – III**

Metallic Materials – Metals and alloys, ferrous materials- introduction to Iron carbon Diagram, steel and their Heat treatment, Properties and applications. Different types of heat treatment processes. Non-ferrous alloys: - Copper based alloys. Al based alloys, other important nonferrous alloys, properties and applications. (10hrs)

**Module – IV**

Polymers- Basic concepts of Polymers Science, polymer classifications. Crystallinity of polymers, Copolymers, Thermoplastic and Thermosetting polymers, Elastomers, Properties and Applications. (5hrs)

**Module – V**

Ceramics- Basic concepts of ceramics science, traditional and new ceramics. Oxide and Non-Oxide ceramics, Ceramics for high temperature applications. Glass, applications of ceramics, and glass. (5hrs)

**Module -VI**

Composite materials- Definition, general characteristics. Particles reinforced and fibre reinforced composite materials, MMC, CMC, PMC, properties and applications. (5hrs)

**Textbooks:**

1. Elements of Material Science by Van Vlack
2. Material Science by O.P. Khanna
3. Material Science and Engineering by V. Raghavan 4. Material Science by R. K.Sharma and R.S. Sedha

Reference Books:

1. Material Science and Engineering by Wiliam D. Callister

**Course Outcomes:**

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

- Select different materials other than conventional metals and alloys for specific engineering applications.
- To solve the materials problems associated with the weight reduction through the appropriate choice of metals, polymers, ceramics and composites.
- Selection criterion for polymers and composites for various engineering applications.

# ENVIRONMENTAL SCIENCE

**Course code –BSC 302**

**(COMMON FOR ALL BRANCH)**

**Module-1**

Concept and scope of Environment science, components of environment, environmental segment and their importance. (2 Hrs)

**Module-II**

Ecology: Ecosystem and its characteristics features, structure and function of forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystem, ecological balance and consequences of imbalance. (4 Hrs)

**Module-III**

Atmosphere: Atmospheric composition, energy balance, climate, weather, depletion of ozone layer, greenhouse effect, acid rain, particles, ions and radicals in the atmosphere, chemical and photochemical reactions in the atmosphere.

**Module-IV**

Air pollution and control: Air pollutants, sources and effect of air pollutants, primary and secondary pollutants, photochemical smog, fly ash, inorganic and organic particulate matter. Air quality standards, sampling, monitoring and control
measures for pollutants. (4 Hrs)

**Module-V**

Water pollution and control: Aquatic environment, water-pollution, sources and their effect, lake and ground water-pollution, eutrophication, water quality standard and water pollution control measures, wastewater treatment.

**Module-VI** (4 Hrs)

Land pollution; Lithosphere, composition of soil, acid base and ion exchange reactions in soil, soil erosion, landslides, desertification, pollutants (municipal, industrial, commercial, agricultural, hazardous solid wastes), origin and effects, collection and disposal of solid wastes, recovery and conversion methods.

**Module-VII**

Noise pollution; Noise classification and its sources, effects and measurement, noise pollution hazards, standards and noise pollution control. (2 Hrs)

**Books and References:**


1. Master, G.M Introduction to environment engineering and science, Pearson Education.
2. Nebel, B.J., Environment science, Prentice Hall Inc.
3. Odum, E.P. Ecology: The link between the natural and social sciences. IBH Publishing Company Delhi
4. De, A.K. Environmental Chemistry, Merrut.
5. Sharma B.K Envrionmental Chemistry, Krishna Prakashan Media Merrut.
6. Kaushik, A and Kaushik, C.P. Perspectives in Environmental studies, New Age International Publication.
7. Menon, S.E. Environmental Chemistry.

## MATERIALS ENGINEERING LAB

**(MT301P)**

**List of experiments**

1. To study the Metallurgical Microscope.
2. To study the lattice structure of various types of unit cells, observe the mille indices for various planes & directions in unit cells.
3. To study the microstructure of cast iron, cold work forged, rolled condition.
4. To study the microstructure of mild steel.
5. To study the microstructure of brass solder underancaed.
6. To verify Hall effect.
7. To verify the fracture, characteristics of ductile & brittle materials.
8. To determine the chemical composition of a few common alloys.
9. To determine the percentage of carbon & sulphur contents in a alloy with Fe as main constituent.
10. Estimation of percentage carbon composition of mild steel.

## FLUID MECHANICS LAB

**Course Code-ME302P**

1. To determine the coefficient of impact for vanes.

2. To determine coefficient of discharge of an orifice meter.

3. To determine the coefficient of discharge of Notch (V and Rectangular types).

4. To determine the friction factor for the pipes.

5. To determine the coefficient of discharge of venturi meter.

6. To determine the coefficient of discharge, contraction & velocity of an orifice.

7. To verify the Bernoulli's Theorem.

8. To find critical Reynolds number for a pipe flow.

9. To determine the meta-centric height of a floating body.

10. To determine the minor losses due to sudden enlargement, sudden contraction and bends.

11. To show the velocity and pressure variation with radius in a forced vertex flow.
12. Verification of momentum theory by impact of Jet
13. To study the performance characteristics of a Pelton Turbine
14. Determine the operating characteristic of a reaction turbine
15. Determine the operating characteristic of a reciprocating pump
16. Verification of momentum theory by impact of Jet

## Strength of Material Lab

**Course Code-ME303P**

**Name of the Experiment**

1.Tensile test: To prepare the tensile test upon the given specimen (Mild Steel)
2. Compression test: To determine the compressive strength of the given specimen
3.Torsion test: To perform the Torsion test on the given specimen.
4.Impact test: To determine the Impact toughness of the given material
5.Brinell hardness test: To determine the hardness of the given specimen
6.Vicker, s Hardness test: To determine the hardness of the given specimen
7.Rockwell Hardness test: To determine the hardness of the given specimen.
8.To determine the shear strength of a mild steel specimen by Double Shear Test
9.To determine the modulus of rigidity of a solid circular rod by conducting Torsion Test.

10.To obtain tensile strength, modulus of elasticity, percentage elongation and percentage reduction in area. of cross-section.

## COMMUNICATION SKILL LAB

**Course code HS301**

**This lab paper involves interactive practice sessions in Language Lab along with some class lectures to enable the students to be confident enough in language and professional sphere of life.**

**Module I: Listening Comprehension**

To comprehend spoken material in standard Indian English/ British English & American English

- Current situation in India regarding English American English Vs. British English

**Module II: Phonetics & Phonology**

- Introduction to Phonetics & Phonology
- Organs of Speech/ Speech Mechanism
- Pronunciation, Intonation, Stress and Rhythm, Syllable division
- Consonants/Vowels/Diphthongs Classification

**Module III: Common Everyday Situations: Conversations and Dialogues**

**Module IV: Communication at Workplace**

**Module V: Telephonic Conversation**

- Introduction
- Listening/Speaking
- Telephonic Skills Required
- Problems of Telephonic Conversation
- Intensive Listening

**Module VI: Interviews**

- The Interview Process
- Purpose/Planning/Two-way Interaction/Informality
- Pre-interview Preparation Techniques
- Projecting a Positive Image
- Answering strategies

**Module VII: Formal Presentations**

Introduction
Nature/Importance of Presentation
Planning
Objective with central idea, main ideas, role of supporting materials
Handling Stage Fright

**Module VIII: Forms of Technical Communication:** Technical Report: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; Expert Technical Lecture: Theme clarity; Analysis & Findings; C.V./Resume writing; Technical Proposal: Types, Structure & Draft.

**Module IX: Technical Presentation:** Strategies & Techniques Presentation: Forms; interpersonal Communication; presentation; style; method; Individual conferencing: essentials: Public Speaking: method; Techniques: Clarity of substance; emotion; Humour; Modes of Presentation; Overcoming Stage Fear; Audience Analysis & retention of audience interest; Methods of Presentation: Interpersonal; Impersonal; Audience Participation: Quizzes & Interjections.

**Module X: Technical Communication Skills:** Interview skills; Group Discussion: Objective & Method; Seminar/Conferences Presentation skills: Focus; Content; Style; Argumentation skills: Devices: Analysis; Cohesion & Emphasis; Critical thinking; Nuances: Exposition narration & Description; effective business communication competence: Grammatical; Discourse competence: combination of expression & conclusion; Socio-linguistic competence: Strategic competence: Solution of communication problems with verbal and nonverbal means.

# Detailed Syllabus for IV$^{rth}$ Semester (II$^{nd}$ Year)

## THEORY OF MACHINE(Mechanical)
## Course code -ME 401

**Objective:**

- To understand the kinematics and rigid-body dynamics of kinematically driven machine components.
- To understand the motion of linked mechanism in terms of the displacement, velocity and acceleration at any point in a rigid link.
- To understand the kinematics of gear trains.

**Contents:**

**Module -1**

Classification of mechanisms- Basic kinematic concepts and definition – Degree of freedom, mobility-Grashof 's law , Kinematic inversions of four bar chain and slider crank chains-Limit proportions-Mechanical advantage-Transmission angle – Description of some common mechanisms-Quick return mechanism, Straight line generators-Universal Joint- Rocker mechanism**(8hrs)**

**Module-II**

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centres, velocity and acceleration analysis using loop closure equation-kinematics analysis of simple mechanisms-slider crank mechanism dynamics-Coincident points-Coriolis component of acceleration – introduction to linkage synthesis-three position graphical synthesis for motion and path generation**(8hrs)**

**Module-III**

Classification of cams and followers –Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions derivatives of follower motion-specified counter cams-circular and tangents cams – pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers**(8hrs)**

**Module – IV**

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting –helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics**(8hrs)**

**Module – V**

Surface contacts-slidingand rolling friction- friction drives-bearings and lubrication-friction clutches-belt and rope drives-friction in brakes**(8hrs)**

**Course outcomes:**

- After completing this course, the students can design various types of linkage mechanism for obtaining specific motion and analyse them for optimal functioning.

**Textbook:**

1.Thomas Bevan, Theory of machines,3rdedition,CBS Publishers & Distributors,2005.
2.Cleghorn W.L., Mechanisms of Machines, Oxford University Press,2005.
3.Robert L. Norton, Kinematics and Dynamics of machinery, TataMcGrawHill,2009.
4.Ghosh A. And Mallick A. K, Theory of Mechanism and Machines, Affiliated East-West Pvt.Ltd,New Delhi,1988.

## Fluid Machine(Mechanical)

**Course Code (ME402)**

**Module I**

**Introduction: Impulse of jet and Impulse turbine.**
Classification of Fluid Machines & Devices, Application of momentum and moment of momentum equation to flow through hydraulic machinery, Euler's fundamental equation. Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), Classification of turbines, Impulse turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Governing of Pelton wheel. (8 hrs)

**Module II**

**Reaction Turbines:**
Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Degree of reaction, Draft tube, Cavitation in turbines, Principles of similarity, Unit and specific speed, Performance characteristics, Selection of water turbines. (8 hrs)

**Module III**

**Centrifugal Pumps:**
Classifications of centrifugal pumps, Vector diagram, Work done by impellor, Efficiencies of centrifugal pumps, specific speed, Cavitation & separation, Performance characteristics. (8 hrs)

**Module IV**

**Positive Displacement and other Pumps:**
Reciprocating pump theory, slip, Indicator diagram, Effect of acceleration, air vessels, Comparison of centrifugal and reciprocating pumps, Performance characteristics.
(8 hrs)

**Module V**

Hydraulic accumulator, Hydraulic intensifier, Hydraulic Press, hydraulic crane, hydraulic lift, hydraulic RAM, Hydraulic coupling, Hydraulic torque converter, air lift pump, jet pump. (8 hrs)

**TEXTBOOKS:**


1. Hydraulic Machines by Jagdish Lal, Metropolitan book co. pvt. Ltd.
2. Hydraulic Machines by K Subramanya, Tata McGraw Hill
3. Fluid Mechanics and Machinery by C.S.P. Ojha, R. Berndtsson, P.N. Chandramouli, Oxford University Press.
4. Fluid Mechanics and Fluid Power Engineering by D S Kumar, S K Kataria & Sons
5. Fluid Mechanics and Turbo machines by Das, PHI
6. Fluid Power with Applications, by Esposito, Pearson
7. Fluid Mechanics and hydraulic machines by Modi & Seth, Standard Book House
8. Fundamentals of Turbomachinery by Venkanna B.K., PHI
9. Hydraulic Machines: Theory & Design, V.P. Vasandhani, Khanna Pub.
10. Fluid Mechanics and Hydraulic Machines by SukumarPati, Tata McGrew Hill.


## APPLIED THERMODYNAMICS

**Course Code-ME 403**

**Objectives:**

1. To learn about of 1st law for reacting systems and heating value of fuels.
2. To learn about gas and vapor cycles and their first law and second law efficiencies.
3. To understand about the properties of dry and wet air and the principles of psychometry.
4. To learn about gas dynamics of air flow and steam through nozzles. 5) To learn the about reciprocating compressors with and without intercooling 6) To analyse the performance of steam turbines.

**Module-1**
Introduction to solid, liquid and gaseous fuels- Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy. (8Hrs)

**Module -II**
Vapor power cycles Rankine cycle with superheat, reheat and regeneration, energy analysis Super- critical and ultra-super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles- Air standard Brayton cycle, effect of reheat, regeneration and intercooling – Combined

gas and vapor power cycles- vapor compression refrigeration cycles, refrigerants and their properties(12hrs)

**Module-III**

properties of dry and wet air, use of psychrometric chart, processes involving heating/cooling and humidification/ dehumidification, dew point(4hrs)

**Module-IV**

Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, chocked flow, subsonic and supersonic flows- normal shocks-use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, super saturation-compressible flow in diffusers, efficiency of nozzle and diffuser. (8hrs)

**Module-V**

Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors. (5hrs)

**Module-VI**

Analysis of steam turbines, velocity and pressure compounding of steam turbine. (3hrs) **Outcomes:**

1. After completing this course, the students will get a good understanding of various practical power cycles and heat pump cycles.
2. They will be able to analyse energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and reciprocating compressors.
3. They will be able to understand phenomena occurring in high speed compressible flows.

## MANUFACTURINGPROCESSES I

**Course Code-PE 401**

**Objectives:**

- To know about different manufacturing process and its Classification.
- To know about different machining operation and its parameters.
- To understand the functional and Constructions features of lathes.
- To understand the functional and constructional features of drilling, milling, planning machine etc.
- To know about the different finishing operations in machining.

**Module-I**

Introduction to different manufacturing process and its classification, Manufacturing System, 4M’s of Manufacturing.

**Module-II**

Machine tool classification, spectrum of machining operation performed on machine tools, Types of cutting tools signature, cutting speed, feed and depth of cut, Cutting tool Material, Use of coolants during machining operation.

**Module-III**
Constructional features, specification, operations and drives of lathe, Classification of lathe working principles of Capstan and turret lathes. Tool layout and operation of Capstan and turret lathes.

**Module-IV**
Constructional features, specification, operations and drives of basic machine tools such as shaper, planer, slotter, drilling machine and boring machine.

**Module-V**
Constructional features, specification, operations and drives of milling machine. Milling machine classifications, indexing in milling operations.

**Module-VI**
Finishing operations; Grinding; Cylindrical; surface and centreless grinding, Broaching, lapping, honing and buffing.

**Books and References:**

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition) Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.
3. Materials and Manufacturing by Paul Degarmo.
4. Manufacturing Processes by Kaushish, PHI.
5. Principles of Foundry Technology, Jain, MCGRAW HILL INDIA
6. Production Technology by RK Jain.
7. Degarmo, Black &Kohser, Materials and Processes in Manufacturing.


## ELECTRONICS AND INSTRUMENTATION ENGINEERING

**Course code – EC404**

**Module 1: Basic Electronic Components**
Active and Passive Components, Types of resistors and Colour coding, Capacitors, Inductors applications of Resistor, Capacitor and Inductor, Relay, LDR, Basic Integrated Circuits (IC 7805, 7809, 7812, 555 etc.). Measuring Instruments like CRO, Power supply, multi-meters etc.

**Module II: Semiconductors, Diode and Transistors:**
Difference between Insulators, Semiconductors and Conductors, Mobility and Conductivity, Intrinsic and Extrinsic Semiconductors, Fermi Level, Energy band, P-N Junction Diode, construction, working, characteristics and diode equation Application of Diode, Rectifier: Half Wave, Full Wave and Bridge Rectifier, Zener Diode and its Applications, Varactor Diode, Schottky Diode, Regulated Power Supply using Zener Diode and Regulated ICs, LED, Photodetector, Construction, Working, Modes and Configuration of BJT, Input and Output Characteristics of all Configurations, Comparison of all Configuration & Modes, BJT as a Switch and as an Amplifier. JFET Construction, working and

characteristics. MOSFET Construction, working and Characteristics, Types of MOSFET,

**Module III: Digital Electronics Fundamentals:**
Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.

**Module IV: Electronic Instruments:**
Measurement of Temperature, RTD, Thermistors, LVDT, Strain Gauge, Piezoelectric Transducers, Digital Shaft Encoders, Tachometer, Hall effect sensors. Sensors and Transducers for physical parameters: temperature, pressure, torque, flow. Speed and Position Sensors. Electronic Display Device, Digital Voltmeters, Digital Energy meter, CRO, measurement of voltage and frequency, Lissajous Patterns, Plotting B-H curve of a magnetic material, Wave Analysers, Harmonic Distortion Analyzer. Digital Energy Meter. Measurements of R, L and C.Digital Multi-meter, True RMS meters, Clamp-on meters, Meggers. Digital Storage Oscilloscope.

**Module V: Electronic Communication Systems:**
The elements of communication system, IEEE frequency spectrum and Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system, Ultrasonic wave & its application in distance measurement.

**Text Books**


1. Basic Electronics and Linear Circuits by N. N. Bhargava, D. C. Kulshreshtha and S. C. Gupta, TMH Publications.
2. Op-Amps and Linear Integrated Circuits by Ramakant A. Gayakwad, PHI Publications.
3. Electronic Devices and Circuits by Godse and Bakshi Technical, Vol-1 Technical Publication Pune.
4. Floyd ," Electronic Devices" Pearson Education 9th edition, 2012.
5. R.P. Jain , "Modern Digital Electronics", Tata Mc Graw Hill, 3rd Edition, 2007.
6. Frenzel, "Communication Electronics: Principles and Applications", Tata Mc Graw Hill, 3rd Edition, 2001


**Reference Books**


1. Integrated Devices & Circuits by Millman & Halkias, TMH Publications.
2. Electronics Devices and Circuit Theory by R. Boylestad & L. Nashelsky, Pearson Publication
3. Electronic Communication System by G. Kennedy, TMH Publications.
4. Basic Electronics by Sanjeev Kumar & Vandana Sachdeva, Paragaon International Publication


## HEAT TRANSFER

**Course code – PE403**

**Module I**
**Fundamental:** Modes of heat transfer, effect of temperature on thermal conductivity of different solids, liquids and gases, derivation of

generalized equation in Cartesian, cylindrical and spherical coordinates and its reduction to specific cases, General laws of heat transfer

**Module II**

**Conduction:** Fourier's law, One dimensional steady state conduction, heat conduction through plane and composite walls, cylinders and spheres, electrical analogy, critical radius of insulation for cylinder and sphere, overall heat transfer coefficient.
Transient heat conduction- lumped heat capacity analysis, time constant, transient heat conduction in solids with finite conduction and convective resistances Heat transfer from extended surface: Types of fin, heat flow through rectangular fin, infinitely long fin, fin insulated at the tip and fin losing heat at the tip, efficiency and effectiveness of fin, Biot number, Estimation of error in temperature measurement in a thermometer well

**Module III**

**Convection:** Newton's law of cooling, Dimensional analysis applied to forced and free convection, dimensionless numbers and their physical significance, empirical correlations for free and forced convection Continuity, momentum and energy equations, thermal and hydrodynamic boundary layer, Blasius solution for laminar boundary layer, General solution of Von-Karman integral momentum equation

**Module IV**

**Radiation:** Absorptivity, reflectivity and transmissivity, black, white and grey body, emissive power and emissivity, laws of radiation – Planck, Stefan-Boltzmann, Wein's displacement, Kirchhoff's law, intensity of radiation and solid angle, Lambert's cosine law Radiation heat exchange between black bodies, shape factor, heat exchange between non-black bodies- infinite parallel planes and infinite long concentric cylinders, radiation shield, heat exchange between two grey surfaces, electrical analogy

**Module V**

**Heat exchanger:** Classification, heat exchanger analysis, LMTD for parallel and counter flow exchanger, condenser and evaporator, overall heat transfer coefficient, fouling factor, correction factors for multi pass arrangement, effectiveness and number of transfer unit for parallel and counter flow heat exchanger, introduction of heat pipe and compact heat exchanger Two-phase heat transfer: Boiling of liquids, Pool boiling curve, different types of pool boiling, condensation of vapor. Film wise & drop wise condensation.

**Reference Books:**


1. Heat & Mass Transfer by P.K. Nag, McGraw Hill
2. Heat and Mass Transfer: Fundamentals and Application by Yunus Cengel, McGraw Hill
3. Fundamental of Heat and Mass Transfer by Incropera and Dewitt, Wiley Publication
4. Heat Transfer by Mills and Ganesan, Pearson Education
5. Heat Transfer by J P Holman , McGraw Hill
6. Heat and Mass Transfer by R K Rajput, S.Chand Publication
7. Heat Transfer: Principles and Applications by Dutta, Binay K, PHI Publication.

**Module I**

Business Organisation: Legal forms of Business organisation- types of ownership and their formation. Share and their classes, borrowing of capital through Debentures and Bonds.

**Module II**

The element of managerial functions- planning organising, staffing, Direction and control. Authority and responsibility, leadership and principles of co-ordination. Organisation structure and Organisation chart.

**Module III**

Marketing Management: Function of sales and marketing, Sales promotion, Advertising, Publicity and Product packaging.

**Module IV**

Human Resource Development: Main functions of personnel department, Handling of Industrial grievance through joint consultation and collective bargaining.

**Module V**

Objectives and Principles of facility design and their analysis. Factors affecting plant location, techno economic analysis, concept of location theory and models – design. Plant layout, types of layout problems, techniques and tools.

**Module VI**

Types of flow patterns, Material handling, types of load, Diagnosis and analysis of handling problems. Interrelationship between material handling and plant layout, Design of an integrated plant/facility layout.

**References:**

1. Engineering Management (Industrial Engineering & Management)/ S.C. Sharma & T.R.
Banga, Khanna Book Publishing Co. (P) Ltd., Delhi (ISBN: 978-93-86173-072) 2. Industrial Engineering and Management/ P. Khanna, Dhanpatrai publications Ltd.
3. Production & Operation Management /PaneerSelvam /PHI.
4. Industrial Engineering Management/NVS Raju/Cengage Learning.
5. Industrial Engineering Management I Ravi Shankar/ Galgotia.

## CYBER SECURITY

**Course code –IT 402**

**Module I: Introduction to Cybercrime:** Introduction, Cybercrime, and Information Security, Who are Cybercriminals, Classifications of Cybercrimes, and Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

**Module II: Cyber Offenses:** How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber Cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.

**Module III: Cybercrime :** Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit

card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies an Measures in Mobile Computing Era, Laptops.

**Module – IV: Tools and Methods Used in Cybercrime:** Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

**Module V: Cyber Security:** Organizational Implications Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

**TEXT BOOK:**

- Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA.

**REFERENCE BOOK:**

- Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
- Introduction to Cyber Security , Chwan-Hwa(john) Wu,J.David Irwin.CRC Press T&F Group

## ENGINEERING ECONOMICS

**Course code –EN 401**

**COURSE OUTLINE:**

The basic purpose of this course is to provide a sound understanding of concepts and principles of engineering economy and to develop proficiency with methods for making rational decisions regarding problems likely to be encountered in professional practice.

**Module -1**

**Introduction of Engineering Economics and Demand Analysis:** Meaning and nature of Economics, Relation between science, engineering, technology and economics; Nature of Economic problem, Production possibility curve, Concepts and measurement of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility – its practical application and importance. Meaning of Demand, Individual and Market demand schedule, Law of demand, shape of demand curve, Elasticity of demand, measurement of elasticity of demand, practical importance & applications of the concept of elasticity of demand.

**Module -II**

Meaning of production and factors of production; Law of variable proportions, Returns to scale, Internal and External economics and diseconomies of scale.

Various concepts of cost – Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost. Shape of average cost, marginal cost, total cost, Cost curves.

**Module III**

Meaning of Market, Types of Market – Perfect Competition, Monopoly,

Oligopoly, Monopolistic Competition (Main features of these markets)

Pricing Policies- Entry Deterring policies, Predatory Pricing, Peak load Pricing. Product Life cycle

Firm as an organisation- Objective of the Firm, Type of the Firm, Vertical and Horizontal

Integration, Diversification, Mergers and Takeovers.

**Module -IV**

Nature and characteristics of Indian economy (brief and elementary introduction), Privatization – meaning, merits and demerits. Globalisation of Indian economy – merits and demerits. Elementary Concepts of VAT, WTO, GATT & TRIPS agreement, Business cycle, Inflation

**RECOMMENDED BOOKS:-**


1.R.Paneer Seelvan: Engineering Economics, PHI

2.Managerial Economics, D.N. Dwivedi, Vikash Publication

3.Managerial Economics, H.L. Ahuja, S. Chand and Co. Ltd.

4.Managerial Economics, Suma Damodaran, Oxford.

5.R.molrishnd Ro T.V S 'Theory of firms : Economics and Managerial Aspects'. Affiliated East West Press Pvt Ltd New Delhi

6.Managerial Economics, H. Craig Petersen &W. Cris Lewis, Pearson Education.


## APPLIED THERMODYNAMICS LAB

**Course Code-ME 402P**

List of Experiments: (At least 8 of the following)

1. Study of Fire Tube boiler.
2. Study of Water Tube boiler.
3. Study and working of Two stroke petrol Engine.
4. Study and working of Four stroke petrol Engine.
5. Determination of Indicated H.P. of I.C. Engine by Morse Test.
6. Prepare the heat balance sheet for Diesel Engine test rig.
7. Prepare the heat balance sheet for Petrol Engine test rig.
8. Study and working of two stroke Diesel Engine.
9. Study and working of four stroke Diesel Engine.
10. Study of Velocity compounded steam turbine.
11. Study of Pressure compounded steam turbine.
12. Study of Impulse & Reaction turbine.
13. Study of steam Engine model.
14. Study of Gas Turbine Model.

| Sl. No. | Name of the Experiment |
|---|---|

| | |
|---|---|
| 1 | To study the construction and operation of a Cochran boiler |
| 2 | To study the construction and operation of a Babcock boiler |
| 3 | To study the construction and operation of a Lancashire boiler |
| 4 | To study the construction and operation of a vertical water tube boiler |
| 5 | To study about 2-Stroke petrol Engine |
| 6 | To study about 4-Stroke petrol Engine |
| 7 | To study about CI Engine (Diesel Engine) |
| 8 | Study of simple and compound Steam Engine |
| 9 | To determine the volumetric and isothermal efficiency |
| 10 | To determine the static efficiency and total efficiency |

## THEORY OF MACHINE LAB

**ME402P**

**Name of the Experiment**

1. To draw velocity diagram of four bar mechanism
2. To draw velocity diagram of slider crank mechanism.
3. To draw acceleration diagram of four bar mechanism
4. To draw acceleration diagram of slider crank mechanism
5. To study Different types of Cam profile
6. To draw displacement diagram, velocity diagram & acceleration diagram of cam follower
7. To draw a cam profile
8. To study Different types of Gears
9. To draw Involute gear profile.
10. To draw Cycloidal gear profile

## MANUFACTURINGPROCESS LAB

**Course Code-PE401P**

**List of Experiments:** (At least 8 of the following along-with study of the machines/processes)

1. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine.
2. Bolt (thread) making on Lathe machine.
3. Tool grinding (to provide tool angles) on tool-grinder machine.
4. Gear cutting on Milling machine.
5. Machining a block on shaper machine.
6. Finishing of a surface on surface-grinding machine.
7. Drilling holes on drilling machine and study of twist-drill
8. Study of different types of tools and its angles & materials.
9. Experiment on tool wear and tool life.
10. Experiment on jigs/Fixtures and its uses.
11. Gas welding experiment.
12. Arc welding experiment.
13. Resistance welding experiment.
14. Soldering & Brazing experiment.
15. Study and understanding of limits, fits & tolerances.
16. Study of temperature measuring equipment's.
17. Measurement using Strain gauge.
18. Experiment on dynamometers.
19. To study the displacement using LVDT.

**Course Outcomes:** Upon completion of this course, students will be able to understand the different conventional and unconventional manufacturing methods employed for making different products.

# Detailed Syllabus for V$^{th}$ Semester III$^{rd}$ Year

## HEAT TRANSFER
### Course Code - MEC501

**Objectives :**

- The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three Modes will be provided, along with solution of practical problems using empirical correlations.
- The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

**Contents:**

**Module I**

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one-dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical thickness of insulation, lumped system approximation and Biot number, heat transfer through pin fins. Two Dimensional conduction solutions for both steady and unsteady heat transfer- approximate solution
To unsteady conduction, heat transfer by the use of Heissler charts. (12)

**Module II**

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and
free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and
external flow- Estimating heat transfer rates in laminar and turbulent flow situations using
appropriate correlations for free and forced convection. (10)

**Module III**

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method. (8)

**Module IV**

Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and $\varepsilon$-NTU methods. Exposure of numerical technique of heat transfer. (6)

**Module V**

Boiling and Condensation heat transfer, Pool boiling curve (3)

**Module VI**

Introduction mass of transfer, Fick's law, Similarity between heat and mass transfer (3)

**Course Outcomes:**

1. After completing the course, the students will be able to formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.
2. The students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer.
3. The students will be able to design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.

**Text Books:**

1. P. K. Nag, Heat and Mass Transfer
2. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002
3. Frank Kreith, Raj M. Manglik, Mark S. Bohn: Principles of Heat Transfer, Cengage Learning

References Books:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley,Sixth Edition, 2007.

4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002

## DESIGN OF MACHINE ELEMENTS

**Course Code - MEC502**

**Objectives :**

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

- A strong background in mechanics of materials-based failure criteria underpinning the safety-critical design of machine components
- An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
- An overview of codes, standards and design guidelines for different elements
- An appreciation of parameter optimization and design iteration
- An appreciation of the relationships between component level design and overall machine system design and performance

**Contents:**

**Module I**

Design considerations - limits, fits and standardization, Review of failure theories for static and
dynamic loading (including fatigue failure), (6)

**Module II**

Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling
contact bearings, (8)

**Module III**

Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives, (8)

**Module IV**

Design of springs: helical compression, tension, torsional and leaf springs, (6)

**Module V**

Design of joints: threaded fasteners, pre-loaded bolts and welded joints, (6)

**Module VI**

Analysis and applications of power screws and couplings, Analysis of clutches and brakes,
Engine Components. (9)

**Course Outcomes:**

Upon completion of this course, students will get an overview of the design methodologies
employed for the design of various machine components

**Textbooks:**

[1] Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.

[2] Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice,Macmillan, 1992.
[3] Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
[4] Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
[5] R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

## INTERNAL COMBUSTION ENGINES

**Course Code - MEC503**

**Objectives:**

- To familiarize with the terminology associated with IC Engines.
- To understand the basics of IC Engines.
- To understand Combustion and various parameters and variables affecting it in various types of IC Engines.
- To learn about various systems used in IC Engine required for various applications.

**Contents:**

**Module I**

Review of ideal cycles; Details of fuel-air cycles. [6 hrs]

**Module II**

Combustion in SI and CI engines, combustion stages, combustion chamber and abnormal combustion. [8hrs]

**Module III**

Fuel supply systems in SI and CI engines, carburetor. [7hrs]

**Module IV**

Port fuel injection, direct injection and common rail injection. [7hrs]

**Module V**

Ignition system, lubrication systems and cooling Systems [7hrs]

**Module VI**

Testing of IC Engines, Engine emissions and control, advanced IC engine concepts [7hrs]

**Course Outcomes:**

1. Students who have done this course will have a good idea of the basics of IC engines.
2. They will have good knowledge of different parameters influence the operational characteristics of IC Engines.
3. Students will have good idea about different operational parts of IC Engines.
4. They will have understood the functions of fuel combustion of IC Engines.
5. They will have the good knowledge about designing and modifying the IC engines.

**Textbooks:**

1.Obert E. F. "Internal combustion engines and air pollution " Harper and Row Publication Inc.NY,1973.
2. Heisler H. " Advanced Engine technology " Edward Arnold 1995.
3. Heywood J.B. " Internal combustion Engine fundamentals ", McGraw Hill Book Co. NY, 1989.

4. Heldt P.M."High combustio Engines", Oxford &IBH Publishing Co.India, 1985.
5. Stockel M.W.,Stockel TS and Johnson C, " Auto Fundamentals ", The Goodheart, WilcoxCo.Inc. Illinois, 1996.

## INDUSTRIAL ROBOTICS

**Course code-MEP504**

Objective:

- To Gain knowledge of Robotics and automation.
- To Understand the working methodology of robotics and automation.
- Write the program for robot for various applications

**Contents:**

**Module-I**

Robotics-classification, Sensors-Position sensors, Velocity sensors, Proximity sensors, Touch
and Slip Sensors, Force and Torque sensors. (6hrs)

**Module-II**

Grippers and Manipulators-Gripper joints, Gripper force, Serial manipulator, Parallel Manipulator, selection of Robot-Selection based on the Application (8hrs)

**Module-III**

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation. (8hrs)

**Module-IV**

Differential Kinematics and static- Dynamics-Lagrangian Formulation, Newton-Euler Formulation for RR & RP Manipulators. (6hrs)

**Module-V**

Trajectory planning-Motion Control- Interaction control, Rigid Body mechanics, Control architecture- position, path velocity and force control systems, computed torque control, adaptive
control, and Servo system for robot control. (6hrs)

**Module-VI**

Programming of Robots and Vision System- overview of various programming languages. (4hrs)

**Module-VII**
Application of Robots in production systems- Application of robot in welding, machine tools,material handling, and assembly operations parts sorting and parts inspection. (2hrs)

**Course Outcomes:**
- Understand the basic components of robots.
- Differentiate types of robots and robot grippers.
- Model forward and inverse kinematics of robot manipulators.
- Analyze forces in links and joints of a robot.
- Programme a robot to perform tasks in industrial applications.
- Design intelligent robots using sensors.

**Text Books:**
1. Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., Robotics control, Sensing, Vision and Intelligence, McGraw-Hill Publishing company,New Delhi, 2003.
2. Klafter, R.D., Chmielewski, T.A., and Negin. M, Robot Engineering-An Integrated Approach, Prentice Hall of India, New Delhi, 2002.
3. Craig, J.J., Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.

## DESIGN FOR MANUFACTURING

**Course code-MEP505**

**Objective:**
- To educate students on factors to be considered in designing parts and components with focus on manufacturability.

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- To impart the knowledge on design considerations for designing components produced using various machining operations.

**Contents:**
**Module-I**
Introduction: Overview of the course, Design for manufacturing, Typical Case studies,Innovative product and service designs. (4hrs)

**Module-II**
Material Selection: Requirements for material selection, systematic selection of processes and materials, ASHBY charts (4hrs)

**Module-III**
Design for Casting: Basic characteristics and Mold preparation, Sand casting alloys, Design rules for sand castings, Example calculations, Investment casting overview, Cost estimation, Number of parts per cluster, Ready to pour liquid metal cost, Design guidelines for Investment casting, Die casting cycle, Determination of optimum number of cavities, appropriate machine size, Die cost estimation, Design principles. (8hrs)

**Module-IV**
Design for Injection molding: Injection molding systems, Molds, molding cycle time, mold cost estimation, estimation of optimum number of cavities, Assembly techniques, Design Guidelines. (5hrs)

**Module-V**
Design for Hot Forging: Characteristics of the forging process, forging allowances, flash removal, die cost estimation, Die life and tool replacement costs. (5hrs)

**Module-VI**
Design for Sheet metal working: Press selection, press brake operations, Design rules. (2hrs)

**Module-VII**
Design for Powder Metal processing: Powder metallurgy, tooling and presses for Compaction,
Sintering, materials, heat treatments, Design guidelines. Design for machining: Machining using
single point cutting tools, multipoint cutting tools, abrasive wheels, Assembly, cost estimation
for machined components, Design guidelines. (10) Module 8: Design for Assembly: Design guidelines for manual assembly, large assemblies, analysis of an assembly, rules for product
design for automation, design for robot assembly, Design for manufacture and Computer aided
design. (4hrs)

**Course Outcomes:**

- Understand the design principles of design for manufacturing processes
- Estimates the cost of dies, molds and machined components based on die life.
- Understand the design for manual assembly and automated assembly.
- Design typical assemblies using principles of design for X concepts.
- Understand the design rules for machining with single point and multi point cutting tools.

**Textbooks:**
1. Geoffrey Boothroyd, Dewhurst.P, Knight.W, roduct design for manufacture and assembly,
2. CRC press, 2002
3. George E Dieter, Engineering Design-A material processing approach,Mc Grawhill international, 2003.
4. ASM Handbook, Design for manufacture, 2000.

## ENERGY SYSTEM AND MANAGEMENT

**Course code-MEP506**

**Objectives:**

- To understand the basics of Energy Resources.
- To understand the Energy Conversion Systems and Management.
- To learn about basic concept of Power Systems Engineering.

**Contents:**
**Module- I**

**Energy Resources:** Energy and Development, Units and Measurements, Conventional and Non-Conventional Sources of Energy, Fossil and Mineral Energy Resources, Details of Coal, Peat, Oil, Natural Gas and Nuclear Resources, Recovery of Fossil Fuels, Classification and Characterization of Fossil fuels, Basic of Solar, Wind, Bio, Hydro, Tidal, Ocean Thermal and other Renewable Energy Sources, Impact of Energy on Environment, Flow of Energy in Ecological System, Environmental Degradation due to energy, Control of Pollution from Energy.(7hrs)

**Module- II**
**Energy Conversion Systems I:** Energy, Conversion routes, Direct and indirect way of Energy Conversion, Principles of heat and mass transfer, Thermodynamics, Fluid static and dynamics, Electricity generation, distribution and use, Basic of Solar Thermal Conversion, Technology of
Selective Coating, Fundamentals of Flat Plate Collector and Evacuated Collector, Basic of Wind Energy Conversion, Wind machine, Wind electric generator, Wind pump. (7hrs)

**Module- III**
**Energy Conversion Systems II:** Basics of Photovoltaic Conversion technology and PV systems, PV system design methodologies, Basics of Bio-energy conversion, bio

methanation technology, Thermochemical Conversion through Pyrolysis, Gasification and Esterification, Bio Oil,
Application of Ocean Thermal Gradient and Geothermal gradient for power generation, Basics of hydropower, Tidal and Wave power, Basics of Hydrogen fuel, Fundamentals of Fuel Cells, Basics of Fusion power, Energy Storage Technologies, Mechanical storage, Chemical storage
and Electrical storage, Details of Pb-acid battery, Ni-Cd-alkaline battery, Ni-iron and Na-S batteries, battery maintenance and safety precautions. (7hrs)

**Module- IV**
Energy Management: Fundamental of Energy conservation, Energy Management and Audit,Basics of Energy Demand and Supply, Principles of Economic analysis in the Energy Management and Audit Programme, Supply side and demand side energy management, Boilers and Firing System, Steam, Condensation Systems, Energy Conservation and Management in power plant, Energy conservation in Buildings, Heating, Ventilation and Air Conditioning System, Degree day in energy use monitoring, Energy Conservation Opportunities, in chemical industries, Waste heat recovery, Co-generation, Energy Conservation in Agricultural Sector, Energy conservation in illumination engineering, Combustion stoichiometry, airfuel ratio, optimum loading in boilers, etc (7hrs)

**Module- V**
Industrial Energy Analysis: Materials and energy balance in the industries, Products and the process, industrial demand and supply networking, Optimization techniques, efficiency analysis,
methods, Energy monitoring and ongoing information dissertation in terms of energy consumption, production and cumulative sum of differences. Energy efficiency analysis in various conversion systems like boilers, furnaces, compression systems, controlling systems, etc.
Case studies for large scale, medium scale and small-scale industries, efficiency integration methodologies. (7hrs)

**Module- VI**
Power Systems Engineering Basic concept of power plants, types of power plants, thermal power stations, various components of thermal power stations, power plant cycles, fuel handling, combustion, waste disposal methodologies, economizers, turbo alternators, heat balance and
efficiencies, hydroelectric power plant, various components, capacity calculation, design methodologies, operation and maintenance methodologies, elements of nuclear power stations, reactor design, fuel, moderator, coolant control and safety, waste disposal. (7hrs)

**Course Outcomes:**
Upon completion of this course, students will be able to understand Energy Resources, Energy Conversion Systems and Energy Management.

**Textbooks:**

1. Albert Thumann, Handbook of Energy Audits, The Fairmont Press Inc., Atlanta gergia,1979.
2. Murphy W.R and Mckay G, Energy Management, Butterworths, London,1982.
3. Albert Thumann, Plant Engineer and Management guide to Energy Conservation, VanNost and Reinhold Co., Newyork.
4. Energy Audits, E.E.O.-Booklets, U.K. 1988.
5. Craig B.Smith, "Energy Management Principles", Pergamon Press.
6. The role of Energy Manager, E.E.O., U.K.

7.The Energy conservation Design Resource Handbook-The Royal architectural Institute of Canada.
8. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill

## Project Management
**Course code- ME0507**

**Objective:**
• To facilitate the understanding of project management principles and processes

**Contents:**

**Module- I**
Introduction: Introduction to Project Management, definitions, History of Project Management, project identifications, establishing a project, Project Life Cycle. (4 hrs)
**Module- II**
Project Analysis: Facets of Project Analysis, Resource Allocation, Market Analysis, Technical Analysis, Economic and Ecological Analysis. (7 hrs)
**Module- III**
Financial Analysis: Financial Estimates and Projections, Investment Criteria, Financing of Projects. (8 hrs)
**Module- IV**
Network Methods in PM: Origin of Network Techniques, AON and AOA differentiation, CPM network, PERT network, other network models.(9 hrs)
**Module- V**
Optimisation in PM: Time and Cost trade-off in CPM, Crashing procedure, Scheduling when resources are limited. (6 hrs)
**Module- VI**
Project Risk Management: Risk analysis, Work Breakdown Structure, Earned Value Management. (8 hrs)
**Course Outcomes:**
At the end of the course, the student will be able to:
1.Understand the importance of projects and its phases.
2.Analyze projects from marketing, operational and financial perspectives.
3.Evaluate projects based on discount and non-discount methods.
4.Develop network diagrams for planning and execution of a given project.
5.Apply crashing procedures for time and cost optimization.
**Textbooks:**
1. Prasanna Chandra, Project: A Planning Analysis, Tata McGraw Hill Book Company, New Delhi, 4th Edition, 2009.
2. Cleland, Gray and Laudon, Project Management, Tata McGraw Hill Book Company, New Delhi, 3rd Edition, 2007.
3. Jack R. Meredith., Samuel J. Jr. Mantel., Project Management - A Managerial Approach,John Wiley, 6th Edition, 2011.

## Principles of Management
**Course code- MEO508**

**Objectives:**
- To understand the principles of Management and their application to the functioning of organization

**Contents:**
**Module- I**

Definition of management, science or art, manager vs. entrepreneur; Types of managers-managerial roles and skills; Evolution of management-scientific human relations, system and contingency approaches. (6 hrs)
**Module- II**
Types of Business organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; current trends and issues in management, Nature and purpose of planning, types of planning, objectives, policies , Strategic Management, planning Tools and Techniques, Decision making steps & processes. (8 hrs)
**Module- III**
Nature and purpose of Organizing, formal and informal organization, organization structure,types, line and staff authority, departmentalization, delegation of authority, centralization and
decentralization. Job design, human resource management, HR planning, Recruitment selection,Training & Development, Performance Management, carrier planning and Management. (8 hrs)
**Module- IV**
Directing, individual and group behavior, motivation, motivation theories, motivational techniques, Job satisfaction, job enrichment, leadership, types and theories of leadership, effective communication. (6 hrs)

**Module- V**
Production planning and control: Forecasting models, aggregate production, and planning, scheduling, materials requirement planning; Controlling, system and process of controlling,
budgetary and non-budgetary control techniques (8 hrs)
**Module- VI**
Inventory Control: Deterministic models, safety stock inventory control system Use of computers and IT in management control, productivity problems and management, control and
performance, direct and preventive control, reporting. (6 hrs)
**Course Outcomes:**
Upon completion of this course, the students will
1. Get a clear understanding of management functions in an organization
2. Develop leadership quality to guide their work force to get done assigned jobs in time.
3. Maintain correct stock of spares and material for sustained production

4. Maintaining and hiring human resources of required skill and experience in time
5. Preparation of master budget and other budget to arrange required funds to carry out planned activities of organization
**Textbooks:**
1. Robbins S.P. and Couiter M, Management, Prentice Hall India, 10th ed., 2009
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata Mcgraw Hill, 1999.
4. O.P.Khanna - Industrial Engineering and Management – Dhanpat Rai PublicationsO.P.Khanna

## Total Quality Management
**Course code- MEO509**

**Objective:**
To facilitate the understanding of total quality management principles and processes.
**Contents:**
**Module-I**
Introduction, evolution of quality control; Definitions of quality, Quality and productivity; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby.; Quality
conformance, customer need, customer orientation & satisfaction, customer complaints; Quality cost, product & service costing, measuring quality cost (8 Hrs).
**Module-II**
TQM principles; leadership, strategic quality planning; Quality councils- employee involvement,
motivation; Empowerment;6 Hrs.
**Module-III**
Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCA cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.
8 Hrs.
**Module-IV**

The seven traditional tools of quality management; New management tools; Six sigma-concepts, methodology, applications to manufacturing, Bench marking process, evaluation; FMEA-stages, types. 6 Hrs.
**Module-V**
TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures.8 Hrs.
**Module-VI**
Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000-concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.6 Hrs.
**Course Outcomes:** At the end of course, the students will be able to
1.Understand the importance of quality and its assurance.

2.Analyze quality statements, customer focus and market plan.
3.Evaluate quality-based products & methods.

4.Develop tools, methodology for the assurance of quality.

5.Apply & use the tools and techniques of TQM in manufacturing and

service sector.

Textbooks:
1. Besterfield D.H. et al., Total Quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian
edition, Cengage Learning, 2012.
3. Janaki raman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

## Heat Transfer lab (ME501P)

**LIST OF EXPERIMENTS**
1.Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Determination of Thermal conductivity of composite wall.
6. Determination of Thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (natural & forced convection modes)
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of Parallel / counter flow heat exchanger.

## Design of Machine Elements Sessional (ME502P)

**List of Experiments**
1. Study of different types of design considerations used in machine design. Explain the design procedure of Machine Design and Design of machine elements. What do you mean by standardization in design? Why it is necessary? What are the importance's of Aesthetic and Ergonomic consideration in design? Elaborate. What are preferred numbers? What is the importance and advantages of it in design?
The maximum & minimum load carrying capacities of dumpers in a manufacturing unit are 40 KN and 630 KN respectively. The company is interested in developing seven models in this range. Specify their load carrying capacities. Explain the design consideration of following processes with neat sketches. Castings b) forging C) Welding
2. What is DFMA? Explain design considerations for DFMA.
3. Study of selection of materials for given applications.
What is the importance of materials in design of machine element? What factors one considers for selection of materials?
Explain the different properties of materials.
Differentiate between resilience and toughness.
How do you classify engineering materials? Explain in brief different types of Castirons materials.
4. Study of effect of different alloying elements on the properties of materials and comparison of it with properties of steel and Cast Iron.
How are the steels classified?
Explain the BIS system of designation of steels with one example of each type.
Why the alloying elements added to steel to get alloy steels? Explain effect of these alloying elements on the properties of alloy steels. Give at least one example of each.
Explain the following heat treatment processes: a. Normalising; b. Hardening; and c.Tempering.
How the case hardening of steels can be achieved? Explain the methods used for case hardening of steel.

5. Study of design of mechanical components subjected to fluctuating loads.
What is fatigue or fatigue failure? Explain the factors affecting fatigue behavior of the components. What do you mean by stress concentration? Explain the methods of reduction of stress concentration.
What is endurance limit? Explain the method of approximate estimation of endurance limit of the component.
Explain Miner's rule in design of component subject to fluctuating stresses.
6. Study of specification and selection of mechanical springs for various applications and design of springs subjected to different loads.
7. Study of selection, specification and design procedure for belt drives, ropes drives chain and sprockets with an exposure to ASTM materials code.
8. Study of selection and design procedure for chain drives.
9. Study of design of pressure vessels.

## MECHANICAL ENGINEERING IC ENGINE LAB

**COURSE CODE (ME 503P)**

**List of the experiments**

1 To study the cut models of I.C. engine.
2 To study the actual valve timing diagram of 4-stroke petrol engine.

3 To study the actual valve timing diagram of 4-stroke diesel engine.

4 To determine the flash point & fire point of the diesel engine by means of the Cleveland apparatus.
5 To determine the calorific value of diesel by bomb calorimeter.

6 To prepare the heat balance sheet by conducting performance test on single cylinder 4-stroke diesel engine (with electrical brake dynamometer)
7 To determine the load test on a single cylinder 4-stroke diesel engine(with rope brake dynamometer)
8 To determine the Morse test on a multi cylinder petrol engine.

## Industrial Robotics lab (ME504P)

**List of Experiments**

1. Demonstration of Cartesian/ cylindrical/ spherical robot.
2. Demonstration of Articulated/ SCARA robot.
3. Virtual modelling for kinematic and dynamic verification any one robotic. Structure using suitable software.
4. Design, modelling and analysis of two different types of grippers.
5. Study of sensor integration.
6. Two programs for linear and non-linear path.
7. Study of robotic system design.
8. Setting robot for any one industrial application after industrial visit.

# DETAILED SYLLABUS VI$^{th}$ SEMESTER III$^{rd}$ YEAR

## SOLID MECHANICS
**Course Code – MEC601**

**Objectives:**
The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.
**Course Contents:**
**Module-I**
Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and
compatibility, strain gauges and rosettes. (8hrs)

**Module-II**
Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions, octahedral shear stresses. (8hrs)
**Module-III**
Constitutive equations: Generalized Hooke's Llainwea, r elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition. (6hrs)
**Module-IV**
Plane stress and plane strain problems, introduction to governing equations in polar and cylindrical coordinates, axisymmetric problems. (7hrs)
**Module-V**
Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress
concentration, thermo-elasticity. (8hrs)
**Module-VI**
Solutions using potentials energy methods, Introduction to plasticity. (5hrs)
**Course Outcomes:**
Upon completion of this course, students will be able to:
1. Understand the deformation behavior of solids under different types of loading.
2. Find mathematical solutions for simple geometries under different types of loading.

3. Transform the state of stress from one set of co-ordinate axes to another set of co-ordinate axes.

4. Apply compatibility equation for different system of strain.
5. Find the mathematical solution for axisymmetric problem.
6. Understand the concept of elasticity and plasticity.
**Text Books:**
[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.
[2] Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
[3] Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall
international, 1969.
[4] S M A Kazimi, Solid Mechanics, Mc Graw Hill, 2016

## AUTOMOBILE ENGINEERING
**Course Code – MEC602**

**Objectives:**
To understand the construction and working principle of various parts of an automobile
**Contents:**
**Module-I**
Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics,
IC engines- components, function and materials, (5)
**Module-II**
Engine auxiliary systems, fuel supply system, starting system, ignition system, electronic injection for SI
and CI engines, engine lubrication and cooling system, engine emission control by 3-way catalytic
converter system, Emission norms .(10)
**Module-III**
Transmission systems, AWD and 4WD transmission, clutch types & construction, gear boxes, Automatic
transmission, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, differential
and rear axle, (6)
**Module-IV**
Steering geometry and types of steering gear box, power steering, types of front axle, wheel alignment
types of suspension systems. (5)
**Module-V**
General braking requirement, elementary theory of shoe brake, weight transfer, mean

lining pressure and heat generation during braking, mechanical Pneumatic and hydraulic braking systems, power brake,
antilock braking system (ABS), (6)

**Module-VI**

Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in
automobiles, modifications needed, performance, combustion &emission characteristics of alternative
fuels in SI and CI engines. Electric and Hybrid vehicles, application of Fuel Cells, ( 10)

**Module-VII**

**Course Outcomes:**

Upon completion of this course, students will understand the function of each automobile component
and also have a clear idea about the overall vehicle performance.

**Text books:**

(i)Kirpal Singh, Automobile Engineering, 7thed., Standard Publishers, New Delhi, 1997.
(ii) Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi,2002.
(iii)Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
(iv)Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

## DESIGN OF TRANSMISSION SYSTEM

**Course Code – MEC603**

Objectives:

- To learn about the design procedures for mechanical power transmission components

**Contents:**

**Module-I**

Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys,
selection of hoisting wire ropes and pulleys, design of chains and sprockets. (6 hrs)

**Module-II**

Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears. (6 hrs)

**Module-III**

Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears. (4 hrs)

**Module-IV**

Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears. (4 hrs)

**Module-V**

Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine too applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications. (10 hrs)

**Module-VI**

Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expandingrim clutches; Electromagnetic clutches; Band and Block brakes. (6 hrs)

**Module-VII**

External shoe brakes, internal expanding shoe brake. (4 hrs)

**Course Outcomes:**

1. Upon completing this course the students will be able to design transmission systems for
engines and machines.

**Text Books:**

(i) Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8thed., Tata McGraw Hill, 2010.
(ii) Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley,2010.
(iii) Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill,2001.

## COMPUTER AIDED DESIGN

**Course Code – MEP604**

**Objectives:**

- To provide an overview of how computers can be utilized in mechanical component design

**Contents:**

**Module- I**

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D
and 3D transformations, viewing transformation (8 hrs)

**Module- II**

Geometric Modelling- straight line, representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves (5 hrs)

**Module- III**

Techniques of surface modelling, plane surface, cylindrical surface, surface of revolution, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces (6 hrs)

**Module- IV**

Fundamental of solid design, parametric space of a solid, surface and curves in a solid, Solid modelling techniques, CSG and B-rep. (6 hrs)

**Module- V**

Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation (5 hrs)

**Module- VI**

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics
Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards (12 hrs)

**Course Outcomes:**

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

1. Use computer and CAD software for modelling mechanical components
2. draw different types of curves in 2D
3. draw different types of surface
4. draw solid modelling
5. assembly of different part modelling

**Text Books:**

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw Hill, 1989.
4. D. Hearn and M.P Baker, Computer Graphics, Prentice Hall Inc., 1992.

## MECHATRONIC SYSTEMS

**Course Code – MEP605**

**Objective:**

- To provide an overview of mechatronics applications and the use of micro-sensors and microprocessors.

**Contents:**

**Module-I**

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man- Machine Interface. (8hrs)

**Module-II**

Sensors and transducers: classification, Development in Transducer technology, Opto-electronics- Shaft encoders, CD Sensors, Vision System, etc.(5hrs)

**Module-III**

Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor
and Stepper motor, Drive circuits, open and closed loop control.(5hrs)

**Module-IV**

Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems.(6hrs)

**Module-V**

Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation,etc.(8hrs)

**Module-VI**

Micro mechatronic systems: Micro sensors, Micro actuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology. (10hrs)

**Course Outcomes:**

- To understand the structure of microprocessors and their applications in mechanical devices
- To know the use of various sensors and transducers
- To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
- To know the static and dynamic characteristics of actuators
- To understand the use of micro-sensors and their applications in various fields

**Text Books:**

1. Devdas Shetty & Richard A. Kolk, Mechatronics System Design, PWS Publishing Company (Thomson Learning Inc.)
2. William Bolton, Mechatronics: A Multidisciplinary Approach, Pearson Education
3. R. K. Rajput, A Textbook of Mechatronics, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall

## MICROPROCESSOR IN AUTOMATION

**Course Code – MEP606**

Objectives:

- To introduce the basic concepts of Digital circuits, Microprocessor system and digital Controller.

**Contents:**

**Module- I**

Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip- flops, Sequential logic circuits design: Counters, Shift registers. Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals. (10 hrs)

**Module- II**

Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing. (3 hrs)

**Module- III**

Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller; Interfacing peripherals: Programmable peripheral interface (8255). (10 hrs)

**Module- IV**

Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features (10 hrs)

**Module- V**

Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z Transform, Digital Filters, Implementation of Digital Algorithm. (7 hrs)

**Course Outcomes:**

1. Students who have done this course will have a good idea of the use of microprocessers for automation.

**Text Books:**

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.

3. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
4. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition,2007).
5. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall

## OPERATIONS RESEARCH

**Course Code-ME0607**

**Course Objectives :** This course enables the students:

(1) Formulate a real-world problem as a mathematical programming model
(2) Know the theoretical workings of the simplex method for linear programming and perform iterations of it
(3) Analyze the relationship between a linear program and its dual, including strong duality and complementary slackness
(4) Solve specialized linear programming problems like the transportation, assignment, sequencing, games theory, and queuing model problems
(5)The use of Operations Research approaches in solving real problems in industry; mathematical models for analysis of real problems in Operations Research.

**Course Outcomes:** After completion of the course, the learners will be able to:

(1) Capability to recognize the importance and value of Operations Research and mathematical modeling.
(2) Ability to formulate a managerial decision problem into a mathematical model;
(3) Recognize Operations Research models and apply them to real-life problems;
(4) Use various approaches to solve a mathematical model for various practical problems in industry.
(5) Describe dynamic programming terminology.

Syllabus

**MODULE I**

Introduction: Scope and limitations of O.R., Linear Programming: Mathematical formulation of
the problem. Graphical solution and Simplex Method. 8L

**MODULE II**

Linear Programming: Big-M Method, Concept of duality, Dual simplex method. 6L

**MODULE III**

Transportation Model: Basic feasible solution by different methods, Finding optimal solutions, Degeneracy in transportation problems, Unbalanced transportation problems.
Assignment Model: Balanced and unbalanced assignments,Assignment to given schedules.10L

**MODULE IV**

Sequencing: Processing of 2 jobs through machines –graphical method, Processing of n jobs through two machines, processing n jobs through three machines. 5L

**MOLULE V**

Games Theory: Two-persons zero sum games, Pure and mixed strategies, Rules of dominance, Solution methods without saddle point. 5L

**MOLULE VI**

Queuing Model: Queuing systems and their characteristics, The M/M/1/FIFO/ Queuing system, Introduction to dynamic programming. 8L

**Text Books:**
1. P. Rama Murthy , Operations Research, New Age, New Delhi
2. P.K. Gupta & D. S. Hira , Operations Research, S.Chand & Company Ltd, New Delhi.

**References Books:**
1. Hamdy A Taha, 1999. Introduction to Operations Research, PHI Limited, New Delhi.
2.Sharma, J.K., 1989. Mathematical Models in Operations Research, Tata McGraw Hill publishing Company Ltd., New Delhi.
3.Beer, Stafford, 1966. Decision and Control, John Wiley & Sons, Inc., New York.

## RELIABILITY ENGINEERING
**Course Code – MEO608**

**Objectives** : To understand the applications of reliability in engineering decision making

**Contents:**

**Module-I**
Introduction: Probabilistic reliability, failures and failure modes, repairable and non-repairable items, pattern of failures with time, reliability economics. (6)

**Module-II**
Component Reliability Models: Basics of probability & statistics, hazard rate & failure rate, constant hazard rate model, increasing hazard rate models, decreasing hazard rate model, time-dependent & stress-dependent hazard models, bath-tub curve. (10)

**Module-III**
System Reliability Models: Systems with components in series, systems with parallel components, combined series-parallel systems, k-out-of-m systems, standby models, load-sharing models, stress- strength models, reliability block diagram. (10)

**Module-IV**
Life Testing & Reliability Assessment: Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions & estimation of parameters, reliability assessment of components and systems. (8)

**Module-V**
Reliability Analysis & Allocation: Reliability specification and allocation, failure modes and effects and criticality analysis (FMECA), fault tree analysis, cut sets & tie sets approaches; Maintainability Analysis: Repair time distribution, MTTF / MTBF, MTTR, availability, maintainability, preventive maintenance. (6)

**Course Outcomes:** At the end of the course, the student will be able to:
1. Understand the concepts of reliability, availability and maintainability
2. Develop hazard-rate models to know the behavior of components
3. Build system reliability models for different configurations
4. Asses reliability of components and systems using field and test data
5. Implement strategies for improving reliability of repairable and non-repairable systems

**Text Books:**
(i) Ebeling CE, An Introduction to Reliability and Maintainability Engineering, TMH, New Delhi, 2004.
(ii) O'Connor P and Kleymer A, Practical Reliability Engineering, Wiley, 2012.

## MACHINE TOOL DESIGN
**Course Code – MEO609**

**Objectives:**
- Implement the tool design process when designing tooling for the manufacturing of a product.
- Apply Geometric Tolerancing principles in the designs of tooling.
- Evaluate and select appropriate materials for tooling applications.
- Design, develop, and evaluate cutting tools and work holders for a manufactured product.

**Contents:**

**Module- I**

Introduction to Machine Tools: Classification, similarities; various cutting tools and cutting fluids: speed of cutting, feed rate, machining rate and machining time. (4 hrs)

**Module- II**

Lathe: Construction, important mechanisms viz. apron, tail stock, head- stock, feed box; specification, operations e.g., taper turning, eccentric turning, screw cutting. (4 hrs)

**Module- III**

Milling machine: Construction, types specifications; cutters, dividing head, simple compound and differential indexing; various operations: Slab milling, angle cutting, slot milling, fly milling, slit gear milling, spur and bevel, T- slot milling, nature of operations, up and down milling. (10hrs)

**Module- IV**

Shaper, Slotter, Planer: Construction, automatic feed mechanism, quick return mechanisms: operations e.g., horizontal, vertical and inclined machining, spline cutting, keyway cutting, contour machining. (7 hrs)

**Module- V**

Drilling machine: Construction, feed mechanism: Specification, geometry and nomenclature of twist drill, operations e.g. reaming, boring, tapping. (5 hrs)

**Module- VI**

Grinding Machines: M, N types and construction features, Operations e.g. Plane, cylindrical,internal and centreless grinding, tool and cutter grinding, grinding wheels-specifications, shapes,setting, dressing, truing. (10 hrs)

**Course Outcomes:**

At the end of the course, the student will be able to, Understand basic motions involved in a machine tool. Design machine tool structures. Design and analyze systems for specified speeds and feeds. Select subsystems for achieving high accuracy in machining. Understand control
strategies for machine tool operations.

**Text Books:**

1. B.L.Juneja, G.S.Sekhon&Nitin Seth, Fundamentals of Metal Cutting & Machine Tools, New Age International Publications
2. P.N.Rao, Manufacturing Technology: Metal Cutting & Machine Tools, Tata McGraw Hill Publications.
3. G.K.Lal, Introduction to Machining Science ,New Age International Publications.
4. B.S.Raghuwanshi, Workshop Technology , Dhanpat Rai& Sons, Publications
5. HazraChandhari, Elements of Workshop Technology.

## Solid Mechanic laboratory (ME601P)

**List of Experiments**

1. To conduct tension test on the given steel specimen for determining the Stress at yield point. Ultimate stress. Nominal breaking stress. Actual breaking stress. Percentage elongation. Percentage reduction in area. Young's modulus.
2. To determine the shear stress and rigidity modulus orate given material using the torsion testing machine.
3. To determine the impact strength of the given specimen by conducting Charpy test.
4. To determine the suitability of a material, which is expected to resist repeated shocks by determining the energy required to break the material by conducting Izod test.
5. Compression test to determine the ultimate crushing strength of concrete and wood.
6. To measure the Rockwell hardness number for the given material (hard steel).
7. To measure the Brinnel hardness number for given material (mild steel).
8. To determine the young's modulus and bending stress for the given steel beam by conducting deflection test.
9. To determine the Stiffness of the spring while Tension and Compression loads are applied and to determine in which case tension / compression the stiffness is more.
10. To determine bending moment in simply supported beam.

## Automobile Engineering Laboratory (ME602P)

**List of Experiments**

1. To study and prepare report on the constructional details, working principles and operation of the Automotive Clutches.
2. To study and prepare report on the constructional details, working principles and operation of the Automotive Transmission systems.
3. To study and prepare report on the constructional details, working principles and operation of the Automotive Drive Lines & Differentials.
4. To study and prepare report on the constructional details, working principles and operation of the Multi-cylinder: Diesel and Petrol Engines.
5. To study and prepare report on the constructional details, working principles and operation of the Automotive Engine Systems & Sub Systems.
6. To study and prepare report on the constructional details, working principles and operation of the Fuels supply systems.
7. To study and prepare report on the constructional details, working principles and operation of the Engine cooling & lubricating Systems.
8. To study and prepare report on the constructional details, working principles and operation of the Automotive Suspension Systems.
9. To study and prepare report on the constructional details, working principles and operation of the Automotive Steering Systems.
10. To study and prepare report on the constructional details, working principles and operation of the Automotive Brake systems.
11. To study and prepare report on the constructional details, working principles and operation of the Automotive Tyres & wheels.
12. To study and prepare report on the constructional details, working principles and operation of Automotive Emission / Pollution control systems.

## Manufacturing laboratory (ME603P)

**Objective:**
To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

**List of Experiments**

1. Fabrication of simple structural shapes using Gas and Arc Welding.
2. Preparation of green sand moulds from the prepared pattern .
3. Manufacturing of simple sheet metal components using shearing and bending operations.
4. Spur gear cutting in milling ma chine.
5. Helical Gear Cutting in milling machine .
6. Plain Surface grinding.
7. Cylindrical grinding.
8. External slot cutting in shaper.
9. Machining and Machining time estimations for:
(a) Straight Turning (b) Taper Turning (c) External Thread cutting
10. Study of chip morphology and tool wear in turning of ductile and brittle metals.
11. Measurement of cutting forces in Milling / Turning Process .

## Computer Aided Design lab (ME604P)

**LIST OF EXPERIMENTS**

1. Introduction of 3D Modelling software
2. Initiating the Graphics Package; Setting the paper size, space; setting the limits, units; use
of snap and grid commands.
3. Drawing of primitives (Line, arc, circle, ellipse, triangle etc.)
4. Dimensioning the drawing and adding text.
5. Setting the layers and application of layers.
6. Isometric and Orthographic projections.
7. Viewing in three dimensions.
8. Removal of hidden lines – Shading and Rendering.
Creation of 3D assembly model of following machine elements using 3D Modelling.

# Detailed Syllabus of VII$^{th}$ & VIII$^{th}$ Semester IV Year

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEC701** | **Automation in Manufacturing** | **L** | **T** |
| | | **3** | **0** |

**Course Objectives:**

1. To understand the importance of automation in the of field machine tool based manufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC.
3. To understand the basics of product design and the role of manufacturing automation

DETAILED SYLLABUS

**Module 1**

Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers. **(10)**

**Module 2**

NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing. **(6)**

**Module 3**

Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC Adaptive Control. **(10)**

**Module 4**

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies Introduction to Modeling and Simulation. **(6)**

**Module 5**

Product design, process route modeling, Optimization techniques, Case studies & industrial applications, Autonomous vehicles. **(10)**

**Course Outcomes:**

Upon completion of this course, the students will get a comprehensive picture of computer based automation of manufacturing operations.

**Text Books:**

i. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.

ii. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition, Pearson.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEP702** | **Refrigeration and Air Conditioning** | **L** | **T** |
| | | **3** | **0** |

**Objectives:**

1. To familiarize with the terminology associated with refrigeration systems and air conditioning 2. To understand basic refrigeration processes
3. To understand the basics of psychrometry and practice of applied psychrometrics
4. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

DETAILED SYLLABUS

**Module 1**

Classification of refrigeration systems: Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics - Ozone depletion and global warming issues – System components. **(10)**

**Module 2**

Compressors, Condensers, Expansion devices and Evaporators -Performance matching of components of refrigeration systems. **(8)**

**Module 3**

Advanced sorption refrigeration systems and their components **(4)**

**Module 4**

Review of Psychrometry and Air-conditioning processes - Comfort air conditioning and Cooling load calculations. **(8)**

**Module 5**

Applications of AC systems - Concept of enthalpy potential – Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils. **(10)**

**Course Outcomes:**

A student who has done the course will have a good understanding of the working principles of refrigeration and air-conditioning systems.

**Text Books:**


1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill,1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEP703** | **Cryogenics** | **L** | **T** |
| | | **3** | **0** |

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

1. Understand principles of cryogenic systems.
2. Understand air and helium liquefaction processes.
3. Classify cascade refrigeration systems.
4. Understand principles of ultra-low temperature systems and their applications.
5. Evaluate storage systems used in cryogenic applications.

DETAILED SYLLABUS

**Module 1**

Introduction: Definition and Engineering Applications of Cryogenics, Properties of solids for cryogenic systems. **(5)**

**Module 2**

Refrigeration and Liquefaction: Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual- pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle.

**(10)**

**Module 3**

Ultra-low-temperature refrigerators: Definition and Fundamentals regarding ultra-low-temperature refrigerators, Equipment associated with low-temperature systems, Various Advantages and Disadvantages. **(10)**

**Module 4**

Storage and Handling of Cryogenic Refrigerants: Storage and Transfer systems, Insulation, Various Types of Insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation, and so on. **(10)**

**Module 5**

Applications: Broad Applications of Cryogenic Refrigerants in various engineering systems.

**(5)**

**Text Books:**


1. Traugott H.K. Frederking and S.W.K. Yuan, Cryogenics - Low Temperature Engineering and Applied Sciences, Yutopian Enterprises, 2005.
2. Arora, C.P., Refrigeration and Air-conditioning, Tata-McGraw Hill, 2008.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEP704** | **Gas Dynamics** | **L** | **T** |
| | | **3** | **0** |

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

1. Solve flow equations for quasi one dimensional flow through variable area ducts.
2. Analyze the flow through constant area ducts with friction and heat transfer.
3. Analyze flows with normal and oblique shocks.
4. Solve flow problems with supersonic velocities using shock-expansion theory.
5. Solve linearized velocity potential equation for multi-dimensional flows.

DETAILED SYLLABUS

**Module 1**

Introduction: Review of basic fluid dynamic and thermodynamic principles, Conservation equations for inviscid lows. **(10)**

**Module 2**

One Dimensional flow: One-dimensional wave motion, normal shock waves, Oblique shock waves, Prandtl-Meyer expansions and applications, Generalized one-dimensional flow Nozzle.

**(10)**

**Module 4**

Flow: Isentropic flow with area change, Flow with friction (Fanno flow), Flow with heat addition (Rayleigh flow), Method of characteristics (application to one-dimensional unsteady isentropic flow). **(10)**

**Module 5**

Supersonic Flow: Velocity Potential Equation, Numerical Techniques for Steady Supersonic Flow, Time Marching Technique for Supersonic Blunt Bodies and Nozzles. **(10)**

**Text Books:**


1. Anderson, J.D Jr., Modern Compressible Flows, Tata McGraw Hill, 2012.
2. Yahya, S.M., Fundamentals of Compressible Flow, New age International Pub., 2013.
3. Zucrow, M., Gas Dynamics, Wiley India, 2013.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEP705** | **Power Plant Engineering** | **L** | **T** |
| | | **3** | **0** |

**Objectives:**
To provide an overview of power plants and the associated energy conversion issues.

DETAILED SYLLABUS

**Module 1**
Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems. **(10)**

**Module 2**
Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems. **(8)**

**Module 3**
Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants. **(10)**

**Module 4**
Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems Energy.

**(5)**

**Module 5**
Economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants. **(10)**

**Course Outcomes:**
Upon completion of the course, the students can understand the principles of operation for different power plants and their economics.

**Text Books:**


1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEP706** | **Finite Element Analysis** | **L** | **T** |
| | | **3** | **0** |

Objectives:

1. To illustrate the principle of mathematical modeling of engineering problems
2. To introduce the basics and application of Finite Element Method

DETAILED SYLLABUS

**Module1**

Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method. **(10)**

Module2

One dimensional second order equation, discretization, linear and higher order elements,derivation of shape functions, Stiffness matrix and force vectors, assembly of elementalmatrices, solution of problems from solid mechanics and heat transfer, longitudinal vibrationand mode shapes, fourth order beam equation, transverse deflections and natural frequencies.

(12)

**Module3**

Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors. **(6)**

**Module 4**

Application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Planestresses and plane strain problems, body forces and thermal loads, plate and shell elements. **(8)**

**Module 5**

Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software. **(6)**

Course Outcomes:

Upon completion of the course, students will understand the FEM formulation and itsapplication to simple structural and thermal problems

**Text Books:**


1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.
3. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann, 2004.
4. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEP707** | **Tool Design** | **L** | **T** |
| | | **3** | **0** |

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

1. Interpret the geometrical and dimensional details of a production drawing.
2. Understand principles of locating and clamping systems.
3. Design jigs and fixtures for conventional and NC machining
4. Select and design progressive, compound or combination dies for press working operations
5. Design single point and multipoint cutting tools

DETAILED SYLLABUS

**Module 1**

Basic principles of tool design: Tool design – An overview, Introduction to Jigs and fixtures.

Work holding devices: Basic principle of six point location, Locating methods and devices, Principle of clamping and Types of clamps. (10)

**Module 2**

Design of jigs: Type of Drill bushes, Classification of drill jigs, Design of drill jigs. (3) Design of fixtures: Design of milling fixtures, Design of turning fixtures (3)

**Module 3**

Introduction of press tool design: Introduction to Die cutting operations, Introduction to press and classifications, Die set assembly with components, Introduction to Centre of pressure, Examples of centre of pressure, Design of piercing die, Design of blanking die, Progressive, Compound and Combination dies . (10)

**Module 4**

Design of cutting tools: Introduction to cutting tools, Design of single point tool, Design of drill bit, Design of milling cutter (4)

**Module 5**

Brief introduction of NC machines work holding devices: Tool design for NC machines- An introduction, Fixture design for NC Machine, Cutting tools for NC Machine, Tool holding methods for NC Machine, ATC and APC for NC Machine, Tool presetting for NC Machine. (10)

**Text Books:**

1. F.W.Wilson.F.W. "Fundamentals of Tool Design", ASME, PHI, New Delhi, 2010

2. Donaldson.C, G.H.Lecain and V.C.Goold "Tool Design", TMH, New Delhi, 2010

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO708** | **Mechanical Vibrations** | **L** | **T** |
| | | **3** | **0** |

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

1. Understand the causes and effects of vibration in mechanical systems.
2. Develop schematic models for physical systems and formulate governing equations of motion.
3. Understand the role of damping, stiffness and inertia in mechanical systems
4. Analyze rotating and reciprocating systems and compute critical speeds.
5. Analyze and design machine supporting structures, vibration isolators and absorbers.

DETAILED SYLLABUS

**Module 1**

Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models. (6)

Module 2

SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert's method, Energy method, (4)

Module 3

Free Vibration:: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation. (5)

Module 4

Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration. (6)

**Module 5**

Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion.

Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial

conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers. (10)

**Module 6**

Multi degree of freedom systems: Introduction , Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis. (6)

**Module 7**

Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method. (4)

**Text Books:**


1. L. Meirovich, Elements of Vibration analysis, 2nd Ed. Tata Mc-Grawhill 2007
2. Reference Books:
3. Singiresu S Rao, Mechanical Vibrations. 4th Ed. , Pearson education 2011
4. W.T., Thompson, Theory of Vibration. CBS Publishers
5. Clarence W. de Silva , Vibration: Fundamentals and Practice, CRC Press LLC, 2000

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO709** | **Convective Heat Transfer** | **L** | **T** |
| | | **3** | **0** |

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

1. Understand principles of forced and free convection heat transfer processes.
2. Formulate and solve convective heat transfer problems.
3. Estimate heat dissipation from heat transfer devices.
4. Evaluate energy requirements for operating a flow system with heat transfer.
5. Understand current challenges in the field of convective heat transfer.

DETAILED SYLLABUS

**Module 1**

Introduction: Course structure, Basics of Thermodynamics, Fluid mechanics and Heat transfer Fundamental Principles: Continuity, momentum and energy equations, Reynolds transport theorem, Second law of TD, Rules of Scale analysis, Concept of Heat line visualization. (8)

**Module 2**

Laminar forced convection: External flows: Boundary layer concept, velocity and thermal boundary layer, Governing equations, Similarity solutions, various wall heating conditions, Flow over sphere, wedge and stagnation flow. (8)

**Module 3**

Laminar forced convection: Internal flows: Fully developed laminar flow: Constant heat flux, Constant wall temperature, developing length. (4) External Natural convection: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Boundary layer equations, Scale analysis, Low and high Prandtl number fluids, vertical walls, horizontal walls, sphere. (6)

**Module 4**

Internal Natural Convection: Natural convection in enclosures: isothermal and constant heat flux side walls, triangular enclosures, heated from below, inclined enclosures, annular space between horizontal cylinders. (8)

**Module 5**

Turbulent boundary layer flow: Boundary layer equations, mixing length model, flow over single cylinder, cross flow over array of cylinders, Natural convection along vertical walls, Turbulent duct flow. (6)

**Text Books:**


1. Bejan, A., Convection Heat Transfer, John Willey and Sons, New York, 2001.
2. Louis, C. Burmeister, Convective Heat Transfer, John Willey and Sons, New York, 2003.
3. Kays,W.M. and Crawford,M.E, Convective Heat and Mass Transfer, McGraw Hill, NewYork,2001.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO710** | **Micro and Nano Manufacturing** | **L** | **T** |
| | | **3** | **0** |

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

1. Understand manufacturing considerations at the micro and nano scale.
2. Understand design-and-analysis methods and tools used for micro and nano manufacturing
3. Select manufacturing methods, techniques and process parameters for material processing quality
4. Design and select industrially-viable processes, equipment and manufacturing tools for specific industrial products

## DETAILED SYLLABUS

**Module 1**

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

Nanomaterials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials- sol- gel process, Liquid solid reactions; Gas Phase synthesis of nanomaterials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing(GPC), Chemical Vapour Condensation(CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing(GPC). (11)

**Module 2**

Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). (9)

**Module 3**

Spectroscopic characterizations: Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement, Raman spectroscopy.

Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS). (10)

**Module 4**

Thermal Characterization of Nanomaterials: DTA, TGA, DSC (Principle and Applications), Determination of thermo physical parameters.

Microfabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding. MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining. (6)

**Module 5**

Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing. MEMS devices and applications: Pressure sensor, Inertial sensor, Optical MEMS and RF-MEMS, Micro-actuators for dual-stage servo systems. (4)

**Text Books:**


1. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.
2. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009.
3. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer, 2005.
4. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc, New York, 1994. 5.
   B.D. Cullity - Elements of X-Ray Diffraction, 3rd edition, Prentice Hall , 2002.
5. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture," McGraw- Hill, 2008.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO711** | **Energy Systems and Management** | **L** | **T** |
| | | **3** | **0** |

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

1. Understand principles of energy management and its influence on environment.
2. Comprehend methods of energy production for improved utilization.
3. Improve the performance of thermal systems using of energy management principles
4. Analyze the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems.
5. Evaluate energy projects on the basis of economic and financial criteria.

## DETAILED SYLLABUS

**Module 1**

Introduction to Thermodynamics, Fluid Flow and Heat Transfer

Heat transfer media: Water, steam, Thermal fluids, Air-water vapour mixtures. (8)

**Module 2**

Heat transfer equipment: Heat exchangers, Steam plant

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energystorage systems (10)

**Module 3**

Energy conversion systems: Furnaces, turbines

Heat recovery systems: Incinerators, regenerators and boilers

Energy Management: Principles of Energy Management, Energy demand estimation, Organising and Managing Energy Management Programs, Energy pricing. (10)

**Module 4**

Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries. (8)

**Module 5**

Economic Analysis: Scope, Characterization of an Investment Project, Case studies. (5)

Text Books:


1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Murphy, W. R., Energy Management, Elsevier, 2007.
4. Smith, C. B., Energy Management Principles, Pergamon Press, 2007.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO712** | **Condition Monitoring** | **L** | **T** |
| | | **3** | **0** |

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

1. Understand and apply maintenance schemes in industries.
2. Monitor condition of rotating machinery using signature, temperature and corrosion analysis.
3. Apply oil analysis technique to diagnose the wear debris.
4. Understand modern technologies for effective plant maintenance.

## DETAILED SYLLABUS

**Module 1**

Introduction: Failures – System, component and services failures – classification and its causes, Maintenance Schemes – objectives – types and economic benefits, break down, preventive and predictive monitoring. (8)

**Module 2**

Vibration Monitoring – causes and effects of vibration, review of mechanical vibration concepts – free and forced vibrations, vibration signature of active systems – measurement of amplitude, frequency and phase. (5)

**Module 3**

Vibration monitoring equipment– vibration sensors (contact and non-contact type) –factors affecting the choice of sensors, signal conditioners, recording and display elements, vibration meter and analyzers, measurement of overall vibration levels. (6)

**Module 4**

Contaminant analysis: Contaminants in used lubricating oils – monitoring techniques (wear debris)
– SOAP technique, Ferrography, X-ray spectrometry, Particle classification.
Temperature Monitoring – Various techniques – thermograph, pyrometers, indicating paint and NDT methods. (11)

**Module 5**

Special Techniques: Ultrasonic measurement method, shock pulse measurement, Kurtosis, Acoustic Emission mentoring, critical speed analysis, shaft orbit analysis, Cepstrum analysis. Non- destructive techniques, Structural health monitoring weldments for surface and subsurface cracks.

(10)

**Text Books:-**

1.Rao J. S., Vibration Condition Monitoring, Narosa Publishing House, 2/e 2000.
2.Isermann R., Fault Diagnosis Application, Springer-Verlag Berlin, 2011.
3.Allan Davis, Hand book of Condition Monitoring, Chapman and Hall, 2000.
4.Choudary K K., Instrumentation, Measurement and Analysis, Tata McGraw Hill.
5.Collacott, R. A., Mechanical Faults Diagnosis, Chapman and Hall, London, 1990

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO713** | **Rapid Prototyping** | **L** | **T** |
| | | **3** | **0** |

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

1. Identify suitable time compression techniques for rapid product development.
2. Model complex engineering products and develop process plans for rapid production.
3. Analyse and select a rapid manufacturing technology for a given component.
4. Identify the errors during generation of STL files and minimize them.
5. Optimize FDM process parameters to improve the quality of the parts.

## DETAILED SYLLABUS

**Module 1**

Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP. (5)

**Module 2**

RP Software: Need for RP software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP.

Photopolymerization RP Processes: Stereolithography (SL), SL resin curing process, SL scan patterns, Microstereolithography, Applications of Photopolymerization Processes. (9)

**Module 3**

Powder Bed Fusion RP Processes: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.

Extrusion-Based RP Systems: Fused Deposition Modelling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes. (6)

**Module 4**

Printing RP Processes: 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes.

Sheet Lamination RP Processes: Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. (6)

**Module 5**

Beam Deposition RP Processes: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks.

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods. (6)

**Module 6**

Reverse Engineering: Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development. Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS, etc.
RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP. (6)

**Text Books:**


1. Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.
2. Ian Gibson., David W Rosen., Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
3. RafiqNoorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO714** | **Industrial Automation** | **L** | **T** |
| | | **3** | **0** |

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

1. Enumerate principles, strategies and advantages of industrial automation.
2. Select level of automation and calculate manpower requirement.
3. Design material handling and material storage systems for an automated factory.
4. Automate shop floor controls and part/device identification methods.
5. Study the effect of automation by simulation and experimentation.

## DETAILED SYLLABUS

**Module 1**

Principles and Strategies of Automation-Power to Accomplish the Automated Process, program of Instruction, Control System, Advanced automation Functions-safety Monitoring, maintenance and repair Diagnostics, error Detection and Recovery, levels of automations-Five levels of automation and control in manufacturing. (10)

**Module 2**

Material Handling systems and Design-Introduction to Material Handling, Material Transport Equipment, analysis of Material Transport Systems, Storage systems-Storage System Performance and Location Strategies, Conventional Storage Methods and Equipment. (10)

**Module 3**

Automation Storage Systems, Engineering Analysis of Storage Systems.
Automatic identification methods-Overview of Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies. (6)

**Module 4**

Industrial control systems-Process Industries Vs Discrete Manufacturing Industries, Levels of Automation in the two industries, Variables and Parameters in the two industries.
Continuous Vs Discrete control- Continuous Control System, Discrete Control System.
Computer process control and its forms- Control Requirements, Capabilities of Computer Control, and Forms of Computer process Control. (10)

**Module 5**

Control system components-Sensors, Actuators, Analog-to-Digital Convertors, Digital-to-Analog Convertors, Input/output Devices for Discrete Data. (4)

**Text Books:**

1.Groover, M.P., Automation production Systems and Computer Integrated Manufacturing, Pearson Education, 2003.
2.Krishna Kant, Computer Based Industrial Control, Prentice Hall of India, New Delhi, 2000.
3.Tiess Chiu Chang and Richard A.W., An Introduction to Automated Process planning Systems, Tata McGraw-Hill Publishing company, New Delhi, 2000.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO715** | **Technology Management** | **L** | **T** |
| | | **3** | **0** |

**Objectives:** In the Management of Technology programme the students learn to explore andunderstand technology as a corporate resource - a resource that allows a firm to keep many differentballs in the air. It shows how firms can use technology to design and develop products and servicesthat maximize customer satisfaction on the one hand, while maximizing corporate productivity,profitability and competitiveness on the other.

**Outcomes:** The programme addresses challenging questions most companies face such as:

1. What technologies do we need and when?
2. Do we procure the technology we need with our own research capabilities, in collaborationwith outside parties, or by acquiring it or licensing it from others?
3. How can we use the abundant technological opportunities to affect our mission, objectives and strategies?

## DETAILED SYLLABUS

**Module 1: Introduction to Technology Management**

Definition, Concept of creativity, Components, Features, Classification of Technology, Concept andNature of Technology Management, Drivers of MOT, Significance and Scope of MOT, Role ofChief Technology Officer, Responding to Technology challenges. (8)

**Module-2: The Role of Technology in the Creation of Wealth**

The creation of wealth, Long-wave cycle, Evolution of production technology, Critical Factors inManaging Technology: The creativity factor, Types of innovation, Technology, price relationship,Managing change. (6)

**Module 3: Management of Technology**

The New Paradigms Essential issues in technology management, Project planning and management,Management paradigm and the technology factor. (4)

**Module-4: Technology Life Cycles**

S-curve of technological progress, Multiple generation technologies ,Diffusion of technology (2)

**Module-5: The Process of Technological Innovation**

Innovation and creative transformation in the knowledge age: critical trajectories, Case- Xerox, Amodel for technological innovation in biomedical devices. (5)

**Module-6: Strategic planning**

Competitiveness,Business Strategy and Technology Strategy, Technology Planning. TheAcquisition and Exploitation of Technology: Acquisition of technology. Exploitation of technology,Stages of technology development, Technology Transfer (6)

**Module-7: Technology Diffusion**

Concept of Diffusion, Integrated Diffusion Strategy, influencing factors, Innovation adoption, Diffusion strategies, Community effects and network externalities, Distribution of Adopters, Crossing the Chasm, Market dynamics. Technology Absorption and Deployment, Technology Absorption, Influencing factors, Deployment strategies, Corporate Venturing, Benefits and Drawbacks of Corporate Venturing, Spin-off Companies. (9)

**Text Book:**


1. Management of Technology by Tarek Khalil.
2. Rastogi P.N: "Management of Technology and Innovation", Sage Publications, New Delhi, 2009.
3. Scott Shane: "Technology Strategy for Managers and Entrepreneurs", Pearson Education, New Delhi, 2009.
4. CSG Krishnamacharyulu, Lalitha Ramakrishnan, "Management of Technology", Himalaya, Publishing House Private Limited, New Delhi, 2008.


| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO716** | **Computer Aided Manufacturing** | **L** | **T** |
| | | **3** | **0** |

**Objectives**

1. This course introduces students with computer assisted modern manufacturing technologies.
2. The objective of this course is to make students learn the important theoretical concepts, and the state-of-the-art technological developments in the area of modern manufacturing.
3. Various topics to be covered are basics of automation, NC programming (Manual and APT),
4. concepts of group technology, Flexible Manufacturing system, CIM and robotics.

**Outcomes:** Student will be able to:

1. Understand the current status of CAM systems in industry.
2. Learn the concepts of group technology, automation, FMS and CIM.
3. To write manual part programs using G and M codes for lathe and milling m/c.
4. To write APT part programs milling m/c.

## DETAILED SYLLABUS

**Module 1**

**Automation:** Definition of Automation, Need for Automation, building block of automationtechnology, Types of automation systems, Automation strategies, levels of automation, types of control system, Advantages, Disadvantages and applications of Automation. (8)

**Module 2**

**NC, CNC and Adaptive control:** Introduction, history, components of NC machines, classificationof NC machines, input media for NC machines, microprocessor based CNC systems, block diagramof a typical CNC system, features of CNC, advantages of CNC, direct numeric control (DNC) and itsadvantages, Adaptive control and its types. (10)

**Module 3**

**Part programming:** Introduction, NC coordinate system, fixed and floating zero machines, NC motion control systems, part programming methods, Manual part programming for milling and latheusing G and M codes, various canned cycles, Computer aided part programming: Introduction toAPT language, simple problems on APT programming. (10)

**Module 4**

**Group Technology:** Introduction, part families, part classification and coding, production flow analysis, composite part concept, machine cell design, benefits of GT. (4)

**Module 5**

**FMS and CIM:** Concept and definition of Flexible Manufacturing System (FMS), components ofFMS, FMS workstations, Automated material handling and storage systems, Automated storage andretrieval system and Industrial robots, FMS layout and benefits, Introduction and concept ofComputer Integrated manufacturing (CIM) through CIM wheel. (8)

**Text books:**


1. Groover M. P., Automation, Production Systems And Computer-integrated Manufacturing, PHI.
2. Kundra, Rao and Tiwari., Computer Aided manufacturing, Tata McGraw Hill Publishers.


**Reference books:**


1. Steve Krar, Arthur Gill, "CNC technology and programming", McGraw-Hill, 1990
2. James Madison, "CNC machining hand book", Industrial Press Inc., 1996
3. Jha, N. K., Handbook of Flexible Manufacturing Systems, Academic Press Inc.
4. Miller R. K., FMS/CIM Systems Integrated Handbook, Prentice Hall.

| Mechanical Engineering | | | |
|---|---|---|---|
| **MEO717** | **Maintenance Engineering & Management** | **L** | **T** |
| | | **3** | **0** |

**Objectives:**

1. To keep asset in productivity and availability state based on requirement level of reliability and effectiveness.
2. To spend optimal maintenance cost in relation to achieve the availability and effectiveness of equipments.
3. To prevent or reduce the likelihood or frequency of failures of engineering components and systems.
4. To increase the quality, quantity of the product with minimal cost and increase the productivity of the plant.
5. To identify and correct the causes of failures that does occur in engineering system.

**Outcomes:** Student will be able to:

1. Maintenance management skill
2. Need of safety devices
3. Increase the productivity of the plant at minimal cost
4. Failure analysis of plant machineries
5. Concept of tribology, conditioning monitoring
6. Concept of maintainability and availability of mechanical components and systems.

## DETAILED SYLLABUS

### Module 1

**Introduction:** Fundamentals of Maintenance Engineering, Maintenance engineering its importance in material &energy conservation, Inventory control, Productivity, Safety, Pollution control, Safety Regulations,Pollution problems, Human reliability. (8)

### Module 2

**Maintenance Management:** Types of maintenance strategies, Planned and unplanned maintenance, Breakdown, Preventive &Predictive maintenance their comparison, Computer aided maintenance, Maintenance scheduling,Spare part management, Inventory control, TPM.

(8)

### Module 3

**Tribology In Maintenance:** Friction wear and lubrication, Friction & wear mechanisms, Prevention of wear, Types of lubricationmechanisms, Lubrication processes. Lubricants types, General and special purpose, Additives,Testing of lubricants, Degradation of lubricants, Seal & packing. (8)

### Module 4

**Machine Health Monitoring:** Condition based maintenance, Signature analysis, Oil analysis, NDT, Vibration, Noise and thermal signatures, Online & offline Techniques, Instruments & equipment used in machine health monitoring. Instrumentation in maintenance, Signal Processing, Data acquisition and analysis, Application of intelligent systems, Data base design. (8)

**Module 5**

**Reliability, Availability & Maintainability (RAM) Analysis:** Introduction to RAM failure mechanism, Failure data analysis, Failure distribution, Reliability ofrepairable and non-repairable systems, Improvement in reliability, Reliability testing, Reliabilityprediction, Utilization factor, System reliability by Monte Carlo Simulation Technique. (8)

**Text Books:**


1. Krishnan Gopal and Banerji S. K., Maintenance & Spare parts Management, PHI
2. Mishra R. C. and Pathak K., Maintenance Engineering and Management, PHI
3. Shrivastava S.K., Industrial Maintenance Management, S. Chand Publications.
4. Rao C. N. R., Handbook of Condition Monitoring,.
5. Banga and Sharma, Industrial Engineering & Management Science, Khanna Publishers.


**Reference Books:**


1. Higgins L., Mobley R. K. and Mobley K., Maintenance Engineering Hand Book, Mc-Graw Hill, 7th edition.
2. Higgins L., Mobley R. K. and Mobley K., Maintenance Engineering Standard Hand Book, Mc-Graw Hill, 6th edition