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| **Scheme of B.Tech -Mechanical Engineering** |
| **For the candidates admitted in session 2018-19** |
| **SEMESTER – III** |  |  |  |  |  |
| **Sr.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| **1** | ME3CO01 | Production Processes | 3 | 0 | 0 | 3 |
| **2** | ME3CO02 | Strength of Materials | 3 | 1 | 2 | 5 |
| **3** | ME3CO03 | Theory of Machines | 3 | 1 | 2 | 5 |
| **4** | ME3CO04 | Engineering Thermodynamics | 3 | 1 | 0 | 4 |
| **5** | ME3CO17 | CAD Lab | 0 | 0 | 2 | 1 |
| **6** | ME3CO06 | Fluid Mechanics | 3 | 1 | 2 | 5 |
| **7** | ME3ES09 | Engineering Materials | 3 | 0 | 0 | 3 |
|   |   | **Total** | **18** | **4** | **8** | **26** |
| **SEMESTER – IV** |  |  |  |  |  |
| **Sr.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| 1 | EN3BS03 | Engineering Mathematics -III | 3 | 1 | 0 | 4 |
| 2 | ME3CO07 | Manufacturing Processes and Machines  | 3 | 0 | 2 | 4 |
| 3 | ME3CO08 | Machine Design -I | 3 | 0 | 2 | 4 |
| 4 | ME3CO09 | Energy Conversion -I | 3 | 0 | 2 | 4 |
| 5 | ME3CO10 | Dynamics of Machines | 3 | 1 | 2 | 5 |
| 6 | EN3MC08 | Fundamentals of Soft Skills and Aptitude | 2 | 0 | 0 | 0 |
| 7 | EN3HS04 | Fundamentals of Management, Economics & Accountancy  | 3 | 0 | 0 | 3 |
|   |   | **Total** | **20** | **2** | **8** | **24** |
| **SEMESTER – V** |  |  |  |  |  |
| **Sr.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| 1 | ME3CO11 | Energy Conversion -II | 3 | 1 | 2 | 5 |
| 2 | ME3CO12 | Machine Design -II | 3 | 0 | 2 | 4 |
| 3 | ME3CO13 | Heat and Mass Transfer | 3 | 1 | 2 | 5 |
| 4 |   | Elective -I | 3 | 0 | 0 | 3 |
| 5 |   | Elective -II | 3 | 0 | 0 | 3 |
| 6 | EN3MC10 | Soft Skills -III | 2 | 0 | 0 | 0 |
| 7 | EN3MC15 | Universal Human Values and Professional Ethics | 2 | 0 | 0 | 0 |
| 8 |   | Open Elective-I | 3 | 0 | 0 | 3 |
|   |   | **Total** | **22** | **2** | **6** | **23** |
| **SEMESTER – VI** |  |  |  |  |  |
| **Sr.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| 1 | ME3CO14 | CAD/CAM/CIM | 4 | 0 | 2 | 5 |
| 2 | ME3CO15 | I. C. Engines | 3 | 1 | 2 | 5 |
| 3 | ME3CO16 | Refrigeration and Air Conditioning  | 3 | 1 | 2 | 5 |
| 4 |   | Elective -III | 3 | 0 | 0 | 3 |
| 5 |   | Elective - IV | 3 | 0 | 0 | 3 |
| 6 | EN3MC01 | Open Learning Courses | 1 | 0 | 0 | 0 |
| 7 |   | Open Elective-II | 3 | 0 | 0 | 3 |
|   |   | **Total** | **20** | **2** | **6** | **24** |
| **SEMESTER – VII** |  |  |  |  |  |
| **Sr.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| 1 |   | Elective - V | 3 | 0 | 0 | 3 |
| 2 |   | Elective - VI | 3 | 0 | 0 | 3 |
| 3 |   | Open Elective-III | 3 | 0 | 0 | 3 |
| 4 | ME3PC01 | Project Work -I | 0 | 0 | 8 | 4 |
| 5 | ME3PC03 | Industrial Training | 0 | 0 | 4 | 2 |
|   |  | **Total** | **9** | **0** | **12** | **15** |
| **SEMESTER VIII** |  |  |  |  |  |
| **Sr.No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Credits** |
| 1 | ME3PC02 | Project Work -II | 0 | 0 | 28 | 14 |
|   |   | **Total** | **0** | **0** | **28** | **14** |

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| **Course Code**  | **Course Name** | Hours per Week | Total |
| **L** | **T** | **P** | Credits |
| ME3CO01 | Production Processes | 3 | 0 | 0 | 3 |

**UNIT-I MOULDING:**

Cores, Core Prints, Core boxes, Pattern design, Pattern layout and construction, testing of moulding sand. moulding and core making machines, use of chaplets, CO2 - Process, fluid sand process, shell moulding, cold curing process, hot-box method, high pressure and flask less moulding, Design of metal moulds, Die Design for die Casting.

**UNIT II CASTING:**

Directional principles, Solidification, types of gating systems, Pouring time and temperature. Design criteria of pouring basin, screw, runner, gate and riser, gating ratio, chill and its uses. Selection of melting furnaces, Crucible furnaces, Electric furnaces, Induction furnace, Control of melt and Cupola charge calculations. Foundry mechanization and lay out. Casting defects, Causes and remedies.

**UNIT-III FORGING**:

Classification of forging processes - forging processes - forging defects and inspection. Rolling: Classification of rolling processes - rolling mill - rolling of bars and shapes. Extrusion: Classification of extrusion processes - extrusion equipments - examples.

**Extrusion:** Drawing of rods, wires and tubes.

**Sheet Metal Working** : Sheet metal forming methods: Shearing, Blanking, Bending, Stretch Forming, deep forming. Spinning: Spinning processes.

**UNIT-IV WELDING:**

Principle, classification, advantages, limitations and applications, Tungsten Inert Gas welding, Metal Inert Gas welding, Electro - slag welding, Electro - Gas Welding, Explosive Welding, Ultrasonic Welding, Electron Bean Welding, Laser Beam Welding, Friction Welding, Cold Welding, Thermit Welding, Codification of Electrodes, Welding Defects-causes and remedies.

**UNIT- V POWDER METALLURGY:**

Definition, advantages, limitations and applications, Powder metallurgy processes and operations, Compaction – Sintering and Finishing – Design considerations for powder metallurgy and Process capability – Shaping of ceramics –Forming and shaping of glass – Design considerations for ceramics and glass – Processing of superconductors.

**TEXT BOOKS:**

1. Rao P.N., “Manufacturing Technology”, Vol. 1, Tata McGraw Hill.

2. Sharma P.C., “A Text Book of Production Engineering”, Vol.1, S. Chand Publication, New Delhi.

3. Hajra Choudhry, Elements of Workshop Technology**,** Vol I & II Media Promoters

REFERENCE BOOKS

1. Production Technology by HMT, Tata Mcgraw Hills
2. Chapman W.A.J, Workshop Technology , Volume II , Oxford and IVH Publishing Company Ltd
3. Lindberg RA , Processes and Materials of M<anufacture, Prentice Hall Publications

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| **Course Code**  | **Course Name** | Hours per Week | Total |
| **L** | **T** | **P** | Credits |
| ME3CO02 | Strength of Materials | 3 | 1 | 2 | 5 |

**UNIT-I INTRODUCTION**:

Stress and strain; normal, shear and bearing stresses; normal and shear strain, modulus of Elasticity, Poisson’s ratio, Elastic and Bulk modulus, relation between elastic constants, deformation of axial members, tensile tests for ductile and brittle materials, yield strength, yield criteria, ultimate strength, factor of safety, mechanical properties, temperature stresses in simple and composite members.

**UNIT-II COMPOUND STRESS AND STRAINS**:

Strain energy due to axially applied loads (gradual, sudden and impact loads).State of stress, Generalized Hook’s Law, stress transformation, principal planes, principal stresses and strains, maximum shear stress, Mohr’s Circle representation for stress and strains.

**UNIT-III STRESSES IN BEAMS**:

 Pure bending, bending of beams with symmetric cross section, composite cross sections, shear stress in beams, deflection in beams by different methods for various boundary conditions. Shear Force and Bending Moment Diagrams **Deflection of Beams**; Equation of elastic curve, cantilever and simply supported beams, Macaulay’s method, area moment method.

**UNIT-IV TORSION OF SHAFTS**:

 Torsional Moment Diagram, torsion formula for solid and hollow shafts, maximum normal and shear stress, angle of twist, combined effect of axial load, bending moment and torsional moment on circular shafts.

**UNIT-V COLUMNS AND STRUTS**:

 Buckling and stability, slenderness ratio. Euler’s theory for pin ended columns, effect of end conditions on column buckling, Ranking Gordon formulae, examples of columns in mechanical equipment’s and machines.

**TEXT BOOKS:**

1. Mechanics of Materials by Hibbeler, Pearson.

2. Mechanics of Materials by.Beer, Jhonston, DEwolf and Mazurek, TMH

3. Mechanics of Materials by James M Gere & Barry J Goodnoo cengage learning

4. Strength of Materials by Pytel and Singer, Harper Collins

5. Strength of Materials by Ryder, Macmillan.

6. Strength of Materials by Gere and Goodno.

**REFERENCE BOOKS:**

1. Timoshenko, S.P., Gere, M.J., Mechanics of Materials, C.B.S., Publishers.

2. Ramamurtham, S., Strength of Materials,, Dhanpat Rai Publications.

3. Popov, E.P., Engineering Mechanics of Solids, Prentice-Hall.

**LIST OF PRACTICAL:**

1. To determine the Brinell Hardness Number of CI, MS, Al and Brass specimen.
2. To determine the Rockwell Hardness Number of CI, MS, Al and Brass specimen.
3. To determine the Vicker’s Hardness Number of CI, MS, Al and Brass specimen.
4. Study of Universal Testing Machine and to carry out tensile test, compression test.
5. To determine Impact strength of given specimen by Charpy and Izod test.
6. To study of Impact testing of PVC pipes by falling dart method.
7. To compare observed & theoretical values of Deflection of Simply supported Beam.
8. To verify the slope & deflection of beam using moment area method.
9. To find the value of flexural rigidity for a given beam & compare it with theoretical value.
10. To find bending moment as a beam apparatus & compare with theoretical value.

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| **Course Code**  | **Course Name** | Hours per Week | Total |
| **L** | **T** | **P** | Credits |
| ME3CO03 | Theory of Machines | 3 | 1 | 2 | 5 |

**UNIT I MECHANISMS AND MACHINES**

Rigid and resistant body, Definitions and classification of Links, Kinematic pairs, Chains and Mechanism, Difference between mechanism and machine., Degrees of freedom : for a pair and mechanism, Gruebler’s & Kutzback’s Criterion for planer mechanisms, Inconsistencies in Gruebler’s criteria, Equivalent linkages, Kinematic inversion, Different Inversions of Four bar chain, Slider crank chain and Double slider-crank chain. Number Synthesis of mechanism, **Different lower paired mechanisms**: Kinematic analyses of- Straight line mechanisms : Approximate and Exact Mechanisms, Davi’s and Ackermann Steering Mechanisms, Hooke’s Joint- Single and Double type , Pantograph Mechanisms, Quick Return Mechanisms- Slotted Lever and Whitworth’s type.

**UNIT II VELOCITY AND ACCELERATION ANALYSIS IN MECHANISMS**

Concepts of planer motion of body as a point and as a rigid body, Displacement of a rigid body - Combination of rotation and translation, Relative displacement of two points on a rigid body, Pure rotation of a rigid body- Angular velocity of link , **Kinematic Analysis of Mechanisms :** **Graphical Methods** **of** **Velocity Analysis of Planer Mechanisms**: Relative Velocity Method- Velocity Diagrams of Mechanisms upto six links, Instantaneous Centre of Rotation Method : Properties of instantaneous centers, Aronhold- Kennedy Theorem of three centers, Velocity determination in mechanisms upto six links, **Acceleration Analysis of Planer Mechanisms:** Concepts of Radial and Tangential acceleration, Coriolis Component of acceleration, Acceleration Diagrams of different mechanisms. Klein’s Construction for velocity and acceleration of Slider Crank mechanism.

**UNIT III CAMS AND FOLLOWERS**

Classification of Cams and Followers, Terminologies of Cams, Displacement, velocity and accelerations of followers for standard motions – Uniform motion, Parabolic, SHM and Cycloidal. Cam profile generation, Analysis for cams with specific contours, circular arc and tangent cams.

**UNIT IV GEARS AND GEAR TRAINS**

Classification of gears , Law of gearing, Spur Gears : Terminology, Velocity of sliding, Tooth profiles- Cycloidal and Involute and their comparison, Concept of path of contact, arc of contact and contact ratio and their relationship for spur gear pair, Concepts of Interference and Undercutting, Minimum number of teeth to avoid interference between – Gear and Pinion and between Rack and Pinion, Terminologies of Helical, Spiral, Worm and Worm gear and Bevel gears. **Gear Trains:** Spur Geared trains : Simple, Compound, Reverted and Epi-Cyclic - Velocity ratio and Torque calculations in gear trains, Introduction to Automobile Differential Gear Box.

**UNIT V : GYROSCOPE**

Concepts of Gyro-couple and Gyro-reaction Couples. Evaluation of gyroscopic couple. Evaluation of gyro-reaction couples and their effects in different machines – Boat, Aeroplane, Two wheeler and Four wheeler, Stabilization of naval ship using Gyroscopic effect.

**TEXT BOOKS :**

1. Rattan S.S.; Theory of machines; Mc-Graw Hills Publications.

2. Ambekar A.G.; Mechanism and Machine Theory; PHI. Eastern Economy Edition.

3. Rao, J.S., and Dukkipati, R.V.: “Mechanism and Machine Theory”, Wiley Eastern Ltd.

4. Jagdish Lal; Theory of Machines; Metropolitan Book Co; Delhi

5. Khurmi R.S. and Gupta J K**,** Theory of Machines, S.Chand & Co.

**REFERENCES BOOKS:**

1. Bevan T., “Theory of Machines: A text book for engineering students”, CBS, New Delhi.

2. Shigley, J.E. and Uicker, J.J. and Pennock, G. R.. “Theory of Machines and Mechanisms”, Oxford University Press.

3. Ghosh, A, and Malick, A. K. “Theory of Mechanisms and Machines”, East West Press Pvt. Ltd.

**LIST OF PRACTICALS**

### To determine the degree of freedom of different kinematic pairs

### To verify the principle of Pantograph apparatus.

1. To verify the principle of Watt’s and Peaucellier’s Straight line mechanisms.
2. To determine the cutting ratios in Whitworth and Slider Lever Quick Return Mechanisms
3. To verify the torques due to Coriolis component of acceleration.
4. To draw the cam profile of a given cam.
5. To study different types of gears.
6. To verify the velocity ratio and the holding torque in an epi-cyclic gear train.

 9. To verify the applied gyroscopic couple using motorizedgyroscopic apparatus

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| **Course Code** | **Course Name** | Hours per Week | Total |
| **L** | **T** | **P** | Credits |
| ME3CO04 | Engineering Thermodynamics | 3 | 1 | 0 | 4 |

**UNIT-I BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS:**

Basic concepts, system, state, boundary, surroundings, path and point functions, process, equilibrium, polytropic processes, heat and work transfer, work as a function of p and v; pdv work for various processes, Heat transfer for various processes, concept of internal energy, first law of thermodynamics for a process and for a cycle, enthalpy, first law for steady flow, limitations of first law, PMM1.

**UNIT II SECOND LAW OF THERMODYNAMICS:**

Statements of second law, PMM2, reservoirs, Heat engines, refrigerator, heat pump, calculation of efficiency and COP, reversibility and irreversibility, Clausius inequality, Carnot cycle, Carnot's theorem, Entropy, T-s diagram, calculation of entropy for various processes, simple vapor compression refrigeration cycle.

**UNIT-III STEAM PROPERTIES:**

Pure Substances, phase transformation, formation of steam, its representation on T-Q, T-v, p-v, p-h, h-s, T-s charts, processes involved in phase transformation of water to superheated steam, dryness fraction, use of steam tables and Mollier chart, Separating calorimeter, Throttling calorimeter, combined separating and throttling calorimeter.

**UNIT-IV AIR STANDARD CYCLES:**

Overview of Stirling, Ericsson, Atkinson, Lenoir cycles, Otto (SI), Diesel (CI), Dual, Brayton cycles,, calculation of efficiency for each cycle and its comparison with Carnot efficiency, Comparison of Otto, Diesel and Dual efficiency for various working conditions.

**UNIT- V MIXTURE OF GASES**:

Properties of mixture of ideal gases, internal energy, Enthalpy and specific heat of gas mixtures, Entropy of gas mixtures, thermodynamic relations, Maxwell relations.

**TEXT BOOKS:**

1. P.K.Nag; Engineering Thermodynamics; TMH
2. Van GJ; Thermodynamics; John Wylen
3. Cengel Y; Thermodynamics; TMH
4. Arora CP; Thermodynamics; TMH

**REFERENCE BOOKS:**

1. Omkar Singh, Engineering Thermodynamics, New Age International.
2. Ratha Krishanan, Engineering Thermodynamics, PHI India Pvt. Ltd.
3. M. Achuthan, Engineering Thermodynamics, PHI India.
4. David R. Gaskell, Introduction to Thermodynamics of Materials, Taylor and Francis Publisher.
5. M. Achuthan, Engineering Thermodynamics, Prentice Hall India Limited.

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| **Course Code**  | **Course Name** | Hours per Week | Total |
| **L** | **T** | **P** | Credits |
| ME3CO17 | CAD Laboratory  | 0 | 0 | 2 | 1 |

**LIST OF PRACTICALS**

1. Getting familiar with the Auto CAD Environment. Toolbars, working area, sub menus, working modes. Starting with some basic commands.
2. Study addressing schemes with different commands.
3. Studying basic objects and their commands e.g. circle, donut rectangle, arc, ellipse, polygon.
4. Studying commands that duplicate objects e.g. array, offset and modify commands e.g. trim, break, chamfer, fillet.
5. Studying Mirror, hatch, ltype, adding toolbars and object snap, zoom, text.
6. Making Isometric objects with isometric settings.
7. Applying dimensions (Aligned, Radius, Diameter, Angular, Leaders). Increasing / Decreasing working area, changing measuring scales.
8. Changing properties of dimensions through style. Modifying properties of objects. Changing dimensions using stretch and extend.
9. Studying setting of AutoCAD environment and Layers. Raster Images and External Reference Files.
10. Working on 4 view ports.
11. Changing views for 3d drawings, studying Solids and 3d objects box, sphere, cylinder, cone, wedge, torus, extrude, revolve.
12. Converting basic shapes example circle, rectangle, polygon, ellipse to solids using extrude command. Applying revolve command on polyline.
13. Subtracting solids and extruded objects. Studying 3d command.
14. Working with AutoCAD Views, 3D orbit, continuous orbit.
15. Generating finished objects by render.

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| **Course Code**  | **Course Name** | Hours per Week | Total |
| **L** | **T** | **P** | Credits |
| ME3CO06 | Fluid Mechanics | 3 | 1 | 2 | 5 |

**UNIT-I FLUID PROPERTIES AND HYDROSTATICS:**

Density – Viscosity – Surface tension – compressibility – capillarity – Hydrostatic forces on plane – inclined and curved surfaces – buoyancy – centre of buoyancy – metacentre.

**UNIT-II KINEMATICS OF FLOW:**

Types of flow-ideal & real , steady & unsteady, uniform & nonuniform, one, two and three dimensional flow, path lines, streak-lines, streamlines and stream tubes; continuity equation for one and three dimensional flow, rotational & irrotational flow, circulation, stagnation point, separation of flow, sources & sinks, velocity potential, stream function, flow netstheir utility & method of drawing flow nets.

**UNIT-III DYNAMICS OF FLOW:**

Euler’s equation of motion along a streamline and derivation of Bernoulli’s equation, application of Bernoulli’s equation, energy correction factor, linear momentum equation for steady flow; momentum correction factor. The moment of momentum equation, forces on fixed and moving vanes and other applications. Fluid Measurements: Velocity measurement (Pitot tube, Prandtl tube, current meters etc.); flow measurement (orifices, nozzles, mouth pieces, orifice meter, nozzle meter, venturi-meter, weirs and notches).

**UNIT-IV** **DIMENSIONAL ANALYSIS AND DYNAMIC SIMILITUDE:**

 Dimensional analysis, dimensional homogeneity, use of Buckingham-pi theorem, calculation of dimensionless numbers, similarity laws, specific model investigations (submerged bodies, partially submerged bodies, weirs, spillways, rotodynamic machines etc.)

**UNIT-V LAMINAR FLOW:**

 Introduction to laminar & turbulent flow, Reynolds experiment & Reynolds number, relation between shear & pressure gradient, laminar flow through circular pipes, laminar flow between parallel plates, laminar flow through porous media, Stokes law, lubrication principles. Flow through pipes , Boundary Layer

**TEXT BOOKS:**

1. Modi & Seth; Fluid Mechanics; Standard Book House, Delhi
2. Streeter VL, Wylie EB, Bedford KW; Fluid Mechanics; TMH
3. Som and Biswas; Fluid Mechnics and machinery; TMH
4. Cengal; Fluid Mechanics; TMH

**REFERENCE BOOKS:**

1. White ; Fluid Mechanics ; TMH
2. Gupta; Fluid Mechanics; Pearson
3. JNIK DAKE; Essential of Engg Hyd; Afrikan Network & Sc Instt. (ANSTI)
4. R Mohanty; Fluid Mechanics; PHI.

**LIST OF PRACTICAL:**

1. To determine the local point pressure with the help of pitot tube.
2. To Study terminal velocity of a spherical body in water.
3. Calibration of Orifice meter and Venturi meter
4. Determination of Cc, Cv, Cd of Orifices
5. Calibration of Nozzle meter and Mouth Piece
6. Reynolds experiment for demonstration of stream lines & turbulent flow
7. Determination of meta-centric height
8. Determination of Friction Factor of a pipe
9. Verification of Impulse momentum principle.

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| **Course Code** | **Course Name** | Hours per Week | Total |
| **L** | **T** | **P** | Credits |
| ME3ES09 | Engineering Materials | 3 | 0 | 0 | 3 |

**UNIT I STRUCTURES:**

Atomic structure and bonding in materials. Crystal structure of materials, crystal systems, unit cells and space lattices, determination of structures of simple crystals by x-ray diffraction, miller indices of planes and directions, packing geometry in metallic, ionic and covalent solids. Imperfections in crystalline solids and their role in influencing various properties.

**UNIT II MATERIAL BEHAVIOR &MECHANICAL PROPERTIES:**

Elasticity in metals, Mechanism of plastic deformation, strengthening mechanisms, Stress-strain diagrams of metallic, ceramic and polymeric materials. Ductile to brittle transition, creep failure mechanism, Fatigue mechanism. Mechanical properties, testing of materials under tension, compression and shear loads, Hardness tests & Impact tests.

**UNIT III PHASE DIAGRAMS & HEAT TREATMENT:**

Introduction - Solid solutions, Phase rules , Free energy in intermediate phases , Phase diagrams - Binary phase diagrams; iron-iron carbide metastable diagram, development of micro-structures in iron-carbon alloys. Isothermal transformation diagrams, TTT curves, various heat treatment processes.

**UNIT IV METALLIC MATERIALS:**

Stainless and tool steels, HSLA, Maraging steels, TRIP steel – Cast Irons, Copper and copper alloys, Aluminum and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

**UNIT V NONMETALLIC MATERIALS:**

polymeric materials - Formation of polymer structure – production techniques of fibre, foams, adhesives and coating - structure and properties and applications of engineering polymers - Advanced structure ceramics, WC, TiC, Al203, SiC, Si2N4, CBN and Diamond - Properties, processing and applications. Composite materials: Types, production techniques, structure, properties and applications.

**TEXT BOOKS:**

1. Raghavan V; Material Science and Engineering, PHI Publication.
2. Narula - Material Science, TMH
3. W.D. Callister, Jr., Materials Science and Engineering: An Introduction, Wiley & Sons
4. Krishnan K. Chawla, Composite materials, Science and Engineering Springer.

**REFERENCE BOOKS:**

1. J.C. Anderson, K.D. Leaver, P. Leavers and R.D. Rawlings, (2003), Materials Science for Engineers, 5th edition, Tata McGraw Hill Publishers.
2. William F. Smith and Javad Hashemi (2004), Foundations of Materials Science and Engineering 4th ed., Mc Graw Hill.
3. Sidney H Avner, (2005) “Introduction to Physical Metallurgy, Tata McGraw Hill Publishing Company Limited
4. Lawrence E.Murr (2000), Failure analysis, Marcel Dekker Inc. Publications.

 5. Askeland; The science and engineering of material, Cengage learning.

**SEMESTER: IV**

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| EN3BS03 | Engineering Mathematics-III | 3 | 1 | 0 | 4 |

**Unit I**

**Functions of Complex Variables:** Functions of complex variables: Analytic functions, Harmonic Conjugate functions, Cauchy-Riemann Equations, Complex Line Integral, Cauchy’s Theorem, Cauchy’s Integral Formula, Singular Points, Poles and Residues, Residue Theorem, Application of Residue theorem for evaluation of real integrals.

**Unit II**

**Numerical Analysis –I :** Errors and Approximations, Solution of Algebraic & Trancendental Equations (Regula Falsi method , Newton-Raphson formula and Iterative method), Solution of Simultaneous linear equations by Gauss Elimination, Gauss Jordan, Crout’s Triangularization method , Jacobi’s and Gauss-Siedel Iterative method.

**Unit III**

**Numerical Analysis –II:** Difference Operators, Interpolation (Newton Forward and Backward Formulae), Central Interpolation Formulae (Gauss, Bessel’s and Sterling’s formula), Lagrange’s and Divided difference formulae, Numerical Differentiation.

**Unit IV**

**Numerical Analysis –III :** Numerical Integration, Numerical Solution of Ordinary Differential Equations (Taylor’s Series, Picard’s Method, Euler’s Modified Method, Runge-Kutta Method, Milne’s Predictor and Corrector method) .

**Unit V**

**Statistics :** Correlation, Karl Pearson’s Coefficient of Correlation, Spearman’s Rank Correlation Coefficient , Linear Regression, Regression coefficients ,Curve fitting (Method of Least Square),Testing of Hypothesis , Student’s t-test, Fisher’s z-test, Chi-Square test**.**

**Text Books:**

1. B.S. Grewal, Higher Engineering Mathematics, Edition-43, Khanna Publishers, New

 Delhi, 2014.

2. B .V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing

 Company Ltd., New Delhi, 2006.

**References Books:**

1. George R., Mathematical Statistics, Springer.
2. M .K. Jain, Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publication

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO07 | Manufacturing Processes and Machines | 3 | 0 | 2 | 4 |

**Unit-I**

**Theory of Metal Cutting:** Tool geometry **,** Mechanism of chip formation, Orthogonal and Oblique cutting, Machining force, Merchant’s Circle Diagram, Thermal aspects of metal machining, Machinability, Cutting tool materials, Tool wear and Tool life calculations. Cutting fluids, Classification of machine tools and their basic components, NC and CNC Machines

**Unit -II**

**Lathe:** Specification, components & accessories, various operations on lathes, capstan & turret lathes, tool layout, methods of thread production, machining time, single point cutting tools, tool signature and nomenclature

**Unit-III**

**Milling:** Vertical, horizontal and universal type machines, specifications and classifications of milling machines, universal dividing head plain and different indexing, gear cutting, milling cutters. **Shapers:** Classification and specifications, principle parts, quick return mechanism, shaper operations, speed feed, depth of cut, machining time.

**Unit-IV**

**Grinding:** Types of grinding machines, surface, cylindrical and internal grinding, grinding wheels, specifications, wheel turning and dressing without eccentricity, centre-less grinding.

**Drilling & Broaching:** Fixed spindle, radial and universal drilling machines, drilling time, broaching principle, broaches and broaching machines.

**Unit- V**

**Gear Cutting:** Die casting, methods of forming gears, generating process, Gear shaping, gear shaving, gear grinding gear testing.

**Nontraditional Machining Processes:** Principle of AJM, WJM, USM, EDM, ECM, LBM - Process characteristics – Applications.

**Text Books:**

1. S. Kapakjian and S.R. Schmid, (2010), Manufacturing Engineering and Technology, 6th Edition, Pearson Education (Singapore) Pvt. Ltd.
2. P. N. Rao, (2009), Manufacturing Technology, Vol. 2, 2nd ed., Tata McGraw Hill Publications.
3. P.C. Sharma, (2000), Text book of Production Technology, S.Chand & Company Ltd, New Delhi.

**Reference Books:**

1. Lindberg RA; Processes and Materials of Manufacturing; PHI.
2. Raghuvanshi;BS; Work shop technology Vol-I, II; Dhanpat Rai Delhi
3. Alciatori DG, Histand MB; Introduction to Mechatronics and Measurement system; TMH

**Web Sources:**

1. <http://nptel.ac.in/downloads/112105127/>
2. <http://home.iitk.ac.in/~vkjain/Lecture1-Introduction.pdf>
3. <http://www2.isikun.edu.tr/personel/ahmet.aran/mfgprop.pdf>

**Suggested Practical :**

1. To make a job on lathe machine.

2. To make a job on milling machine.

3. To make a job on a shaper.

4. To make a job on drilling machine.

5. To study broaching machine.

6. To study Tool Signature.

7. To study center less grinding.

8. To study nontraditional machining processes.

9. To study formation of chips during machining processes.

10. To study capstan and turret lathe.

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO08 | Machine Design-I | 3 | 0 | 2 | 4 |

**Unit I**

**Design against Static & Fluctuating loads:** Types of static loads, Theories of failure , design under static load, Stress concentration and its effect on ductile and brittle materials, stress concentration factor for various geometries, cyclic stresses, notch sensitivity, design for finite and infinite life, Soderberg, Goodman & Gerber criteria.

**Unit II**

**Keys & Couplings:** Keys; Types and selection, design of square and flat keys, splines. Selection of couplings, design of rigid coupling: Muff coupling, Clamp coupling and Flange coupling, Flexible couplings: Bushed pin flexible coupling.

**Unit III**

**Shafts:** Cause of failure in shaft, materials for shaft, stress in shaft and design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments.

**Unit IV**

**Mechanical Spring:** Types, nomenclature of helical springs, spring materials, types of ends, design of helical springs subjected to static load. Leaf springs: types, classification, nomenclature and design.

**Unit V**

**Belt Rope and Chain drives:** Design of belt drives, Flat & V-belt drives, Condition for Transmission of max. Power, Selection of belt, design of rope drives and design of chain drives with sprockets.

**Text Books:**

1. Design of Machine Elements by V. B. Bhandari, TMH Publishing Co. Ltd., New Delhi

2. Machine Design by Shigley, McGraw hill

3. Sharma P C and Aggarwal D K, “Machine Design”, Kataria Publishers (2002)

**Reference Books:**

1. Machine Design by Norton, Prentice Hall

2. Machine Design by Spots, Prentice hall

**Web Sources:**

1. <http://nptel.ac.in/downloads/112105125/>

2. http://www.svecw.edu.in/Docs%5CMEDMMLnotes2013.pdf

**Suggested Practical:**

1. To study and draw the methods of reducing stress concentration.

2. Design and drawing of different types of keys.

3. Design and drawing of Muff coupling.

4. Design and drawing of Clamp coupling.

5. Design and drawing of Flange coupling.

6. Design of shafts subjected to combined twisting and bending moments & drawing of bending and twisting moment diagrams.

7. Design and drawing of different types of springs.

8. Design and drawing of different types of chains.

9. Design and drawing of different types of belts.

10. Design and drawing of different types of wire ropes.

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO09 | Energy Conversion - I | 3 | 0 | 2 | 4 |

**Unit I**

**Steam Generators:** Classification, Features of high pressure (power) boilers, Boiler mountings and accessories, Performance evaluation of boilers ; Equivalent evaporation, Boiler efficiency by direct and indirect method Energy balance, Boiler draught (natural and artificial draught)

**Unit II**

**Cycles:** Vapor Power Cycles Carnot cycle, Rankine cycle, Comparision of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle , Relative efficiency, Effect of superheat, boiler and condenser pressure on performance of Rankine cycle. Reheat & Regenerative cycle, Binary Vapor Cycle.

**Unit III**

**Steam Condensers & Cooling Towers:** Introduction, classification of heat exchangers , types of condensers, back pressure and its effect on plant performance air leakage and its effect on performance of condensers, various types of cooling towers, design of cooling towers,

**Unit IV**

**Air compressors:** Working of reciprocating compressor, work input for single stage compression, effect of clearance, volumetric efficiency, actual indicator diagram, isentropic isothermal and mechanical efficiency, multi stage compression, inter - cooling, condition for minimum work input.

**Unit V**

**Gas dynamics:** Speed of sound in a fluid, mach number, mach cone, stagnation properties, one-dimensional isentropic flow of ideal gases. Steam nozzles: isentropic flow of vapors, flow of steam through nozzles, condition for maximum discharge.

**Text Books:**

1. P.K.Nag; Engineering Thermodynamics; TMH
2. B K Sarkar;Thermal Engineering; TMH
3. R K Rajput; Thermal Engineering; Laxmi Publicaions

**Reference Books:**

1. Van GJ; Thermodynamics; Willey Publication
2. Cengel Y; Thermodynamics; TMH
3. Moran & Shapiro; Engineering Thermodynamics, Willey Publication

**Web Sources:**

1. <https://lecturenotes.in/subject/155/energy-conversion-techniques-ect>
2. <https://ocw.mit.edu/courses/mechanical-engineering/2-60-fundamentals-of-advanced-energy-conversion-spring-2004/lecture-notes/>

**Suggested Practicals:**

1. To study high pressure boilers and their accessories and mountings.
2. To prepare heat balance sheet for given boiler.
3. To determine effectiveness of parallel & counter flow heat exchanger.
4. To study of Induced, forced and balanced draught by chimney.
5. To determine efficiency of cooling tower.
6. To find calorific value of a given sample of fuel using Bomb calorimeter.
7. To study and find volumetric efficiency of a reciprocating air compressor.
8. To find dryness fraction of steam by separating and throttling calorimeter.
9. To study condenser and its types.
10. To find dryness fraction of steam by using electrical calorimeter.

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO10 | Dynamics of Machines | 3 | 1 | 2 | 5 |

**Unit 1:**

**Force Analysis in Mechanisms :** Static force and Inertia force, D’ Alembert’s Principle, Static force analysisin mechanisms, Free body diagrams and equilibrium of two, three and four force members, superposition of forces and torques, Concept of dynamically equivalent system,Inertia force analysis using graphical approach - in four bar and slider crank mechanisms.

**Unit 2:**

**Dynamic Analysis of Reciprocating Engines**: Analytical expressions of displacement, velocity and acceleration of piston, Analytical expressions of Piston effort, Connecting rod force and turning moment in engines, Turning moment diagrams of : Single Cylinder and Multi-cylinder Internal combustion engines, Double acting steam engines, Coefficient of fluctuation of- Energy and Speed, Flywheel and it’s applications in reciprocating engines and Punching and riveting machine.

**Unit 3 : Governor Mechanisms**: Governors and its type, Types of governors, terminology of Centrifugal Governors, Different types of centrifugal Governors- Watt, Porter, Proell, Hartnell Hartung, Gravity and Spring Controlled Governor , their performance characteristics, Different characteristics like – Stability, Isochronism and Hunting in Governors.

**Unit 4:**

**Balancing of Inertia Forces and Moments** : Balancing of rotating masses : Two Plane Balancing, Balancing of several masses rotating in different planes, Balancing of reciprocating masses in : single cylinder IC engines, Multi-cylinder inline engine, Radial Engine V-twin engines, Concept of firing order and harmonic balancing in multi-cylinder engine,

**Unit 5**:

**Friction:** Laws of Dry Friction,Boundary and Fluid film lubrication, Friction in Journal and thrust bearings, Concept of friction circle and axis in mechanisms, Rolling friction, Frictional torque in pivots and collars by Uniform Pressure and Uniform Wear Rate Criteria

**Clutches:** Single plate and multi plate clutches, cone and centrifugal clutches and torque transmission calculations.

**Text Books :**

1. Ambekar, A.G.; Mechanism and Machine Theory; PHI

2. Rattan S.S.; Theory of machines; TMH

3. Bansal R.K.; Theory of Machines;

**References Books:**

1. Bevan Thomas; Theory of Machines; CBS Publishers
2. Ghosh and Mallik; Theory of Mechanisms and Machines; Affiliated East-West Press, Delhi
3. Norton R.L.; Kinematics and Dynamics of machinery; TMH

**Web References:**

1. <https://nptel.ac.in/downloads/112101096/>
2. <http://www.vssut.ac.in/lecture_notes/lecture1429901026.pdf>

**Suggested Practicals :**

1. Determination of moment of inertia of flywheel by falling weight method.
2. Determination of center of percussion of long body,
3. Determination of radius of gyration of a bar using Bifilar suspension method.
4. To determine the performance characteristics of Watt, Porter and Proell Governor
5. To determine the performance characteristics of Hartnell Governor.
6. To perform dynamic balancing of unbalanced rotating shaft.
7. To study the balancing of reciprocating masses in an reciprocating engine.
8. To study different types of clutches.
9. To determine stopping distance and braking torque using internal expanding shoe brake.

10. To determine center of gravity of compound pendulum (Symmetrical and Unsymmetrical body).

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Hrs.** | **Credits** |
|  EN3MC08 |  Fundamentals of soft skills and aptitude | 2 | 0 | 0 | 2 | 0 |

**UNIT I**

**Body Language and professionalism:** To make participants aware of the importance of Body language trains them to project a better outlook of themselves. This helps in presenting themselves in Personal interview and Group discussions. Grooming and presenting oneself are the main focus. Interview dress code, facial expressions, body language, hand shake etiquettes etc., are dealt in the session. Worksheets, anecdotes, videos and role-plays are some of the important components of the session.

**Interpersonal skills:** Effective interpersonal skills are crucial to increase employment
opportunities and to compete in the business environment. This session makes the participants understand different barriers to proper interpersonal communication and to tackle them head-on. Activities are an integral component of the session.

**Reporter:** The aim of the session is to make every student ask rational questions and make diplomatic replies. The session is a press- meet like group activity session.

**UNIT II**

**Team Building:**  To make every student intermingle within a team and contribute to the team’s success. To make them understand the importance of working as a team. Importance of complimentary skill sets, and synergy effects of a team are proved using real-life examples and classroom activities.

**Picture connector:** To make the students participate in group interactions, create dialogue and present on the stage. Students link various pictures from newspaper to come up with a pictorial representation of a story or idea and narrate/present the same. Creativity and presentation skills are concentrated. Students also learn to connect various variables and come up with concrete ideas.

**UNIT III**

**Time and work:** Work with different efficiencies, Pipes and cisterns, Work equivalence, Division of wages

**Goal Setting:** • To make students goal oriented and to help them realise and sketch their personal and professional goals. SMART goal technique for goal setting is taught and explained using examples. Students will be encouraged to set a personal and career goal based on the SMART technique. Tactics to deal with hurdles for attaining the goals are dealt. Famous goal setting success stories are shared to boost confidence.

**UNIT IV**

**Time Management:** To make students understand the value of time and effective management of their time. Paper tower activity helps students practically experience the importance of managing time and to improve at it. Time management grid helps students understand the importance of prioritizing.

**Tourism pitch:** The session makes students present and promotes their choice of tourist spot or their favourite city in order to convince the client (trainer) to visit the city. Presentation skills are enhanced. Teamwork is practised during the preparation phase of the activity.

**UNIT V**

**Shopping role play:** To enable students to frame dialogues for their day-to-day life scenarios. A shopping scenario has to be mimicked by the students with impromptu conversation. This helps them in practising speaking in English in their daily conversations. Sample everyday conversations are presented for practical learning.

**Shipwreck:** The main objective of this is to enhance the skill capacity of the students to think out of the box and try to enhance the cognitive thinking capability.

**Play teacher:** The session makes students understand the different values and virtues like empathy- by which they will try to enact the scenario given to them try solving the problem like an adviser.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
|  | **L** | **T** | **P** | **Hrs.** | **Credits** |
| EN3HS04 | Fundamentals of Mgm, Economics & Accountancy | 3 | 0 | 0 | 3 | 3 |

**Unit 1:** Concepts of Management Definition, characteristics and importance of management; Management: Science or Art Difference between Management and Administration. Levels of management. Functions of Management, Managerial Roles, Managerial skills and competencies; Decision Making: Definition, process and types; Decision making under certaint). uncertainty and risk: Cross cultural issues in management and challenges.

**Unit II:** Fundamentals of Marketing and Human Resource Management Introduction to Marketing: Definition. importance. function and scope of marketing, core concepts of marketing. Marketing concepts and orientations, Marketing environment. Marketing-Holistic marketing concept, Customer Relationship Management (CRM). Introduction to Human Resource Management (HM): Nature, Scope, Objectives and Functions; Role of HR manager. Process and need for Human Resource Planning. Human resource policies, Changing role of I iuman Resource in India\_ Globalization and its impact on Human Resource.

**Unit III:** Fundamentals of Economics Introduction to Economics: Definition. nature, scope and significance: Difference between micro and macro economics; Time value of money. Law of diminishing marginal utility; Theory of Demand and Supply. Price elasticity of demand: Meaning and types of costs, Law of variable proportions; Types of market structure; National income and related aggregates; Meaning and types of Inflation; Meaning and phases of business cycle.

**Unit IV:** Basic Accounting Principles Accounting Principles and Procedure. Double entry system. Journal, Ledger, Trail Balance. Cash Book; Preparation of Trading, Profit and Loss Account: Balance sheet: Cost Accounting: Introduction, Classification of costs. Methods and Techniques of costing. Cost sheet and preparation of cost sheet; Breakeven Analysis: Meaning and its application.

**Unit V:** Fundamentals of Financial Management Introduction of Business Finance: Meaning. Definition of Financial Management, Goals of Financial Management (Profit Maximization and Wealth Maximization), Modem approaches to Financial Management - (Investment Decision\_ Financing Decision and Dividend Policy Decisions).

**Text Books** I. FL D. Agan.val, --Organization and Management". McGraw Hill Education. 2. P. C. Tripath). and P. N. Reddy, "Fundamentals of Management, Economies and Accountancy-. T'ata McGraw Hill Kotler Philip and Keller Kevin Lane, "Marketing Management-, Pearson

**SEMESTER: V**

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO11 | Energy Conversion - II | 3 | 1 | 2 | 5 |

**Unit I Introduction to Turbo machinery**

Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, application of first and second laws of thermodynamics to turbo machines, moment of momentum equation and Euler turbine equation, principles of impulse and reaction machines, degree of reaction,

**Unit II Steam Turbines**

Steam turbines, single stage impulse turbine (DeLaval Turbine), velocity triangles and calculation power, thrust and efficiency; pressure, velocity and pressure-velocity compounding, analysis of optimum blade speed, Curtis stage, and Rateau stage, effect of blade and nozzle losses on vane efficiency, stage efficiency, analysis for optimum efficiency, mass flow and blade height. Reaction turbines (Parson), degree of reaction, conditions for optimum efficiency, speed ratio, axial thrust, reheat factor in turbines, governing of turbines.

**Unit III Hydraulic Turbines**

Hydraulic Turbines, classification, Hydraulic, volumetric, mechanical and overall efficiencies, Pelton, Francis and Kaplan Turbines, their velocity triangles, calculation of power and efficiency and other performance parameters, draft tube and its applications, unit quantities, specific speed.

**Unit IV Centrifugal Pumps**

Centrifugal pumps, classification, advantage over reciprocating type, definition of mano-metric head, gross head, static head, vector diagram and work done. Main and operating characteristics of the machines, cavitations, priming of pumps, specific speed of pump

**Unit V Blowers and Compressors**

Root blowers, Vane type compressors, centrifugal compressors, vector diagrams and calculation of various parameters, axial compressors, vector diagrams and calculation of various parameters, applications of rotary compressors.

**Text Books**

1. R. Yadav, Steam and Gas Turbine, Central Pub.

2. M. M. Rathore, Thermal Engineering, TMH

3. R.K.Bansal, Fluid Mechanics & Fluid Machines, Lakshmi Pub.

**Reference Books**

1. V. Kadambi and M. Prasad, An introduction to EC Vol. III-Turbo machinery, Wiley Eastern.

2. B.K.Venkanna, Turbomachinery, PHI

3. K.L. Kumar, Fluid Mechanics, S. Chand Pub.

**List of Practicals**

1. To conduct a test on Centrifugal Pump and plot its characteristics.

2. To conducts an experiment on Pelton turbine test rig.

3. To conducts an experiment on Francis turbine test rig.

4. To find the friction factor for flow through pipes.

5. To study the effect of a draft tube on reaction turbines.

6. To study the hydraulic controls rig.

7. To study the cavitations phenomenon in turbines.

8. To study the hydraulic couplings and torque converters.

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO12 | Machine Design-II | 3 | 0 | 2 | 4 |

**Unit I**

**Journal Bearing:** Types of lubrication, viscosity, hydrodynamic theory, design factors, temperature and viscosity considerations, Reynold's equation, stable and unstable operation, heat dissipation and thermal equilibrium, boundary lubrication, dimensionless numbers, Design of journal bearings, Rolling-element Bearings: Types of rolling contact bearing, bearing friction and power loss, bearing life; Radial, thrust & axial loads; Static & dynamic load capacities; Selection of ball and roller bearings.

**Unit II**

**Spur Helical and Bevel Gears:** Force analysis of gear tooth, modes of failure, beam strength, Lewis equation, form factor, formative gear and virtual number of teeth; Gear materials; Surface strength and wear of teeth; strength against wear; Design of straight tooth spur and Helical Gears. Bevel Gears: Application of bevel, formative gear and virtual number of teeth; Force analysis; Lewis equation for bevel gears; Strength against wear.

**Unit III**

**Design of I.C. Engine Components:** General design considerations in I C engines; design of cylinder; design of piston and piston-rings; design of connecting rod; design of crankshaft.

**Unit IV**

**Design of Brakes**

**Brakes:** Various types of Brakes, band brakes. Self energizing condition of brakes, Design of shoe brakes Internal & external expanding.

**Unit V**

**Design of Clutches**

**Clutches:** Various types of clutches in use, Design of friction clutches, Disc. Multidisc, Cone & Centrifugal, Torque transmitting capacity.

**Text Books**

1. J.E.Shigley, Machine Design, TMH

2. V. B.Bhandari, Design of Machine Elments, TMH

3. P.C.Sharma and D.K.Agrawal, Design of Machine Elements, S. K. Kataria & Sons Pub.

**Reference Books**

1. Hall and Somani, Machine Design, Schaum Series, TMH
2. A. Mubeen, Machine Design, Khanna Pub.
3. R.Norton, Design Of Machinery, TMH

**List of Practicals**

1. Design of Journal bearing.

2. Design and drawing of Roller bearing.

3. Design and drawing of Spur Gears.

4. Design and drawing of Helical Gears.

5. Design and drawing of Bevel Gears.

6. Design and drawing of Cylinder head and Piston.

7. Design and drawing of Connecting rod/Crankshaft.

8. Design and drawing of Single plate/Multiplate clutch.

9. Design and drawing of Centrifugal Clutch.

10. Design and drawing of Shoe Brakes.

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO13  | Heat and Mass Transfer  | 3  | 1  | 2  | 5 |

**Unit I**

**Conduction:** Fourier heat conduction equation, its form in rectangular, cylindrical and spherical coordinates, thermal diffusivity, linear one dimensional steady state conduction through a slab, tubes, spherical shells and composite structures, electrical analogies, critical-insulation-thickness for pipes, effect of variable thermal conductivity.

**Unsteady heat conduction:** Transient and periodic conduction, heating and cooling of bodies with known temperatures distribution, systems with infinite thermal conductivity.

**Unit II**

**Extended surfaces (Fins):** Heat transfer from a straight and annular fin for a uniform cross section; error in measurement of temperature in a thermometer well, fin efficiency, fin effectiveness, applications.

**Unit III**

**Convection:** Introduction, free and forced convection; principle of dimensional analysis, Buckingham ‘pie’ theorem, application of dimensional analysis of free and forced convection, empirical correlations for laminar and turbulent flow over flat plate and tubular geometry; calculation of convective heat transfer coefficient using data book.

**Unit IV**

**Heat exchangers**: Types- parallel flow, counter flow; evaporator and condensers, overall heat transfers coefficient, fouling factors, long-mean temperature difference (LMTD), method of heat exchanger analysis, effectiveness of heat exchanger, NTU method.

**Mass transfer:** Fick’s law, equi-molar diffusion, diffusion coefficient, analogy with heat transfer, diffusion of vapour in a stationary medium

**Unit V**

**Thermal radiation**: Nature of radiation, emissive power, absorption, transmission, reflection and emission of radiation, Planck’s distribution law, radiation from real surfaces; radiation heat exchange between black and gray surfaces, shape factor, analogical electrical network, radiation shields.

**Text Books**

1. S.P.Sukhatme, Heat and Mass Transfer, University Press Hyderabad

2. J.P.Holman, Heat Transfer, TMH

3. R. K. Rajput, Heat and Mass Transfer, S. Chand Pub.

**Reference Books**

1. Y Cengel, Heat and Mass Transfer, TMH
2. D.S.Kumar, Heat and Mass Transfer; S.K. Kataria and Sons.
3. P.K.Nag, Heat Transfer,TMH

**List of Practicals**

1. Determination of thermal resistance of a composite slab.
2. Determination of convective heat transfer coefficient in natural convection process.
3. Determination of thermal conductivity of insulating powder.
4. Determination of emissivity of a grey body.
5. Study of effect of thickness of insulation on heat transfer rate.
6. Determination of Stefan Boltzmann constant.
7. Determination of heat transfer through lagged pipe.
8. Determination of efficiency of pin fin.
9. Determination of thermal conductivity of metal rod.

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3EI02 | Operations Research | 3 | 0 | 0 | 3 |

**Unit I**

**Introduction:** Definition and Development of Operations Research, Necessity and scope of OR in Industry, Operations Research in Decision making, Models in OR, Fields of application, Difficulties and Limitation of OR. General Linear Programming Problems: Introduction, Maximization and minimization of function with or without Constraints, Formulation of a linear programming problem, Graphical method and Simplex method, Big M method, Degeneracy, Application of Linear Programming (LPP) in Mechanical Engineering.

**Unit II**

**Transportation Problems:** Mathematical formulation, Stepping stone method, Modified Distribution Method, Vogel’s Approximation Method, Solution of balanced and unbalanced transportation problems and case of Degeneracy.

**Assignment Problems;** Mathematical formulation of assignment problems, Solution of assignment problems, Traveling salesman problems, Air crew Assignment problems.

**Unit III**

**Waiting Line Theory:** Basic queuing process, Basic structure of queuing models, Some commonly known queuing situations, Kendall’s notation, Solution to M/M/1: ∞ /FCFS models. **Network Analysis;** CPM/PERT, Network Representation, Techniques for drawing network, Resource smoothing and leveling, Project cost, Optimum project duration, Project crashing, Updating, Time estimation in PERT

**Unit IV**

**Decision Theory and Game Theory:** Decision making, Steps in decision theory approach, Decision making under certainty, Uncertainty and under condition of risk, Decision Tree, Theory of Games, Two person zero sum game, Methods for solving two person zero sum game. **Simulation:** Basic concept of simulation, Applications of simulation, Merits and demerits of simulation, Monte Carlo simulation, Simulation of Inventory system, Simulation of Queuing system.

**Unit V**

**Inventory models:** Inventory models – Various Costs and Concepts–EOQ–Deterministic inventory models –Production models – Stochastic Inventory models – Buffer stock.

**Text Books**

1. D.S.Hira and P.K.Gupta, Operations Research, S.Chand Pub.
2. H.Taha, Operations Research, PHI.
3. J.K.Sharma, Operations Research, Macmillan.

**Reference Books**

1. F.S.Hillier and G.J.Liberman, Introduction to Operations Research Concept and Cases, TMH
2. R.P.Sen, Operations Research-Algorithms and Applications, PHI.
3. R.Bronson, Theory and Problems of Operations Research, Schaum Series,TMH .

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3EC03 | Finite Element Methods | 3 | 0 | 0 | 3 |

**Unit I**

**Introduction to Finite Element Method:** General description of Finite Element Method, Historical development Comparison with classical methods, General procedure of FEM, Applications of FEM, FEA softwares. General Field problems, discrete and continuous models, Variational formulation in finite elements, Ritz method, Weighted residual methods, Galerkin sub domain method of least squares and collocation method numerical problems.

**Unit II**

**Discretization and Interpolation Function**: Discretization, Geometrical approximations, Simplification through symmetry, Element shapes and behavior, Choice of element types size and number of elements, Element shape and distortion, Location of nodes, Node and Element numbering. Interpolation Function: Simplex , Complex and Multiplex elements, Selection of interpolation polynomials, Convergence requirements, Natural coordinate systems, Derivation of shape functions for various elements, Iso-parametric elements, Numerical Integration.

**Unit III**

**Applications in structural:** One dimensional elasticity, Castigliano’s first theorem, Principle of minimum potential energy, Linear spring, Elastic bar with constant and varying cross sections using linear and quadratic elements, Truss structures and Beams.

**Unit IV**

**Applications in plane elasticity**: Introduction to plane elasticity theory, Plane stress, Plane strain and Axi-symmetric problems, Finite Element formulations of plane elasticity problems using CST and four noded quadrilateral elements only.

**Unit V**

**Applications in Heat Transfer and Fluid Mechanics:** Finite Element formulation of One-dimensional and Two-dimensional steady state heat conduction problems with convection, Simplex elements only. Finite Element formulation of inviscid and incompressible flow Potential function formulation, Stream function formulation.

**Text Books**

1. T. R. Chandrupatla and A. D. Belugundu, Introdution to Finite Elements in Engineering, Prentice Hall.
2. D.V. Hutton, Fundamentals of Finite Element Analysis, TMH.
3. D.L.Logan, A First Course in the Finite Element Method, Cengage Learning.

**Reference Books**

1. B. K.Jurgen, Finite element procedures, PHI.
2. S.S.Rao, The Finite Element Method in Engineering, Elsevier.
3. O.C.Zienkiewicz, R.L. Taylor and J.Z. Zhu, The Finite Element Method: Its basis and fundamentals, Butterworth Heinmann.

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3EM02 | Electronic Devices and Circuits | 4 | 0 | 0 | 4 |

**UNIT-I**

**Semi Conductor Physics:** Energy band formation in solids, classification of solids using energy band diagrams, Fermi Dirac function, Intrinsic and extrinsic semiconductors, Fermi level in intrinsic and extrinsic Semiconductors, charge densities in semiconductors, mobility and conductivity, drift and diffusion, Hall effect, continuity equation.

**UNIT-II**

**Junction Diode Characteristics:** Open circuited p-n junction, Biased p-n junction, p-n junction diode, current components in PN junction Diode, diode equation, V-I Characteristics, temperature dependence on V-I characteristics, Diode resistance, Diode capacitance, energy band diagram of PN junction Diode. Special Semiconductor Diodes: Zener Diode, Breakdown mechanisms, Zener diode applications, LED, Photo diode, Tunnel Diode.

**UNIT-III**

**Diode Applications and Bjt:** Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit, Clippers, clamper circuits. Junction transistor, transistor current components, transistor equation, transistor configurations, transistor as an amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, Ebers-Moll model of a transistor, punch through/ reach through.

**UNIT-IV**

**Bjt Biasing and Fet:** Transistor Biasing and Thermal Stabilization: Need for biasing, operating point, load line analysis, BJT biasing methods: fixed bias, voltage divider bias, self bias, collector to base bias.

FET types, construction, operation, characteristics, parameters, MOSFET-types, construction, operation, characteristics, comparison between JFET and MOSFET.

**UNIT-V**

**Feedback Amplifier and Oscillators:** Concept of Feedback Amplifiers, Effect of Negative feedback on the amplifier Characteristics.  Four Feedback Amplifier Topologies.  Method of Analysis of Voltage Series, Current Series, Voltage Shunt and Current Shunt feedback Amplifiers. Condition for oscillations :LC Oscillators, Hartley, Colpitts, RC Phase Shift and Weinbridge Oscillators.

**Text Books**

1. Jacob Millman and Christos C. Halkias , Integrated electronics, TMH
2. Robert Boylestad and Nashelsky: Electronic Devices and Circuit Theory, Pearson Education
3. S.Saliva Hanan , Electronic Circuits analysis and Design, TMH

**References Books**

1. Sedra and Smith: Microelectronics, Oxford Press.
2. Anil K. Maini, VarshaAgarwal: Electronic Devices and Circuits, Wiley Publications.
3. Rashid: Electronic Devices and Circuits, Cengage learning.
4. Donald A Neamen: Electronic Circuits Analysis and Design, TMH

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| **Course Code** | **Course Name** | Hours per Week | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3EL01 | Measurement & Instrumentation | 3 | 0 | 0 | 3 |

**Unit I**

**General concepts of measurement:** Definition, Standards of measurement, Errors in measurement, various systems of limits, fits and tolerance, ISI and ISO, Calibration: Static calibration, dynamic calibration, static sensitivity, range, accuracy and precision, Introduction to uncertainty, zero order, first order, and second order system.

**Strain Measurement:** Stress and strain, resistance strain gauges, gauge factor, strain gauge electrical circuits and multiple gauge bridge.

**Unit II**

**Force Measurement:** Displacement measurement, Potentiometers, Linear variable differential transformers (LVDT), rotary variable differential transformer (RVDT)

**Torque measurement:** Measurement of torque on rotating shafts.

**Vibration measurements:** Working principle of Vibrometer and accelerometer, Frequency measurement.

**Unit III**

**Temperature Measurement:** Measurement of temperature, liquid in glass thermometer, resistance thermometers – constructional details, resistance thermometer circuits, laws of thermocouples, pyrometers.

**Pressure Measurement:** Standards of pressure measurement, measurement of high pressure, measurement of low pressure – The McLeod Gauge.

**Flow measurement:** Pressure differential meters: Orifice meter, Venturi meter.

**Unit IV**

**Linear and Angular Measurements:** Slip gauges, micrometres, vernier callipers, dial gauges, surface plates, comparators- mechanical, angular measuring instruments- sine bar, angle gauges, spirit level, autocollimators.

**Measurement of surface finish:** Surface finish- definition, terminology, types of surface texture, surface roughness measurement methods, comparison, profile-meters.

**Metrology of screw threads and gears:** Internal/external screw threads, terminology, measurement of various elements of threads, thread micrometre method, **Gears** : terminology, measurement of various elements, constant chord method, base tangent method.

**CMM** – Types, constructions and measurements.

**Unit V**

**Transducers and data acquisition systems:** Classification of transducers, selection of transducers, resistive, capacitive & inductive transducers, piezoelectric, optical and digital transducers, Elements of data acquisition system – Analog to digital (A/D) and Digital to analog (D/A) converters, Smart sensors.

**Electrical and electronics instruments:** Principle and types of analog and digital voltmeters, ammeters, multi-meters, Single and three phase wattmeter’s and energy meters, Magnetic measurements, Determination of B-H curve and measurements of iron loss – Instrument transformers, Instruments for measurement of frequency and phase.

**Text Books:**

1. J. B. Gupta, ‘A Course in Electronic and Electrical Measurements’, S. K. Kataria &Sons
2. R. K . Jain, Engineering Metrology, Khanna Publishers, New Delhi.
3. S.P. Venkateshan, Mechanical Measurements, John Wiley & Sons.
4. C. Sujatha, Vibration and Acoustics, Tata McGraw Hill.

**Reference Books:**

1. I.C. Gupta, Engineering Metrology, Danpat Rai Publications.
2. H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw Hill.
3. Nakra and Chowdhry, Measurement and Control, Tata McGraw Hill.

 4. Robert J. Hocken, Paulo H. Pereira, Coordinate Measuring Machines and Systems, [CRC Press](http://www.crcpress.com/product/isbn/9781420017533).

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| **Course Code** | **Course Name** | **Hours Per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| OE00005 | Digital Electronics | 3 | 0 | 0 | 3 |

**UNIT I NUMBER SYSTEM :**

Introduction to binary numbers, data representation , binary, octal, hexadecimal number system and their conversion, Various coding schemes such as BCD codes, Excess-3 code, Gray code. Binary arithmetic, Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Boolean Functions, Canonical and Standard forms, minimization techniques, Sum of products and Product of Sums Simplification, Karnaugh's map method, Quine Mecluskey method.

**UNIT II LOGIC GATES AND COMBINATIONAL LOGIC:**

Digital Logic Gates such as AND,OR, NAND,NOR, EX-OR,EX-NOR. Realization of Boolean functions using logic gates. Adders, substractors, BCD adder, magnitude comparator, decoders and encoders, multiplexers and demultiplers, code converters. Analysis and design of combinational circuits. Implementation of combinational logic using multiplexers, decoders etc.

**UNIT III SEQUENTIAL CIRCUITS:**

Introduction, comparison of sequential and combinational circuits. Various types of flip-flops and their conversions, triggering of flip flops, timing issues, setup and hold times, registers, counters, ring, johnson, asynchronous and synchronous counters.

**UNIT IV MEMORIES:**

 ROM, PLA and PAL. Memories : organisation and construction of RAM, SRAM, DRAM, ROM, PROM, EPROM, EEPROM

**UNIT V LOGIC FAMILIES:**

 DTL, RTL, TTL, IIL, PMOS, NMOS and CMOS logic families, interfacing between TTL and MOS vice-versa.

**Text Book**

1. D Roy Chudhury, Digital Electronics,Vol-I & II, TMH Publication.
2. M. Mano, Digital and Computer Design, Pearson Education.

**References Books:**

1. Leach and Malvino, Digital Principles and Applications, TMH.
2. Millman and Taub, Pulse, Digital and Switching Waveforms, MGM.
3. A.Anand Kumar: Digital Circuits, PHI.
4. Salivahanam and Ari Vahagan: Digital Circuits and Design, Vikas Publishing House.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| **EN3MC15** | **Universal Human Values and Professional Ethics** | **2** | **0** | **0** | **0** |

**UNIT-I**

**Introduction**-**Need,BasicGuidelines,ContentandProcessfor ValueEducation**

Understanding the need, basic guidelines, content and process for Value Education, Self-Exploration – what is it ?-its content and process; ‘Natural Acceptance’ and Experiential Validation- as the mechanism for self - exploration, Continuous Happiness and Prosperity-A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities-the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

**UNIT-II**

**Understanding Harmony in the Human Being-Harmony in Myself**

Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’, Understanding the needs of Self (‘I’) and ‘Body’- Sukhand Suvidha, Understanding the Body as an instrument of ‘I’(I being the doer, seer and enjoyer), Understanding the characteristics and activities of ‘I’ and harmony in ‘I’, Understanding the harmony of I with the Body: SanyamandSwasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

**UNIT-III**

**Understanding Harmony in the Family and Society-Harmony in Human- Human Relationship**

Understanding harmony in the Family- the basic unit of human interaction, Understanding values in human -0/’[-789\*-0o human relationship ;meaning of Nyayaand program for its fulfilment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship, Understanding them eaningof Vishwas; Difference between intention and competence, Understanding the meaning of Samman ,Difference between respect and differentiation ;the other salient value in relationship, Understanding the harmony in the society(society being an extension of family ):Samadhan, Samridhi, Abhay, Sah-astitvaascomprehensive Human Goals, Visualizing a universal harmonious order in society-Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)-from family to world family!.

**UNIT- IV**

**Understanding Harmony in the Nature and Existence-Whole existence as Co-existence**

Understanding the harmony in the Nature,Interconnectedness and mutual fulfilment among the four orders of nature –recyclability and self-regulation in nature, Understanding Existence as Co-existence(Sah-astitva) of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.

**UNIT-V**

**Implications of the above Holistic Understanding of Harmony on ProfessionalEthics**

Natural acceptance of human values, Definitiveness of Ethical Human Conduct,Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics:

a) Ability to utilize the professional competence for augmenting universal human order,

b) Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems, technologies and management models, Case studies of typical holistictechnologies,managementmodelsandproductionsystems,Strategyfor transition from the present state to Universal Human Order:

a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers,

b) At the level of society :asmutually enriching institutions and organizations.

**TextBooks:**

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

**References:**

1. IvanIllich,1974,Energy& Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F.Schumacher,1973, Smallis Beautiful: a sudyof economics as if people mattered, Blond &Briggs, Britain.
3. SussanGeorge,1976,HowtheOtherHalfDies,PenguinPress.Reprinted 1986, 1991
4. Donella H .Meadows, DennisL. Meadows,JorgenRanders, WilliamW. BehrensIII, 1972, Limits to Growth–Club of Rome’s report, UniverseBooks.
5. ANagraj, 1998, JeevanVidyaEkParichay, DivyaPathSansthan, Amarkantak.
6. PLDhar, RRGaur,1990,Science and Humanism,Commonwealth Publishers.
7. A NTripathy, 2003, Human Values, New Age International Publishers. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) KrishiTantraShodh, Amravati.
8. EGSeebauer&RobertL.Berry,2000,FundamentalsofEthicsforScientists&Engineers , Oxford University Press
9. MGovindrajran,SNatrajan&V.S.SenthilKumar,EngineeringEthics(includingHumanValues),EasternEconomyEdition,PrenticeHallofIndia Ltd.
10. BP Banerjee,2005, Foundations of Ethics andManagement, Excel Books. BLBajpai,2004,IndianEthosandModernManagement,NewRoyal Book Co.,

Lucknow. Reprinted 2008.

**SEMESTER: VI**

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO14 | CAD/CAM/CIM | 4 | 0 | 2 | 5 |

**Unit I**

**Introduction:** Information requirements of mfg organizations; business forecasting and aggregate production plan; MPS, MRP and shop floor/ Production Activity Control (PAC); Mfg as a system, productivity and wealth creation; production processes on volume-variety axes; importance of batch and job shop production; CIM definition and CIM wheel, evolution and benefits.

**Unit II**

**Product Life Cycle (PLC) mgt:** Design for mfg (DFM) and concurrent engg; product design in conventional and CIM environment; terms like CAD, CAE, CAM, CAP, CAPP, CATD and CAQ.

**Unit III**

**Numeric control and part programming:** Principles of NC machines, CNC, DNC; NC modes of point to point, -line and 2D, 3D contouring; NC part programming; ISO standard for coding, preparatory functions(G)- motion, dwell, unit, preset, cutter compensation, coordinate and plane selection groups; miscellaneous (M) codes; CLDATA and tool path simulation; ISO codes for turning tools and holders; ATC, modular work holding and pallets; time and power estimation in milling, drilling and turning; adaptive control, sequence control and PLC; simple part programming examples.

**Unit IV**

**Group Technology:** Importance of batch and job shop production; merits of converting zigzag process layout flow to smooth flow in cellular layout, Production Flow Analysis (PFA) and clustering methods; concept of part families and coding; hierarchical, attribute and hybrid coding; OPITZ, MICLASS and DCLASS coding; FMS; material handling; robots, AGV and their programming; agile mfg; Computer Aided Process Planning (CAPP), variant/ retrieval and generative approach

**Unit V**

**Rapid Prototyping:** Introduction, basic concepts, Need - Development of Rapid Prototyping systems, Rapid Prototyping process chain - Impact of Rapid Prototyping on Product Development –Digital prototyping - Virtual prototyping- Rapid Tooling - Benefits-Applications. Stereolithography (SLA), Solid Ground Curing (SGC), Fused deposition Modeling (FDM), Laminated object manufacturing (LOM), Selective Laser Sintering (SLS), Powder based 3DP systems.

**Text Books:**

1. S.Kant Vajpay; Principles of CIM; PHI

2. PN Rao CAD/CAM;TMH

3. MP Groover ; Automation, Production Systems & CIM; P.H.I.

**Reference Books:**

1. PN Rao , NK Tiwari , TK Kundra ; Computer Aided Manufacturing; TMH

2. A Alavudeen, N Venkteshwarn; Computer Integrated Mfg; PHI

3. P Radhakrishnan, S Subramanian and V Raju ; CAD/CAM/CIM; New age Pub

**List of Practical**

1. Basic concepts of CAD/CAM
2. Study and development of 2 D model on CAD software (SolidEdge).
3. Study and development of 3 D model on CAD software (SolidEdge).
4. Study of Part Programming fundamentals and G & M codes.
5. Manual part programming for CNC lathe and simulation.
6. Manual part programming for CNC milling and simulation.
7. Part program generation by CAM software (UGCAM).
8. Study of Group technology and part families.
9. Study of Computer Aided Process Planning.
10. Study of Flexible Manufacturing System

 11. A Case study on ‘CIM model for a modern industry CNC application

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO15 | I C Engines | 3 | 1 | 2 | 5 |

**Unit I**

**Introduction:** Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, cylinder arrangement, determination of engine dimensions, speed and engine hypothetical/actual performance parameters of IC Engines, Valve timing diagram and firing order.

**Fuel Air Cycles and Actual Cycles;** Assumptions for fuel–air cycles, Reasons for variation of specific heats of gases, isentropic expansion with variable specific heats, effect of variable specific heats on Otto, Diesel and Dual cycle, dissociation, comparison of air standard and fuel air cycles, effect of operating variables, comparison of air standard and actual cycles, effect of time loss, heat loss and exhaust loss in Petrol and Diesel engines.

**Unit II**

**Combustion in SI engines:** Stages of combustion – Normal and Abnormal combustion - Flame development and propagation, ignition lag, effect of air density, temperature, engine speed, turbulence and ignition timings, Knock - Factors affecting knock, physical and chemical aspects of knocking, effect of engine and fuel variables on knocking tendency, H.U.C.R., action of dopes, pre-ignition, its causes and remedy, salient features of various type combustion chambers,

**Unit III**

**Combustion in CI engines:** Stages of combustion – Normal and Abnormal combustion -delay period, factors affecting delay period as compression ratio, injection timing, its duration, Detonation in C.I. engines, factors affecting detonation, controlling detonation, comparison of abnormal combustion in SI and CI engine, Salient features of various types of combustion chambers (DI and IDI type)

**Unit IV**

**Measurement and Testing of IC engines:** Measurement of indicated power, brake power, fuel consumption and emission, Measurement of friction power by Willan’s Line Method and Morse Test, and heat balance sheet of IC Engines. Octane and Cetane number.

**Unit V**

**Supercharging:** Need for supercharging, Effect of supercharging, types of supercharger, methods of supercharging, limitations of supercharging, low and high pressure super charging, turbo charging.

**Text Books:**

1. V. Ganeshan, Internal Combustion Engines, McGraw Hill Education Pvt Ltd.
2. P.W Gill, ‎J H. Smith, ‎E J. Ziury Fundamentals of Internal Combustion Engines
3. H.N. Gupta, Fundamentals of Internal Combustion engine, PHI Learning.

**Reference Books:**

1. J.B.Heywood,Internal Combustion Engine Fundamentals
2. C.F.Taylor, The Internal Combustion Engine in Theory and Practice: Vol. 1 & 2
3. W.W Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine

**List of Practical:**

1. study of Carburetor.
2. Study of Fuel Injection System in SI engine (MPFI System)
3. Study of Battery Ignition System.
4. Study of Electronic Ignition System.
5. Study of Diesel Fuel pump.
6. Study of Diesel fuel injector.
7. Study of Lubrication System in IC Engine.
8. Study of Determination valve timing Diagram (4 stroke CI Engine)
9. Draw a Heat balance sheet for a 4 stroke diesel engine and determine it performance parameters.
10. To Carry out Morse test on a multi cylinder spark ignition engine at constant speed to find out its Indicated power & Mechanical efficiency.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| ME3CO16 | Refrigeration and Air Conditioning | 3 | 1 | 2 | 5 |

**Unit 1**

**Introduction and Air Refrigeration cycles:** Different methods of refrigeration, COP, Tone of refrigeration, Carnot cycle with air as a refrigerant, Joule’s cycle or Bell Coleman cycle, Boot-strap cycle, reduced ambient cycle and regenerative cooling cycles. Refrigerants: nomenclature & classification, desirable properties, common refrigeration, Environment friendly refrigerants.

**Unit 2**

**VCR Cycles:** Carnot cycle with vapor as a refrigerant, VCR cycle with p-v and T-s diagram, p-h diagram, sub-cooling and super heating, effects of condenser and evaporator pressure on cop, Actual VCR cycle on T-s and p-h diagram.

**Unit 3**

**Multi Pressure system, Control Device and Vapor Absorption System:** Removal of flash gas, Multiple expansion & compression with flash inter cooling; Low temperature refrigeration: Production of low temperatures, Cascade system. Thermostatic expansion valve, Automatic expansion valve, capillary tube. Vapour absorption system: Theoretical and practical systems such as aqua-ammonia, Electrolux & other systems.

**Unit 4**

**Psychrometric and Comfort Air Conditioning:** Air properties, Psychrometric chart, Psychrometric processes: Sensible heating and cooling, Evaporative cooling, Cooling and dehumidification, Heating and humidification, Mixing of air stream, Sensible heat factor.Comfort Air Conditioning; Mechanism of Body Heat Loss, Unit of Metabolic Heat Generation, Comfort Index, Effective Temperature, Comfort Chart & Thermal Sensation, Comfort chart.

**Unit 5**

**Air Conditioning system and Air Conditioning Loads:** Air conditioning system & its Types, Air conditioning loads: calculation of summer & winter air conditioning load, bypass factor of coil, calculation of supply air rate & its condition, room sensible heat factor, grand sensible heat factor, effective sensible heat factor, dehumidified air quantity. Problems on cooling load calculation.

**Text Books:**

1. C.P. Arora, Refrigeration and Air conditioning, TMH
2. E.G. Pita, Air Conditioning Principles and systems, Parson Education Pte. Ltd.
3. R.Rajpt, Refrigeration and Air conditioning

**Reference Books:**

1. M. Prasad, Refrigeration & Air Conditioning, New Age International (P) Limited,
2. PL Balani, Refrigeration & Air conditioning, Khanna Publishers, 2-B Nath Market, Nai Sadak, Delhi – 110006
3. W.F. Stoecker, Refrigeration and Air conditioning, McGraw-Hill Book Company

**List of Practicals:**

1. determination of COP of three fluid ELECTROLUX absorption refrigeration systems.
2. Study of various components and working of simple vapor compression cycle refrigeration trainer.
3. Determination of COP of simple vapor compression cycle refrigeration system on the trainer.
4. Study of various components and working of thermoelectric based refrigeration system on TCL hot & cold water dispenser.
5. Study of various components and working of air conditioning system on re-circulated type trainer.
6. Plotting the change in the psychometric properties of air under sensible heating, sensible cooling and heating with humidification; on re-circulated type air conditioning trainer
7. Study the various components and working of window air conditioning system.
8. Study the various components and working of three fluid ELECTROLUX absorption refrigeration system.
9. Study of Steam Jet Refrigeration system.
10. Study of control devices

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
|  | Program Elective VI-I |  |  |  |  |
| ME3EL02 | Mechanical Vibrations | 3 | 0 | 0 | 3 |

**Unit I**

**Basics Of Vibration:** Basic concepts of vibrations, causes and effects of vibrations, applicatons of vibration Classification of Vibrations, Basic elements of vibratory system - spring, mass, damper. Degree of freedom, Mathematical modeling of physical systems, Formulation of differential equations by various principles and determination of natural frequency of undamped SDOF vibratory system

**Unit II**

**Free DampedVibration :**  Damping and its Classification- viscous, coulomb, slip and structural damping, derivation of differential equation under damped, critically damped and over damped SDOF vibratory system, Logarithmic decrement. Derivation for coulomb’s damping and rate of decay of amplitude.

**Unit III**

**Forced Vibration System:** Forced single degree of freedom vibration system, analysis of linear and torsional vibratory systems subjected to harmonic force, vector representation of forces in the system, vibration isolation and transmissibility ratio for systems subjected to excitation of support, concept of absolute and relative motion.

**Unit IV**

**Two and Multi Degree of Freedom System :** Derivation of governing equations, natural frequencies and mode shapes for 2 DOF vibratory system, concept of semidefinite system and coordinate coupling, Determination of natural frequency of multi degree of freedom system using – matrix method, method of Influence coefficients and Rayleigh's method

**Unit V**

**Vibration Measuring Instruments:** Principle of seismic instruments- Vibrometer, accelerometer, sensors used in vibration measurement. Introduction to FFT analyser, Introduction to condition Monitoring and Fault diagnosis.

**Text Books:**

1. S. S. Rao, Mechanical Vibrations, Pearson Education,
2. A. G. Ambekar, Mechanical Vibrations, PHI Learning,
3. G. K. Grover, Mechanical Vibrations, Nem Chand & Bros

**Reference Books:**

1. V. Rao Dukkipati and J. Srinivas, Mechanical Vibrations, Second Edition, PHI Learning
2. G. Kelly, Mechanical Vibrations, Schaum’s outline series, Tata McGraw Hill, Special Edition,
3. W.T. Thomson, Theory of vibrations with applications, CBS Publishers, Delhi

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
|  | Program Elective VI-2 |  |  |  |  |
| ME3EC02 | Computational Fluid dynamics | 3 | 0 | 0 | 3 |

**Unit I**

**Introduction and Governing Equations:** Introduction - Impact and applications of CFD in diverse fields - Governing equations of fluid dynamics – Continuity - Momentum and energy - Generic integral form for governing equations - Initial and Boundary conditions - Governing equations for boundary layers - Classification of partial differential equations – Hyperbolic - Parabolic - Elliptic and Mixed types - Applications and relevance.

**Unit II**

**Discretization:** Basic aspects of discretization - Discretization techniques – Finite difference – Finite volume and Finite Element Method– Comparison of discretization by the three methods - Introduction to Finite differences - Transient one-dimensional and two-dimensional conduction – Explicit - Implicit - Crank-Nicolson - ADI scheme – Stability criterion. Difference equations - Numerical errors - Grid independence test - Optimum step size.

**Unit III**

**Grid Generation:** Grid generation – General transformation of the equations - Form of the governing equations suitable for CFD – Boundary fitted co-ordinate systems – Elliptic grid generation - Adaptive grids - Modern developments in grid generation.

**Unit IV**

**Convection:** Diffusion Steady one-dimensional convection and diffusion - Central difference, upwind, quick, exponential, false diffusion, hybrid and power law schemes. Transient one dimensional heat conduction equation.

**Unit V**

**Calculation of Flow Field:** Representation of the pressure - Gradient term and continuity equation – Staggered grid -Momentum equations - Pressure and velocity corrections - Pressure Correction equation -Numerical procedure for SIMPLE algorithm - Boundary conditions for the pressure correction method. Stream function – Vorticity method - Discussion of case studies.

**Text Books:**

1. K.A. Hoffman, , Computational Fluid Dynamics for Engineering, Vol I – III Engineering Education System, Austin, Texas.
2. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere, New York.
3. V.V. Ranade, , Computational Flow Modeling for Chemical Reactor Engineering, Academic Press

**Reference Books:**

1. J.D. Anderson, Jr., Computational Fluid Dynamics – The basics with applications, McGraw-Hill, Incs.
2. K. Muralidhar, T. Sundarajan, Computatioanl Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
|  | Program Elective VI-2 |  |  |  |  |
| ME3EI03 | Production Planning and Control  | 3 | 0 | 0 | 3 |

**UNIT I:**

**Introduction:** Objectives and benefits of planning and control-Functions of production control, Types of production, job, batch and continuous, Product development and design, Marketing aspect, Functional aspects, Operational aspect, Durability and dependability aspect aesthetic aspect, Profit consideration, Standardization, Simplification.

**UNIT II:**

**Process Design:** Systems approach to process planning and design, linkage between product planning and process planning, distinction between process planning and facilities planning, types of process design, process design procedure. Break even analysis-Economics of a new design.

**UNIT III:**

**Forecasting:** characteristics of demand over time, forecasting qualitative model: Delphi, naive quantitative models: simple average, simple moving average, weighted moving average, exponential smoothing, smoothing coefficient selection, adaptive exponential smoothing, incorporating trend and seasonal components, linear regression, selection of forecasting models.

**UNIT IV:**

**Production Scheduling:** Production Control Systems, Loading and scheduling, Master Scheduling, Scheduling rules, Gantt charts-Perpetual loading, Basic scheduling problems, Line of balance, Flow production scheduling, Batch production scheduling, Product sequencing, Production Control systems, Periodic batch control, Routing, Loading, Scheduling, forward and backward, Dispatching, priority rules, Sequencing, Johnson’s algorithm for n jobs and two machines, Gantt’s chart, Bar chart, Flow process chart.

**UNIT V:**

**Work Study:** Method study, basic procedure, Selection-Recording of process, Critical analysis, Development, Implementation, Micro motion and memo motion study, work measurement, Techniques of work measurement, Time study, Production study, Work sampling, Synthesis from standard data, Predetermined motion time standards.

**Text Books:**

1. V. Thomas , B. William, D Clay, “Manufacturing Planning and Control Systems” Galgotia Publications, New Delhi.

2. W.J. Stevensons, Operations Management, Mc-Graw Hills.

3. M.Telsang, Industrial Engineering and Production Management, S. Chand Publications.

**Reference Books:**

1. Introduction to Work Study by ILO.

2. S.N. Chapman, Fundamentals of Production Planning and Control, Pearson

3. L. C. Jhamb, Production Planning and Control, Everest Publishing House

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
|  | Program Elective VI-2 |  |  |  |  |
| ME3EE03 | Energy Auditing and Management | 3 | 0 | 0 | 3 |

**Unit-I**

**Energy Audit Methodology and recent trends**.: General Philosophy, need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy. Economics of implementation of energy optimization projects. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy

**Unit-II**

**Electrical Distribution and Utilization:** Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches.

**Unit-III**

**Thermal Systems:** Boilers performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers, Heat recovery, Boilers limitations and constraints.

**Unit-IV**

**System Audit of Mechanical Utilities:** Pumps, types and application, unit’s assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems. Bloomers (Blowers) types & application, its performance assessment, series & parallel operation applications & advantages.

**Unit-V**

Energy Saving in Blowers Compressors, types & applications, specific power consumption, compressed air system & economic of system changes. Energy Saving in Compressors & Compressed Air Systems Cooling towers, its types and performance assessment & limitations, water loss in cooling tower, Energy Saving in Cooling Towers.

**Text Books**

1. Energy Efficiency in Electrical Systems, Volume-II,IECC Press

2. W.R.Murphy, G.Mckay, Energy Management, Butterworths Scientific

3. C.B Smith, Energy Management Principles, Pergamon Press

**Reference Books:**

1. D.A. Reay , Industrial Energy Conservation, Pergammon Press
2. W.C. Turner , Energy Management Handbook, John Wiley and Sons,

 3. L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilization, Hemisphere Publication, Washington,

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
|  | Open Elective -II |  |  |  |  |
| OE00035 | Advanced Entrepreneurship | 3 | 0 | 0 | 3 |

**Unit I**

**Orientation To Growth:** Getting Ready for Growth, Why growth stage is different compared to startup phase, Why Product-Market fit is not enough, Case study, To assess readiness for growth, To chart a growth path

**Unit II**

**Customers:** Expanding Customer Base-Revisit your business model and develop few variants (more business model types), Identify additional customer segments that your solution can address, Evaluate business models for the new customer segments, Re-look at the Problem Statement (can you expand the scope and scalability of your business by repositioning your problem statement?), Explore additional ways to monetize

**Unit III**

**Traction: Scaling**-How to gain traction beyond early customers, Defining traction (in quantifiable terms) and identifying the most important metrics to measure traction, Calculate cost of new customer acquisition, Estimate your customer lifetime value (LTV), Identifying waste in your operations and focusing your team on what is important for traction

**Channels and Strategy**- The Bullseye framework Identify Channels using Bulls Eye Framework Measuring the effectiveness of selected channels Budgeting and planning

**Unit IV**

**Money:Growing Revenues**-Stabilizing key revenue streams, Developing additional revenue streams (licensing, franchising), Exploring new channels and partnerships

**Sales Planning-**Understanding why customers buy and how buying decisions are made; Listening skills, Sales planning, setting targets, Unique Sales Proposition (USP); Art of the sales pitch (focus on customer’s needs, not on product features) Follow-up and closing a sale; Asking for the sale

**Strengthening Sales**-Building a professional sales team, Sales compensation and incentives, Sales planning, setting targets

**Improving Margins**-Testing price elasticity, Optimizing costs and operational expenses, Advanced concepts of unit costing

**Financial Modeling**-Financial modeling of your venture's growth, Analyzing competitor and peer's financial models

**Unit V**

**Support: Legal-**Overview of legal issues and their impact on entrepreneurs, Importance of getting professional help (legal and accounting), Importance of being compliant and keeping proper documentation, Patents and Intellectual property, Trademarks

**Mentors, Advisors, and Experts**-The importance of a Mentor and how to find one, Role of business advisors and experts for specific targets in your growth plan

**Text Books:**

1. A. Mathur, Entrepreneurship, Taxmann,
2. V. Desai,Fundamentals of Entrepreneurship & small business management, Himalaya Publishing House.
3. Entrepreneurial Development by S.S. Khanka, S. Chand Publication.

**References:**

1. S.Shane, A General theory of entrepreneurship: The individual opportunity nexus, Edward Elgar Publication.
2. J. A. Timmons & S. Spinelli, New Venture Creation: Entrepreneurship for the 21st century, McGraw-Hill.
3. R.D Hisrich and M Peters, Entrepreneurship, McGraw-Hill.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
|  | Open Elective -II |  |  |  |  |
| OE00036 | Renewable Sources of Energy | 3 | 0 | 0 | 3 |

**Unit-I**

**Introduction**: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

**Unit-II**

**Solar Energy**: Energy from Sun, Types of Solar Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish , Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Solar Cookers, Solar pond. Solar Cells: Components of Solar Cell System

**Unit-III**

**Wind Energy**: Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection. **Geothermal Energy**: Geothermal Systems, Classifications, Geothermal Resource Utilization Geothermal Based Electric Power Generation

**Solid waste and Agricultural Refuse**: Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling, Sources and Types of Waste,Recycling of Plastics.

**Unit-IV**

**Biomass Energy**:Biomass Production, Energy Plantation,Biomass Gasification, Updraft and Downdraft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier.

**Biogas Energy**: Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas,

**Unit-V**

**Ocean Thermal Energy**: Introduction,Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants,

**Tidal Energy**: Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India

**Text Books**

1. Kothari, Singal & Rajan; Renewable Energy Sources and Emerging Technologies, PHI
2. B.H Khan, Non Conventional Energy, TMH.
3. Sukhatme and Nayak, Solar Energy, Principles of Thermal Collection and Storage, TMH.

**Reference Books**

1. K. Rao, Energy Resources, Conventional & Non-Conventional, BSP Publication.
2. C.S.Solanki, Solar Photovoltaics: Fundamental, technologies and Application, PHI
3. A.Tasneem and SA Abbasi; Renewable Energy Sources; PHI Learning.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
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| **ME3EI07** | **Program Elective VII-1** | **3** | **0** | **0** | **3** |
| **TQM & SQC** |

**Unit I**

**Introduction:** Introduction to quality: Definition, Dimensions of quality. Goal post and Kiazen view of quality. Need of quality management, quality of design, conformance, and performance, Quality cost and its components

**Unit II**

**TQM :** TQM definition, Evolution of TQM, key principles of TQM, Benefits and limitations of TQM, Barrier to implementing TQM, Contribution of various quality guru’s (W. Shewhart, Deming PDCA cycle and 14 point philosophy, Taguchi’s Loss function, DOE, )

**Unit III**

**SQC Processes :** Understanding processes ,definition, causes of variation and feedback, funnel marble experiment, rules of adjustment and its effect, measures of centraltendency, variability and shapes, sampling, size and central value theorem, control chart structure, process plotting and stability, study of out-of-control evidences, defect detection and prevention, use of control charts in evaluating past, present and future trends; attribute and variable control charts, count and classification charts, construction and interpretation of p , np , c and u charts, X and R charts, and s charts.

**Unit IV**

**Quality Improvement Tools and Techniques**: Pareto’s chart, Histogram, Ishikawa Diagram, flow charts, scatter diagram, constructions and applications. Benchmarking and its types, Benchmarking process, Quality Function Deployment ( QFD), KANO model, six sigma concept, methodology , application to manufacturing ,.

**Unit V**

**Quality Standards :**  acceptance sampling & operational characteristics curve (OC curve ) Consumer and producer’s risk, AOQ, LTPD , sampling plans ( single , double ) Quality Circles ,structure , roles and responsibilities Quality standards, introduction to ISO 9001-2000 series , certification process, benefits, ISO 14000,Conformance to specification, quality assurance , quality audits and its types,

**Text Books:**

1. Gitlow HS, Oppenheim,Quality Management,TMH
2. Total Quality Management by Kataria, Arora
3. Statistical Quality Control by M. Mahajan

**Reference Books:**

1. Gryna FM; Juran’s Quality Planning and Analysis; TMH
2. Crosby Philips; Quality is still free; New Amer Library

 3. Total Quality management by Besterfield D.H., Pearson Education

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
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| **ME3EL03** | **Program Elective VII-1** | **3** | **0** | **0** | **3** |
| **Robotics Engineering** |

**Unit I**

**Introduction:** Definitions, Laws of Robotics, Historical Development, Classification of Robots, Robot Anatomy, Robot Manipulator, Basic Robot Configurations and their Relative Merits and Demerits, the Wrist & Gripper Subassemblies, Work Volume.

**Unit II**

**Kinematics of Robotic Manipulator:** Introduction, Direct Kinematics problem, Rotation matrix, Composite Rotation matrix, Homogenous Transformations, Robotic Manipulator Joint Co-Ordinate System, D-H Representation & Displacement Matrices for Standard Configurations, Inverse Kinematics problems.

**Unit III**

**Dynamics of Robotic Manipulators:** Introduction,. Preliminary Definitions, Generalized Robotic Coordinates, Jacobian for a Two link Manipulator, Euler Equations, Lagrangian Equations of motion, Lagrange–Euler Formulation of Robotic Manipulators.

**Unit IV**

**Robot End Effectors & Sensors:** Introduction, Types of End Effectors, Mechanical Grippers, Other types of Grippers, Tools as End Effectors, Considerations in Gripper Selection & Design, Transducers & Sensors, Types of Sensors, Tactile, Proximity, Range & Miscellaneous Sensors.

**Unit V**

**Robot Programming & Languages:** Introduction, Methods of Robot Programming, Lead through Programming Methods, Motion Interpolation, Wait, Signal & Delay Commands, Branching, Textual Robot Languages, Robot Language Structure, Motion Commands, End Effect or Commands, Sensor Commands, Program Control & Subroutines.

**Text Books:**

1. Fu, Lee and Gonzalez, Robotics, control vision and intelligence- McGraw Hill International

2. John J. Craig, Addison, Introduction to Robotics- Wesley Publishing

3. S K Saha, Introduction to Robotics, Tata McGraw-Hill.

**References Books:**

1. Yoram Koren, obotics for Engineers - McGraw Hill International

2. Saeed Niku, Introduction to Robotics: Analysis, Control, Applications John Wiley & Sons.

3. R K Mittal, I J Nagrath, Robotics and control, Tata McGraw Hill.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
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| **ME3EE07** | **Program Elective VII-1** | **3** | **0** | **0** | **3** |
| **Bio and Solid Waste Management** |

**Unit I**

**Introduction:** Sources and engineering classification, characterization, generation and quantification; Objectives, principles, functional elements of solid waste management system Regulatory aspects of solid waste management, major problems.

**Unit II**

**Waste Generation:** Rate of generation, frequency, storage and refuse collection, physical and chemical composition, quantity of waste, engineering properties of waste, prediction, Collection, Segregation and Transport: Handling and segregation of wastes at source.

**Unit III**

**Waste Minimization**: 4R- reduce, recover, recycle and reuse, case study, guidelines Treatment Methods -Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery

**Unit IV**

**Disposal Methods:** Impacts of open dumping, site investigation and selection, sanitary land filling - Types, geotechnical considerations, design criteria and design, Role of various organizations in Solid Waste Management : Governmental, Non - Governmental, Citizen Forums

**Unit V**

**Recent Developments in Solid Wastes Reuse and Disposal:** Power Generation, Blending with construction materials and Best Management Practices (BMP). Community based waste management, Waste as a Resource concept, Public private partnership (PPP)

**Text Books:**

1. Mantell C.L., “Solid Waste Management”, John Wiley

2. Peavy, Rowe and Tchobanoglous, “Environmental Engineering”, McGraw Hill.

3. Paul T Willams, “Waste Treatment and Disposal”, John Wiley and Sons

**Reference Books:**

1. Bhide A.D. and Sundaresan, B.B. “Solid Waste Management Collection”, Processing and Disposal

2. George Tchobanoglous and Frank Kreith”Handbook of Solidwaste Management”,
McGraw Hill, New York

3. Flintoff F., “Management of Solid Wastes in Developing Countries”, WHO

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| **ME3EI01** | **Program Elective VII-2** | **3** | **0** | **0** | **3** |
| **Operations Management** |

**Unit I**

**Introduction:** Operations Management: Introduction and overview, Operations Management Strategy framework, Responsibilities of operation manager Understanding similarities and difference among goods and services, Historical evolution of operations management-Changes & Challenges.

**Unit II**

**Product Development:** Operations strategy, Product Strategy and integrated product development, Process Strategy, Systematic approach to capacity planning, Capacity Decisions, Facilities Location Strategies, BPO, DFM, DFE, 3’S

**Unit III**

**System Design:** Facilities Layout and Material Handling Strategy, Group Technology, Flexible manufacturing system, Assembly line balancing, Project Management-CPM PERT, Line of Balance (LOB). Traditional v/s Concurrent Design, form & functional design, simplification & standardization

**Unit IV**

**Planning and Managing Operations:** Purchasing, vendor selection and material management, Just-in-Time Systems, MPS. Materials Requirement Planning, MRP II and ERP Aggregate Operations Planning, Product structure tree,

**Unit V**

**Advance Operation Management:** Service Operations Management, Lean systems, Constraint management – TOC, Computer integrated manufacturing, Analytical tools for decision support system (DSS) for operations management, Kanban and CONWIP, shop floor controls, Kaizen.

**Text Books:**

1. Chary S N , Production and Operations Management, Tata Mc Graw Hill
2. Chase, Jacobs and Aquilano, Operations Management for Competitive advantages, Tata Mc Graw Hill
3. Everett Adam, Ronald J Ebert, Production and Operations Management Prentice Hall

**Reference Books:**

1. Joseph G. Monks, Operations Management Theory and Problems, Mc. Graw Hill .
2. William J Stevenson, Operations Management Concepts, McGraw Hill
3. Norman Gaither, Greg. Frazier , Operation Management, Thomson

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| **ME3EL04** | **Program Elective VII-2** | **3** | **0** | **0** | **3** |
| **Manufacturing Automation** |

**Unit I**

**Introduction to automation :** Automation, the basic elements and their description, other advanced functions of automation, types of automation, levels of automation, reasons of automation, automation principles and strategies – USA principle, ten strategies of automation, automation migration strategy.

**Unit II**

**Production Systems :** Production system and its types – low ,medium and high, manufacturing support system, reasons of manual labor in production systems, types of manufacturing operations, product- production relationship- quality vs quantity, product and part complexity, capabilities and limitations of manufacturing plant, production concepts and mathematical models.

**Unit III**

**Industrial control systems:** Automation in continuous and discrete product industries, continuous control system- regulatory, feed forward, steady state optimization, adaptive, discrete control system- event and time driven control, computer process control – types, control requirements and forms of computer control, signal conversion- analog to digital and vice versa, discrete control using programmable logic controller (PLC) - components of PLC and a few examples of ladder logic diagrams

**Unit IV**

**Flexible Manufacturing Systems:** Limitations of conventional manufacturing, need for FMS, definition, types, components, layout and configuration of FMS, benefits and limitations of FMS, computer control system in FMS, automated handling and transport system – types of handling systems, AGV and its types, applications, guidance technologies automated storage/retrieval - performance of storage system and location strategies, automated storage and retrieval system AS/RS –objectives, types and applications of automated storage, components of AS/RS,

**Unit V**

**Automated Inspection:** Types of inspection, inspection accuracy, inspection vs testing, automated inspection, inspection during manufacturing, contact vs non-contact inspection techniques, Coordinate measuring machine – construction and types based on structure, types of CMM controls and programming methods, CMM applications and benefits, Machine vision **–** basic steps and applications

**Text Books:**

1. Mikell P. Groover, “ Automation, Production Systems and Computer Integrated Manufacturing , Pearson Education.
2. P Radhakrishanan, S Subramanyan, V Raju, “CAD/CAM/CIM, New Age Publication
3. Vikash Sharma, “Fundamental of CAD/CAM/CIM”, S K Katariya and Sons

**Reference Books:**

1. H K Shivanand, M M Benal, V Koti,“Flexible Manufacturing System” New Age International
2. B R Mehta, Y J Reddy, “Industrial Process Automation Systems”, Elsevier Science
3. Robert J Hocken, Paulo H Pereira, “ Coordinate measuring Machines and Systems” , CRC Press

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| **L** | **T** | **P** | **Credits** |
| **ME3EE06** | **Program Elective VII-2** | **3** | **0** | **0** | **3** |
| **Utilization of Solar Energy** |

**Unit I**

**Basics of Solar Energy**: Brief History of solar energy utilization - Various approaches of utilizing solar energy - Blackbody radiation, Factors governing availability of solar energy on the earth; Estimation of average daily global solar radiation.

**Unit II**

**Solar Cookers and Solar Driers:** Types of solar cookers; Solar box type solar cooker; SK type solar cooker (parabolic); Solar steam cooking system; Solar bowl cooking concentrators; Classification of solar dryers; Active and passive solar energy dryers

**Unit III**

**Solar Energy Collectors**: Stationary collectors – flat plate collectors, compound parabolic collectors and evacuated tube collectors; Sun tracking concentrating collectors – parabolic trough collectors, Fresnel collectors, parabolic dish reflectors

**Unit IV**

**Solar Water Heating Systems**: Passive solar water heating systems – Thermal siphon systems, integrated collector storage systems; Active solar water heating systems – Direct circulation systems, indirect water heating systems

**Unit V**

**Photovoltaic Systems**: Semiconductors; Photovoltaic panels; Types of photovoltaic technologies; Equipment related to photovoltaic technology – batteries, invertors, charge controllers, peak power trackers

**Text Books:**

1. Kalogirou S, Solar Energy Engineering: Processes and Systems, Academic Press, USA

2. Sukhatme SP, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill

3. Tiwari GN, Solar Energy-Fundamentals, Design, Modelling & Applications, Narosa

**Reference Books:**

1. Solar Engineering and Thermal Processes, J. A. Duffie and W.A. Beckman, John Wiley and sons.

2. Solar Energy, G. N. Tiwari, Narosa Publishing House

3. Garg HP and Prakash J, Solar Energy fundamentals & Applications, Tata Mc-Graw Hill.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| **OE00047** | **Open Elective VII-1** | **3** | **0** | **0** | **3** |
| **Advance Machining Processes** |

**Unit I**

**Mechanical Type Processes :** Limitations of conventional machining process, classification of advanced machining processes, **Classification of mechanical type processes** : Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - abrasive jet machining (AJM), ultrasonic machining (USM), water jet machining (WJM), recent developments in all the processes.

**Unit II**

**Chemical and Electrochemical** **Type Processes :** Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - chemical machining (CHM), maskants and its type, methods of applying maskants, Electrochemical machining[ECM], electrolyte flow design in ECM.

**Unit III**

**Thermal Processes :** Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - electric discharge machining(EDM), different circuits of pulsating dc supply, wire-cut EDM, transferred and non transferred arc type plasma arc machining (PAM), Electron beam machining(EBM) and Laser Beam machining (LBM).

**Unit IV**

**Hybrid Processes:** Principle and mechanics of metal removal, advantages, disadvantages and limitations of – abrasive electro-discharge machining (AEDM), ultra sonic assisted EDM (EDMUS), laser assisted ECM (ECML) , ultra sonic assisted ECM (USECM)

**Unit V**

**Hybrid Finishing Processes:** Working principle, applications, advantages and limitations of - electrochemical grinding (ECG), electro-discharge grinding (EDG), electrochemical de-burring (ECD), electrochemical honing (ECH), magnetic abrasive finishing (MAF),

**Text Books:**

1. P.C. Pandey and H.S.Shan, “Modern Machining processes”, McGraw Hill Education

2. M.K.Singh, “Unconventional Manufacturing Processes” New Age International

3. Hassan Abdel-Gawad El-Hofy, “Advanced Machining processes”, McGraw Hill

**Reference Books:**

1. G.F. Benedict, Marcel Dekker,Nontraditional Manufacturing Processes", Inc. New York.

2. Vijay.K. Jain, “Advanced Machining Processes” Allied Publishers.

3. Amitabha Ghosh and Asok Kumar Mallick, “Manufacturing Science”, East West Press.

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| **Course Code** | **Course Name** | **Hours per Week** | **Total** |
| **L** | **T** | **P** | **Credits** |
| **OE000048** | **Open Elective VII-1** | **3** | **0** | **0** | **3** |
| **Supply Chain Management** |

**Unit I**

**Introduction & Building a Strategic Framework to Analyze Supply Chains:** An Introduction, Strategic view of supply chains, Evolution of Supply Chain Management (SCM), Importance of the supply chain, Decision phases in a supply chain, Process views of supply chain, Enablers of supply chain performance, Supply chain strategy and performance measures–competitive and supply chain strategies – Achieving strategic fit, managing material flow in supply chain

**Unit II**

**Designing the Supply Chain Network:**  Designing distribution networks and applications to e-business, network design in the supply chain, network designing an uncertain environment, supply chain planning, supply chain coordination, decision modeling for supply chain, green supply chain

**Unit III**

**Supply Chain Distribution and Integration and Risk Pooling:** Supply chain integration, Warehouse Management Systems, Storage Systems, Material Handling Requirements, Distribution Strategies – Traditional Retail, Direct Shipping, Cross-docking, Cross-dock Operations, Distribution Strategies: Pool Distribution, Transshipment, Milk-Run Systems, Classic Techniques of Risk Management, Pooling based on Location, Product, lead Time and capacity.

**Unit IV**

**Supplier Relationship Management: Integrating Suppliers into the e-Value Chain :** Defining Purchasing and Supplier Relationship Management, Components of SRM, The Internet-Driven SRM Environment, e-SRM Structural Overview, e-SRM Services Functions, e-SRM Processing, e-SRM Technology Services, Anatomy of The e-SRM Marketplace Exchange Environment, Implementing e-SRM

**Unit V**

**Transportation and Packaging :** Transportation – Drivers, Modes, Measures - Strategies for Transportation, 3PL and 4PL, Vehicle Routing and Scheduling. Packaging- Design considerations, Material and Cost. Packaging as Unitisation. Consumer and Industrial Packaging.

**Text Books:**

1. Ronald H. Ballou and Samir K. Srivastava, Business Logistics and Supply Chain Management, Pearson education
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education
3. Mohanty R.P and Deshmukh S.G, Supply chain theories and practices, Biztantra publications.

**Reference Books:**

1. Bowersox Donald J, Logistics Management – The Integrated Supply Chain Process,Tata McGraw Hill
2. Vinod V. Sople, Logistics Management-The Supply Chain Imperative, Pearson.
3. Coyle et al., The Management of Business Logistics, Thomson Learning