**Third Semester Theory**

**Title of Course: Mathematics- Transform Calculus, Numerical Methods and Complex Analysis**

**Course Code: BSC011**

**L-T Scheme: 3-1 Course Credits: 4**

**Course Contents:**

**Transform Calculus**

**Module 1: Laplace Transformation (9L)**

Laplace Transform & its Properties, Laplace transform of periodic functions. Inverse Laplace transform, convolution theorem and application (in ODE & PDE).

**Module 2: Fourier Transformation (7L)**

Fourier transforms and Inverse Fourier Transform, convolution theorem and applications.

**Numerical Methods**

**Module 3: (6L)**

Accuracy and Precision: Error Analysis. Solution of polynomial and transcendental equations – Bisection method, Newton-Raphson method and Regula-Falsimethod.Ordinary differential equations: Taylor’s series, Euler and modified Euler’s methods. Runge- Kutta method.

**Complex Analysis**

**Module 4: Analytic Function (6L)**

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions and their properties; Conformal mappings.

**Module 5: Complex Integral (6L)**

Contour integrals, Cauchy-Goursat theorem, Cauchy Integral formula, Taylor’s series, Laurent’s series; Residues, Cauchy Residue theorem

**Reference Books**

* Engineering Mathematics-III(B.K Pal and K.Das)
* Brown J.W and Churchill R.V: Complex Variables and Applications, McGraw-Hill.
* Grewal B S: Higher Engineering Mathematics, Khanna Publishers.
* Dutta& Jana: Introductory Numerical Analysis(All course).
* Dr.B.S.Grewal:Numerical Methods in Engineering &science
* Jain, Iyengar ,& Jain: Numerical Methods.
* Baburam: Numerical Methods, Pearson Education.
* Advanced Engineering Mathematics 8e by Erwin Kreyszig is published by Wiley India
* Engineering Mathematics: B.S. Grewal (S. Chand & Co.)

# Title of Course: Data Structure & Algorithm using Python

# Course Code: CSD303

# L-T: 3-0 Credits: 3

**Pre-requisite:** Basic concepts in mathematics and programming languages.

**Introduction:**

This course examines data structures and algorithms basics using python. The Topics to be covered (tentatively) include: an introduction to programming and problem solving in Python with basic concepts such as conditionals, loops, functions, lists, strings and tuples; Time and space analysis of algorithms; Linear Data structures like array, linked list, stack, queue; Non-linear Data structures like graph and tree; Sorting; Searching and Hashing.

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**Course Outcomes (CO):**

In this course we will study the basic components of data structure and algorithm.Students are expected to be capable of understanding the data structures, their advantages and drawbacks, how to implement them in python, how their drawbacks can be overcome and what the applications are and where they can be used.To reach this goal, the following objectives need to be met:

1. Know about basic concepts of python programming.
2. To learn about the data structures/ methods/algorithms mentioned in the course with a comparative perspective so as to make use of the most appropriate data structure/ method/algorithm in a program to enhance the efficiency (i.e. reduce the run-time) or for better memory utilization, based on the priority of the implementation
3. To implement different types of linear data structure.
4. Study the Python dictionaries as well as classes and objects for defining non liner data structure like graph and tree.
5. Understand different types of sorting, searching and hashing technique..

**Course Contents:**

**Module-1:** Basics of python: data types, assignment statements, control flow,strings,lists,functions, simple input output.

**Module-2:** Algorithm efficiency and analysis, time and space analysis of algorithms – order notations.

**Module-3:** Linear Data structures–Array,Matrix, Linked List, Stack, Queue and Recursion with their types, different operations and applications

**Module-4:** Nonlinear Data structures–Graph, Trees, Minimum spanning treewith their types, different operations and applications.

**Module-5:** Sorting, Searching and Hashing- Bubble sort and its optimizations, insertion sort, shell sort, selection sort, merge sort, quick sort, heap sort (concept of max heap, application – priority queue), radix sort. Sequential search and binary search.Hashing functions, collision resolution techniques

**Text Books**

1. Data Structures and Algorithms in Python:Michael H. Goldwasser, Roberto Tamassia, Michael T. Goodrich,Publisher: John Wiley & Sons
2. Data Structure and Algorithmic Thinking with Python:NarasimhaKarumanchi; Careermonk publication.

**References**

1. Problem Solving in Data Structures & Algorithms Using Python: Programming Interview Guide:Hemant Jain; Createspace Independent Pub
2. Data Structures and Algorithms Using Python:NecaiseRance D;Wiley publisher

**Title of Course: Manufacturing Process**

**Course Code: MEC303T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit1:** **Introduction**

**Unit 2:** **Casting:**

History, Definition, Major Classification Casting Materials, Sand mould casting Moulding sands: composition, properties & testing, Design of gating system: sprue, runner, ingate & riser, Estimation of powering time, Foundry equipments, Furnaces Melting, pouring and solidification, Type of patterning, use of a core, Different type of sand mould casting, Floor mould casting, Centrifugal casting, Shell mould & CO2 casting, Investment casting, Permanent mould casting, Die casting, types, methods, advantages & applications, Slush casting, principle & use, Casting defects, types, causes & remedy.

**Unit 3: Welding Process and Forming**

Introduction to metallic parts, Major grouping of joining processes, welding, brazing and soldering, Broad classification of welding processes, types and principles, Fusion welding, types, principles, equipments, characteristics & applications, Sources of heat-chemical action, Gas welding & thermit welding, Sources of heat-electrical energy, Arc welding, Submerged arc welding, TIG & MIG; Plasma arc welding, Resistance welding; Spot & butt welding, Solid state welding Principles, advantages & applications of: Hot forge welding, Friction welding, Pressure & percussion welding, Precision welding processes: Ultrasonic welding, Laser beam welding, Electron beam welding, Welding defects, types, causes & remedy.

**Unit 4: Forming**

Forging: Introduction, definition, classification, hot forging & cold forging,: characteristics & applications, Forging material operations, equipments & tools: Smith forging, Drop forging, Pressing or press forging, Forging dies, materials & design,

Rolling: Introduction, basic principles, hot rolling & cold rolling, characteristics & applications Rolling processes & applications, operations, equipments & roll Stands,

Wire drawing & extensions: Basic principles & requirements, Classification, methods & applications,

Press tool works Basic principles, systems, operations & applications, Shearing, parting, blanking, piercing & notching, Cupping(drawing), Spinning & deep drawing Blanks & forces needed for shearing & drawing operations, Coining & embossing.

**Text Book:**

1. Manufacturing technology, Foundry, Forming & Welding-P.N Rao.
2. Manufacturing Science-A Ghosh & A Mullick.
3. Manufacturing Engineering & Technology-S Kalpakjian; Pub:Addison Wesley.
4. Principles of manufacturing materials & processes-James & Campbell.

**Reference Books:**

1. Manufacturing engineering & technology-K Jain.
2. Materials & processes in manufacturing-E.P Degarmo, Black & Kohser, Pub: Wiley(10th ed.)
3. Processes & materials of manufacturing-R.A Lindberg.
4. Introduction to manufacturing technology-PP Date, Pub: Jaico.
5. Manufacturing processes-S.K Sharma & S Sharma, Pub: I.K International.

**Title of Course: Thermodynamics**

**Course Code: MEC304**

**L-T Scheme: 3-1 Course Credits: 4**

**Course Contents:**

**Module-1**

**Fundamentals of Thermodynamics**

Introduction to the thermodynamics, its definition and application in engineering. Fundamentals-System & Control volume; Property, State, path & Process; thermodynamic equilibrium , quasi-static process .Exact & Inexact differentials; Work- Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.

**Temperature**

Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic &Non-cyclic processes; Concept of total energy E; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

**First law thermodynamics**

First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.

**Properties of pure substances**

Pure Substance and its example, Properties of pure substance; Phases of pure substances- Phase rule; Phase Change Processes of Pure Substances – triple point., critical point. Saturation temperature and pressure. Property diagrams of Phase change Processes of water on T-V, P-V, T-S and h-s plots ; P-V-T surface for phase change. Concept of dryness fraction or quality for liquid vapour mixture.

**Module-2**

**2nd Law of Thermodynamics**

The 2nd Law of Thermodynamics; the corollaries & their proofs; the property of entropy; entropy change of a pure substance. Energy analysis, Tds equations and calculation of entropy change; concept and uses of entropy; The second law of thermodynamics for an open system. Concept of entropy generation, Reversible work and irreversibility and its numerical

**Module- 3**

**Joule Thompson Effect**

Maxwell relations, T-ds equations and its derivations. Derivations of Joule Thompson co-efficient & Clapeyron Equation.

**Module -4**

**Study of Thermodynamic Cycles**

Introduction to I.C.Engine, Air Standard cycles. Otto cycle p-v and t-s diagram, efficiency . Diesel cycle p-v and t-s diagram , efficiency . Dual Combustion cycle p-v and t-s diagram. Different cycle performance comparison.

**Module-5**

**Vapor power cycles**

Vapor power cycles, Rankine cycle & its modifications its p-v,t-s, h-s diagram and efficiency calculations.

**Text Books:**

1. Engineering Thermodynamics-4e by P.K .Nag, TMH
2. Engineering Thermodynamics - P.K Chattopadyay, OUP
3. Engineering Thermodynamics- by R.K RAJPUT

**Reference Books:**

1. Fundamentals of Thermodynamics - 6e by Sonntag, Borgnakke & Van Wylen, John Wily
2. Thermodynamics- an Engineering approach - 6e, Cengel & Boles,TMH

**Title of Course: Mechanics of Materials-I**

**Course Code: MEC305T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1:**

Importance of Mechanics in engineering; Introduction to Statics; Concept of Particle and Rigid Body; Types of forces: collinear, concurrent, parallel, concentrated, distributed, Vector and scalar quantities, Transmissibility of a force (sliding vector). Two dimensional force system; Resolution of forces; Moment; Varignon’s theorem; Couple; Resolution of a coplanar force by its equivalent force-couple system; Resultant of forces..

**Unit 2**:

Distributed Force: Centroid and Centre of Gravity; Centroids of a triangle, circular sector, quadrilateral, composite areas consisting of above figures. Moments of inertia: MI of plane figure with respect to an axis in its plane, MI of plane figure with respect to an axis perpendicular to the plane of the figure; Parallel axis theorem.

**Unit 3:**

Concept of mechanics of deformable solids; concept of stress developed against external force/pressure; brief review of normal and shearing stress and strain; Deformation of axially loaded members, statically determinate and indeterminate problems. Strain energy in tension and compression

**Unit 4**:

Analysis of Biaxial stresses-Mohr’s circle for biaxial stress; concept of normal stress, principal stress and pure shear. Shear strain and shear strain energy. Stresses in thin walled pressure vessels- tangential and Hoop stress. Relation between shear modulus and Young’s modulus

**Unit 5:**

Stresses in beams; shear force (SF), axial force and bending moment (BM); differential relations for BM, SF and load; SF and BM diagrams; bending stresses in straight beams – symmetric loading; stresses in beams of various cross sections; stresses in built-up beams and beams of different materials.

**Unit 6:**

Deflection of statically determinate and indeterminate beams due to bending moment, differential equation of elastic line, double integration method, Macaulay method, Strain energy method- Catigliano’s theorem, superposition method.

**TEXT BOOKS:**

1. R. K. Bansal,” A Textbook of Strength of Materials”,Laxmi publications(P) Ltd.
2. Rattan.S.S., “Strength of Materials, “, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011
3. B B Ghosh,S Chakrabarti, S Ghosh, “Engineering Mechanics”,Vikash Publishing House Pvt. Ltd

**REFERENCES**:

1. Timoshenko, Strength of Materials, vol. 1, CBS publications, 3rd Edition, 2014
2. S. Ramamrutham, Strength of Materials, Dhanpat Rai Publication, 18th Edition, 20142.
3. Rajput R.K. “Strength of Materials (Mechanics of Solids)”, S.Chand & company Ltd., New Delhi, 2010.

**Third Semester Practical**

**Title of Course: Manufacturing Process Lab**

**Course Code: MEC303P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

1. Machining of typical products involving lathe, milling/shaping operations and finishing process(es); Machining of gears
2. Foundry operations
3. Basic Forging processes like upsetting, drawing down and forge welding
4. Practicing Resistance Spot Welding, MIG and TIG Welding
5. Making a typical product using sheet metal

**Text Book:**

1. Hazra Choudhary, Media Promoters & Publishers Pvt Ltd.
2. Principles of manufacturing materials & processes-James & Campbell.
3. Manufacturing technology, Foundry, Forming & Welding-P.N Rao
4. A.B. Chattopadhyay, Machining and Machine Tools, Wiley India (P) Ltd., New Delhi.
5. Stephenson & Agapion, Metal Cutting Theory and Practice, Taylor and Francis, NY.
6. M.C. Shaw, Metal Cutting Principles and Practices, Oxford University Press.

# Title of Course: Data Structure & Algorithm using Python Lab

# Course Code: CSD393

# L-T-P: 0-0-2 Credits: 1

**Pre-requisite:** Basic concepts in mathematics and programming languages.

**Introduction:**

This course examines data structures and algorithms basics using python. The Topics to be covered (tentatively) include: an introduction to programming and problem solving in Python with basic concepts such as conditionals, loops, functions, lists, strings and tuples; Time and space analysis of algorithms; Linear Data structures like array, linked list, stack, queue; Non-linear Data structures like graph and tree; Sorting; Searching and Hashing.

**Objectives:**

1. Develop problem solving ability using Programming.
2. Develop ability to design and analyze algorithms.
3. Introduce students to data abstraction and fundamental data structures.
4. Develop ability to design and evaluate Abstract Data Types and data structures.
5. Apply data structure concepts to various examples and real life applications

**Learning Outcomes:**

The course will use hands on practice and applying the knowledge gained in theory course to different day to day real world applications.Upon the completion of data structure and algorithm practical course, the student will be able to:

* **Understand** and implement different type of data structure techniques
* **Analyze** the hashing method..
* **Implement** different type sorting searching techniques.

**Course Contents:**

**Exercises that must be done in this course are listed below:**

Exercise No.1: Implementation of array operations

Exercise No. 2: Stacks and Queues: adding, deleting elements

Exercise No. 3: Circular Queue: Adding & deleting elements

Exercise No. 4: Merging Problem :Evaluation of expressions operations on Multiple stacks & queues

Exercise No. 5: Implementation of linked lists: inserting, deleting, inverting a linked list.

Exercise No. 6: Implementation of stacks & queues using linked lists, Polynomial addition, Polynomial multiplication

Exercise No. 7: Sparse Matrices : Multiplication, addition.

Exercise No. 8: Recursive and Non-recursive traversal of Trees

Exercise No. 9: Threaded binary tree traversal. AVL tree implementation

**Title of Course: Mechanics of Materials Lab**

**Course Code: MEC305P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

Exercise No.1: To Study The Universal Testing Machine (U.T.M.)

Exercise No. 2: To determine tensile test on a metal.

Exercise No. 3: Compression test of ductile and brittle materials on UTM

Exercise No. 4: Brinnel Hardness Test

Exercise No. 5: Rockwell Hardness Test.

Exercise No. 6: To perform Izod impact test

Exercise No. 7: To perform Charpy impact test

Exercise No. 8: To perform Fatigue test

Exercise No.9: Sample preparation and etching of ferrous and non-ferrous metals and alloys for metallographic observation

Exercise No.10: Study of heat treatment Processes

Exercise No.11: Study of non-destructive techniques, such as dye penetration (DP) Test, ultrasonic or eddy-current test.

**NOTE:- At least seven experiments should be performed in this course.**

**Text Book:**

1. Materials science and engineering: an introduction (7th edition), William D. Callister, Jr., John Wiley and Sons
2. Chandler, H., Heat Treater’s Guide, 2nd ed., ASM International, Metals Park, OH.
3. Materials Science and Engineering: by Raghavan.
4. V. Dieter, G.E., Mechanical metallurgy, 1988, SI metric edition, McGraw-Hill.

**Fourth Semester Theory**

**Title of Course: Engineering Materials**

**Course Code: MEC406**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1:**

**Crystal Structure:**. Crystal structure of metals, crystal lattice of (i) Body centered cubic (ii) Face centered cubic (iii) Closed packed hexagonal, crystallographic Notation of atomic planes and Directions (Miller Indices), polymorphism and allotropy, Crystal imperfection.

**Unit 2**:

**Plastic Deformation of Metals and Alloys**: Mechanism of elastic and plastic deformation, role of dislocation; slip and twining. Elementary treatment theory of work hardening, Theories of recrystallization and grain growth, Creep and Fatigue, Hardness: Rockwell, Brinell and Vickers and their relation to strength.

**Unit 3:**

**Phase and Phase Equilibrium:** Solidification of alloys, Phase Diagrams, relationship with structure and properties; Eutectic systems. Iron Carbon alloys, Iron-Carbon equilibrium diagram Effects of alloying elements in steel.

**Unit 4**:

**Heat Treatment of Alloys:** Phase transformation in steel. 'S' Curves, Detailed study of various heat treatment Processes- hardening, annealing, tempering, Austempering and Martempering Case hardening, Hardenability, Precipitation hardening, Heat treatment Furnaces.

**Unit 5:**

Classification of Metals and Alloys-compositions, general properties and uses, Ferrous alloys, Non-ferrous alloys, Low alloy steels, Stainless steel, Magnetic materials for high and low temperature service. Brasses and bronzes; Aluminum base alloys. Bearing Materials, Polymers & Elastomers, Ceramic Materials ,Composite materials. Introduction to non-destructive testing (NDT), Introduction to corrosion, Introduction to various standards used in industry for testing.

**Text Book:**

1. Donald R Askeland and Pradeep, P.Phule (2006), The Science

2. Engineering of Materials for Science and Engineering, 5th edition

**References**

1. Materials Science and Engineering by W.D. Callister and adapted by R.Balasubramaniam,Willey India, 2010 Ed.
2. Engineering Materials: properties and selection by Budinski&Budinski,9thEd.,Prentice HallIndia
3. Engineering Materials and Metallurgy byR.Srinivasan, 2ndEd.,TataMcGrawHill.
4. Materials & Processes in Manufacturing by E. P. Degarmo and adapted by Black & Kosher, 10thEd.,Wiley India.
5. Materials Science and Engineering by V. Raghavan, 5thEd.,Prentice HallIndia.

**Title of Course: Fluid Mechanics & Fluid Machines**

**Course Code: MEC407T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Module 1:**

**Introduction:** Fluid Properties: Definition of a fluid, Viscosity-dynamic and kinematic, Surface Tension. Fluid Statics: Basic equation of fluid statics, Manometers, Force on plane areas and curved surfaces, center of pressure

**Module 2:**

Buoyancy force, Stability of floating and submerged bodies, Kinematics of fluid flow: fluid flow and classifications. Continuity equation in 1D & 3D. Potential flow & Stream function; types of flow lines.

**Module 3:**

Dynamics of fluid: equations of motion; Euler’s equation; Bernoulli’s equation; Applications of Bernoulli’s equation.

**Module 4:**

Momentum Analysis of flow systems; the linear momentum equation for steady flow, Momentum equation and its applications

**Module 5:**

Flow through pipes; Darcy – Weisbach equation of friction loss; Major and minor Losses in pipe

Hydraulic grade line and total energy line.

**Module 6:**

Basic principle for flow through orifices, V-notches (rectangular-v), weirs (rectangular). Flow through open channels; use of Chezy’s formula.

**Module 7:**

Dimensional Analysis & Model investigation applied to flow systems – Buckingham Pi theorem.

**Module 8:**

Hydraulic press, Hydraulic accumulator, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump

**Module 9:**

Hydraulic Turbines; Principles and Classifications; working principle of a Pelton Wheel, Francis Turbine, Kaplan Turbine, Function of Draft Tube, Cavitation in Turbines.

**Text Books:**

1. Fluid Mechanics & hydraulic machines – R.K.Bansal, Luxmi Publications.

**References:**

1. Fluid Mechanics and Fluid Power Engineering - Dr. D.S. Kumar

2. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.

**Title of Course: Kinematics &Theory of Machines**

**Course Code: MEC408T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1:**

Introduction to mechanisms, Difference between Machine and Mechanism; Classification of Pairs of Elements, Kinematic chain, types of joints in a chain; Four-bar linkage: motions of links, Grashof’s criterion of movability. Degrees of freedom for plane Mechanisms, Gruebler’s criterion for plane mechanism, Kinematic inversions – four Inversions of a Slider-Crank Chain.

Velocity analysis in Mechanisms: Relative velocity method – slider crank mechanism, four bar mechanism, Crank and slotted lever mechanism; Instantaneous centre method –kennedy’s theorem; Acceleration analysis: Acceleration Images, Klein’s construction.

**Unit 2**:

Belt-drive – introduction; Law of belting, Length of flat belt for open and cross belt connections; Stepped pulley for open flat belt; Tension in flat belt and V-belts; Power transmitted in belt drive, centrifugal effects on belt, initial tension, creep.

**Unit 3:**

Gear terminology, Laws of gearing, types of gears – Spur, Bevel, Helical, Worm; tooth profile, interference; Gear trains – simple, compound, epicyclic gear train; Speed-torque analysis of gear trains.

**Unit 4**:

Classification of Cams and followers; Radial Cam, Analysis of knife-edge, roller and flat face follower motion – constant velocity, simple harmonic, constant acceleration & deceleration, cycloidal; Offset follower.

**Unit 5:**

Study of lower pair Mechanisms- Pantograph, Parallel linkage mechanisms, Straight line mechanism, Automobile steering mechanism, Hooks joint.

Kinematic Synthesis: Introduction to problems of function generation, path generation and rigid body guidance; Type, Number and Dimensional Synthesis; Two and three position synthesis of four bar mechanism and slider –crank mechanism: Graphical – pole, Relative pole and Inversion method; Analytical solution - Freudenstein’s Method.

**TEXT BOOKS:**

# S S Rattan,” Theory of Machines”, Tata McGraw Hill Education Pvt. Ltd., New Delhi.

1. Sadhu Singh : Theory of Machines, “Kinematics of Machine”, Third Edition, Pearson Education.

# Khurmi, R.S., ”Theory of Machines”,14th Edition, S Chand Publications.

**REFERENCES**:

1. Robert L. Norton, “Kinematics and Dynamics of Machinery”, Tata McGraw-Hill.

2. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., New Delhi.

**Title of Course: Mechanics of Materials-II**

**Course Code: MEC409**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit-I**

Theory of Failure- significance and its importance; Maximum principle stress theory, Maximum principle strain theory, Maximum shear stress theory, Maximum strain energy theory, Maximum shear strain energy theory; Graphical representation of theories for two dimensional stress system; Yield point phenomena; Stain Aging; Strain hardening; Strain energy and impact loading, expression for strain energy for- gradual, sudden and impact load.

**Unit-II**

Torsion of a circular shaft; Shear energy in torsion; Torque and power transmitted by solid and hollow circular shaft; Strength of the shaft and torsional rigidity; Strength of the shaft in varying section; Composite shaft; Combined bending and torsion; Concept of closed and open coiled helical springs, Stresses and deflection of helical springs under axial pull.

**Unit-III**

Theory of columns and strut; Failure of column; Euler’s column theory and its limitation; End conditions for long column; Effective length of the column; Rankine formula; Eccentric loading of short strut; column buckling; Empirical column formulae – straight line, initial curvature.

**Unit-IV**

Analysis of Stress in 3-Dimensions: Body force, surface force and stress vectors, state of stress at a point, normal shear stress components, stress component on arbitrary plane, principal stresses in 3-dimensions, stress invariants, decomposition of stress matrix into hydrostatic and pure shear states, Lame’s stress ellipsoid, differential equations of equilibrium.

**Unit-V**

Analysis of Strain in 3-Dimensions: introduction, deformation in neighborhood of a point, change of length of linear element, state of strain at a point, principal axes of strain and principal strains, compatibility conditions.

**Unit-VI**

Stress strain relations for linearity elastic bodies, generalized Hooke’s law, stress-strain relations for anisotropic, orthotropic and isotropic materials.

**Reference Books:**

1. Rajput RK, Strength of Materials (Mechanics of Solids), S.Chand & company Ltd., New Delhi.
2. Rattan.S.S., “Strength of Materials”, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
3. Advance Mechanics of Solids, Srinath L.S., Tata McGraw Hill.
4. Solid Mechanics, Kazimi S.M.A., Tata McGraw Hill.

**Title of Course: Metrology & Measurement**

**Course Code: MEC410T**

**L-T Scheme: 3-1 Course Credits: 3**

**Course Contents:**

**Unit 1:**

**Introduction:** Definition and importance of Metrology Measurement; Methods of measurements – direct, indirect, comparison, substitution, transposition, deflection and null measurement; Errors in measurement – absolute, relative, parallax, alignment, loading, dynamic and calibration error; Units of measurements – SI base and derived units, SI prefixes of units.

**Unit 2**:

**Linear Metrology:**Vernier scale; construction and use of Vernier calliper, Vernier height and depth gauge, micrometer; slip gauge.

**Angular Metrology:** Constructional features and use of protractor, Vernier bevel protractor, angle gauges, sine bar and slip gauges

**Measurements of:** (i) Level using spirit-level; (ii) Flatness using straight edge, interferrometry (Newton’s rings) and surface plate; Parallelism, cylindricity and concentricity using dial indicator; Vacuum Measurement.

**Unit 3:**

**Interchangeability of components:** concept of limits, tolerances and fits; Hole basis and shaft basis system of fits; Go and No Go limit gauges; plug, ring, snap, thread, radius and filler gauges.

**Unit 4**:

Definition, use and essential features of Comparators; working principle and application of (i) dial gauge, (ii) Cook optical comparator, (iii) back pressure Bourdon gauge pneumatic comparator, (iv) optical comparator-profile projector.

**Unit 5:**

**Measuring Instruments:** Functional elements of an instrument – sensing, conversion & manipulation, data transmission and presentation element; Characteristics – accuracy, precision, repeatability, sensitivity, reproducibility, linearity, threshold, calibration, response, dynamic or easurement error; Transducers – definition, primary and secondary, active and passive; Force and Torque Measurement- Dynamometer; Introduction to Advance Measuring Machines.

**Unit 6:**

**Measurement of Surface Finish:** Definition; Terminologies – geometrical surface, effective surface, surface roughness, roughness (primary texture), waviness (secondary texture), form, lay, sampling length; Numerical evaluation of surface roughness: peak-to-valley height (Rmax), centre line average (CLA, Ra), average depth (Rm), smoothness value (G) Principle of operation of a Talysurf.

**Unit 7:**

**Principle of operation of a few measuring instruments:** displacement by LVDT; force by strain – gauge load cell and piezoelectric load cell; pressure by Bourdon – tube gauge; temperature by liquid-in-glass thermometer, thermocouples, optical pyrometer; liquid velocity by pitot tube; water flow by orifice meter.

**Text Book:**

1. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2005.
2. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.

**References**

1. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA,1990.
2. Backwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education , 2006.
3. A. K. Bewoor, VinayA Kulkarni, Metrology and measurement, M G Hills, 2017, Tamilnadu.

**Title of Course: Mechatronic Systems**

**Course Code: MED402**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit-I: Introduction**

Basic definition and key elements; Philosophy and approach, Function of mechatronic system- division of functions between mechanics and electronics, improvement of operating properties; Way of integration- hardware and software; Scope and importance of mechatronics; Mechatronic system design

**Unit-II: Sensors, Transducers and Actuators**

Classification of sensors and transducers, Performance terminology, Sensors: Displacement, position and proximity, Temperature, Velocity, Light; Drives and Actuators- Pneumatic, Hydraulic and Electrical such as servo motor, stepper motor, open and close loop control; Development of transducers technology; Micromechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining

**Unit-III: Data Acquisition, and Control system**

Introduction, Signal conditioning and its necessity; Types of signal conditioning system and elements; Signal conditioning elements used in data acquisition system; Quantitizing theory, Analog to Digital Conversion, Digital to Analog (D/A) conversation, transfer function, transient response and frequency response and frequency response, stability criteria.

**Unit-IV: Application of mechatronics as Case study**

Mechatronics system in robotics manufacturing, Coin counter, Machine diagnostics, Road vehicles and medical technology.

**Reference books:**

1. Mechatronics- Electronic Control Systems in Mechanical and Electrical Engineering by W.Bolton, Pearson Publisers.
2. Mechatronics by V.S.Bagad, Technical Publications.
3. Mechatronics by M.D.Singh and J.G.Joshi, Prentice-Hall of India (PHI) publishers.
4. Mechatronics: Principles, Concepts and applications, Mahalik N.P., Tata McGraw Hill.
5. Mechatronics: Integrated Technologies for Intelligent Machines, Smaili and Mrad, Oxford.

**Fourth Semester Practical**

**Title of Course: Fluid Mechanics & Fluid Machines**

**Course Code: MEC407P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

1. Exercise No.1: Determine Coefficient of discharge for venturimeter.
2. Exercise No. 2: Determine Coefficient of discharge for orificemeter.
3. Exercise No. 3: Determine Reynolds number and hence the type of flow.
4. Exercise No. 4: Calculate the velocity of flow by pitot-tube.
5. Exercise No. 5: Determine the metacentric height of a ship model.
6. Exercise No. 6 verify bernoulli’s theorem.

**Text Books:**

1. Fluid Mechanics & hydraulic machines – R.K.Bansal, Luxmi Publications.

**References:**

1. Fluid Mechanics and Fluid Power Engineering - Dr. D.S. Kumar

2. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.

**Title of Course: Metrology & Measurement Lab**

**Course Code: ME410P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

**Exercise No.1:** Taking measurements using following instruments:

(i) Vernier height & depth gauge, (ii) Dial micrometer, (iii) Thread gauge, (iv) Radius gauge, (v) Filler gauge, (vi) Slip gauge, (vii) Dial Thickness Gauge, (vii) External and Internal Groove Comparator Gauge.

**Exercise No. 2:**

Measurement of angle of a component using:

(i) Vernier bevel protractor, (ii) angle gauges, (iii) Sine-bar and slip gauges.

**Exercise No. 3:**

Checking / measuring parallelism, cylindricity and concentricity of components using dial indicator.

**Exercise No. 4:**

Measurement of a specific dimension for a lot of components, and prepare a histogram from the data obtained.

**Exercise No. 5:**

Measurement of surface finish by a Talysurf instrument.

**Exercise No.6:**

Measurement of micro feature of a product (eg. Thread of a bolt or saw etc.) in a profile projector.

**Exercise No. 7:**

Determine natural cooling characteristics of a heated object by using a thermocouple.

**Exercise No. 8:**

Measurement of air velocity across an air duct using anemometer.

**Exercise No. 9:**

Fixing a strain gauge on a cantilevered flat section of steel. Then calibration of it as a force dynamometer using a Wheatstone bridgeand loading arrangement.

**Text Book:**

1. HazraChoudhary, Media Promoters & Publishers Pvt Ltd.

2. Ashish Dutt Sharma, S. Chand

**Title of Course: AutoCAD Lab**

**Course Code: ME420**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Module 1: Introduction to Autocad**

Starting AutoCAD ,AutoCAD Screen Components ,Drawing Area ,Command Window, Navigation bar Status bar, Invoking Commands in AutoCAD- Keyboard Ribbon, Application Menu ,Tool Palettes, Menu Bar, Toolbar ,Starting a New Drawing- Open a Drawing ,Start from Scratch, Use a Template , Saving Your Work , Files Closing a Drawing ,Opening an Existing

**Module 2: Getting Started With Autocad**

Drawing Lines in AutoCAD, Coordinate Systems; Absolute Coordinate System, Relative Coordinate System ,Relative Polar Coordinates, Direct Distance Entry, Erasing Objects, Cancelling and Undoing a Command, Object Selection Methods, Window Selection , Drawing a Circle , Setting Units Type and Precision ,Specifying the Format ,Specifying the Angle Format, SETTING the Limits OF A DRAWING

**Module 3: Starting With Advanced Sketching**

 Drawing Arcs, Drawing Rectangles, Drawing Ellipses, Drawing Regular Polygon, Drawing Polylines, Placing Points, Drawing Infinite Lines, Writing a Single Line Text, Multi line Text;

**Module 4:** **Working With Drawing Aids**

Introduction, Understanding the Concept and use of LAYERS, Advantages of Using Layers, Working with Layers, Creating New Layers, Making a Layer Current, Controlling the Display of Layers, Deleting Layers, Object Properties- Changing the Colour, Changing the Line type, changing the Line weight, working with Object Snaps.

**Module 5:** **Editing Sketched Objects-I**

Editing Sketches, Moving the Sketched Objects, Copying the Sketched Objects, Creating Multiple Copies, Creating a Single Copy, Offsetting Sketched Objects, Rotating Sketched Objects, Scaling the Sketched Objects, Filleting the Sketches, Chamfering the Sketches, Trimming the Sketched Objects, Extending the Sketched Objects, Stretching the Sketched Objects, Lengthening the Sketched Objects, Arraying the Sketched Objects, Rectangular Array, Polar Array, Path Array, Mirroring the Sketched objects, Text Mirroring, dimensioning the Sketched Objects, inquiry of the Sketched Objects

**Module 6: Editing Sketched Objects-II**

Zooming Drawings: Real-time Zooming, All Option: Centre Option, Extents Option, Dynamic Option, Previous Option, Window Option, Scale Option, Object Option, Zoom In and Out.

Changing the Properties Using the PROPERTIES Pale, Matching the Properties of Sketched Objects

**Module 7: Creating Text and Tables**

Creating Text: Writing Single Line Text, Entering Special Characters, Creating Multiline Text, Text Window, Text Editor Tab, Editing Text, Modifying the Scale of the Text. Inserting Table in the Drawing, Creating a New Table Style, Modifying Tables, Creating Text Styles, Determining Text Height

**Module 8: Basic Dimensioning and Geometric Dimensioning**

Dimensioning in AutoCAD, Fundamental Dimensioning Terms, create dimensional style, modifying dimensional style, Drawing Leaders, Dimensioning and Tolerance, Creating Text Styles, Determining Text Height

**Module 9: Plotting Drawings**

Plotting Drawings in AutoCAD, Plotting Drawings Using the Plot Dialog Box, Plot options, Area Preview, Adding Plotters

**Module 10: Hatching Drawings**

Hatch Patterns, Hatch Boundary, Hatching Drawings Using the Hatch Tool, Hatching Around Text, Dimensions, and Attributes

**Module 11: Working With Blocks**

Drawing Objects for Blocks, Converting Entities into a Block, Block Editor, Creating Drawing Files using the Write Block Dialog Box, Exploding Blocks Using the XPLODE Command

**Module 12: Working With Isometric Drawing**

Introduction, overview, isometric drawing, plane selection, iso-circle, text on isometric drawing

**Module 13: Working With 3D**

3D workplace, introduction of 3D tools, Extrude, loft, revolve, sweep, poly solid, press/pull, union, subtract, extract edge, separate, 3D array, 3D mirror, 3D move, 3D planes, render, materials, wireframe view, detailed drawing

**Text Books**

1. AutoCAD 2014 in Simple Steps, ByKogent Learning Solutions Inc. ,dreamtech publications
2. Machine drawing Includes AutoCADBy Ajeet singh, McGraw Hill

**Reference Books**

1. AUTOCAD 2010 AND AUTOCAD LT 2010: No Experience Required By**:**Jon Mcfarland , Wiley press
2. Exercise work book for beginning AutoCAD 2005 By Cheryl R. Shrock, Industrial press, Newyork

**Fifth Semester Theory**

**Title of Course: Heat Transfer**

**Course Code: MEC511T**

**L-T Scheme: 3-1 Course Credits: 3**

**Course Contents:**

**Unit 1**: Introduction: Heat transfer processes, conduction and radiation. Fourier’s law of heat conduction, thermal conductivity, thermal conductivity of solids, liquids and gases, effect of temperature on thermal conductivity. Newton’s law of cooling.

**Unit 2:** Conduction: General 3-Dimensoinal conduction equation in Cartesian, cylindrical and spherical coordinates; one dimensional heat conduction with and without heat generation; electrical analogy; definition of overall heat transfer coefficient. General parameters influence the value of heat transfer coefficient. heat conduction through composite walls; critical thickness of insulation.

**Unit 3:** Heat transfer from extended surfaces: Governing differential equation of fin, fin efficiency and effectiveness for different boundary conditions.

**Unit 4:** Introduction to transient heat conduction, Lumped parameter approach, Time constant, Biot number: 1-D transient heat conduction solution without heat generation.

**Unit 5:** Thermal Radiation: Plank distribution law, Krichoff's law; radiation properties, diffuse radiations; Lambert's law. Radiation intensity, heat exchange between two black bodies heat exchanger between gray bodies. Shape factor; electrical analogy; reradiating surfaces heat transfer in presence of reradiating surfaces. concept of Gray- Diffuse Isotropic (GDI) surface. Radiation exchange between GDI surfaces by radiation network.

**Unit 6:** Heat exchangers: types of heat exchangers, parallel and counter flow types, Introduction to LMTD. Correction factors, fouling factor. E- NTU method for heat exchangers.

**Unit 7:** Non – dimensional quantities in heat transfer, importance and physical significant order of magnitudes, Analysis for a flow over a flat plate.

**Unit 8:** Convective heat transfer, Newton’s law of cooling and significance of heat transfer coefficients. Momentum and energy equation in 2-D. Natural convection over a vertical plate. 1-D solution for Coutte flow and Poiseullie flow. Hhydrodynamic and thermal boundary layers; laminar boundary layer equations.

**Text Books**

1. [Heat and Mass Transfer -by](https://books.google.com/books/about/Heat_and_Mass_Transfer.html?id=g4iwCgAAQBAJ) R k Rajput, S. Chand publication.

2. [Heat And Mass Transfer](http://www.amazon.in/Heat-Mass-Transfer-D-Kumar/dp/8185749906/ref%3Dsr_1_sc_3?s=books&ie=UTF8&qid=1483769097&sr=1-3-spell&keywords=heaqt+transfer+ds+kumar) -by Dr. D. S. Kumar , Publisher: S K Kataria and Sons.

**References**

### 1. [Heat and Mass Transfer -by D K Dixit](https://books.google.com/books/about/Heat_and_Mass_Transfer.html?id=g4iwCgAAQBAJ) , Mc Graw Hill.

2. Heat Transfer – by  **J Holman**  and **Souvik Bhattacharyya (**SIE)

**Title of Course: Dynamics of Machines**

**Course Code: MEC512T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1:**

**Inertia force and inertia torque in reciprocating engine;** Equivalent dynamical system; correction couple (torque); Turning moment diagram and flywheel

**Unit 2**:

**Balancing:** Static balancing; dynamic balancing of rotating masses - graphical and analytical methods; Balancing of inline single cylinder and four cylinder engine; Balancing of symmetric two cylinder V-engine, Balancing of radial engines; swaying couple; Hammer blow

**Unit 3:**

**Governors:** Use and classification; Study and analysis of Porter, Proell and Wilson-Hartnell governors; Sensitiveness, stability, isochronism, hunting, effort and power of governors; Controlling force diagram and stability criteria analysis; coefficient of insensitiveness.

**Unit 4**:

**Gyroscope:** Gyroscopic couple and precessional motion; Effect of gyroscopic couple on aeroplane and ship; Stability of two wheel and four wheel vehicles taking turn.

**Unit 5:**

**Vibration:** Definition & types of vibration; Differential equations of vibratory motions (longitudinal & torsional); Natural frequency of free longitudinal vibration-Equilibrium method, Energy method (Rayleigh’s maximum energy principle); Effect of inertia in longitudinal vibration; Natural frequency of free transverse vibration of a beam due to point loads - Rayleigh’s method. Whirling of shaft, synchronous whirling; critical speed - Dunkerley’s method.

**Free damped vibration;** Damping factor; Logarithmic decrement. Forced vibration, concept of under damped, critically damped and over damped system; Dynamic magnifier (magnification factor).

**TEXT BOOKS:**

# S S Rattan,” Theory of Machines”, Tata McGraw Hill Education Pvt. Ltd., New Delhi.

1. Sadhu Singh : Theory of Machines, “Kinematics of Machine”, Third Edition, Pearson Education.

# Khurmi, R.S., ”Theory of Machines”,14th Edition, S Chand Publications.

**REFERENCES**:

1. Robert L. Norton, “Kinematics and Dynamics of Machinery”, Tata McGraw-Hill.

2. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., New Delhi.

**Title of Course: Machine Design-I**

**Course Code: MEC513T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1:** Objective and scope of Mechanical Engineering Design; Design considerations; Review and selection of materials and preferred sizes; codes and standards

**Unit 2:** Design/allowable stress; Stress-Strain Diagrams; Mechanical Properties Of Engineering Materials; Cast Iron; Heat Treatment Of Steels; Case Hardening Of Steels; Aluminium And Copper Alloys; Plastics And Ceramics;

**Unit 3:** Selection Of Manufacturing Method; Design Considerations of Castings And Forgings; Hot and Cold Working of Metals; Design for Manufacturing and Assembly(DFMA); Tolerances; Types of Fits; Selection Of Fits; Selective Assembly;

**Unit 4:** Modes of failure; Stress-Strain Relationship; Factor of safety (FoS); Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria; Design for stability; Design of (i) Cotter joint; (ii) Knuckle joint

**Unit 5:** Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Cumulative fatigue damage – Miner’s equation; Gerber Equation;

**Unit 6:** Welded Joints; Welding Processes; Stress Relieving Of Welded Joints; Butt Joints; Fillet Joints; Strength Of Butt And Fillet Welds; Maximum Shear Stress In Parallel And Transverse Fillet Welds; Axially Loaded Unsymmetrical Welded Joints; Welded Joints Subjected To Bending Moment; Strength Of Welded Joints; Welded joints Subjected To Fluctuating Forces; Welding Symbols;

Riveted Joints- joints : Unwin’s formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap / cover plate;; Types Of Rivet Heads; Rivet Materials; Types Of Failure; Strength Equations; Efficiency Of Joints; Caulking And Fullering;

**Unit 7:** Bolted joints : Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts;

**Unit 8:** Design of : (i) Solid and hollow shafts, strength design of shafts, design based on torsional rigidity; (ii) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling; (iii) Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers’ catalogues, pulley (iv) Chain drives – roller chains, polygonal effect, power rating, sprocket wheel, silent chain;

**Unit 9:** Design of: (i) Transmission screw, Screw jack, (ii) Helical compression spring - stress and deflection equations, stiffness, curvature effect: Wahl’s factor, springs in parallel and series; (iii) Multi-leaf springs: load-stress and load-deflection equations, Nipping.

**Text Book:**

1. V. B. Bhandari, Design of Machine Elements, TMH.
2. V.B. Bhandari, Machine Design Data Book TMH

**Reference Books:**

1. Shigley and Mischke, Mechanical Engineering Design, TMH.
2. Hall, Holowenko and Laughlin, Theory and Problems of Machine Design, TMH.
3. P.C. Gope, Fundamentals of Machine Design, PHI.
4. M.F. Spotts, Design of Machine Elements, Prentice Hall. 6. P. Kannaiah, Machine Design, Scitech Publications.

**Title of Course: Operations Research**

**Course Code: MEC514**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Module: 1: Linear Programming Problems (10 Lectures)**

Basic LPP and Applications, LP Problem Formulation, Simultaneous Equations and Graphical Method, Simplex Method, Big-M Method, Duality Theory, Transportation Problems and Assignment Problem

**Module 2: Network Analysis (8 Lectures)**

Shortest Path; Floyd Algorithm, Maximal Flow Problem (Ford-Fulkerson); PERT-CPM (Cost Analysis, Crashing, Resource Allocation excluded)

**Module 3: Dynamic Theory (5 Lectures)**

Dynamic programming problems and their characteristics; Bellman’s principle of optimality; solving (i) Stage coach problem, (ii) Knapsack problem.

**Module 4: Game Theory(5 Lectures)**

Introduction; 2-Person Zero-sum Game; Saddle Point; Mini – Max and Maxi – Min Theorems (statement only) and problems; Games without Saddle Point; Graphical Method; Principle of Dominance.

**Module 5: Queuing Theory(8 Lectures)**

Introduction, Axiomatic Derivation of the Arrival &Departure (Poisson Queue).Poisson Queue Models: (M/M/1:∞/FIFO) and (M/M/1:N/FIFO).

**Reference Books**

* H.A.Taha,“Operations Research”, Pearson
* P. M.Karak–“Linear Programming and Theory of Games”, ABS Publishing House
* KantiSwaroop— “Operations Research”, Sultan Chand &Sons
* RathindraP.Sen—“Operations Research: Algorithms and Applications”, PHI
* R.Panneerselvam- “Operations Research”,PHI
* A.M.Natarajan, P.BalasubramaniandA.Tamilarasi- “Operations Research”, Pearson
* M.V.DurgaPrasad–“Operations Research”, CENGAGE Learning

**Title of Course: Industrial Management**

**Course Code: HSM018**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1**: **Management**

Definition, nature, importance, evolution of management thoughts–pre & post scientific era, contributions made by Taylor, Fayol, Gilbreth, EltonMayo,McGregor,Maslow–covering Time & Motion Study, Hawthrone Experiments; Is management science or art? Functions of manager, ethics in managing and social responsibility of managers.

**Unit 2: Planning &Control**

Why Management process start s with planning, steps in planning, planning premises, types of planning, barriers to effective planning, operational plan, strategic planning, Mckinsey’s 7’s.

**Unit 3: Decision Making & Organizing**

Nature, process of decision making, decision making under Certainty and Uncertainty, decision-

Tree, group-aided decision, brain-storming.

Organizing– concept, nature and process of organizing, authority and responsibility, delegation and empowerment, centralization and decentralization, concept of departmentalization.

**Unit 4: Staffing &Motivation**

Concept, Manpower planning, Job design, recruitment & selection, training and development, performance appraisal, motivation, motivators and satisfaction, motivating towards organizing objectives, morale building.

**Unit 5: Leadership & Communication**

Defining leadership and its role, should managers lead, leadership style, leadership development, Leadership behavior. Communication- Process, Bridging gap-using tools of communication, electronic media in Communication.

**Unit 6: Financial Management**

Financial functions of management, Financial Planning, Management of Working Capital, Sources of Finance.

**Unit 7: Marketing Management**

Functions of Marketing, Product Planning & Development, Marketing Organization, Sales Organization, Sales Promotion, Consumer Behavior, Marketing Research and Information.

**Text Books**

1. Robbins & Caulter, Management, Prentice Hall of India.

2. John R.Schermerhorn, Introduction to Management, Wiley-India Edition.

3. Koontz, Principles of Management, Tata-McGrewHill.

4. RichardL.Daft, New Era of Management, Engage Learning.

**Fifth Semester Practical**

**Title of Course: Heat Transfer Lab**

**Course Code: MEC511P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

1. Study and performance test of a single acting reciprocating air compressor.
2. Study of a shell and tube heat exchanger and determination of LMTD..
3. Determination of thermal conductivity of a metal rod.
4. Determination of ‘h’ for forced convection over a pin fins.
5. Verification of emissivity of a plate.
6. Determination of thermal conductivity of an insulating powder/or an insulating plate.

**Text Books:**

1. [Heat and Mass Transfer -by](https://books.google.com/books/about/Heat_and_Mass_Transfer.html?id=g4iwCgAAQBAJ) R k Rajput, S. chand publication.

2. [Heat And Mass Transfer](http://www.amazon.in/Heat-Mass-Transfer-D-Kumar/dp/8185749906/ref%3Dsr_1_sc_3?s=books&ie=UTF8&qid=1483769097&sr=1-3-spell&keywords=heaqt+transfer+ds+kumar) -by Dr. D. S. Kumar , Publisher: S K Kataria and Sons.

**Title of Course: Dynamics of Machine Lab**

**Course Code: MEC512P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

Exercise No.1: To perform experiment on watt governor and plot force vs. radius and speed vs. radius curves.

Exercise No. 2: To perform experiment on Porter governor and plot force vs. radius and speed vs. radius curves.

Exercise No. 3: To perform experiment on Hartnell governor and plot force vs. radius and speed vs. radius curves.

Exercise No. 4: Cam Analysis – Cam Profile and Jump-speed Characteristics

Exercise No. 5: Whirling of Shaft – Determination of Critical Speed

Exercise No. 6: Balancing of Rotating Masses

Exercise No. 7: Determination of Gyroscopic Couple

**NOTE:- At least five Experiments should be performed in this course.**

**Text Book:**

1. S.S. Rattan, Theory of Machines, Tata McGraw Hill.

2. R. S Kurmi, Theory of Machines, S. Chand Pub.

**REFERENCES**:

Robert L. Norton, “Kinematics and Dynamics of Machinery”, Tata McGraw-Hill

**Title of Course: Machine Design-I**

**Course Code: MEC513P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

Exercise No.1: Cotter joint

Exercise No. 2: Knuckle joint

Exercise No. 3: Riveted joints

Exercise No. 4: Welded joints

Exercise No. 5: Shaft coupling

Exercise No. 6: Turn buckle

Exercise No. 7: Bolted bracket

Exercise No. 8: Helical compression spring/ Leaf spring

Exercise No. 9: Screw jack

**Text Book:**

1. V.B. Bhandari, Machine Design Data Book TMH

2. Shigley and Mischke, Mechanical Engineering Design, TMH

**Sixth Semester Theory**

**Title of Course: Machining Principles & Machine Tools**

**Course Code: MEC616**

**L-T Scheme: 3-1 Course Credits: 4**

**Course Contents:**

**Module 1:**

**Introduction:** Machining: Basic principle, purpose, definition and requirements

**Module 2:**

**Geometry of cutting tools:** Geometry of single point turning tools in ASA, ORS and NRS systems, Conversion formula of tool angles from one system to another.

**Module 3:**

**Mechanism of machining**: Chip formation mechanism, yielding and brittle fracture, chip reduction coefficient, cutting ratio, shear angle and cutting strain, Built-up edge formation, cause, type and effects, orthogonal cutting and oblique cutting, Machining chips: types and conditions, chip formation in drilling and milling.

**Module 4:**

**Mechanics of machining:** Purposes of determination of cutting forces and basic two approaches, cutting force components in ORS and Merchant’s circle diagram, Determination of cutting forces, analytical methods, measurement, Dynamometers construction and working principles.

**Module 5:**

**Cutting temperature:** Heat generators and cutting zone temperature, sources, courses and effects on job and cutting tools, role of variation of the machining parameters on cutting temperature. Control of cutting temperature and application of cutting fluids(purpose, essential properties, selection and methods of application)

**Module 6:**

**Cutting tools-failure, life and materials:** Methods of failure of cutting tools mechanisms, geometry and assessment of tool wear, Tool life, definition, assessment and measurement, Taylor’s tool life equation and it’s use, Cutting tool materials, essential properties, characteristics and applications of HSS, carbide(uncoated/coated), ceramic, diamond and CBN tools

**Module 7:**

**Broaching and grinding:** Modes and mechanisms of chip formation, selection and application ,Grinding forces, surface roughness and wheel life..

**Module 8:**

**Machine tools** – Introduction : Purpose of use , definition and general features of machine tools, Generatrix and Directrix and tool – work motions in different operations of conventional machine tools.

**Module 9:**

**General constructions function of machine tools :** Major components and their functions in lathes ;Capstan & Turret lathe shaping , planning and slotting machines ; drilling machines and Milling machines, Machining operations and application of the common machine tools and their way of specification. NC and CNC machines.

**Module 10:**

**Machining time :** Estimation of time required for various operations like turning , drilling and shaping.

**Text Books:**

1.Production technology by PC SHARMA

2. Manufacturing Technology: Metal Cutting and Machine Tools, 3e

**References:**

 1. Manufacturing Engineering and Technology by Kalpakjian

2. Stephenson & Agapion, Metal Cutting Theory and Practice, Taylor and Francis, NY.

3. M.C. Shaw, Metal Cutting Principles and Practices, Oxford University Press.

4. G.C. Sen and A. Bhattacharyya, Principles of Machine Tools,

5. Acharkan, Machine Tool Design, Vol. I, II, III and IV, Mir Publication, Moscow.

6. A.B. Chattopadhyay, Machining and Machine Tools, Wiley India

**Title of Course: Machine Design-II**

**Course Code: MEC617T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1:** Clutches: Function, types; Friction clutches – torque capacity based on uniform pressure and uniform wear theory for disc and cone clutch; Centrifugal clutch; Friction materials; Considerations for heat dissipation.

**Unit 2:** Brakes: Function, types; pivoted block brake (single and double block brakes), internal expanding shoe brake, self energizing and self locking; Pivoted block brake; Band brake-simple and differential; Energy equation for braking time calculation; Magnetic and hydraulic thruster operated fail-safe brakes; Brake lining materials; Thermal considerations during braking.

**Unit 3:** Gears: Design objectives, types, terminologies, conjugate action and involutes tooth profile, tooth systems, standard modules; Gear materials.

Spur Gear : Strength design, static and dynamic considerations in strength design, Lewis formula, Lewis form factor, beam strength, Buckingham equation for dynamic tooth load; Endurance strength and wear strength; Designing a pinion based on above considerations;

Helical Gear: Helix angle, minimum face width, virtual number of teeth; Strength design, Buckingham

Formulae for checking dynamic load and wear load.

**Unit 4:** Bevel Gear: Terminologies, formative number of teeth; Lewis equation, dynamic load, endurance strength and wear strength checking.

Worm- worm wheel: Terminologies and their inter-relation; Preferred combination of various parameters; Efficiency; Materials.

**Unit 5:** Pressure vessels– thin cylinder, thick cylinder, Lame’s equation, Clavarino’s equation, Birnie’s equation, Autofrettage– compound cylinders, End Covers, Opening in pressure vessel – area compensation method, Fired and unfired vessels – category, Industrial Code.

**Unit 6:** Flywheel design for application to: (i) Punching press; (ii) 2-stroke engine; (iii) 4-stroke engine, Torque analysis, Solid disc and rimmed flywheel.

**Unit 7:** Sliding contact bearings: Bearing types and materials; Stribeck Curve, Petroff equation, Hydrodynamic lubrication theory - pressure development; Tower experiment, Reynolds equation, Finite bearings – Raimondi-Boyd charts, Design factors/variables, Heat generation & dissipation; Hydrostatic bearing; Plummer block.

**Unit 8:** Rolling contact bearings: Bearing types, nature of load; Static and dynamic load capacity, Stribeck equation, Load - Life relation; Bearing selection from manufacturers’ catalogues; Methods of lubrication; Bearing mounting on journal and bearing block.

**Text Book:**

1. V. B. Bhandari, Design of Machine Elements, TMH.
2. V.B. Bhandari, Machine Design Data Book TMH

**Reference Books:**

1. Shigley and Mischke, Mechanical Engineering Design, TMH.
2. Hall, Holowenko and Laughlin, Theory and Problems of Machine Design, TMH.
3. P.C. Gope, Fundamentals of Machine Design, PHI.
4. M.F. Spotts, Design of Machine Elements, Prentice Hall. 6. P. Kannaiah, Machine Design, Scitech Publications.

**Title of Course: Internal Combustion Engines**

**Course Code: MED601T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit- 1:**

Classification and working of basic engine types: 2-stroke, 4- stroke, C.I., S.I., etc, Analysis of air standard cycles: fuel- air cycles and actual cycles. Fuels: classification and desirable characteristics of I.C. engine fuels, Rating of S.I. and C.I. engine fuels, Alternative fuels (liquid, gaseous, etc.), Analysis of combustion product, HCV and LCV of the fuels.

**Unit- 2:**

Combustion of fuels in I.C. engines, Combustion in S.I and C.I engines, Parameter influencing combustion, Detonation and knocking in S.I. and C.I. engines and their preventions, Combustion chamber types, Basic principles of combustion chamber in I.C. engines.

**Unit- 3:**

Fuel- air mixing in S.I. engines, Working principle of a carburetor, Analysis of simple carburetor, Mechanical and electronic fuel injection system and their control in S.I. engines. Basic principles of MPFI in SI engines.

**Unit- 4:**

Fuel-oil injection in C.I. engines, Fuel injection systems, Working principles, Injection pumps and nozzles. Ignition: ignition systems in I.C. engines (Battery, magneto and electronic), ignition timing and spark advance.

**Unit- 5:**

Supercharging and scavenging of I.C. engines, supercharging limits, Turbo charging, Scavenging - ideal and actual, scavenging parameters, and scavenging pumps. Principles of lubrication in I.C. engines, Properties of lubricating oil. Air and liquid cooling of I.C. engines, Principles and systems.

**TEXT BOOKS:**

1. Ramalingam. K.K., “Internal Combustion Engine Fundamentals”, Scitech Publications, 2002. 2. Ganesan, “Internal Combustion Engines”, II Edition, TMH, 2002.

**REFERENCES:**

1. Mathur. R.B. and R.P. Sharma, “Internal Combustion Engines”., Dhanpat Rai & Sons 2007.

2. Duffy Smith, “Auto Fuel Systems”, The Good Heart Willcox Company, Inc., 1987. 3. Eric Chowenitz, “Automobile Electronics”, SAE Publications, 1995.

**Title of Course: Refrigeration & Air Conditioning**

**Course Code: MED604T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Module 1:**

Introduction - Refrigeration and second law of Thermodynamics, Refrigeration effect and unit of Refrigeration, Heat pump, reversed Carnot cycle. Vapour Compression Refrigeration System - Analysis of simple vapour compression Refrigeration cycle by p-h and T-S diagram, actual refrigeration cycle,

**Module 2**:

Gas cycle Refrigeration - Limitation of Carnot cycle with gas, reversed Brayton cycle, Brayton cycle with regenerative heat exchanger. Air cycle for air craft - Necessity of cooling of air craft, Basic cycle, boot strap, regenerative type air craft refrigeration cycle.

**Module 3:**

Vapour Absorption System - Simple Vapour absorption system,Analysis of Ammonia absorption refrigeration system, Lithium Bromide Absorption Refrigeration System. Refrigerants - Classification, Nomenclature, selection of Refrigerants, global warming potential of CFC Refrigerants. Refrigeration Equipments - Compressor, condenser, evaporator, expansion devices – types & working.

**Module 4:**

Multiple Evaporator and compressor system, Individual compressor, compound compression, cascade system, Application air compressor systems: individual compressor, compound compression, cascade system

**Module 5:**

Psychrometry- Psychrometric properties, psychometric relations, pyschrormetric charts, psychrometric processes, cooling coils, Bypass factor and air washers. Human Comfort - Mechanism of body heat losses, factors affecting human comfort, effective temperature, comfort chart, selection of air conditioning, apparatus for cooling and dehumidification,.

**Module 6:**

Cooling load calculations - Internal heat gain, system heat gain, RSHF, ERSHF, GSHF, cooling load estimation, heating load estimation, psychometric calculation for cooling,

**Module 7:**

Duct systems: Introduction, classification, duct material, duct shape, equations for ducts, losses in ducts, Types of ducts, design

**Text Books**

1. Refrigeration and Air Conditioning -by Khurmi & Gupta, S. Chand publication.

**Title of Course: Production and Operations Management**

**Course Code: HSM019**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Module 1: Introduction: An overview of Operations Management**

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

**Module 2: Product development: Operations strategy**

Product Strategy and integrated product development**,** Process Strategy**,** Capacity Planning Decisions**,** Facilities Location Strategies

**Module 3: System Design**

Facilities Layout and Material Handling Strategy, Group Technology, Flexible manufacturing system, Assembly line balancing, Project Management-CPM PERT, Line of Balance (LOB)

**Module 4: Productivity & Quality tools**

Productivity Concepts : Quality Circle, Kaizen and other SGA, Value analysis and Value Engineering, Work Study-Method study & Work Measurement, Learning Curves

**Module 5: Planning and managing operations**

Demand Forecasting, Value chain and Supply chain Management, Purchasing, vendor selection and material management, Inventory Management & Just-in-Time Systems, Materials Requirement Planning, MRP-II and ERP, Aggregate Operations Planning, Scheduling, Sequencing and Dispatching

**Module 6: Advance operation management**

Service Operations Management, Lean systems, Constraint management – TOC, Computer integrated manufacturing, Analytical tools for DSS for operations management

**Text Book:**

1. Production and Operations Management, Adam Everett E.& Elbert Ronald J., PHI

production & Operation Management; S.N.Charry, TMH

1. Operations Management: Theory and Problems Monk J.G.
2. Manufacturing planning and control systems; Berry W.L.Whybark D.C. Vollman T.E.Galgotia Publication Pvt. Ltd

**References**

1. Production and Operations Management, Adam Everett E.& Elbert Ronald J., PHI

Production & Operation Management; S.N.Charry, TMH

**Sixth Semester Practical**

**Title of Course: Machine Design-II**

**Course Code: MEC617P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

Exercise No.1: 2-D and 3-D modeling of mechanical components and systems using software packages like AUTOCAD, CATIA, PRO E or similar software.

Exercise No. 2: Design analysis of mechanical components using software packages like CATIA, PRO E or similar software

Exercise No. 3: Design Practice using codes, e.g., Pressure vessel codes, Gear design codes etc.

Exercise No. 4: Selection of mechanical components from manufacturers’ catalogue, e.g., chain drive, rolling element bearings etc.

**Text Book:**

1. V.B. Bhandari, Machine Design Data Book TMH

2. Shigley and Mischke, Mechanical Engineering Design, TMH

**Title of Course: Internal Combustion Engines Lab**

**Course Code: MED601P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

1. Disassembling and assembling of multi cylinder petrol and diesel engine.

2. To study and draw the valve timimg diagram of four stroke singlr cylinder diesel engine.

3. To study the construction details and working principles of two stroke diesel engine.

4. Study of Air brake system.

5. Study of Hydraulic brake system.

6. Morse test on four stroke petrol engine.

7. Study of MPFI system

**Text Book:**

1. Ramalingam. K.K., “Internal Combustion Engine Fundamentals”, Scitech Publications, 2002.

2. Ganesan, “Internal Combustion Engines”, II Edition, TMH, 2002.

**Title of Course: Refrigeration and Air Conditioning Lab**

**Course Code: MED604P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Exercises that must be done in this course are listed below:**

1. Study of basic vapour compression Refrigeration Cycle.
2. Study of different control devices of a refrigeration system.
3. To study various components in room air conditioner.
4. Study of basic vapour absorption Refrigeration Cycle.
5. To study and perform fault testing of compressor.
6. To study and perform function of relay and testing of compressor without relay.
7. To study and perform brazing.
8. To study and perform refrigerant refilling and leakage testing in room air conditioner.

**Text Books**

1. Refrigeration and Air Conditioning -by Khurmi & Gupta, S. Chand publication.
2. Refrigeration and Air Conditioning -by [Manohar Prasad](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Manohar+Prasad&search-alias=stripbooks) – New Age publications

**Seventh Semester Theory**

**Title of Course: Automation in Manufacturing**

**Course Code: MEC719T**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1:**

**Introduction to and scope of the subject of Advanced Manufacturing Technology**.

**Unit 2**:

**Manufacturing Systems and Automation:**

Job shop, Flowlines, Transfer lines, Project shop, Continuous processes, Cellular manufacturing system, Flexible Manufacturing System:

**Automation:**

(i) Degree of automation and their justified application in different levels of production

(ii) Benefits and draw backs of employing automation

(iii) Examples of conventional non-automatic, semi-automatic and automatic machine tools.

(iv) Extent of automation in transfer machines

**Integrated Manufacturing Production System:**

Steps involved in implementation, forming the linked-cell factory.

**Unit 3:**

**CNC machine tools and systems**

(i) Types of automation; fixed (or hard), programmable and flexible

(ii) Need and advantages of flexible automation

(iii) Basic principles of NC system

Components and their functions in NC machines

(i) Control; MCU, DPU and CLU

(ii) Feed drives; special motors and screw-nut system

(iii) Advantages of CNC over NC machines

Basic systems of NC and CNC machines

(i) Coordinate system

(ii) Control – open loop and closed loop

(iii) Dimensioning – absolute and incremental

CNC machine tools;

(i) Structure and working principle

(ii) Examples and use of CNC machines

(iii) Machining centre (MC) – characteristics and applications.

Control of tool – work travel;

(i) Point – to – point and contouring

(ii) Interpolation – linear and circular

**Part programming for NC, CNC and MC systems**

Manual part programming

(i) Definition and codes used

(ii) Sequential steps

(iii) Examples; part programming for machining in CNC lathes, drilling machines and milling.

Computer aided part programming

(i) Definition and advantages

(ii) Programming languages

(iii) Statements in APT

(iv) Examples of CA part programming in APT

**Unit 4**:

**An overview of Non Traditional Manufacturing -**

Advantages over traditional, classification, characteristics of all processes:

**Abrasive Jet Machining (AJM)**

Working principle with help of layout, Applications, Effect of pressure, strand-off distance, grain size, abrasive flow rate on material removal rate (mrr) Mechanism of material removal. Advantages and limitations.

**Water Jet Machining:** Introduction, Machining System, Basic principle, Process parameters, Applications, Advantages and Disadvantages.

**Ultrasonic Machining (USM)**

Schematic Diagram of USM- Working principle, Functions of each equipment used in the set up, Material removal process. Influence of Process parameters on (i) machining rate (ii) Surface finish and accuracy and repeatability, Applications.

**Plasma Arc Machining**

Basic principle, applications

**Unit 5:**

**Chemical Machining-** Introduction, Blanking, Chemical Machining to

Multiple depths, Design factors, advantages and disadvantages.

**Electro-Chemical Machining-** Process principle, Equipment, Applications.

**Electron Beam Machining** Set up, Basic Principle, Applications.

**Electrical Discharge Machining (EDM)** Diesinking- Basic principle, Schematic diagram of EDM setup, Dielectric fluid, Electrode materials. System for maintaining the spark gap constant, Effect of cutting parameters pulse- on-time, pulse off time, peak current setting, no load voltage, servo reference voltage, Applications.

**Wire-cut EDM:**

Schematic diagram, working principle Dielectric fluid, use. Advantages & Disadvantages of EDM, Applications.

**Unit 6:**

**Laser Beam Machining (LBM)**

Characteristics of Laser light, Basic mechanism of Ruby laser, Energy level diagram of Ruby laser. Carbon Dioxide laser, Energy level diagram. Commercial lasers available for machining, welding Heat treating, cladding.

**Hybrid Machining-** Introduction, Methodology for Hybrid Machiningthermal interaction, chemical and electrochemical interaction, mechanical interaction, Electromechanical Discharge Machining (ECDM/ECAM), Electrical Discharge Machining with Ultrasonic Assistance (EDMUS).

**Unit 7:**

**Rapid Prototyping-** Overview of Rapid Prototyping, Basic Process- CAD Model Creation, Conversion to STL format, Slice the STL File, Layer by layer construction, Clean and finish.

**Principles, systems, relative advantages and applications of the common RP methods:**

(i) Stereo lithography (SLG)

(ii) Selective laser sintering (SLS)

(iii) fused deposition modelling (FDM)

(iv) laminated objects manufacturing (LOM)

(v) 3-D Inkjet Printing

**Unit 8:**

1. Automation and economy and Time elements.
2. Basic Elements of modernization and Automation
3. Prerequisites for Automation, feasibility, viability- A) 1. For existing set up of different mfg process. 2. for new set up of different conventional and newer manufacturing concept. B) Small, medium, large industry. C) Level of automation, break even and techno-economy. D) Developing country and developed country.
4. Selection of modernization, part automation,
5. Process control and automation, involvement of material handling, metrology and measurement, mechatronics
6. Useful life of automated production system, subsystem and maintainability, replacement, salvaging
7. Automation and QAP, SQC, effect or process control, quality and system, redesign of product and system.
8. Case studies
9. Statistics A) industries undergone/modernization, part automation. B) new industry designed/implements with part automation or with automation of selected level.

C) Hybrid Industry.

**Text Book:**

1. Production and Operations Management, Adam Everett E.& Elbert Ronald J., PHI

production& Operation Management; S.N.Charry, TMH

1. Operations Management: Theory and Problems Monk J.G.
2. Manufacturing planning and control systems; Berry W.L.Whybark D.C. VollmanT.E.galgotia Publication Pvt. Ltd

**References**

1. Production and Operations Management, Adam Everett E.& Elbert Ronald J., PHI

production & Operation Management; S.N.Charry, TMH

**Title of Course: Finite Element Analysis**

**Course Code: MEC720**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit-I:**

Introduction to FEM and its applicability, Review of :Matrix algebra, Gauss elimination method, Uniqueness of solution, Banded symmetric matrix and bandwidth. Structure analysis: Two-force member element, Local stiffness matrix, coordinate transformation, Assembly, Global stiffness matrix, imposition of Boundary conditions, Properties of stiffness matrix

**Unit-II:**

One-dimensional Finite Element Analysis: Basics of structural mechanics, stress and strain tensor, constitutive relation, Principle of minimum Potential, General steps of FEM, Finite element model concept / Discretization, Derivation of finite elements, equations using
potential energy approach for linear and quadratic 1-D bar element, shape functions and their properties, Assembly, Boundary conditions, Computation of stress and strain.

**Unit-III:**

Two Dimensional Finite Element Analysis: Finite element formulation using three nodded triangular (CST) element , Plane stress and Plain strain problems, Shape functions, node numbering and connectivity, Assembly, Boundary conditions, Isoparametric formulation of 1-D bar elements, Numerical integration using gauss quadrature formula, computation of
stress and strain.

**Unit-IV:**

Finite Element Formulation from Governing Differential Equation: Method of Weighted Residuals, Collocation, Sub domain method, Least Square method and Galerkin’s method, Application to one dimensional problems, one-dimensional heat transfer, etc. introduction to variational formulation (Ritz Method.)

**Unit-V:**

Higher Order Elements: Lagrange’s interpolation formula for one and two independent variable, Convergence of solution, compatibility, element continuity, static condensation, p and h methods of mesh refinement, Aspect ratio and element shape, Application of FEM, Advantages of FEM, Introduction to concept of element mass matrix in dynamic analysis.

**Reference book:**

1. Dixit, U. S., “Finite Element Methods for Engineers” Cengage Learning 2003

2. Finite Element Procedure in Engineering Analysis, Bathe K.J., Prentice 2001

3. An Introduction to the Finite Element Method, Reddy J.N., Tata McGraw Hill, New Delhi 1993.

4. Concepts & Applications of Finite Element Analysis, Cook and Plesha, Willey India New Delhi. 2007

5. Introduction to Finite Elements in Engineering, Chandupatla and Belegundu, Prentice Hall India.

**Title of Course: Power Plant Engineering**

**Course Code: MED706**

**L-T Scheme: 3-1 Course Credits: 4**

**Course Contents:**

**Module -1**

**Power plant cycles**: Introduction of Power plant cycles reheat, regenerative cycle, binary vapor and co-generation cycles.

**Module-2**

**Boilers:** Definition, classification fire tube and water tube boilers, mountings and accessories, Draft in boilers, performance of boiler - boilers efficiency, equivalent evaporation.

**Module -3**

**Boiling and circulation principal:** Introduction to boiling and circulation in boilers. Power station boilers - Benson, Lamont. Supercritical boiler.

**Module-4**

**Boilers accessories and Handling of coal and ash.**

Boilers accessories: Super heater, economizer and air-pre heater, Handling of coal and ash.

**Module-5**

**Steam turbine**

Impulse turbine - velocity diagram, work done and blade efficiency. Pressure compounding

velocity compounding of steam turbine. Impulse reaction turbine - Velocity diagram, degree of reaction and Parsons turbine.

**Module-6**

**Governing and condensing**

Governing in Steam turbine, Condensers – Basic ideas

**Module-7**

**Power plant economics**

Load duration curve and various factors, cost of power generation. Introduction to Hydel, Nuclear and Renewable power plants.

**Text Books:**

1. P.K. Nag, “Power plant Engineering,” Tata McGraw - Hill.

**References**:

2. Arora and Domkundwar, “A course in Power plant Engineering” Dhanpat Rai & Sons.

3. M.M.EI- Wakil, “Power plant technology,” Tata McGraw - Hill.

**Title of Course: Turbo Machinery**

**Course Code: MED707T**

**L-T Scheme: 3-1 Course Credits: 3**

**Course Contents:**

**Module 1: Open Channel Flow**

Classification of flow in channels, discharge through open channels, chezy’s formula, specific Energy and specific energy curve, hydraulic jump.

**Module 2: Hydraulic Similitude**

Dimensional analysis-Rayleigh’s method and Buckingham’s pi theorem-study of Hydraulic models – Geometric, kinematic and dynamic similarities-dimensionless numbers – model and prototype relations.

**Module 3: Basics of Turbo Machinery**

Hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes, jet striking centrally and at tip, velocity triangles at inlet and outlet, expressions for work done and efficiency-Angular momentum principle, Applications to radial flow turbines.

**Module 4: Hydraulic Turbines**

Layout of a typical Hydropower installation – Heads and efficiencies-classification of turbines-pelton wheel-Francis turbine-Kaplan turbine-working, working proportions, velocity diagram, work done and efficiency, hydraulic design, draft tube – theory and function efficiency.

**Module 5: Performance of Hydraulic Turbines** Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.

**Module 6: Centrifugal-Pumps**
Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies- specific speed- pumps in series and parallel-performance characteristic curves, cavitation & NPSH

**Module 7: Reciprocating Pumps**

Working, Discharge, slip, indicator diagrams.

**Module 8: Hydropower Engineering**
Classification of Hydropower plants – Definition of terms – load factor, utilization factor, capacity factor, estimation of hydropower potential.

**Text Books:**

1. A text of Fluid mechanics and hydraulic machines by Dr. R.K. Bansal – Laxmi Publications (P) ltd., New Delhi
2. Fluid mechanics and fluid machines by Rajput, S.Chand &Co.
3. Fluid Mechanics & Fluid machines by Narayana pillai, Universities press.

**Reference Books:**

1. Elements of Open channel flow by Ranga Raju, Tata Mc.Graw Hill, Publications
2. Fluid Mechanics, Hydraulic and Hydraulic Machines by Modi & Seth, Standard book

**Title of Course: Renewable Energy Technology**

**Course Code: GE\*\*\***

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1**: Introduction: Principles of Renewable Energy, history of energy scene, energy future: energy and sustainable, Development and role of renewable energy

 **Unit 2: Solar Energy:** Definition, Energy available from Sun, Sun-Earth geometry, Solar radiation, Solar Radiation Measurement , solar energy conversion into heat, Flat plate and Concentrating collectors, Principle of natural and forced convection, ,. Solar cells, Application and Systems, solar Grid.

**Unit 3: Solar Thermal Applications**: solar water heating system, Air heaters, Water Desalination, Space Cooling, Solar Concentrators, Solar ponds.

**Unit 4: Wind Energy:** Energy available from wind, Lift and drag, Basis of Wind energy conversion, Effect of density, Horizontal axis and Vertical axis windmill, wind power, Mechanical & Electrical Power from Wind Turbines, working principle of wind power plant.

**Unit 5:** Principles of **Bio-Conversion**, Anaerobic/aerobic digestion, types of Bio-gas digesters, combustion characteristics of bio-gas, utilization for cooking and other applications.

**Unit 6:**  **Geothermal Sources:** Definition and Utilization for electricity generation and direct heating, potential in India.

**Unit 7:**

 **OCEAN ENERGY**, OTEC, Principles utilization, Setup of OTEC plants. Tidal and wave energy: Potential and conversion techniques.

**Books**

1. Non Conventional Energy Sources- G.D. Rai, Khanna Publishers.

2. Non Conventional Energy Resources- B.H. Khan, M H.

**References**

1. Renewable Energy – G. Boyle, 2nd edition, OUP, 2010.

2. Renewable Energy Resources- Twidell, J & Weir, T, 2nd edition, Taylor & Francis, 2006.

**Seventh Semester Practical**

**Title of Course: Automation in Manufacturing Lab**

**Course Code:MEC719P**

**L-T-P scheme: 0-0-2 Course Credit: 1**

**Course Contents:**

**Exercises that must be done in this course are listed below:**

**Exercise No.1:** AMT- any four of eight topics- WJM, EDM, LASER, ECM,

**Exercise No. 2:** CNC- Two Program- i) CAPP ii) LATHE

**Exercise No. 3:** Rapid Prototyping- 3-D Printing.

**Exercise No. 4:** Automation – Flexibility Study – Level 1 Automation – Modernization + Automation

**Eighth Semester Theory**

**Title of Course: Automobile Engineering**

**Course Code: MED811**

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit 1:**

**Introduction:** History & Development of Automobile. various sub system of Automobile

**Prime Mover:** Engine for Two –Wheeler & Three- Wheeler vehicles, Engine for passenger cars, commercial and other vehicle, Fuel system for carburetted engine, MPFI engine and Diesel engine, Lubrication and cooling system.

**Unit 2:**

**Auto Electrical:** Electric Motor as prime mover, Battery, generator, Ignition system, Starting system, lighting & signalling

**Steering System:** Devis steering & Ackerman steering system. Rack & pinion, cam & lever, worm & sector system.

**Unit 3:**

**Transmission System:** Flywheel & clutch. Gearbox sliding and constant mesh type, Automoatic Transmission, Universal joint, Propeller shaft.

**Differential & Axle:** Construction & function of differential, Different types of front & rear axles.

**Unit 4:**

**Suspension System:** Conventional and independent suspension system, application **Brake System:** Disc & drum brake, Hydraulic brake, Parking brake. Stopping distance, Antilock braking system (ABS), electronic brake force distribution (EBD) and traction

control.

**Unit 5:**

**Power Requirement:** Various resistances such as air resistance, gradient resistance, rolling resistance. Tractive effort. Torque- Speed curve. Horse power calculation

Maintenance of Vehicle. engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS).

**TEXT BOOKS:**
1. Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 1997.
2. Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.

**REFERENCES:**

1. Newton ,Steeds and Garet, “Motor Vehicles”, Butterworth Publishers,1989.

2. Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999

3. Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart –Will Cox Company Inc, USA ,1978.

4. Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.

5. Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2007.

**Title of Course: Material Handling**

**Course Code: MED813**

**L-T Scheme: 2-0 Course Credits: 3**

**Course Contents:**

**Unit 1:**

**Introduction :** Definition, importance and scope of materials handling (MH); classification of materials;codification of bulk materials ; utility of following principles of MH – (i) materials flow, (ii) simplification, (iii)gravity, (iv) space utilization, (v) unit size, (vi) safety, (vii) standardization, (viii) dead-weight, (ix) idle time,(x) motion.

**Unit 2**:

**Unit load:** Definition; advantages & disadvantages of unitization; unitization by use of platform, container, rack,sheet, bag and self-contained unit load; descriptive specification and use of pallets, skids, containers, boxes, cratesand cartons; shrink and stretch wrapping.

**Unit 3:**

**Classification of MH Equipment:** Types of equipment –(i) industrial trucks & vehicles, (ii) conveyors, (iii) hoisting equipment, (iv) robotic handling system and (v)auxiliary equipment; Independent equipment wise sub classification of each of above type of equipment (vi) Bulk Material Handling Equipment (Seaport Handling- Marine/River Connected Handling, Offshore Handling-Bombay Hi, oil/gas pipeline)

**Unit 4**:

**Industrial trucks & vehicles :** Constructional features and use of the following equipment – (i) wheeled handtruck, (ii) hand pallet truck, (iii) fork lift truck; Major specifications, capacity rating and attachments of fork lift truck.

**Unit 5:**

**Conveyors :** Use and characteristics of belt conveyor, constructional features of flat and troughed belt conveyor;Use and constructional features of Flg. types of chain conveyors – (i) apron, car and trolley type; Construction oflink-plate chains; Dynamic phenomena in chain drive; Use and constructional features of roller conveyors;Gravity and powered roller conveyor; Pneumatic conveyor-use and advantages; Positive, negative andcombination system of pneumatic conveyors; constructional feature, application and conveying capacity of screwconveyor, Hydraulic Conveyor.

**Unit 6:**

**Hoisting Equipment :** Advantage of using steel wire rope over chain; constructional features of wire ropes;Rope drum design; Pulley system-simple vs. multiple pulley; Load handling attachments : hooks, grabs, tongs,grab bucket; Arrangement of hook suspension with cross piece and pulleys (sheaves); Use and constructionalfeatures of (i) hand operated trolley hoist , (ii) winch; (iii) bucket elevator, (iv) Jib crane, (v) overhead travelling crane and (vi) wharf crane; Level luffing system of a wharf crane; Utility of truck mounted and crawler crane.

**Unit 7:**

**Robotic handling:**Materials handling at workplace; Major components of a robot; Applications of robotichandling.

**Unit 8:**

**Auxiliary Equipment:** Descriptive specification and use of –(i) Slide and trough gates, (ii) belt, screw and vibratory feeders,(iii) Chutes, (iv) positioners like elevating platform, ramps, universal vise; (v) ball table.(vi) Coil/De-coiling reel (electrical cable, conveyor belt), Material Handling Equipment Selection.

**Unit 9:**

**Technical Specification:** River Bridge, D. H. Rail bridge- Reserch in sea-seabed equipment handling); Flyover Track Laying Equipment, Dust/Ash Exhaust System/Filter/Bag/Chimney)

**Text Book:**

1. S. Ray, Introduction to Materials Handling, New Age Int. Pub.

2. T. K. Ray, Mechanical Handling of Materials, Asian Books Pvt. Ltd.

**References**

1. T.H. Allegri, Materials Handling: Principles and Practices, CBS Publishers and Distributors.

2. J.A. Apple, Material Handling System Design, John Wiley & Sons.

**Title of Course: Total Quality Management**

**Course Code: GE\*\*\***

**L-T Scheme: 3-0 Course Credits: 3**

**Course Contents:**

**Unit-I:**

**Introduction to TQM:** Definition, Basic approach, Guru's of TQM, TQM framework, benefits. Leadership: Characteristics of Quality Leadership, Leadership Concepts, The 7 Habits of Highly Effective People, The Deming Philosophy, The Role of TQM Leaders, Quality Council, Core Values, Concepts, and Framework, Quality Statements, Decision Making. Customer Satisfaction: Introduction, Customer Perception of Quality, Feedback, Using Customer Complaints, Service Quality, Translating Needs into Requirements, Customer Retention.

**Unit-II:**

**Continuous Process Improvement:** Introduction, Process, The Juran Trilogy, Improvement Strategies, Types of Problems PDSA Cycle, Problem-Solving Method, DMAIC, Kaizen, Reengineering. Supplier Partnership: Principles of Customer/Supplier Relationship Partnering, Sourcing Supplier, Selection , Supplier Certification Supplier Rating, Relationship Development. Performance Measures: Basic Concepts, Strategy, performance measure presentation, Cost of Quality.

**Unit-III:**

**Lean Enterprise:** Historical Review, Lean Fundamentals, Value Stream Map, Implementing Lean, Benefits. Six Sigma: Statistical Aspects, Improvement Methodology, Organizational Structure Benefits. Benchmarking: Benchmarking Defined, Reasons to Benchmark, Process, deciding what to benchmark, Pitfalls and Criticisms.

**Unit-IV:**

**Quality Management Systems:** Benefits of ISO Registration, ISO Series of Standards, Sector-specific Standards, ISO 9001 Requirements, Implementation, Documentation, Writing the Documents, Internal Audits, Registration. Environmental Management Systems: ISO 14000 Series Standards, Concepts of ISO 14001, ISO 14001, Requirements, Benefits, Integrating QMS and EMS. Other EMS Systems, Relationship to Health and Safety Quality Function Deployment: The QFD Team, Benefits, the voice of the Customer, Organization of Information, House of Quality, Building a House of Quality, QFD Process. Total Productive Maintenance: The Plan, Learning the New Philosophy, Promoting the Philosophy, Training, Improvement Needs, Goal Developing Plans, Autonomous Work Groups

**Unit-V:**

**Management Tools:** Forced Field Analysis, Nominal Group Technique, Affinity Diagram, Interrelationship Digraph, Tree Diagram, Matrix Diagram, Prioritization Matrices, Process Decision Program Chart, Activity Network Diagram Experimental Design: Introduction, Basic Statistics, Hypothesis, t Test F Test. One Factor at a Time Orthogonal Design, Point and Interval Estimate, Two Factors Full Factorials. Taguchi's Quality Engineering: Introduction, Loss Function, Orthogonal Arrays, Signal-to-Noise Ratio, Parameter Design, Tolerance
Design, Case study

**Reference Books:**

1**.** Total Quality Management: text with cases, John S Oakland, Butterworth-Heinemann 2003

2. Total Quality Management for Engineers, Zaire, M., Wood Head Publishing Ltd.1991

3. Total Quality Control, Feigenbaum. Armand V., McGraw Hill 1991

4. The Management and Control of Quality,(5th Edition), James R.Evans and William M.Lidsay, South-Western (Thomson Learning)