MECHANICAL ENGINEERING

Course Name	**:**	**INTRODUCTION TO MECHANICAL ENGINEERING**
Course Code	**:**	**MEN-101**
Credits	**:**	**2**
L T P	**:**	**2-0-0**

Course Objectives:
To familiarize the students with the basic of Mechanical Engineering To introduce the basic machine elements To familiarize with basic manufacturing processes, industrial engineering and property rights To familiarize with the sources of Energy and Power generation

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO MECHANICAL ENGINEERING:** History, Role and Scope of Mechanical Engineering, Introduction to the materials, Mechanical properties and their engineering applications, Design consideration and basic steps in design.	5
2	**INTRODUCTION TO MACHINE ELEMENTS:** Introduction to springs, cams, shafts, axles, bearings, flywheel and their applications. Introduction to belts and gears drives and their engineering applications.	5
3	**INTRODUCTION TO SOURCES OF ENERGY AND POWER GENERATION:** Introduction to sources of energy, and power generation, Mechanical, Electrical, hydraulic sources of energy (layouts, element/component, description, advantages, disadvantages, applications). Introduction to Boiler, Turbines, Compressor, Belower. Introduction to Refrigeration and Air conditioning.	6
4	**INTRODUCTION TO MANUFACTURING:** Basic Manufacturing Processes, casting, welding, brazing and soldering, tools and machine tools and their application. Introduction to various systems directly and indirectly involved in production system.	5
5	**INTRODUCTION TO INDUSTRIAL ENGINEERING & PROPERTY RIGHTS:** Basic concept of quality, product economy, production planning, and inventory. Concept of property rights.	4
6	**RECENT AND FUTURE SCOPE:** Recent trends and future scope in Mechanical Engineering.	3

Course Outcomes:	
1	Students will be able to clear the basic concepts of mechanical engineering.
2	Students will be able to realize the important of design and manufacturing
3	Students will be able to come up with innovative conceptual idea about sources of energy, Industrial Engineering and property rights.

Reference Books:	
1	Hicks, P.E. Industrial Engineering and Management-a new perspective, Mc Graw Hill. Inc. 1994.
2	Materials and Processes in Manufacturing-E. Paul Degarmo.

Course Name	**:**	**ELEMENTS OF MANUFACTURING PROCESSES**
Course Code	**:**	**MEN-102**
Credits	**:**	**4**
L T P	**:**	**3-0-3**

Course Objectives:
To familiarize the students with the basic tools and equipments used in manufacturing. To introduce the practical knowledge on different aspect of manufacturing processes. To familiarize with basic manufacturing processes,

techniques, use of machine and tools etc. To familiarize with the production of basic raw materials, secondary processes joining, assembly etc.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**MANUFACTURING**: Definition, classification. Introduction to product design, manufacturing activities inside and outside the factory, planning and process sheet, selection of raw materials and storing, heat treatment.	4
2	**FOUNDRY: RAW MATERIALS**: Fuels, fluxes, refractory and related materials. **Patterns**: Materials, types, allowances, colours scheme, pattern making and applications. **Moulding**: Materials, type, impurities and additives, mould making, testing of sand and mould. **Core:** types, core boxes, core making processes, testing, applications. **Furnaces and MECHANIZATION**: Melting practices, furnaces for melting of iron, steel and non ferrous metals, calculation of cupola charge, air requirement and efficiency.	5
3	**DESIGN OF CASTING**: Mechanism of solidifications, elementary design of gating system, runner and riser, pouring time calculation, degassing, fettling. **Special Processes**: Non-metallic, carbon dioxide, plaster, shell and permanent moulding, precision, investment, die, centrifugal and continuous casting. Mercast process.	4
4	**CASTING OF COMPOSITES AND CERAMICS:** Al/SiC, Al/ZrO_2, Al/Al_2O_3-MMC; hybrid MMC casting, properties and applications. Casting of ceramics, properties and applications. **INSPECTION AND TESTING**: Inspections, destructive and nondestructive testing, casting defects, their remedial actions. Introduction to Micro casting and applications.	4
5	**METAL FORMING**: **ROLLING**: Hot, cold, splines, planetary, transverse, gear, thread rolling. Rolling mills, power requirement. Piercing, pipe and seamless tube manufacture. Extrusion: types and processes. Drawability and testing of sheet metals. **Drawing**: Wire, rod and tube drawing, spinning, coining, flow turning, embossing, redrawing, shot penning. Sheet metal working: blanking, bending and drawing, punch and die set up. **Forging**: Types, smith, impression die, drop, closed and open die, upset, machine and press forging. Hydraulic and pneumatic forging machine, elements of forging die design, draft angles, flash and gutter. Bolt heads manufacturing. Fullering, edging and cropping. **Special processes:** rotary swaging, ring, tandem rolling. Tension, electro, hydraulic, magneto-electro and hybrid forming. Lubricants used. Defects in forming and remedial actions. Introduction to micro forming.	9
6	**WELDING:** Definition, classification, mechanism of welding, weldability. **Arc welding**: Principle, types, relative merits of AC & DC, welding machine. Carbon, submerged, gas metal, electro-slag, electro-gas, MIG,TIG and plasma arc welding. **Electrodes:** Types, classification and codification, selection and specific applications. R**esistance welding**: Principle, types, size of welds, spot, seam, projection, butt, high frequency resistance and percussion welding. Spot-welding machines. **Solid state welding:** Cold, diffusion, ultrasonic, explosive, friction and forge welding. **Special welding:** Atomic hydrogen, laser beam, wet and dry welding. **Thermochemical welding:** Principle, types, applications.	7
7	**GAS WELDING**: Types, welding torch, pressure cylinder, regulator, gas storage, blow pipes, lighting up, welding techniques, different zone and temperature of flames, applications. **Oxy-flame cutting:** Principle, types, applications.	4
8	**BRAZING AND SOLDERING**: Principle, types, materials, application in marco and micro domain. **Inspection and testing:** Stage inspection, visual, magnetic particle, liquid penetration, stethoscopic (sound), leakage, destructive and non-destructive test. Welding defects, their causes and remedies. **Introduction** to advanced, micro welding, joining and deposition processes.	5

List of Experiments:	
1	Carpentry section: (i) half lap T & L-joint, (ii) pattern of hexagonal nut.
2	Fitting section: (i) leveling & surface marking, (ii) square hole making.

3	Foundry section: (i) mould making, (ii) casting hexagonal nut.
4	Smithy section: (i) round bar to cube, (ii) round bar to V-block.
5	Welding section: (i) arc welding: V, L,T joints, (ii) spot welding on sheet metal.
6	Machine section: (i) turning & tapering, (ii) thread cutting.
7	Assembly and electrical basic connection: (i) study automobile engine, (ii) wiring & electrical connection.
8	Sheet metal & Electroplating: (i) bending & joining, (ii) buffing and electroplating on sheet metal

Course Outcomes:	
1	Students will be able to clear the basic concepts of machine tools, tools, other equipments.
2	Students will be able to realize the important and their actual applications in manufacturing
3	Students will be able to come up with innovative conceptual idea about manufacturing processes and their industrial applications

Text Books:		
Sr. No.	**Name of the Book/ Authors/Publisher**	**Year of Publication/ Reprint**
1	Manufacturing Engineering and Technology; Serope Kalpakjian and Steven R.Schmid-4th edition, Pearson Edition	2007
2	Principles of Manufacturing Materials and Processes; Campbell-Tata Mc.Graw Hill.	1999

Reference Books:		
Sr. No.	**Name of the Book/ Authors/Publisher**	**Year of Publication/ Reprint**
1	Degarmo,E.P, Kohser, Ronald A. and Black J.T.; Material and Processes in Manufacturing, Prentice Hall of India	2008
2	Manufacturing Processes, P.C. Sharma, S. Chand Publication.	2008

Course Name	**:**	**ENGINEERING AND MACHINE DRAWING**
Course Code	**:**	**MEN-103**
Credits	**:**	**4**
L T P	**:**	**2-0-4**

Course Objectives:
At the end of this course, the student should be able to visualize objects and their graphical representations, understand the various engineering drawing symbols, conventions and other requirements of assembly and dis-assembly of mechanical engineering parts and materials and should be able to draw clear and understandable production drawings.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ENGINEERING GRAPHICS:** System of Projections. Technical lettering. Orthographic projections. 3-views. Projection of oblique areas. Circular features. Dimensioning, Rules of dimensioning.	4
2	**READING OF ORTHOGRAPHIC VIEWS:** Meaning of lines and areas. Pictorial sketching. Missing views and missing lines. General introduction to Isometric Projections. Freehand sketching.	4
3	Projections of Points, Lines and Planes. Geometrical Constructions. Elements of descriptive geometry. True length, True shape, minimum distance, true angles.	4
4	Projection of Solids, sectioning. Auxiliary planes and views.	4
5	**REQUIREMENTS OF PRODUCTION DRAWINGS:** Conventional representation, Layout of drawing sheet, symbols of standard tolerances, machining symbols, Various types	3

	of screw threads, nuts and bolts, screws, welding joints and riveted joints. Introduction and familiarization of the code IS:296.	
6	**INTRODUCTION TO AUTOCAD:** Basic commands and features, simple exercises of points, lines, planes and solids on AutoCAD.	3
7	**ASSEMBLY AND DIS-ASSEMBLY DRAWING EXERCISES ON SOME OF THE FOLLOWING USING DRAWING SHEETS AS WELL AS AUTOCAD:** Couplings, Clutches, Knuckle and cotter joints, Pipe and pipe fittings, IC engine parts, Machine tool parts, Boiler mountings, Bearings, Screw Jack, Drill press vice.	6

List of Experiments:		**Number of Turns**
1	Drawing exercises on lettering, dimensioning, points, lines and planes	2
2	Drawing exercises on solids, sectioning and auxiliary planes	3
3	Drawing exercises on isometric projections	1
4	Introduction to AutoCAD, familiarization with basic commands and features	2
5	Simple exercises of points, lines, planes, solids and sectioning of solids on AutoCAD	3

Course Outcomes: By the end of this course, student will be able to	
1	Have knowledge of drawing symbols, conventions and methods of graphical representations.
2	Understand various machine components, their working and functions.
3	Able to read and understand mechanical engineering drawings.
4	Have working knowledge of the drafting package AutoCAD.
5	Able to understand and draw mechanical engineering drawings on AutoCAD.

Text Books:		
Sr. No.	**Name of the Book / Authors**	**Year of Publication / Reprint**
1	Engineering Drawing by R. K. Dhawan	2012
2	Machine Drawing by R. K. Dhawan	2012

Reference Books:		
Sr. No.	**Name of the Book / Authors**	**Year of Publication / Reprint**
1	Engineering Drawing by P. S. Gill	2013
2	Machine Drawing by P. S. Gill	2013
3	Fundamentals of Engineering Drawing by Luzadder and Duff	2009
4	Engineering Graphics with AutoCAD by James D. Bethune	2011

Course Name	**:**	**ELEMENTS OF THERMODYNAMICS**
Course Code	**:**	**MEN201**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to understand the basic principles of Thermodynamics and to give students a feel for how Thermodynamics is applied in Engineering practice.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BASIC CONCEPTS :**Macroscopic and Microscopic Approach, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Thermodynamic Equilibrium, State,	**5**

	Path, Process, cycle, Quasi-static Process, Reversible and Irreversible Process, Working Substance. Thermodynamic Properties like Pressure, Volume and Temperature, Zeroth Law of Thermodynamics. Temperature Scales, Concept of Heat and work in Thermodynamics.	
2	**FIRST LAW OF THERMODYNAMICS:** Joule's Paddle wheel Experiment; Mechanical Equivalent of Heat, First Law for a closed system undergoing a Cycle, First Law for a closed system undergoing a change of state. Different forms of stored Energy, Enthalpy, Energy of An isolated System, Perpetual Motion Machine of First kind. **FIRST LAW APPLIED TO FLOW PROCESSES:** Flow Process and Control Volume, flow work, Flow Energy Equationan and its applications. Throttling Process, Flow Work and Non Flow work. Limitation of First Law.	**8**
3	**SECOND LAW OF THERMODYNAMICS:** Qualitative Difference between Heat and Work, Thermal Reservoir, Statements of 2nd Law by Max.Planck and Claussius, Equivalence between two statements, Energy Analysis of Heat Engine, Refrigerator and Heat Pump Reversibility and Irreversibility, Causes of Irreversibility Carnot Theorem, Carnot cycle, Absolute Thermodynamic Temperature, Scale, Efficiency of the Reversible Heat Engine, Equality of Ideal Gas Temperature and Kelvin Temperature.	**4**
4	**ENTROPY**: Classius Theorem, Classius Inequality and concept of Entropy, Entropy change in an Irreversible Process, Application of Entropy Principle, Entropy Transfer with Heat Flow, Entropy generation in closed and open System, Thermodynamics Equations relating properties of System, Reversible Adiabatic work in a Steady flow System. Entropy and direction, Entropy and disorder.	**5**
5	**AVAILABLE ENERGY AND AVAILABILITY**: Available Energy referred to a cycle, Quality of work, Maximum work in Reversible Process, Useful work, Dead State, Availability, Second Law Efficiency.	**4**
6	**GAS POWER CYCLES**: Air Standard efficiency, Mean Effective Pressure, Otto, Diesel, Dual, Brayton, Stirling and Ericson Cycle, Comparison of cycles.	**5**
7	**PROPERTIES OF GASES AND GAS MIXTURE** : Equation of state of a gas, Properties of Mixture of gases, Internal Energy, Enthalpy and Specific heat of gas, mixtures, Entropy of gas Mixtures.	**2**
8	**PROPERTIES OF PURE SUBSTANCES**: h-S, T-S, p-v, p-t, diagram for a Pure Substance, Properties of Pure substance with special reference to water, Steam and its formation, Wet Dry, Saturated and Superheated Steam, sensible, Latent heat, Dryness fraction and its determination, Separating and Throttling calorimeter Enthalpy, Entropy and Internal Energy of Steam. Use of Steam Table and Mollier Diagram, Basic Thermodynamic Processes of Steam in Closed and Open System and their representation on P-V and H-S chart	**5**
9	**VAPOUR POWER CYCLE :** Carnot and Rankine Steam Power Cycle, Actual Vapour cycle Processes, Comparison of Carnot and Rankine cycle, Mean Temperature of Heat Addition, Reheat Cycle, Ideal Regenerative Cycle Reheat Regenerative Cycle, Feed Water Heater, Characteristics of an Ideal working fluid in Vapour Power cycle.	**4**

Course Outcomes: At the end of this course, the student will be able to :	
1	A fundamental understanding of Laws of thermodynamics and their application to wide range of systems.
2	Familiarity with efficiencies of Heat Engines and other Engineering Devices.
3	Familiarity with Puresilestance, steam tables, Mollies diagrams and their applications to vapour power cycles.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Engineering Thermodynamics", Gordon Rogers & Yon Machew	2006
2	"Thermodynamics", Yunus Cengel and Mike Boles	2006
3	"Thermodynamics", Arora.	2005
4	"Engineering Thermodynamics", P.K. Nag	2005

5	"Thermo dynamics", Dr. D.S. Kumar	2006

Course Name	**:**	**KINEMATICS OF MACHINES**
Course Code	**:**	**MEN202**
Credits	**:**	**04**
L T P	**:**	**3 -1- 0**

Course Objectives:

At the end of this course, the student should be able to use the concepts of various basic Mechanisms, kinematic diagrams, kinematic chains and mobility, Kinematic analysis and synthesis of mechanisms. Review of some fundamental principles of mechanics. The student will be able to design a process based on mechanisms for a given application. The student will be able to apply these mechanisms for various machines and help in case of the failure analysis.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BASIC CONCEPTS** Kinematics and Dynamics of Machines, Mechanisms, Pairs, kinematic chain, four bar chain, Inversions of single and double slider crank chains, Degrees of freedom, Kutzbach's equation. Grubler's criterion,joints and Numerical problems.	5
2	**VELOCITY AND ACCELERATION** Basic concepts of machines, link, Mechanism, Kinematic chain, relative motion of parts of mechanism, displacement, velocity, acceleration diagrams of all basic mechanisms including quick return motion mechanism. Advance problems on velocity diagrams (relative velocity method, instantaneous center method). Kennedy theorem,,Klien's construction, Ritterhaus's construction, Bennett's construction, Acceleration diagram. Coriolis component, advanced problems involving their application.	5
3	**KINEMATIC SYNTHESIS OF MECHANISM** Movability, Number synthesis, Frudenstein's equation, Chebyshev spacing of precision points, Two and three position synthesis of Four-bar mechanism & slider crank mechanism, Overlay method, Bloch's method Transmission angle, Limit position & Least square techniques.	5
4	**LOWER PAIRS** Universal joint- single and double, calculation of maximum torque. Oldham's Coupling, steering mechanism including Ackermann's and Davis steering mechanism. Mechanism with lower pairs, pantograph, exact and approximate straight line motion, engine indicator, elliptical trammel.	5
5	**BELTS, ROPES AND CHAINS** Materials, type of drive, idle pulley, intermediate or counter shaft pulley, angle and right angle drive, quarter turn drive, velocity ratio, crowning of pulleys, loose and fast pulleys, stepped or cone pulleys, ratio of tensions on tight and slake sides of belts. Power transmitted by belts including consideration of creep and slip, centrifugal tension and its effect on power transmitted. Use of gravity, idler, flat, V-belts and rope, materials, Length of belt, rope and chain drive, types of chains.	6
6	**CAMS** Type of cams and followers, definition-basic circle & least radius, angle of ascent. Dwell, descent & action. Displacement, velocity and acceleration diagrams for the followers with uniform velocity motion, simple harmonic motion, uniform acceleration and retardation and cycloidal motion, determination of maximum velocity, acceleration and retardation. Analysis of follower motion for pre-specified cam profiles (tangent cams and convex cams).	5
7	**GEARS:** Toothed gears and their uses, types of toothed gears (spur gears, internal spur gears, spur &	6

	rack, bevel gears, helical gears, double helical gears, spiral gears, worm gears), definitions, pitch circle diameter, pitch surface, pitch point, circular pitch, diametric pitch, module pitch, addendum, dedendum, clearance, addendum circle, outside diameter, internal diameter, dedendum circle, root diameter, base. Base circle diameter, face and flank of tooth, angle of obliquity or pressure angle, path contact, arc of contact, arc of approach, condition ;for correct gearing, forms of teeth, cycloid and its variants, epicycloids and hypocycloid, involute methods of drawing an involute and cycloidal curves, interference in involute gears and methods of its removal, comparison of involute and cycloidal gear systems.	
8	**GEAR TRAINS** Types of gear trains, simple and compound, epicyclic and reverted gear trains. Sun and planet gear, differential. Problems involving their applications, estimation of velocity ratio of worm and worm wheel, helical and spiral gears (determination of No. of teeth, spiral angle and efficiency).	5

Course Outcomes: By the end of this course, the student will be able to:	
1	Explain concepts of displacement, velocity and acceleration and their effects on the machine components.
2	Apply these concepts in the design of machines components to avoid failure
3	Solve the numerical problems based on kinematic analysis of linkages and engineering applications.
4	
5	

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Theory of Machines/ V.P. Singh/ M/s Dhanpat Rai & Co. Pvt. Ltd.,	2014
2	Theory of Machines/P.L. Ballaney/Khanna publishers.	1994
3	Theory of Machines/Shigley/Tata McGraw Hill.	1981
4	Mechanism & Machine Theory/J.S. Rao & R.V. Dukhipati/Wiley Eastren Ltd.	1992
5	Theory of Mechanisms/Amitabh Gosh & A.K. Mallik/East West Press Machines Private Ltd.	2006
6	Theory of Machines/S S. Rattan/ McGraw Hill Education (India) Private Limited	2014

Course Name	**:**	**MANUFACTURING PROCESSES**
Course Code	**:**	**MEN203**
Credits	**:**	**4**
L T P	**:**	**3-1/2-2/2**

Course Objectives:
At the end of this course, the student should be able to manufacturing processes, techniques, use of tools, tooling system, machine etc for fabrication of metal powder parts, plastic, ceramics, and processing of metal and alloys parts. To impart the knowledge about various machine tools and their applications, various conventional and nonconventional machining processes and techniques used in metal cutting, gear manufacturing, key slot cutting etc. Knowledge about the various processes for finishing and polishing. To familiarize the students about the advanced nonconventional and micro machining techniques and their applications for processing of conductive and nonconductive materials.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**POWDER METALLURGY:** Advantages and limitations, Metal Powder products, Methods of Producing powders, Briquette and Sintering, Hot iso-static processing, Sizing and finishing operations.	7

	Applications of powder Metallurgy parts.	
2	**METAL CUTTING:** Advanced cutting tool materials, Geometry of single point cutting tools, Multipoint cutting tools, Tool life, Machinability, Knowledge of machining parameters; Theory and Effect of cutting fluid on cutting parameters; Machine Tools used in metal cutting: Lathe, Milling, Drilling Shaping, Slotting, Planning; Sawing, Boring, Broaching. Effect of machining parameters on machining responses. Taper turning Eccentric turning and thread cutting, Indexing: Simple, Compound, differential and Angular indexing. Calculation of MRR.	12
3	**PROCESSING OF PLASTICS AND CERAMICS** Polymerization, Types of plastics, Processing of Plastics, Casting of plastics; Calendaring, Rotational moulding, Blow moulding, Manufacturing of helmet, machining and welding of plastics. Classification, Properties, Processing, Doctor blade process. Product applications of ceramics. Machining and joining of ceramics.	7
4	**NONCONVENTIONAL AND ADVANCED MACHINING PROCESSES** Need and objective of nonconventional machining methods. ECM, EDM, WEDM, USM, EBM, LBM, AJM: Working principle, Process parameters, Effect of process parameters on machining responses, Calculation of MRR, Applications. Introduction to hybrid machining processes, ECSM, TWECSM, STECM. Process parameters.	10
5	**FINISHING PROCESSES** Grinding, types of Grinding machines, specification of grinding wheel. Honing, Lapping, Super finishing, Polishing, Buffing, Advanced finishing processes: AFF, MRAFF.	6

List of Experiments:		**Number of Turns**
1	Plastic joining by hot welding.	1
2	Thread cutting by single point tool.	2
3	Aluminium joining by friction welding.	2
4	Gear cutting.	2

Course Outcomes: At the end of this course, the student should be able to:	
1	Students will be able to clear the basic concepts and understand about the various manufacturing processes.
2	Students will be able to realize the important of primary and secondary manufacturing operations and their actual applications in manufacturing
3	Understand about the tools, tooling, machine tools, and other related equipments used in manufacturing.
4	Students will be able to come up with innovative conceptual idea about manufacturing processes and their industrial applications

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Manufacturing Engineering and Technology; Serope Kalpakjian and Steven R.Schmid-4th edition, Pearson Edition,	2013
2	Manufacturing Science; Amitava Ghosh and Asok Kumar Mallik,, East-West Press Pvt Ltd. New Delhi,	1993
3	Advance machining processes. Jain V K ; Allied publishers, New Delhi, India,	2002

Course Name	**:**	**STRENGTH OF MATERIALS & BASIC CONCEPT OF DESIGN**
Course Code	**:**	**MEN204**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of this course, the student should be able to understand the basic philosophies of strength of material and designing of a system. The course will prepare the students to apply these to engineering and applied sciences problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**SIMPLE STRESS & STRAIN:** Stress-strain diagrams for various materials, concept of stresses and strains, relationship between elastic constants, stresses produced in compound and simple bars due to axial loading	**4**
2	**COMPOUND STRESSES:** Generalized 2-D state of stress, stresses on an arbitrary plane under Generalized 2-D state of stress, principal stresses and principal planes, Mohr's stress circle and ellipse of stress	**5**
3	**SHEAR FORCE AND BENDING MOMENT IN BEAMS:** Shear force (SF), Bending moment (BM), Relation between rate of loading (w) with shear force (SF) and bending moment (BM). SF and BM diagrams of cantilevers, simply sported beams with or without overhang under different types of loading e.g. concentrate loads, uniformly distributed load, uniformly varying load, moment or its combinations	**5**
4	**BENDING AND SHEAR STRESSES IN BEAMS**: Theory of pure bending, Bending equation, Bending stresses in various cross-sectional beams under different loads, shear stresses in beams, variation of shear stresses in different cross-sectional beams	**6**
5	**GENERAL DESIGN CONSIDERATION:** Scope and meaning of design with special reference to machine design, design process, Concept of tearing, bearing, shearing, crushing, bending, etc. Selection of materials, Factors of safety under different loading conditions, stress-concentration factors, Design stresses for variable and repeated loads. Endurance limit, fatigue. Fits and tolerances and finish	**6**
6	**FASTENERS:** Cotters and cotter joints, pin fasteners knuckle joints. Screws, bolts, preloaded bolts, bolts subjected to shear, tension and torque, eccentrically loaded bolted joints. Welded and riveted connection, eccentrically loaded, welded and riveted connections.	**8**
7	**SHAFTS AND AXLES:** Torsion and its equation for circular shafts, determination of principal stresses and maximum shear stresses in circular hallow and solid shaft due to combined bending and torsion, application of torsional concepts in Shafts & Axles, Keys, Design of Rigid & flexible Coupling	**8**

List of Experiments:		**Number of Turns**
1	To perform Tensile Test on a given material and to determine its various mechanical properties under tensile loading.	1
2	To perform Compressive test on a given material and to determine its various mechanical properties under compression loading.	1
3	To perform Shear test on a given material and to determine its various mechanical properties under shear force loading.	1
4	To determine Rockwell hardness of a given material.	1
5	To perform Column test of a given material and to determine its Euler's buckling load and Young's modulus of elasticity.	1
6	To perform Impact test on a given material and to determine its resilience.	1
7	To perform Torsion test on a given material and to determine various mechanical properties under torsional load.	1
8	To study and perform Fatigue test on a given material and to determine endurance strength and	1

	limit of the material.	
9	To perform test on closed and open coiled helical springs under axial loading on spring tester and to determine modulus of rigidity, stiffness etc. of the spring material.	1
10	To perform various wood tests on given the given wooden specimens on Universal Wood Testing machine and to determine various strengths and properties of the wood.	1
11	To perform Bending test and to determine the Young's Modulus of Elasticity of the beam via deflection formulae.	1
12	To perform a testing of hardness of the speciMENon computerized micro-hardness tester.	1
13	To study the creep behavior of the material and its testing machine.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Apply strength of material & design philosophies in designing of simple systems.
2	Visualize any mechanical system as a model acted upon by various loads and stresses induced in it.
3	Carry out the experiment on a given material to determine its various mechanical properties.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Strength of Material - G. H. Ryder (MacMillan)	1969
2	An Introduction to the Mechanics of Solids – Crandall & Dahl (Mc-Graw Hill)	2012
3	Engg. Mechanics of Solids - E. P. Popav (Pearson Education)	2003
4	Strength of Material: D S Bedi	2010
5	Strength of Material by R K Rajput	2012

Course Name	**:**	**ENGINEERING ANALYSIS AND DESIGN**
Course Code	**:**	**MEN206**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the objective of the subject is to uphold a steadiness between theory, numerical computation, and problem setup for solution by optimization, and applications to engineering systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Introduction, the design process, Engineering design versus analysis, conventional versus optimum design process, optimum design versus optimal control, basic terminology and notation. Design variables, cost function, design constraints; A general mathematical model for optimum design, Design optimization model, maximization problem treatment, treatment of "Greater than type" constraints, constraint set, Active/Inactive/Violated constraints, Discrete and integer design variable, graphical optimization.	6
2	**SOLUTION TECHNIQUES FOR DESIGN OPTIMIZATION PROBLEM** Introduction, single variables, optimality criteria, bracketing methods: Exhaustive search method, Bounding phase method. Region elimination methods Interval halving method, Fibonacci search method, golden section method, point estimation methods and gradient based methods: Newton raphson method, Bisection method, Secant method, cubic search method. Multi variables Optimization, Unidirectional search, direct search methods, gradient based methods, liner programming methods for optimum design.	10
3	**DESIGN OF EXPERIMENTS AND OPTIMIZATION**	8

	Strategy of experimentation, basic principles, guidelines for designing experiments, sampling and sampling distribution, Inference about the difference in means for randomized design, Inference about the difference in means for paired comparison design, inference about the variance of normal distribution, Design of experiments with a single factor and multi factor design, analysis of variance (ANOVA), introduction to factorial design.	
4	**TAGUCHI METHODOLOGY** Design of experiments - The Taguchi Approach, Taguchi philosophy, Concept of the loss function, Experiment design strategy, Areas of application, Quality characteristic, Taguchi quality strategy, Selecting design parameters for reduced variation, Signal to Noise ratio (S/N ratio), Analysis of variance (ANOVA), confirmation experimentation, F-test.	8
5	**MATHEMATICAL MODELLING AND SIMULATION** Introduction, Mathematical Modelling: its needs, techniques, classifications and illustrations. Modelling through ordinary differential equation of first order. Simulation: Random number generation, Simulation of continuous system, Discrete system simulation, Simulation of queuing systems, Simulation of PERT network.	10

Course Outcomes:	
1	Basic theoretical principles in optimization;
2	Formulation of optimization models;
3	Solution methods in optimization and its simulation;
4	Applications to a wide range of engineering problems

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Introduction to Optimal Design - Jasbir S Arora- Mc Graw Hill.	2008
2	Optimization for Engineering Design- Kalyanmoy Deb- PHI	2010
3	Design and Analysis of Experiments- Douglas C Montgomery- WILEY	2005
4	A primer on Taguchi Methodology- Ranjit K Roy	2011
5	System Simulation with Digital Computer- Narsingh Deo, PHI	2009
6	Mathematical Modelling- J N Kanpur, New Age International Publishers	2008

Course Name	**:**	**DYNAMICS OF MACHINES**
Course Code	**:**	**MEN207**
Credits	**:**	**04**
L T P	**:**	**3- 0- 2**

Course Objectives:

At the end of this course, the student should be able to use the concept of force analysis in machinery, speed fluctuations and flywheel calculation, governor, brakes and dynamometers, shaking forces and mass balance, balancing of rigid rotors, gyroscopic effect, mechanical vibrations etc. The student will be able to relate the synthesis and analysis of mechanisms and machines. The student will be able to design a process based on mechanisms for a given application. The student will be able to apply these mechanisms for various machines and help in case of the failure analysis.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**STATIC FORCE ANALYSIS** Equations of equilibrium, Couple, equilibrium of force and four force systems, Free body diagrams, D-Alembert principle, Forces on slider crank mechanism, quick return mechanism & four-bar mechanism with more than two forces acting on a link, slider crank mechanism	5

	with friction at turning pairs and numerical problems	
2	**INERTIA FORCES IN MECHANISM** Determination of forces and couples for a link, inertia of reciprocating parts. Dynamically equivalent system. analytical and graphical methods with and without weight of connecting rod ,inertia force analysis of basic engine mechanism (crank connecting rod and piston etc.). correction couple ,Torque required to overcome inertia and gravitational force of a four bar linkage .inertia torque by analytical method	5
3	**GYROSCOPE** Definition, axis of spin, axis of precision, gyroscope, gyroscopic couple, Gyroscopic effect on the movement of ships and vehicles, ship and plane stabilization, stability of two and for wheeler automobile and locomotive taking a turn, gyroscopic couple on stone crusher and numerical problems	5
4	**FLYWHEEL AND TURNING MOMENT DIAGRAMS** Turning moment and crank effort diagrams for steam and I.C. Engine, dynamics of simple horizontal and vertical engine. Fluctuation of speed, co-efficient of fluctuation of speed and energy, Punching press. Simple problems on turning moment diagrams and the determination of a flywheel taking centrifugal stresses into consideration.	6
5	**FRICTION** Efficiency of inclined plane, limiting friction, laws of friction, angle of repose, Friction in v-threads, screw-jack, efficiency of screw jack, self locking, efficiency of self locking, pivots and collars bearing, flat pivot, flat collar bearing, single and multi plate clutch, cone and centrifugal-clutches, power lost in friction, uniform pressure and uniform wear,friction circle and friction axis of a link.	5
6	**BRAKES AND DYNAMOMETERS** Types of brakes, principles of friction brakes, band, band and block and internal expanding shoe brakes, differential band brake, band and block brake, problems of these brakes, description of vacuum brake, types of dynamometers, measurement of power by prone brake and rope brake dynamometers, Heenan and Froude's Hydraulic dynamometer, Bevis-Gibson"s flash light torsion dynamometer, belt transmission dynamometer.	6
7	**GOVERNORS** Functions, types and characteristics of governors, Watt, Porter and Proell governors. Hartnell and Wilson-Hartnell spring loaded governors.. Sensitivity, stability, isochronism and hunting of governors, governor effort and power, controlling force curve, effect of sleeve friction. numerical problems on these governors	5
8	**BALANCING** Classification, need for balancing, balancing for simple and multiple masses, static and dynamic balancing – Primary and secondary balancing for reciprocating masses, inside and outside cylinder locomotive balancing, swaying couple and variation of tractive effort, hammer blow, partial balancing of locomotive, balancing of the coupled locomotives and its advantages, multi cylinder in line engines (primary and secondary balancing conditions and their applications), balancing of V-engines, balancing machines (Static balancing M/c, dynamic balancing M/c, universal balancing M/c), introduction of balancing of the flexible rotors.	5

List of Experiments:		**Number of Turns**
1	Balance experimentally as far as possible the known unbalanced force due to a rotating weight by introducing two balancing weights in two different planes (a) balancing planes on either side of unbalanced force (b) balancing planes on the same side of unbalanced force.	1
2	Verify experimentally the gyroscopic couple is given by T = T.ω. ωp	1
3	Draw experimentally the approximate straight line be watts mechanism.	1
4	Find out the positions of the four weight, so that the system becomes statically & dynamically balanced.	1

5	Find out experimentally the critical or whirling speed of the given system.	1
6	Study the different types of steering gears find out the value of angle α and ratio of the distance of the point of Intersection of the arms from the front axle to the wheel base for the Ackerman's steering gear fitted in the vehicles.	1
7	Study of the interference under cutting.	1
8	Find the moment of inertia of a given body about an axis passing through C.G. and perpendicular to the plane of the body also calculate the minimum oscillation of the point of suspension be moved period.	1
9	Find out the co-efficient of friction between two given materials with the concept of vibration.	1
10	To find displacement velocity and acceleration of slider in a single slider crank mechanism for different crank angles and draw graphs between x,y and f v/s φ.	1
11	Determination of characteristics curve of the following governors. I. Watt Governor II Porter Governor III Proell Governor IV Hartnell Governor	2
12	Study of the different types of gears	1
13	Experiments of TOM-I and TOM-II plus conolis acceleration set up.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Explain concepts of forces and their effects on machine elements.
2	Design the machine and mechanisms without failure.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Theory of Machines/ V.P. Singh/ M/s Dhanpat Rai & Co. Pvt. Ltd.,	2014
2	Theory of Machines/P.L. Ballaney/Khanna publishers.	1994
3	Theory of Machines/Shigley/Tata McGraw Hill.	1981
4	Mechanism & Machine Theory/J.S. Rao & R.V. Dukhipati/Wiley Eastren Ltd.	1992
5	Theory of Mechanisms/Amitabh Gosh & A.K. Mallik/East West Press Machines Private Ltd.	2006
6	Theory of Machines/S S. Rattan/ McGraw Hill Education (India) Private Limited	2014

Course Name	**:**	**MECHANICS OF MATERIALS**
Course Code	**:**	**MEN208**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to understand the advance topics of strength of materials. The course will prepare the students to apply these to engineering and applied sciences problems

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**COLUMN AND STRUTS**: Definitions, Euler's theory of columns buckling, Euler's equation for various end restraints, Rankine and other empirical formulae	**3**
2	**DEFLECTION OF BEAMS**: Relationship between bending moment, slope and deflection, moment area method, method of integration, Macaulay's method, Use of all these methods to determine slope and deflection for statically determinate and statically indeterminate beams under various loading conditions	**6**

3	**STRAIN ENERGY:** Strain Energy of various types of loads under different loading conditions, total strain energy for a 3-D state of stress, strain energy of dilation and distortion for a 3-D state of stress, deflection of beams via strain energy approach, Castigliano's theorem, Maxwell's reciprocal theorem of deflection and their applications, numerical problems	**5**
4	**THEORIES OF FAILURES**: Different theories of failures including Mohr's & Octahedral theories and their comparisons; Graphical representation and yield locus of these theories of failures for 2-D state of stress, numerical problems	**5**
5	**SPRING** Close and open coiled helical springs under axial load and/or axial moment, leaf spring, flat spiral spring, numerical problems	**5**
6	**CYLINDERS AND SPHERES** Thin cylinders and sphere, thick cylinder and sphere, comparison of thin and thick shell theories, compound cylinders, hub-shrunk on solid shaft, numerical problems	**6**
7	**ROTATIONAL STRESSES** Stresses in rings, disc and cylinders due to rotation with and without hole; Disc of uniform strength; numerical problems.	**6**
8	**BENDING OF CURVED BARS** Stresses in bar of small and large initial curvature, deflection of the curved bars, stresses and deflection of curved bars e.g. crane hook and circular links of various cross section, application of Castigliano's theorem for the curved bars, numerical problems.	**6**

Course Outcomes: By the end of this course, the student will be able to:	
1	Understand the modeling of advance system for its stress analysis.
2	Apply these philosophies in engineering and applied sciences problems.
3	Visualize any mechanical system as a model which is acted upon by various loads and stresses induced in it.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Engg. Mechanics of Solids – E.P. Popav (Pearson Education).	2003
2	Mechanics of Materials by FP Beer and R Johnson, Tata-McGraw Hill Publishers, India	2005
3	Mechanics of Materials- Gere (Thomson Books)	2004
4	An Introduction to the Mechanics of Solids – Crandall & Dahl (McGraw Hill).	2012
5	Mechanics of Material: Kirpal Singh	2007
6	Strength of Material: D S Bedi	2010
7	Strength of Material by R K Rajput.	2012

Course Name	**:**	**APPLIED THERMODYNAMICS**
Course Code	**:**	**MEN209**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of this course, the student should be able to develop an understanding of thermodynamics as it applies to real cycles, develop problem solving skill through the application of thermodynamics and use laboratory studies to rein force knowledge gained in theory classes

Total No. of Lectures – 42

Lecture wise breakup	**Number of**

		Lectures
1	**RECIPROCATING COMPRESSOR:** Use of compressed air in industry, classification of air compressors, work input and the best index of compression, Its thermal and polytropic efficiency, Effect of clearance and volumetric efficiency. Multi stage compression and its advantages.	6
2	**CENTRIFUGAL COMPRESSOR:** Principle of operation, components of a centrifugal compressor complete thermodynamics analysis of centrifugal compressor stage, isentropic and Isothermal efficiencies, work done and pressure rise. Velocity vector diagrams for centrifugal compressors and power calculation, preguide vanes and prerwhirl, slip factor, power input factor, degree of reaction and its derivation, energy transfer in backward, forward and radial vanes. Field of application of centrifugal compressor.	6
3	**AXIAL FLOW COMPRESSOR :** Component of axial flow compressor and their arrangement, Principle of operation, velocity vector diagrams, thermodynamics analysis and power calculation, Factors affecting stage pressure rise, work done factor, Degree of reaction and blade Efficiency and their derivation, Isentropic, Polytropic and isothermal efficiencies. Surging, choking and stalling in axial flow compressors. Characteristics curves for axial flow compressors.	5
4	**STEAM GENERATORS:** Classification of steam generators, Functions of Boiler mountings and accessories, Principles and operations of steam generators. Description of Cochran, Locomotive, Lancashire, Babcock and Wilcox boiler, Modern high pressure boilers with supercritical and sub critical operating temperatures, Characteristics and advantages of high pressure boilers, water treatment and chemical treatment of boilers, water and steam circulation in high pressure boilers ie feed water and condensate cycle, mountings and accessories in boilers, construction and working of generators, efficiency and heat balance sheet of power plant.	5
5	**STEAM ENGINE:** Thermodynamic refinement of Ranking cycle,. Derivation of work done with clearance and compression. Performance of simple steam engine, missing quantity. Compounding of steam engines. Estimation of cylinder dimensions.	4
6	**NOZZLES AND DIFFUSERS:** Types and utility of nozzles. Flow of steam through nozzles. Effect of friction. Nozzle efficiency. Critical pressure conditions for maximum discharge. Supersaturated flow. Classification of diffusers effect of friction and area change the converging – diverging super-sonic diffuser.	4
7	**STEAM TURBINES:** General description of Impulse and Reaction steam turbines, velocity diagrams & work done, Blade efficiency and its derivation, Reheat factor and condition curve, losses in steam turbines, stages in turbine system, the HP and LP bye-pass system, vacuum maintaining in a turbine, load and speed governing of turbine.	2
8	**CONDENSERS:** Utility of condenser. Elements of condensing plants. Brief description of different types of condensers. Dalton's law of partial pressure applied to condenser problems, condenser and vacuum efficiencies. Cooling water calculations. Effect of air leakage. Method of checking and preventing air infiltration. Description of air pump and calculation of its capacity	5
9	**ELEMENTS OF POWER PLANTS:** Types of power plants, Selection of site for steam power plants. Base load and peak load of power plants. Variable load, Heat balance, Economics of power generation. Elements of nuclear power production.	3

List of Experiments:		**Number of Turns**
1	To study the construction and operation of a two stroke and four stroke petrol & diesel engine.	1
2	To draw the valve timing diagram for a Diesel Engine.	1
3	To find the Volumetric Efficiency, Brake Thermal Efficiency Mechanical Efficiency, Frictional Power, Indicated Power Heat Balance sheet of Variable Compression Ratio Petrol Engine at different Compression Ratios and study its affect on various parameters.	1
4	To estimate the Indicated Power, Friction Power and Mechanical Efficiency of a multi-cylinder Petrol Engine when running at constant speed under constant settings of a carburetor by cutting one, the power of one cylinder each in turn (Morse test).	1

5	To find the Volumetric Efficiency, Brake Thermal Efficiency, Mechanical Efficiency, Frictional Power, Indicated Power, Heat Balance Sheet of Variable Compression Ratio Diesel Engine at different Compression Ratios and Study its effect on various parameters.	**2**
6	Trial of a steam engine from no load to full load. Determination I.H.P., B.H.P., mechanical efficiency, brake thermal efficiency and relative efficiency. Plot the variation of these efficiencies against B.H.P. and the power consumption curve (steam consumption and specific steam consumption). Also to draw up the heat balance sheet.	**2**
7	To obtain a power consumption curve, thermal and mechanical efficiency curve for a compound steam engine when tested over the range of power out put from no load to full load.	**1**
8	Study of fire tube boilers-its mountings and accessories.	**1**
9	Study of water tube boiler-its mountings and accessories.	**1**
10	Study of two stage reciprocating compressor.	**1**

Course Outcomes: At the end of this course, the student will be able to :	
1	Develop problem solving skills through the application of thermodynamic
2	Develop basic understanding of various devices like compressor steam generator and various Elements of Thermal Power Plant

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Heat Engineering, Metorpolitan Co. Pvt., Ltd., Delhi, Vasandani and Kumar.	2013
2	Thermal Engineering, Khanna Publisher Delhi, P.L. Ballaney	2005
3	Engineering Thermodynamics, Work and Heat Transfer, ELBS-Publication, Rogers and Mayhew.	1996
4	Thermodynamics and Heat Engines (Vols. I & II), Central Publishers, Allahabad, R. Yadav.	2000
5	Applied Thermodynamics, ELBS Publications, T.D. Eastop & Amc. Conkey.	1996

Course Name	**:**	**REFRIGERATION AND AIRCONDITIONING**
Course Code	**:**	**MEN- 210**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to understand the basic principles of working of Refrigeration Systems & Air Conditioning System, the in and out constructional & working details of the various components of Refrigeration System like evaporators, compressor etc and to design the air conditioning load for a particular building.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**REFRIGERATION** : Refrigeration effect, cooling capacity and C.O.P. of a refrigerator, E.P.R. of heat pump, Reversed Carnot Cycle	2
2	**AIR CYCLE REFRIGERATION: ANALYSIS OF BELL COLEMAN CYCLE;** Need of aircraft refrigeration and air conditioning; Analysis of different Air Cycle Refrigeration Systems for aircraft.	4
3	**VAPOUR ABSORPTION REFRIGERATION**: (Only Introduction: No Derivation)Simple vapour absorption refrigeration; Modifications to	4

	simple vapour absorption refrigeration system; Actual vapour absorption refrigeration system Electrolux system; Lithium BromideWater absorption refrigeration system; Solid-Vapour absorption and absorption refrigeration system.	
4	**VAPOUR COMPRESSION REFRIGERATION**: Vapour compression Cycle on P-V, P-H and T-S diagrams; Deviation of actual Cycle from theoretical one; Mathematical analysis of theoretical and actual vapour compression refrigeration cycle; effect of suction pressure, discharge pressure, sub-cooling, superheating and pressure drop in valves.	4
5	**MULTI-PRESSURE VAPOUR COMPRESSION REFRIGERATION** : Single load compound compression with single expansion and water intercooling; single load compound compression with individual expansion valve and flash intercooling; Multiple load systems with individual expansion valves and individual compressors; Single Load Compound Compression with flash tank and water intercooling; Single Load Compound with flash chamber as intercooler.	4
6	**CONVENTIONAL REFRIGERANTS AND THEIR ENVIRONMENTAL ASPECTS WITH CONSEQUENCES**: Refrigerants: Classification, designation, field of applications, thermodynamic, chemical and physical properties of refrigerant; comparison of commonly used refrigerants (e.g. Ammonia, R-11, R-12, R-22); Environmental aspects of conventional refrigerants and their consequences; Alternate refrigerants and the problems associated with their use.	4
7	**NON-CONVENTIONAL REFRIGERANT SYSTEMS**: Steam Jet Refrigeration; Cascade Refrigeration System; Mixed Refrigeration System; Martinovsky Open Cycle; Vortex Tube Refrigeration; Thermoelectric Cooling, Modern Air Condition Systems like HVAC ,Variable refrigerant volume (VRV/VRF)	5
8	**CRYOGENICS**: Definition, Cryogenic fluids, storage and insulation; Linde-Hampson and Cloude Liquification Cycles (NO ANALYSIS); Adiabatic Demagnetization; Applications.	2
9	**AIR-CONDITIONING**: Definition, Applications; Psychometric properties of air; Dry bulb, wet bulb and dew point temperatures; Relative and specific humidity; Enthalpy of air and water vapours; Human requirements of comfort; Effective temperature.	5
10	**BASIC PROCESSES IN CONDITIONING OF AIR AND AIR CONDITIONING EQUIPMENT**: Sensible cooling and heating of air; simple humidification and dehumidification of air concept of bypass factor; cooling and dehumidification; Evaporative cooling; chemical dehumidification; air washer.	4
11	**LOAD CALCULATIONS AND SUPPLY AIR CONDITIONS**: Sources of heat load; sensible and latent heat load; sensible heat factor; apparatus dew point temperature; quality and state of supply air for air conditioning of various buildings; Load calculations for comfort and cold storage air conditioning.	4

Course Outcomes: At the end of this course, the student will be able to :	
1	Understand the basic principle of working of Refrigerator & Air conditioner.
2	Understand how to analyse the Refrigeration Cycles.
3	Understands the various air conditioning processes & their effect on Human Comfort.
4	Understands the various equipments used in Refrigerator.
5	Understands how to do the design load calculations for air conditioning a building.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Refrigeration and Air Conditioning - W.F. Stoecker, McGraw Hill.	1986
2	Refrigeration and Air Conditioning - Jordon and Priester, Prentice Hall of India	2009
3	Principles of Refrigeration - R.J. Dossat, Wiley Eastern	2001

4	Refrigeration and Air Conditioning - C.P.Arora, Tata McGraw Hill	1997
5	Refrigeration and Air Conditioning - Manohar Prasad New Age International (Pvt.) Ltd., Publishers.	2010
6	Refrigeration and Air Conditioning - P.L. Ballaney, Khanna Publishers	2012

Course Name	**:**	**PRODUCTION ENGINEERING**
Course Code	**:**	**MEN 301**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course, the student should be able to apply the basic knowledge on working of Production Process Tools and their design. The student should have the knowledge of work holding fixtures and their design. He should be able to design press tools and dies for simple jobs. He should be able to implement economic equipment selection of tools. He should have the knowledge of surface measuring tools and production of high finish surface and its measurement.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**MECHANICS OF METAL CUTTING:** Oblique cutting, orthogonal cutting, Types of chips, Tool signature, Tool wear, Shear angle determination, forces in metal cutting, Merchant diagram. Economics of metal cutting, Dynomo metre and cutting forces measurement. Introduction to machining pera- meter optimization.	**7**
2	**SPECIAL MACHINE TOOLS AND TOOL LAYOUT**: Capstan and Turret lathes. methods of holding jobs on the Turret lathe Universal Chucking equipment, Universal Bar Equipment, CNC Lathe process / Operation sheet; Time required for operation, Tool layout and Cam layout..	**7**
3	**JIGS & FIXTURE DESIGN:** Principles of jig and fixture design, Principle of Degrees of freedom, Methods of location and clamping, Various devices for location and clamping, Indexing devices, Hydraulic and pneumatic actuation of clamping devices, Jig bushes, Use of standard parts for jig design, types of drilling jigs, Milling fixtures, Lathe fixtures, Grinding fixtures and their classification.	**7**
4	**DIE DESIGN:** Components of die design, design of die blocks, punches and strippers, methods of holding, Design procedure for press tool Piercing and Blanking operation; Forging die design for forged parts.	**8**
5	**METROLOGY& HIGH FINISH GENERATION PROCESSES:** Limits, fits and tolerances, Limit gauges, Gauge Design, Automated inspection and CMM, Demonstration of various measuring equipments, Elements of surface finish, Indian standards on surface finish, Relation of surface finish to the production methods. Introduction to Advanced and Nano finishing operations.	**7**
6	**ECONOMICS OF TOOLING:** Break-even Analysis, Cost estimation, Cost optimization, Optimum cutting speed and feed. Problems on machining time estimation..	**6**

Course Outcomes: After The course the student will be able to	
1	Design press tool dies for simple piercing and blanking operatios.
2	Select and design the work holding jis and fixtures for common machining operations.
3	Carry out the analysis for economic tool selection by using break even analysis.

4	Solve problems on mechnica of metal cutting and determine cutting parameters in machining process.
5	Layout the sequence of operations for jobs given and prepare an operation sheet.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Tool Design – Donaldson. TMH Publication	2010
2	Fundamentals of tool Design – ASTME	2010
3	Production Engineering by P.C.Sharma S Chand Publications	2014
4	Jig and Fixtutre Design Edward G Hoffman Cengage learning	2004
5	Tool Design by C B Cole , American Technical Society & D. B. Taraporewala and Sons Co.	1985
6	Manufacturing Technology (Machining) – P.N. Rao-Tata Mc.Graw Hill, 2nd Edition	2009

Course Name	**:**	**HEAT TRANSFER**
Course Code	**:**	**MEN- 302**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of this course, the student should be able to apply the basic laws/mechanisms of heat transfer, calculations involved in different fields of thermal engineering. e.g. boilers, thermal design of different equipments.e.g. evaporators, heat exchangers, Thermal Analysis of different equipments.e.g. evaporators, heat exchangers, different procedures involved in solar radiation based thermal-equipments, determination of time span of Heat treatment of metals and heat transfer application in the thermal systems: cooing of i.e. engines, micro-electronic chips, nuclear fuel rod, solar collector, energy savings (energy audit) R & A/C systems, power plants, process industries.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CONDUCTION HEAT TRANSFER:** Radiation Heat Transfer, Dimensions and Units, Steady-State Conduction - 1Dimension,Introduction, The Plane Wall, Insulation and R values, Radial Systems The Overall Heat-Transfer Coefficient, Critical Thickness of Insulation, Heat-Source System, Cylinder with Heat Sources, Thermal Contact Resistance, Stead-State Conduction-Multiple Dimensions, Introduction to Mathematical Analysis of Two-Dimensional Heat Conduction. Graphical Analysis, The Conduction Shape Factor. Numerical Method of Analysis, Numerical Formulation in Terms of Resistance Elements, Gauss-Seidel Iteration, Accuracy Consideration, Conduction-Convection System Fins with uniform cross-sections	8
2	**UNSTEADY-STATE CONDUCTION:** Introduction, Lumped-Heat-Capacity System, Transient Heat Flow in a Semi-Infinite Solid, Convection Boundary Conditions. Multidimensional System Transient, Thermal Resistance and Capacity Formulation	4
3	**PRINCIPLES OF CONVECTION:** Introduction, Viscous Flow, Inviscid Flow, Laminar Boundary Layer on a Flat Plate, Energy Equation of the Boundary Layer, The Thermal Boundary Layer, The Relation between Fluid Friction and Heat Transfer, Turbulent-Boundary-Layer Heat Transfer, Tube Flow, Turbulent Flow in a Tube, Empirical and Practical Relations for Forced-Convection Heat Transfer. Introduction, Empirical Relations for Pipe and Tube Flow, Flow Across Cylinders and Spheres. Flow Across Tube Banks, Liquid-Metal Heat Transfer	5

4	**NATURAL CONVECTION SYSTEMS** Introduction, Free-Convection Heat Transfer on a Vertical Flat Plate. Empirical Relations for Free Convection, Free Convection from Vertical Planes and Cylinders. Free Convection from Horizontal Cylinders, Free Convection from Horizontal Plates. Free Convection from Inclined Surfaces, Free Convection from Spheres, Empirical co-relation and analogy for turbulent flow forced convection over extension surface.	3
5	**RADIATION HEAT TRANSFER:** Introduction, Physical Mechanism, Radiation Properties/laws, Radiation Shape Factor, Relations between shape factors, Heat exchange between non black bodies, Infinite Parallel Planes, cylinders, spheres, Radiation Shields. Solar Radiation, Effect of Radiation on Temperature Measurement.	10
6	**BOILING AND CONDENSATION:** boiling types, mechanism, Pool Boiling: Nucleate Boiling, CHF Flow Boiling: Plug/Slug flow, types, Mechanism Film-wise / Drop wise Condensation	4
7	**HEAT EXCHANGERS:** Introduction, Analysis of Heat Exchangers: LMTD for parallel flow HX, LMTD for counter Flow HX, Effectiveness for parallel Flow /Counter Flow HX, Design of HX, Compact Heat Exchangers, Cross flow Heat Exchangers Some Important Topics from current research.	8

List of Experiments:		**Number of Turns**
1	To determine thermal conductivity of metal rod (Al, Brass and Steel)	1
2	To determine thermal conductivity of insulting metal.	1
3	To determine thermal conductivity of composite wall	1
4	To determine thermal conductance of heat pipe & compare it with other metal rods.	1
5	To determine thermal conductivity of insulator speciMENby guarded hot plate method	1
6	To determine heat- transfer coefficient in natural convection	1
7	To study heat transfer from a pin-fin in natural & forced convection mode	1
8	To determine heat - transfer coefficient in forced convection.	1
9	To find heat transfer coefficient for drop-wise and film-wise condensation process	1
10	To determine overall heat transfer coefficient & compare it with value obtained from standard correlation	1
11	Study of CHF & pool-boiling	1
12	To determine effectiveness of parallel/counter flow heat exchange	1
13	To determine Stefan Boltzmann constant of radiation heat transfer.	1
14	To determine the emissivity of a non-black surface	1

Course Outcomes: At the end of this course, the students will be able to:	
1	Analyze the different alternatives of heat exchangers
2	Design/analyze (thermal)a heat exchanger, evaporator etc
3	Design/analyze solar based energy conversion system .

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Engineering Heat Transfer-R.C.Sachdeva (New Age)	2012
2	Fundamentals of Heat and Mass Transfer-f.p. Incropera,d.p.dewitt (Wiley India Edition)	1997
3	Heat Transfer-J.P.Holman (Mc Graw Hill)	2014
4	Engineering Heat And Mass Transfer-M.M.Rathor (University Science Press)	2015
5	Fundamentals of Heat & Mass Transfer-C. P. Kothandaraman (New Age)	2012

Course Name	**:**	**DESIGN OF MECHANICAL SYSTEMS**
Course Code	**:**	**MEN303**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to develop mechanical systems consisting of wide range of machine elements. Basic design of different machine elements will be discussed.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**DESIGN OF FLEXIBLE MACHINE ELEMENTS;** Belts (Flat & V) types of drives/orientations of driving& driven shaft covered by flat belts along with design of belts, pulleys, keys & shafts. Types of V-belts, their power ratings & design thereof. Ropes (Wire & Fiber). Their specifications, materials, long distance ranges, power ranges and design. Design of wire ropes for hoisting and mine lifting. Chains- roller chains, their designation by IS numbers, designing w.r.t. sagging, centrifugal & transmittal loads. Complete sizing of sprockets.	8
2	**DESIGN OF SPRINGS** Helical (compression, tension, conical, spiral, torsion) complete design for static, dynamic and variable loads along with factors for curvature, direct stresses. leaf springs- concepts of equivalent simply supported and cantilever beams, master & other graduated leaves, nip, spring of uniform strength and designing thereof.	6
3	**BEARINGS** Selection of a sliding and Rolling Type of Bearings Design of Journal Bearing, Somerfield numbers, bearing modulus material for journal bearing, types of lubricants, their designated numbers. Concept of bearing body, oil & environment temperatures. Calculation of heat generated and dissipated. Design of bearing bap & bolts. Design of Rolling Contact Bearings- their designation w.r.t. duty, type & diameter. Concepts of catalogue, average and rating life. Bearings subjected to different loads for different time during one cycle and their equivalent basic dynamic load carrying capacity calculations.	6
4	**DESIGN OF CLUTCHES & BRAKES** Design of Clutches (Axial and Radial friction clutches), clutch load characteristics, mechanical clutches (friction clutches) design for uniform wear & pressure stings. Centrifugal clutches design. Brakes- Design of single & double block brakes. Concepts of self-locking brakes. Design of External& Internal shoe brakes. Band Brakes and Band & Block brakes.	5
5	Design of Fly Wheels, fluctuation of energy, flywheel effect, stresses in flywheel rim due to centrifugal action, change of speed & shrinkage. Stresses in flywheel arms with arms as free cantilever and guided lever.	3
6	**DESIGN OF GEAR DRIVES** Factors influencing the choice of a gear Design Details of Spur gears Design Details of Helical gears Design Details of worm gears Design Details of bevel gears Nomenclature & designing of all gears from basics of tooth loading as done by Lewis and checks for dynamic loading by Buckingham equations, beam strength. Wear load calculations and design of shafts for all gears.	10
7	Introduction to some high end CAD & design analysis software. Designing with examples.	4

Course Outcomes: At the end of this course, the students will be able to:

1	Design a mechanical system with special focus on power transmission
2	Design support system for power transmission (e.g. support of shafts with bearings, shock absorption with springs and smooth functioning of the same with flywheels)

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Mechanical Engineering Design, Shingle, J.E. Shigley & Charles R. Mischke Tata McGraw Hill, 6th edition	2003
2	A Text Book of Machine Design, P.C.Sharma & D.K.Aggarwal,S.K.Kataria & Sons,New Delhi,12th edition	2012
3	Machine Design Robert L Norton, Pearson.	2012
4	Fundamentals of Machine Component Design, Robert C. Juvinall & Kurt M. Marshek, John Wiley & Sons, INC. 3rd edition	2000
5	Design of Machine Elements, V.B. Bhandari,Tata Mc Graw Hill 2nd edition	2007

Course Name	**:**	**MECHANICAL VIBRATIONS**
Course Code	**:**	**MEN304**
Credits	**:**	**4**
L T P	**:**	**3-1/2-2/2**

Course Objectives:
At the end of this course, the student should be able to describe and implement the Mechanical Vibration concepts to one, two, multi and infinite degree of freedom systems with different systems components. The course will prepare the students to apply the concept of Vibration in any engineering system design.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** Basic concept of vibration, Importance and scope, definition and terminology, representation and analysis of harmonic motions/series and, Fourier series, beat phenomenon, work done by an harmonic force on an harmonic motion, introduction to various types of vibrations and types of excitation.	**4**
2	**SINGLE DEGREE OF FREEDOM SYSTEMS:** **UNDAMPED FREE VIBRATIONS:** D' Alemberts Principle, Energy method, Rayleigh method, Newton's second law of motion and its applications in these problems, equivalent spring stiffness. **DAMPED FREE VIBRATIONS:** Introduction to viscous damping, sub-critical, critical and over-damping systems and its solutions, logarithonic decrement, frequency of damped oscillations; Dry friction, Structural damping and Slip damping and its analysis **FORCED VIBRATIONS:** Force vibration analysis for constant harmonic excitation, rotating & reciprocating unbalance masses, support excitation, structural damping, coulomb damping and non-harmonic excitations; Vibration isolation and transmissibility, vibration measuring instruments	**4** **6** **7**
3	**TWO DEGREE OF FREEDOM SYSTEMS:** Undamped, damped and forced harmonic vibrations, principal mode of vibration, normal modes, nodes, natural frequencies, mode shapes, Torsional vibrations of two rotor systems, application of Two degree of freedom in dynamic vibration absorber, centrifugal pendulum absorber, Torsional vibration absorber	**7**
4	**MULTI-DEGREE OF FREEDOM SYSTEMS - EXACT ANALYSIS**	

	Undamped free vibrations, Reciprocity theorem, Matrix Inversion method, Eigenvalues & Eigenvectors, orthogonal properties of normal modes, modal analysis, torsional vibrations of multi rotor system; Free vibration analysis of string, longitudinal vibrations of bar, transverse vibration of beam, torsion of vibrations of circular shaft under various end conditions.	**7**
5	**MULTI-DEGREE OF FREEDOM SYSTEMS- NUMERICAL METHOD** Rayleigh, Dunkerley, Stodola, Holzer, Matrix Iteration and Rayleigh-Ritz methods as applied to multi degree of freedom systems, Eigenvalues & Eigenvectors, characteristic equation and comparison of natural frequencies by these methods	**7**

List of Experiments:		**Number of Turns**
1	To determine the mass movement of inertion of a body by trifilar suspension.	**1**
2	To find the viscosity of a given fluid by the concept of vibrations.	**1**
3	To find the damping co-efficient of a given damper system by free torsional vibrations.	**1**
4	To determine the damping co-efficient of a damper in a free transverse vibrations.	**1**
5	To find the damping factor ratio of a damper system by forced vibrations.	**1**
6	Investigation of node and antinode position for a beam.	**1**
7	Investigation of node and antinode position for a cantilever.	**1**

Course Outcomes: By the end of this course, the student will be able to:	
1	Apply the concept of Mechanical Vibration to one, two, multi and infinite degree of freedom systems with different systems components.
2	Apply the concept of Mechanical Vibration in engineering and applied sciences problems in general.
3	Understand this as a fundamental tool for modeling and analyzing mechanical system.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Mechanical Vibrations", G. K. Grover, Nem Chand & Bros, Roorkee	2009
2	"Mechanical Vibrations", V. P. Singh, Dhanpat Rai & Sons, Delhi	2012
3	"Theory and Practice of Mechanical Vibrations", J. S. Rao & K. Gupta, New Age International (Pvt.) Ltd., New Delhi	2002
4	"Fundamental of Vibration", Balachandran and Magrab, Cengage Learning	2009
5	"Mech. Vibration & Noise Engg.", A.G.Ambekar, PHI	2006
6	"Mechanical Vibration", D.Nag Wiley	2012

Course Name	**:**	**COMPUTER AIDED DESIGN, AND MANUFACTURING**
Course Code	**:**	**MEN305**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

At the end of this course, the students should be able to understand and handle product design and development problems in a systematic manner, difference phases of product development and appreciate the role of computers and CAD software's for modeling, analysis and manufacturing of mechanical products, gain practical experience in handling 2D drafting and 3D modeling software systems, know the basics of CNC machines and understand the concepts of G and M codes and manual part programming and to apply CAD in real life applications.

Total No. of Lectures – 42

Lecture wise breakup	**Number of Lectures**

1	**COMPUTER AIDED DESIGN:** Fundamentals of CAD: The Design Process, Applications of computers for design, Benefits of CAD. CAD/CAM Systems: Systems Configuration & Components Graphics terminal, Input-Output devices, CPU. Computer Graphics, Geometric Modeling & Transformations: Functions of a graphic package Geometric transformations, Homogeneous transformations, Composition of transformations, Geometric Modeling Approaches – Wire frame vs. Solid Modeling, CADCAM data exchange. Computer aided drafting.	**8**
2	**NUMERICAL CONTROL PRODUCTION SYSTEMS:** Conventional Numerical Control, CNC Specifications, NC/CNC Part Programming, DNC, CNC & Adaptive Control.	**6**
3	**INDUSTRIAL ROBOTICS:** Robot Anatomy, Robot Specifications, End Effectors, Robotic Sensors, Robot Programming Applications.	**4**
4	**GROUP TECHNOLOGY L AND CELLULAR MANUFACTURING SYSTEMS:** GT implementation, Part family formation, Classification & coding systems, Benefits of GT Cellular Manufacturing.	**4**
5	**COMPUTER AIDED PROCESS PLANNING:** Process Planning function, Retrieval & Generative process planning systems, Feature Recognition in CAPP, Benefits of CAPP, Machine-ability Data systems, Computer generated time standards.	**6**
6	**COMPUTER INTEGRATED PRODUCTION MANAGEMENT SYSTEMS:** Inventory Management and Materials Requirement Planning: Inventory Management, MRP, MRP inputs, outputs and working, Benefits of MRP. Shop Floor Control & Computer Process Monitoring: Functions of shop floor controls. The shop floor control system, operation scheduling, Factor Data Collection System, Computer Process Monitoring.	**5**
7	**COMPUTER CONTROL** **Control Systems:** Linear Feedback Control Systems, Optimal Control, Sequence Control & Programmable Controllers, Computer Process Control. **COMPUTER AIDED QUALITY CONTROL:** Terminology in quality control. The computer in QC, Contact inspection methods, Computer aided testing.	**5**
8	**COMPUTER INTEGRATED MANUFACTURING SYSTEMS (CIMS):** Types of manufacturing systems, Machine tools and related equipment, Material Handling system, computer control system. Human Labor in the manufacturing system, Benefits of CIMS.	**4**

List of Experiments:		**Number of Turns**
1	Drafting/ Sketching of given geometry using CAD softwares: AutoCAD, CATIA, Pro/E	2
2	Assembly modeling (for any 2 assemblies or sub assemblies)- using top down and bottom up approaches inclusive of sketching, part modeling (using solid and surface modeling / styling tool boxes), drafting (parts and assemblies).	2
3	CAD File / data exchange amongst the various CAD softwares for CMM, CAE, CNC, CAM	2
4	Using any FEA software packages, solve the problem on (a)structural mechanics (b) heat transfer	2
5	Generation of NC Codes / tool path for a given geometry using CAM softwares.	2
6	Preparing different jobs on Lathe, shaper and milling machines.	2
7	Micro Machining (turning and drilling) on drill EDM and CNC precision micro machine tool.	2

Course Outcomes: At the end of this course, the students will be able to:	
1	Students will understand the role of computers in the different phases of product design, development cycle in a systematic manner.
2	Students will acquire the entry level skills in the domain of Computer aided design, drafting and

	Manufacturing.
3	Explain the basic concepts of CNC programming and machining. Compare and distinguish the difference between the operation and programming of a CNC machine tool using manual programming.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Computer Aided Design & Manufacture, Zimmer & Groover	2008
2	CAD/CAM Theory and Practice, Ibrahim Zeid McGraw-Hill	2009
3	Computer Aided Manufacturing, by P. N. Rao, N. K. Tewari and T. K. Kundra	1993
4	Computer Integrated Design and Manufacturing, by David Bedworth, Mark Henderson and Philip Wolfe	1991
5	Automation, Production systems and Computer Integrated Manufacturing, by M. P. Groover	1980

Course Name	**:**	**PRODUCTION AND OPERATION MANAGEMENT (ELECTIVE-I)**
Course Code	**:**	**MEN401**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of the course, the student should be able to understand the basic concepts of Production management, forecasting, Plant layouts, Sequencing and scheduling, Inventory control, Project management techniques and reliability. The student should also be able to apply the studied concepts in the actual practice in industries.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION OF PRODUCTION MANAGEMENT:** System concept, Types of Production Systems Product Design and Analysis, Value Engineering and analysis, Standardization and simplification, Make-buy decision, Concurrent Engineering.	5
2	**CAPACITY PLANNING AND INVESTMENT DECISION:** Plant capacity and capacity planning strategies, Investment decisions. Appraisal of financial decision.	4
3	**FORECASTING:** Time Series Analysis; Correlation and regression, Exponential Smoothing, simple and with trend correction. Decomposition algorithm and exponential smoothing for seasonal data. Measuring forecasting accuracy.	7
4	**PLANT LOCATION & LAYOUT:** Mathematical Models for single and multi-facility, Euclidean and Rectilinear problems. Minimum location problem, covering problem Layout Design – Heuristic algorithms: CRAFT, ALDEP and CORELAP.	4
5	**MATERIALS MANAGEMENT AND INVENTORY CONTROL:** Inventory costs, Deterministic and Probabilistic inventory models with EOQ ordering System, Materials Requirement Planning.	6
6	**SCHEDULING AND SEQUENCING**: Mathematical and Heuristics for scheduling in job shop and flow shops, methods of sequencing on 'n' jobs in single, two and multi machines, Calculations of Mean flow time, tardy jobs, lateness, average inventory etc.	6
7	**PROJECT MANAGEMENT:** PERT and CPM networks for project Management, Critical and non-critical activities, Types of floats and slacks, A-O-A and A-O-N networks, Crashing of activities, Project scheduling	7

	with resource constraints. Resource leveling.	
8	**MAINTENANCE PLANNING AND CONTROL** : Types of Maintenance, Replacement Problems Probabilistic Maintenance model, Reliability and its improvement, Total Productive Maintenance.	3

Course Outcomes: At the end of this course, the students will be able to:	
1	Understand the basic concepts and applications of forecasting techniques.
2	Understand the various aspects of plant capacity, Plant layouts and location, scheduling and sequencing.
3	Understand the concepts inventory control models of Materials Management and material requirement planning.
4	Come up with new ideas for scheduling and Project Management
5	To understand the concepts of maintenance and Reliability.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Production Management", Buffa and Sarin, John Wiley Publication,	2012
2	"Operations Research – An Introduction" A.H. Taha, Macmillan Co., New York.	2012
3	"Computer Aided Production Management", P.B. Mahapatra, PHI, India	2010
4	"Operation Research", Gupta and Hira, S. Chand Publication, Delhi	2013
5	"Industrial Engg. & Production Management", M. Mahajan, Dhanpat Rai & sons, Delhi	2012

Course Name	**:**	**MAINTENANCE ENGINEERING**
Course Code	**:**	**MEN402**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, the student should be able to understand the role and contribution of maintenance towards achieving competitive advantage in the industries , understand key concepts and issues of Maintenance in both manufacturing and service organization, understand the various strategies, philosophy, scheme and schedules of maintenance engineering and it applications in the industry.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Maintenance Concept, objectives and characteristics of maintenance function, organizational set up of the maintenance system, responsibilities of the maintenance department, Types of maintenance: corrective, operating practices in Maintenance, Benefits and Effects of maintenance.	5
2	**MAINTENANCE PLANNING AND CONTROL** Planning of maintenance function; Present material policy for maintenance, classification of spare, spare parts provisioning, spare parts inventory, ABC analysis, FSN Approach, XYZ approach, VED approach, Work planning and scheduling, Long-range and short range planning; Man power allocation; Estimation of maintenance work and control.	5
3	**MAINTENANCE ACTIVITIES AND EVOLUTION**: Evolution of alternative maintenance, Polices breakdown, Preventive and Predictive maintenance, Fault diagnosis and control monitoring techniques, Simulation of alternative practices, Safety aspect in maintenance, Housekeeping practices, Total productive maintenance.	5
4	**RELIABILITY AND AVAILABILITY OF ENGINEERING SYSTEMS** Reliability and Maintainability, Bathtub Hazard Rate concept, Quantitative estimation of	

	reliability of parts, Reliability, maintainability, failure, availability, Reliability structure and optimum design configuration of series, parallel, combination of series and parallel, redundancy structure. Mean time to failure (MTTF), mean time between failure (MTBF), mean time to repair (MTTR). Accuracy and confidence of reliability estimation, Statistical estimation of Reliability Indices, Machine failure pattern: Breakdown time distribution	8
5	**MAINTENANCE IN SERVICE** Maintenance Requirement: Mechanical, Electrical, Process and Service equipment; Maintenance Aspect: Lubrication; Chemical control of corrosion Condition monitoring technique, computerized Maintenance information system, computerized condition Monitoring, Maintenance Decision making.	6
6	**ECONOMIC ASPECT OF MAIANTENANCE** Cost of machine breakdown, Estimation of life cycle cost, Impact of maintenance cost, Application of work measurement in maintenance; selection of Manpower and Training, Incentive Payment of Maintenance workers.	5
7	**INSPECTION, TESTING AND QUALITY CONTROL IN MAINTENANCE** Inspection, Testing and Quality Control in Maintenance, Definitions, Importance of Inspection and testing in maintenance, Inspection internal as Frequency, Destructive Non destructive and semi destructive testing, liquid penetration test, magnetic particle test, ultrasound test, vibration analysis, oil analysis, Definition and importance of Quality control in Maintenance, Statistical Quality Control Tools and Techniques.	8

Course Outcomes: Upon completing this course, students will be able to:	
1	Understand the strategic role of Maintenance/Reliability engineering in asset life cycle optimization.
2	Apply analytical skills and problem-solving tools/techniques to the fault analysis of various machines and equipments.
3	Practice safe work procedures utilizing and understanding other safety regulations in troubleshoot typical industrial mechanical systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"A text Book of Reliability and Maintenance Engineering", Alakesh Manna, I.K.International Publishing House Pvt.Ltd, New Delhi.	2011
2	"Preventive Maintenance", Terry Weriman – Reston Publishing Company.	1984
3	"Principle of planned maintenance", Clifton R. H, McGraw Hill.	1983
4	"Maintenance Planning and Control", Enthory Kelly, EWP.N.Delhi.	1984

Course Name	**:**	**ENERGY CONVERSION**
Course Code	**:**	**MEN411**
Credits	**:**	**4**
L T P	**:**	**3- 1- 0**

Course Objectives:
At the end of this course, the student should be able to understand the different energy conversion technologies, thermodynamic analysis of various energy conversion devices and reinforce fundamentals of Hydraulic Turbines and pumps**.**

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**THERMODYNAMICS OF I.C. ENGINES** Combustion in SI Engines: Combustion in S.I. Engines, Combustion Phenomenon, Flame	**8**

	speed, ignition delay, effect of engine variables on Delay period, abnormal combustion, Preignition, detonation, effect of various engine parameters on detonation, effect of detonation on engine performance and methods employed to reduce detonation. Combustion chamber design for S.I. Engines. Combustion in CI Engines: Combustion in C.I. Engines, Combustion phenomenon, Delay period, Diesel Knock, CI Engine Combustion Chambers, High speed cinematography for combustion visualization – a brief note. Fuels: Rating of SI Engines fuel, Cetane ratings of CI Engine fuels, Octane and Cetane numbers. Performance of IC Engines: Performance curves of C.I. and S.I. engines. Overall IC Engine performance (engine sizing, mean effective pressure (MEP), power and torque). Effect of compression ratio and of air fuel ratio on power and efficiency of an engine. Variation of engine power with altitude, supercharging, its advantages and its applications, types of superchargers.	
2	**GAS TURBINES;** Position of gas turbine in power industry, classification of Gas turbines, on the basis of system of operation and on the basis of combustion (at constant volume or at constant pressure). Thermodynamics of constant pressure gas turbine cycle, calculation of net output, work ratio and thermal efficiency of ideal and actual cycles, cycle air rate, temperature ratio, effect of change in Sp. Heat and efficiency of ideal and mass of fuel o power and efficiency. Operating variables and their effects on thermal efficiency and work ratio. Thermal refinements and their effects on gas turbine cycle. i.e. gas turbine cycle with regeneration, inter cooling and reheating, multistage compression and expansion, pressure losses in heat exchangers and combustion chambers. Comparison of gas turbine with a steam turbine and I.E. engine. Field of application of gas turbines.	**8**
3	**AIRCRAFT PROPULSION USING GAS TURBINE:** Principle of propulsion thrust work and thrust power, propulsion efficiency, Overall thermal efficiency, specific fuel consumption. Intake and Propelling nozzle efficiencies, classification and comparison of ram jets, turbojets, turbo props, pulse jets and rockets. Thermodynamics cycle analysis and efficiencies of propulsive devices of turbojet engine.	**4**
4	**IMPULSE TURBINE** General description, pressure and velocity compounding, Velocity diagram and work done. Blade efficiency and overall efficiency Reheat factor and condition curve.	**3**
5	**REACTION TURBINE:** Degree of reaction, Velocity diagrams, blade efficiency and its derivation. Calculation of blade height etc. Requirement of an ideal working fluid, binary vapour cycles, losses in steam turbines.	**3**
6	**PRINCIPLLES OF HYDRAULIC TURBINE** Force of jet on stationery moving flat and curved plates flow over radial vanes, velocity triangles, Determination of power. Different types of runner, Description of Pelton and Turgo Impulse Turbines, Simple design features of Pelton turbines such as number of jets, number of buckets, depth and width of buckets, velocity diagram, jet ratio, power and efficiency. Description of Francis, Kaplan Turbines and other reaction turbines, velocity diagrams, speed ratios, flow ratio, degree of reaction as applied to Kaplan and Francis Turbines, Cavitations, Various types of draft tubes, Governing of hydraulic turbine and performance of hydraulic turbines.	**8**
7	**CENTRIFUGAL PUMPS:** Brief description and classification of Centrifugal pumps (Radial flow, Axial flow, mixed flow, Single Stage and Multistage). Priming and priming devices. Velocity triangles, work done, pressure rise, various efficiencies, Minimum starting speed, impeller diameter.	**3**
8	**RECIPROCATING PUMPS:** Slip and coefficient of discharge, Effect of acceleration on pressure in suction and delivery pipes, Air vessels (work saved by air vessel on suction and delivery pipe). Comparison with centrifugal pumps.	**3**
9	**DIRECT ENERGY CONVERSION:** Introduction & thermodynamic aspects of energy conversion system like thermoelectric and thermionic converter, MHD generator, solar cell and fuel cells.	**2**

Course Outcomes: At the end of this course, the student will be able to :	
1	Fundamental understanding various Energy conversion devices.
2	Familiarity with efficiencies of Heat Engine, steam, Gas , Hydraulics Turbines and direct energy conversion devices.
3	Develop Problem solving ability through the application of Energy conversion principles.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Thermodynamics and Heat Engines Vol.II", R. Yadav, Dhanpat Rai, & Sons Delhi.	2000
2	"Gas Turbine Theory", Cohan H. and Rogers G.F.C. HIH Sarvanamutto, Pearson Education.	2008
3	"Fundamental of compressible flow with aircraft and rocket propulsion", S.M. Yahya.	2003
4	"Principles of Turbo machinery", D. Shepherd, Macmillan Pub. Co	1956
5	"Thermodynamics an Engineering Approach", Yunus A Cengel and Michael A. Boles, McGraw-Hill, Inc.	2010
6	"Theory of Hydraulic Machines",V.P. Vasandani, Khanna Publishers, Delhi.	1996
7	Hydraulic & Fluid Mechanics, J. Lal, Metropolitan Book Co., N. Delh,.	1991

Course Name	**:**	**TRIBOLOGY AND LUBRICATION**
Course Code	**:**	**MEN412**
Credits	**:**	**4**
L T P	**:**	**3 – 1 -0**

Course Objectives:
At the end of this course, the student will be able to understand the basic concepts lubrication, characteristics of lubrication and various types of bearings. The student should also be able to apply the studied concepts in the actual practice in maintenance of bearings.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**FRICTION AND LUBRICATION:** Laws of dry sliding friction, characteristics of hydrodynamically lubricated surface, Boundary region of lubrication, lubrication oil vs. grease oil lubrication, selection and its application. Sealing devices. Greases, oils in greases including the study of consistency, mechanical stability, bleeding and evaporation properties, synthetic grease selection, specification and application.	10
2	**SELECTION OF BEARINGS AND REQUIREMENTS:** Types of bearings available, slider type bearing, roller element bearings, and principle for selection of bearings, mechanical requirements, environmental conditions and economics.	8
3	**SLIDING BEARINGS:** Types of journal bearings, wick-oiled bearings, pressure fed bearings, externally pressurized bearings, types of thrust bearings, pivoted shoe bearings, springs supported flexible plate thrust bearings, step thrust bearing, externally pressurized bearings, pocket thrust bearings. Viscosity, effect of temperature and pressure on viscosity. The Hagen-Poiseulle Law, Petroff's equation, hydrodynamic bearing theory. Raynold's equation in two dimensions and limitation of the theory. The plane slider bearing, slider bearing, load capacity, slider bearing friction, pivot-equation. The full journal bearing, load capacity, journal bearing friction, non-dimensional charts and simple numerical. Reynold's equation in three dimensions, effect of end flow on load factor, Kingsbury's	14

	electrical analogy, leakage factor. Design aspects of simple journal bearings, multiple journal bearings, pressure bearings and non-pressure bearings.	
4	**ROLLING BEARING:** Elementary study of deep groove bearing, filling notch bearings, angular- contact ball bearing, magneto bearing, self-aligning bearings, miniature ball bearings, double row ball bearing, duplex bearings, ball thrust bearings, detailed descriptions of cylinder, roller bearings, spherical roller bearings, tapered roller bearings, needle bearings, principle of operation, Stribeck's equation for load capacity.	10

Course Outcomes: At the end of this course, the students will be able to:	
1	Understand the basic concepts and applications of lubrication methods.
2	Understand the various aspects of bearing lubrications.
3	Understand the design concepts of various types of bearings

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Engg. Tribology, 3rd Edition, by Gwindon W. Stachowiak and Andrew W. Batchelor, Butterwerth Heineman, Publisher	2005
2	Introduction to Tribology by Bharat Bhushan, 2nd edition,Wiley Publisher	2012

Course Name	**:**	**WORK STUDY AND ERGONOMICS**
Course Code	**:**	**ME 413**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course the student should be able to comprehend the working of industrial workers with respect to industrial environment, wages, fatigue and disorders developed thereby.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**METHOD STUDY** Process Analysis, Process and Activity Charts, Operation Analysis, Basic Procedure, Micro Motion Study, Principles of Motion Economy.	6
2	**WORK MEASUREMENT** Purposes and Uses, Basic Procedure, Techniques- Work Sampling, Stop-Watch Time Study, Rating and Allowances, Setting Standard Times for Jobs, Standard Data, Predetermined Motion Systems, Job Evaluation of Merit Rating, Wage Incentive Plans, MTM(Method Time Measurement), WORK SAMPLING and Application of work sampling, work sampling procedure. Design of work sampling plan	9
3	**ERGONOMICS** Fundamental Concepts, Issues in Work System Design, Measuring Work by Physiological Means, Work Posture, Fatigue Measurement and Evaluation, Environmental Factors and Work Systems, Development of Ergonomics.	9
4	**DESIGN APPROACH** A new Design, Modification of Existing Design, Assessment of Design, Limitation of Man and Machine with Respect to each other, Posture-standing at work, Seated at Work, Work Station Heights and Seats Geometry, Human Anthropometry and its Use in Work place Layout, Analysis, NIOSH/OSHA/OCRA Guidelines	9

5	**WORK LOAD** Static and Dynamic Muscular Work, Human Motor Activity, Metabolism, Physical Work Load, Measurement of Physical Work Load, Mental Work load, Measurement of Mental Work Load, Repetitive and Inspection Work, Work Duration and Rest Pauses	9

Course Outcomes: At the end of this course the student will be able to:	
1	Design optimally a work station which will take care of all aspects, i.e., how to fix wages
2	How to control musculoskeletal disorders, mental burnouts.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Work Study and Ergonomics" , ILO	2000
2	"Introduction of Ergonomics " , Bridger, Tata McGraw Hill	1995
3	"Work Study" , Khanna, OP – Dhanpat Rai & Sons	2010
4	"Work Study" , S. Dalela, Standard Publishers, Delhi	2011
5	"Methods Engineering" , Barns, McGraw Hills, N. York	
6	"Motion and Time Study" , Mundell, Prentice Hall of India	1988

Course Name	**:**	**POWER PLANT ENGINEERING**
Course Code	**:**	**MEN414**
Credits	**:**	**4**
L T P	**:**	**3- 1- 0**

Course Objectives:
At the end of this course, the student will be able to understand the basic functions of boiler mounting and accessories, boiler furnishes water treatment in boiler, power generation various types of power plants with their principles and application.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**STEAM POWER PLANT:** Introductory: Generation of electricity and sources of energy, thermodynamic cycles, selection of power plants on thermodynamic economical and operating considerations, Future trends in power industry, power source of the future. Steam Generators: Principle construction and operation of high pressure boilers, Design trends in water tube boilers, Supercritical pressure systems, Steam generators for special applications, Generator selection, maintenance and operation Boiler furnaces. Feed Water Heating and Steam Turbines: Cycle with finite number of heaters, analysis of optimum rise in ideal cycle efficiency. Type of heater arrangements, equations for single heater arrangement and series of heaters. Losses in various types of heater arrangements. Fuels and Firing: Type of fuels and their characteristics. Coal handling and coal storage, methods of coal firing, stocker fired and pulverized fuel feeding systems, pulverized and different types of stockers. Ash handling and ash disposal. Burning and feeding of oil and gas. Selecting fuel for new plants. Water Treatment: Quality of water needed by the plant. Types of impurities, PH value, Clarification of water and filter designs. Water treatment. Deareators and aerators. Handling and feeding chemicals. Feed water regulation. Condenser cooling water systems.	**15**

	Construction and operation of economizers, air pre-heaters, steam separators. Schematic layout of a modern coal fed steam power station. Heat balance of steam power station. Steam Station costs. Load curves. Site selection.	
2	**DIESEL POWER PLANTS:** Diesel plant elements, arrangements of diesel plant, diesel engine fuel injection system, air intake system, engine lubrication and engine cooling systems, supercharging and superchargers. Methods of starting and stopping the engines. Advantages and disadvantages of using diesel power plant, Economics of diesel plant over steam and hydro-electric plant.	**10**
3	**GAS TURBINE POWER PLANTS:** Elements of gas turbine plants, principle and performance of simple gas turbine plant, thermal refinement of gas turbine cycle. Combination gas turbine cycles. Gas turbine cycle calculations. Economics of gas turbine plant compared with steam power plant.	**10**
4	**NUCLEAR POWER PLANT:** Atomic structure, energy levels, binding energy. Radio-activity, decay laws, half lives, nuclear reaction. The fission chain reaction (Controlled and uncontrolled). Maintenance of chain reaction, heat removal, reactor fuels and materials. Some common types of power reactors. Pressurized water reactor, boiling water reactor and gas cooled reactor. Reactor system safety provisions. Fusion reaction, site selection. Economics of nuclear power plants. Air pollution. Power plant and the air pollution. Units of radiation dose. Control of internal and external hazards.	**9**

Course Outcomes: At the end of this course, the students will be able to:	
1	Understand the basic concepts and applications of power plants and power generation methods.
2	Understand the various aspects of Economics of various types of power plants.
3	Understand the design concepts of various types of boiler mountings and accessories.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Power Plant Engineering ", T.Morse	2010
2	"Power Station Engineering & Economy",- Skrotzkiand	2008
3	Steam Power Plants - Potter	2011
4	Nuclear Power Plant – Taylor	2010
5	Power Plant Engineering - Dr. Mahesh Verma.	2012

Course Name	**:**	**INDUSTRIAL AUTOMATION AND ROBOTICS**
Course Code	**:**	**MEN415**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to apply generic technology and principles associated with robotics and automation systems, Kinematics and dynamic of robotic system and Computer based control to integrated automation system.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO AUTOMATION** Automation production system, Mechanization & Automation, Types of automation,	**3**

	expectations from automation, reasons for automating, basic elements of an automated system, levels of automation, Automation strategies, Role of automation in industries.	
2	**FLUID POWER CONTROL** Fluid power control elements and standard graphical symbols, construction and performance of fluid power generators, hydraulic and pneumatic cylinders, construction design and mountings, hydraulic and pneumatic valves for pressure, flow and direction control, servo valves and simple servo system with mechanical feedback, governing differential equation and its solution for step position input, basic hydraulic and pneumatic circuits. Design of pneumatic logic circuits for a given time displacement diagram or sequence of operations.	**7**
3	**INDUSTRIAL CONTROL SYSTEM** Process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control, forms of computer process control, closed loop versus open loop control, design of control systems. Programmable logic controllers – principle of operation, ladder logic diagram.	**5**
4	**FACTORY AUTOMATION:** Transfer systems-Continuous, intermittent, Indexing mechanisms, vibratory bowl feeders, non vibratory feeders, hopper feeders, rotary disc feeder, centrifugal, revolving feeder, assembly systems, automated assembly, design for automated assembly, synchronous and non synchronous material transfer, Automated Guided Vehicles .	**5**
5	**ROBOT TECHNOLOGY** Automation and Robots, Robot technology and terms related to robot. Robot physical configuration, Classification of Robot Basic, Manipulation of Robot Components, Degree of Freedom and Degree of Motion, Joints and Symbols, Economic and Social Issues, Principles of Robots, Applications. Requirement of a Robot in an Industry, Asimov's law of robotics.	**4**
6	**ROBOT KINEMATICS** Rotation Matrix, Homogeneous transformation matrix, Denavit-Hartenberg convention, Euler angles, Roll-Pitch-Yaw (RPY) Representation, Direct and inverse kinematics for position and orientation, Redundancy, manipulator, End effector.	**6**
7	**WORKPLACE ANALYSIS AND TRAJECTORY PLANNING** Workspace Analysis, Work Envelope of different Robot Configurations, Workspace Fixtures, The Pick and Place Operation, Continuous Path Motion, Interpolated Motion, Straight Line Motion.	**6**
8	**ROBOT SENSING & VISION** Various Sensors and their Classification, Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing Digitizing, Image Processing and Analysis and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors	6

Course Outcomes: At the end of this course, the students will be able to:	
1	Analyze the technology and principles associated with robotics and automation systems.
2	Design robotic system using direct and inverse kinematics.
3	Implement automation in industries.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Automation, Production system and Computer Integrated Manufacturing", Grover**,** 3rd Edition, 2011, Pearson Education.,	2011
2	"Fundamentals of Robotics Analysis and Control", Robert J Schilling, Tata Mc Graw Hill Education	2009
3	"Introduction to Engineering", John J Craig**,** Pearson Education	2013
4	"Robotics and Control", R K Mittal, I.J Nagrath**,** Tata Mc Graw Hill Education	2003
5	"Hydraulic Systems",S R Majumdar, Tata Mc Graw Hill Education	2001
6	Pneumatic Systems by S R Majumdar, Tata Mc Graw Hill Education.	2001

Course Name	**:**	**MECHANICAL MEASUREMENT AND METROLOGY**
Course Code	**:**	**MEN416**
Credits	**:**	**4**
L T P	**:**	**3 – 1/2 – 2/2**

Course Objectives:
At the end of this course, the student should be able to introduce the different techniques of measurement of physical quantities, introduce the concepts of error and uncertainty and how they relate to the credible measurement of different physical quantities with the help of latest measurement systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** Introduction to Measurement: Measurement Units, Measurement System Applications, Elements of Measurement System, Selection of Measuring Instrument. Instruments Types and Performance Characteristics: Review of Instrument Types, Static Characteristics of Instruments, Dynamic Characteristics of Instruments, Types of Error during Measurement Process. Calibration of Measuring Sensor and Instruments.	**6**
2	**DISPLAY OF MEASUREMENT SIGNALS:** Electronic Output Display, , Recording of Measurement Data: Ultra-Violet Recorders, Fibre Optics Recorder, Digital Recorders and Presentation of Measurement Data: Sensor Technologies: Capacitative, Resistive, Magnetic, Hall Effect, Piezo-resistive And Fibre Optic Sensor. Optical Sensors: Intrinsic, Extrinsic, Distributed Sensors. Ultrasonic Transducer, Use of Ultrasound in Tracking 3d Object Motion. Ultrasound as range sensor.	**6**
3	**MESUREMENT OF FLOW, TEMPERATURE & PRESSURE:** Temperature Measurement by radiation thermometers: optical pyrometers, radiation pyrometer, thermo-graphy, fibre optic temperature sensor, acoustic thermometer. Pressure Measurement: Capacitative pressure sensor, fibre optic pressure sensor, intelligent pressure transducer, Flow Measurement: Corilis Flowmeter, Thermal Mass Flow Measurement, Positive Displacement Flowmeter, Electro-magnetic Flowmeter, and Ultrasonic Flowmeter.	**6**
4	**MEASUREMENT OF FORCE AND TORQUE:** Mass Measurement: Electronic, Pneumatic, Intelligent load cells, Force Measurement: accelerometer, vibrating wire sensor, Torque Measurement: Optical Torque Measurement, Rotational Displacement Measurement: Circular and Helical Potentiometer, Rotational differential transformer, gyroscopes, Rotational Velocity Measurement: digital and analogue tachometer, fibre optic gyroscope, Mechanical Flyball, Viscosity Measurement: Rotational Viscometer, Falling Body Viscometer.	**6**
5	**LIMITS, FITS AND TOLERANCES** Concept of interchangeability, types of in interchangeability, need for standard systems of limits, fits and tolerances, BIS: 919:1963standard system, selection of limits and fits exercises on limits, fits and tolerances, design principles for limit gauges. Taylor's principle, types of limit guges tolerance on limit gauges.	**5**
6	**MEASURING AND GAUGING INSTRUMENTS** Design principles of measuring instruments: kinematics design, principle of alignment pivots and bearings, sources of error in measurement, calibration of measuring instruments mechanical linear and angle measuring instruments, venire calipers, micro – meters dial gauges, bevel protectors sine bar spirit level optical instruments: autocollimators, tool room microscope length measuring machines, comparators: magnification principles types of comparators, mechanical optical, pneumatic, electrical and electronic comparators.	**5**
7	**SCREW THREAD AND GEAR METROLOGY** Elements of screw thread metrology, measurement of major, minor and effective diameters	**4**

	of external and internal screw threads, measurement of pitch and screw thread angle, effect of pitch error, elements of gear metrology, measurement of gear tooth thickness, gear profile, gear concentricity, pitch and run-out for involute gear, gear rolling test.	
8	**MEASUREMENT OF SURFACE FINISH** Concept of macro and micro errors, scales: surface roughness measures, datum for surface roughness measurement; M and E system, measurement of surface roughness stylus methods using mechanical optical and electrical magnification.	**4**

List of Experiments:		**Number of Turns**
1	Measurement of angle using sine bar and measurement of cylinder using bore gauge	2
2	Measurement of screw thread element using tool makers microscope & optical projector.	2
3	Measurement of gear tooth thickness using gear vernier caliper.	1
4	Measurement of surface roughness using taly surf	1

Course Outcomes: At the end of this course, the student will be able to :	
1	Demonstrate a critical awareness of static and dynamic parameters of measurements.
2	Demonstrate a critical awareness of the underlying principles of the different measuring instruments and devices.
3	Demonstrate a critical awareness of different state-of-the-art instruments meant for signal record and display.
4	Recognize the latest measuring instruments for measurement of various Mechanical Quantities.
5	Demonstrate a systematic application of the different measuring instruments

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Measurement & Instrumentation Principles", Alan S Morris	2014
2	"Engineering Metrology", R. K. Jain	2014
3	"Statistical Quality Control", E. L. Grant	2014
4	"Quality Planning and Analysis", J. M. Juran	2014
5	"Measurement & Metrology", M. Mahajan.	2014

Course Name	**:**	**AUTOMOBILE ENGINEERING**
Course Code	**:**	**MEN417**
Credits	**:**	**4**
L T P	**:**	**3 -1- 0**

Course Objectives:
At the end of this course, the student should be able to understand the systems of automobile such as cooling and lubrication system, fuel supply system, transmission system, braking system, suspension and steering system, ignition system emission control.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**COOLING AND LUBRICATION SYSTEMS**: cooling systems and their components, antifreeze mixtures. Lubrication purpose and various systems of lubrication, types and desirable properties of lubricants, components like oil filters, oil pumps, and oil pressure indicators, air supply system, air filters, turbo charger and super charger.	**5**

2	**FUEL SUPPLY SYSTEMS**: Fuel injection system for petrol and diesel engines, fuel pumps (mechanical and electrical), air fuel ratio requirements, carburetors: types and general operation throttle body and multipoint fuel injection systems, electronic control module and sensing devices.	**5**
3	**TRANSMISSION SYSTEMS** Clutch function and types, torque converters; manual and automatic transmission/ transaxles; sliding constantly & synchromesh gearboxes, epicyclic gearbox. differential. propeller shafts and universal joint front and rear axles.	**4**
4	**BRAKE SYSTEMS, WHEEL & TYRES**: Braking efficiency and stopping distances. Types of brakes, Drum and disc brakes. Detailed description of hydraulic and pneumatic brake. Mechanical, vacuum and electrical methods of brake actuation, servo brakes, ABS, type of wheels, tyres, type of tyres; cross ply, radial tubeless etc. specification of tyres.	**5**
5	**SUSPENSION SYSTEM**: Road springs, shock absorbers, independent suspension, road springs. air suspension, hydroelastic suspension.	**4**
6	**STEERING SYSTEM:** Steering geometry, details, correct steering angle, Ackerman steering mechanism. Cornering power, over steering and under steering. Worm wheel and Rack pinion types of steering gears. Safety steering columns, power steering.	**5**
7	**IGNITION SYSTEM:** Various ignition systems (coil and magneto) and detailed study of their components, electronic ignition system, distributor less ignition system	**4**
8	**BATTERY AND STARTING SYSTEMS:** Storage battery (lead acid type), Maintenance free batteries, various components, Charging system, starting motors, starting drives, Bendix drive, Electronic starter control, starting system trouble shooting.	**4**
9	**EMISSION CONTROL:** Emission norm like EURO and BHARAT norms, methods and devices to control emissions.	**3**
10	**MISCELLANEOUS TOPICS**: Automotive accessories, hydraulic single lever and two lever hydraulic systems for tractors, Technical specifications, controlling devices such as fuel gauge, temperature gauge, indicator lights speedometer odometer, HVAC Etc. .	**3**

Course Outcomes: At the end of this course, the student will be able to :	
1	Command over automotive engines and the recent development in the area of engines.
2	Command over automotive system and the recent development in the area.
3	Understand the constructional, working principle of various sub system of an automobile.
4	Understand various controlling systems
5	All theoretical information and about electrical components used in a vehicle.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Automobile Engg.", Vol I & II, Kirpal Singh, Standard Publication distributors, Delhi Vol. I & Vol. II	2009
2	"Automotive Mechanics", W.H.Grouse. Tata McGraw Hill Publishing Co.Ltd. New Delhi,	1993
3	"Automotive Mechanics", J.Haitner, Affiliated East West Press, N.Delhi,	1987
4	"Motor Vehicle Newton and Steed", Hiffee, London	1958

Course Name	**:**	**QUALITY ENGINEERING & MANAGEMENT (OPEN ELECTIVE)**
Course Code	**:**	**MEN- 461**

Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of the course, the student should be able to understand the basic concepts of Quality, Quality planning & Control, process capabilities, Statistical quality Control, Control charts, Total quality Management, Quality Standards, Quality & Reliability and Six Sigma. The student should also be able to apply the studied concepts in the actual practice in industries.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** Introduction to quality (Services and manufacturing) quality planning and control, quality cost, economics of quality control, phases of quality evolution	5
2	**PROCESS CAPABILITY & MEASUREMENTS :** Specification, tolerances and process capability studies, precision reproducibility and accuracy of method measurement, Taguchi method	4
3	**STATISTICAL QUALITY CONTROL:** Inspection and quality control, statistical quality control (SQC) statistical process control (SPC), control charts for variables and control charts for attributes, sampling plans for attributes and variables, economics of sampling charts	7
4	**QUALITY CONCEPTS:** Quality Assurance. Total Quality Control: Total quality concept, Deming's 14 points.	4
5	**TQM:** Total Quality Management(TQM): TQM concept, quality planning, quality improvement team, quality circles organization, training for quality circles, just in time (JIT)	6
6	**QUALITY STANDARDS**: Definition, applications, implementation procedure and requirements of Quality ISO 9001, ISO 9002, ISO 9003, ISO 9004 and ISO 14000 Quality standards	6
7	**QUALITY & RELIABILITY:** Product quality and reliability, failure data analysis and life testing, redundancy in design.	7
8	**SIX SIGMA**: Six sigma concept, definition, procedure for six sigma application, TQM and six sigma, six sigma and Indian industries, six sigma concept of process capability	3

Course Outcomes: At the end of this course, the students will be able to:	
1	Understand the basic concepts and applications of Quality & Quality standards.
2	Understand the various aspects of process capability and Taguchi method.
3	Implement the control charts for various industrial applications.
4	Come up with new ideas for Total quality management.
5	To understand the concepts of Quality standards, Quality Reliability and Six Sigma.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Statistical Quality Control; E. L.Grant	1990
2	Statistical Quality Control ; M. Mahajan	2012
3	Statistical Quality Control; Juran	1990
4	Quality Control ; Hansen & Ghare	2005
5	Statistical Quality Control; R.C. Gupta	2000

Course Name	**:**	**RELIABILITY AND MAINTENANCE MANAGEMENT**
Course Code	**:**	**MEN- 462**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, the student should be able to understand the role and contribution of maintenance towards achieving competitive advantage in the industries , understand key concepts and issues of Maintenance in both manufacturing and service organization, understand the various strategies, philosophy, scheme and schedules of maintenance engineering and it applications in the industry.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Maintenance Concept, objectives and characteristics of maintenance function, organizational set up of the maintenance system, responsibilities of the maintenance department, Types of maintenance: corrective, operating practices in Maintenance, Benefits and Effects of maintenance.	5
2	**MAINTENANCE PLANNING AND CONTROL** Planning of maintenance function; Present material policy for maintenance, classification of spare, spare parts provisioning, spare parts inventory, ABC analysis, FSN Approach, XYZ approach, VED approach, Work planning and scheduling, Long-range and short range planning; Man power allocation; Estimation of maintenance work and control.	5
3	**MAINTENANCE ACTIVITIES AND EVOLUTION**: Evolution of alternative maintenance, Polices breakdown, Preventive and Predictive maintenance, Fault diagnosis and control monitoring techniques, Simulation of alternative practices, Safety aspect in maintenance, Housekeeping practices, Total productive maintenance.	5
4	**RELIABILITY AND AVAILABILITY OF ENGINEERING SYSTEMS** Reliability and Maintainability, Bathtub Hazard Rate concept, Quantitative estimation of reliability of parts, Reliability, maintainability, failure, availability, Reliability structure and optimum design configuration of series, parallel, combination of series and parallel, redundancy structure. Mean time to failure (MTTF), mean time between failure (MTBF), mean time to repair (MTTR). Accuracy and confidence of reliability estimation, Statistical estimation of Reliability Indices, Machine failure pattern: Breakdown time distribution	8
5	**MAINTENANCE IN SERVICE** Maintenance Requirement: Mechanical, Electrical, Process and Service equipment; Maintenance Aspect: Lubrication; Chemical control of corrosion Condition monitoring technique, computerized Maintenance information system, computerized condition Monitoring, Maintenance Decision making.	6
6	**ECONOMIC ASPECT OF MAIANTENANCE** Cost of machine breakdown, Estimation of life cycle cost, Impact of maintenance cost, Application of work measurement in maintenance; selection of Manpower and Training, Incentive Payment of Maintenance workers.	5
7	**INSPECTION, TESTING AND QUALITY CONTROL IN MAINTENANCE** Inspection, Testing and Quality Control in Maintenance, Definitions, Importance of Inspection and testing in maintenance, Inspection internal as Frequency, Destructive Non destructive and semi destructive testing, liquid penetration test, magnetic particle test, ultrasound test, vibration analysis, oil analysis, Definition and importance of Quality control in Maintenance, Statistical Quality Control Tools and Techniques.	8

Course Outcomes: Upon completing this course, students will be able to:	
1	Understand the strategic role of Maintenance/Reliability engineering in asset life cycle optimization.
2	Apply analytical skills and problem-solving tools/techniques to the fault analysis of various machines and

	equipments
3	Practice safe work procedures utilizing and understanding other safety regulations in troubleshoot typical industrial mechanical systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"A text Book of Reliability and Maintenance Engineering", Alakesh Manna, I.K.International Publishing House Pvt.Ltd, New Delhi.	2011
2	"Preventive Maintenance", Terry Weriman – Reston Publishing Company.	1984
3	"Principle of planned maintenance", Clifton R. H, McGraw Hill.	1983
4	"Maintenance Planning and Control", Enthory Kelly, EWP.N.Delhi.	1984

Course Name	**:**	**OPERATIONS RESEARCH**
Course Code	**:**	**MEN463**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course, the student should be able to use variables for formulating simple and complex mathematical models in management science, industrial engineering and transportation science, polyhedral theory and valid inequalities and how to integrate the theory to the solution methods for integer programming.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** : Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M method, two-phase method, degeneracy and unbound solutions.	**5**
2	**TRANSPORTATION PROBLEM**. Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.	**5**
3	**ASSIGNMENT MODEL**. Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem.	**5**
4	**SEQUENCING MODEL**S. Solution of Sequencing Problem – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.	**5**
5	**DYNAMIC PROGRAMMING**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems	**6**
6	**GAME THEORY**. Competitive games, rectangular games, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	**6**
7	**REPLACEMENT MODELS**. Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, group replacement policy.	**4**
8	**INVENTORY MODELS**. Inventory costs. Models with deterministic demand – model (a) demand rate uniform and production rate infinite, model (b) demand rate non-uniform and production rate infinite, model (c) demand rate uniform and production rate finite.	**6**

Course Outcomes: After The course the student will be able to	
1	Solve simple and complex optimisation models and implement in softwares
2	Formulate and solve transportation problems for cost minimisation
3	Formulate and solve different inventory model problems for the different type of industries
4	will be able to carry out economical replacement analysis for obsolete /worn out industrial equipments
5	Will be able to solve job sequencing problems for 2/3 machines for minimum cost/time models

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	P. Sankara Iyer, "Operations Research", Tata McGraw-Hill,.	2008
2	A.M. Natarajan, P. Balasubramani, A. Tamilarasi, "Operations Research", Pearson Education,.	2005
3	J K Sharma., "Operations Research Theory & Applications , 3e", Macmillan India Ltd.	2007
4	P. K. Gupta and D. S. Hira, "Operations Research", S. Chand & co.	2012
5	J K Sharma., "Operations Research, Problems and Solutions, 3e", Macmillan India Ltd.	2012

Course Name	**:**	**FINITE ELEMENT METHOD**
Course Code	**:**	**MEN464**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to describe and implement the Finite Element Method as a numerical tool in engineering analysis and its design. The students will be able to apply these concepts to one, two dimensional and dynamic problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** Introduction of the FEM, its historical background, Brief overview of the steps used in FEM, Various approaches to formulate elemental equations, Review of the concept of stresses, strains, equilibriums, boundary conditions, temperature effect and there relations, Concept and application of Minimum Potential energy method, Rayleigh Ritz method, Galerkin Method and Principle of Virtual Work applied to elasticity problems	**7**
2	**MATRIX ALGEBRA & GAUSS ELIMINATION METHOD:** Matrix algebra and its different operations, Eigen values and Eigen vectors, Positive definite matrix, Gauss elimination method to solve a large linear equations	**4**
3	**ONE DIMENSIONAL PROBLEMS:** Introduction, finite element modelling using bar element, shape functions, Iso, super and sub parametric types of FEM formulation, Potential energy approach to solve 1-D problems, assembly of elemental equations, types and applications of boundary conditions, higher order 1-D element and their shape functions, its application to 1-D problem, Accounting of temperature effect in 1-D problems	**8**
4	**TRUSSES PROBLEMS:** Introduction, 2-D and 3-D trusses, concept of local and global coordinate system and its transformation matrix, solution of 2-D and 3-D trusses by the FEM, stress calculations, Accounting of the temperature effect	**4**
5	**TWO-D PROBLEMS USING CONSTANT STRAIN TRIANGLES (CST):** Introduction, finite element modelling using CST elements, its shape function, Potential	**6**

	energy approach, solution of the 2-D problem, Accounting of temperature effect, Problem modelling and boundary conditions for symmetrical problems	
6	**TWO-D ISOPARAMATRIC ELEMENTS AND NUMERICAL INTEGRATION** Introduction, Four noded quadrilateral element based FE Modelling and its solution, Numerical integration, concept of weights and gauss points, its values for one point, two points etc. formulae, 2-D & 3-D numerical integration and its application in FEM, Higher order quadrilateral and triangular elements and it's numerical integration	**6**
7	**BEAMS AND FRAMES** Introduction, Potential energy based FE formulation using beam and frame elements, Boundary consideration, shear stress and bending moment calculations	**4**
8	**DYNAMIC PROBLEMS:** Introduction, mass matrix as used in the FEM, elemental mass matrix for different types of elements as studied above, Evaluation of Eigenvalues and Eigen vectors by FEM	**3**

Course Outcomes: By the end of this course, the student will be able to:	
1	Choose the type of elements for a given problem.
2	Understand the basics of FEM, its principles and its importance in engineering analysis and design.
3	Apply the concept of FEM on one, two dimensional and dynamic problems
4	Apply the FEM to other engineering and applied sciences problems in general.
5	Interpret the results in more meaningful manner as given by FEM based software.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Introduction to Finite Elements in Engineering", Chandrupatala & Belegundu, PHI,	2010
2	"Finite Element Method", J N Reddy, Mc Graw Hill,	1993
3	"Concept & Application of Finite Element Analysis", Cook et al, John Wiley,	2004
4	"The Finite Element Method for Engineers", Huebner et al, John Wiley,	1982
5	"Finite Element Analysis (Theory & programming)", C S Krisnamoorthy, TMH,	2004

Course Name	**:**	**Smart Materials and Devices**
Course Code	**:**	**MEN-465**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, student should be able to apply basic principles and mechanisms of smart materials and devices and provides a spring board for further study, demonstrate knowledge and understanding of the physical principles underlying the behavior of smart materials, describe the basic principles and mechanisms of the important smart materials, demonstrate knowledge and understanding of the engineering principles in smart sensors, actuators and transducer technology, propose improvements on the design, analysis, manufacturing and application issues involved in, integrating smart materials and devices with signal processing and control capabilities to engineer smart structures and products.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** Overview of Smart Materials and their properties, Classification of Smart Materials, Development of smart materials and devices. Areas of application of devices.	5
2	**PIEZOELECTRIC AND ELECTROSTRICTIVE MATERIALS:** constitutive	6

	relationship, electromechanical coupling coefficients, piezoelectric constants, piezoceramic materials, variation of coupling coefficients in hard and soft piezoceramics, polycrystalline vs single crystal piezoelectric materials, polyvinyldene fluoride, piezoelectric composites.	
3	**MAGNETOSTRICTIVE AND MAGNETOELECTRIC MATERIALS:** constitutive relationship, magneto-mechanical coupling coefficients, Joule Effect, Villari Effect, Matteuci Effect, Wiedemann effect, Giant magnetostriction in Terfenol-D, Terfenol-D particulate composites, Galfenol and Metglas materials.	6
4	**SHAPE MEMORY ALLOYS:** Synthesis, Types of shape memory alloys, Nickel-Titanium alloy (Nitinol), Cu based alloys, Chiral materials, Applications, Fastners, Fibers, Reaction vessels, Nuclear reactors, Chemical plants, Satellite antenna, Blood clot filter, Plastics.	5
5	**ELECTRORHEOLOGICAL (ER) AND MAGNETORHEOLOGICAL (MR) FLUIDS:** Suspensions and ER fluids, ER phenomenon, charge migration mechanism, ER fluid actuators, applications of ER fluids. Composition of MR fluid, applications of MR fluids.	5
6	**SENSOR AND ACTUATOR:** Sensing Technology, Types of Sensors, Physical Measurement using Piezo Electric Strain measurement, Inductively Read Transducers, The LVOT, Fiber Optic Techniques. Chemical and Bio-Chemical sensing in Structural Assessment, Absorptive chemical sensors, Spectroscopes, Fibre Optic Chemical Sensing Systems and Distributed measurement. Actuator Techniques, Actuator and actuator materials, Piezoelectric and Electrostrictive Material, Magneto structure Material, Shape Memory Alloys, Electrorheological Fluids, Electromagnetic actuation, Role of actuators and Actuator Materials.	10
7	**MEASURING TECHNIQUES:** Strain Measuring Techniques using Electrical strain gauges, Types, Resistance, Capacitance, Inductance, Wheatstone bridges, Pressure transducers, Load cells, Temperature Compensation, Strain Rosettes.	5

Course Outcomes: By the end of this course, student will be able to	
1	Understand the behavior and applicability of various smart materials.
2	Design and conduct experiments, analyze and interpret data related to smart materials and devices.
3	Design a system, component, or process based on smart materials to meet desired needs.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Piezoelectric Materials and Devices: Applications in Engineering By M. S. Vijaya	2013
2	Smart Electronic Materials: Fundamentals and Applications By Jasprit Singh	2005
3	Smart materials and new technologies by M. Addington, Schodek, L. Daniel.	2005
4	Smart Materials and Structures By M.V. Gandhi, Brian S. Thompson.	1992

Course Name	**:**	**FRACTURE MECHANICS**
Course Code	**:**	**MEN421**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to describe and implement the fracture mechanics and fatigue failure concept in engineering analysis and design. The course will prepare the students to apply the fracture mechanics to engineering and applied sciences problems with lower factor of safety.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BACKGROUND**	

	Historical aspects, kind of failure, different techniques of fracture mechanics, brittle and ductile fracture, modes of fracture, potency of crack, damage control	**3**
2	**ENERGY RELEASE RATE (ERR)** Introduction, dilemma of Griffith, Surface energy, Griffith's realization and analysis, Energy release rate, ERR of Double Cantilever Beam specimen, anelastic deformation at crack tip, crack resistance, stable and unstable crack growth, R- curve for brittle crack, Thin plate v/s thick plate, critical ERR	**8**
3	**STRESS INTENSITY FACTOR (SIF)** Introduction, Linear Elastic Fracture Mechanics (LEFM), Stress and displacement fields in isotropic elastic material, SIF and its mathematical background, Approach of Westergaard for different mode of fracture and its analysis.	**9**
4	**SIF OF MORE COMPLEX CASES** Other application of Westergaard, application of the principles of superposition, crack in a plate of finite dimensions, Edge and embedded cracks, Relationship between ERR and SIF, critical SIF, Bending and twisting of cracked plates.	**5**
5	**ANELASTIC DEFORMATION AT THE CRACK TIP** Investigation at the crack tip, approximate shape and size of the plastic zone, effective crack length, effect of plate thickness.	**5**
6	**J-INTEGRAL APPROACH** Relevance, scope and definition of J-integral, path independence and stress & strain relation, Further discussion on J-integral, Engg. Approach to J integral	**4**
7	**CRACK TIP OPENING DISPLACEMENT (CTOD)** Introduction, relationship between CTOD, SIF and ERR, Equivalence between CTOD and J integral.	**3**
8	**FATIGUE FAILURE:** Introduction, Terminology, S-N curve, crack initiation, crack propagation law, Fatigue life calculation, Effect of an overload, crack closure, variable amplitude fatigue loading environment assisted fracture.	**5**

Course Outcomes: By the end of this course, the student will be able to:	
1	Apply fracture mechanics philosophy in designing of various systems.
2	Apply the concept of fatigue failure under variable fluctuation loading to engineering and applied sciences problems with lower factor of safety.
3	Understand this as a fundamental tool for modeling and analyzing mechanical system from fracture and fatigue failure aspect.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Elements of Fracture Mechanics", Prashant Kumar, TMH, New Delhi.	2009
2	"Elementary Engineering Fracture Mechanics", David Broek, Kluwer Academic Publishers Group, Dordrecht, Netherlands.	1982
3	"Fracture Mechanics: E. E. Gdoutos", Kluwer Academic Publishers Dordrecht, Netherlands	1993
4	"Elementary Fracture Mechanics", S. A. Meguid, Elesvier Applied Science, London.	1989
5	"Introduction to Fracture Mechanics", Kare Hellan, McGraw Hill Book Company.	1985

Course Name	**:**	**MICRO AND NANO SCALE THERMAL ENGINEERING**
Course Code	**:**	**MEN- 422**
Credits	**:**	**4**
L T P	**:**	**3 - 1/2 – 2/2**

Course Objectives:

At the end of this course, the student will be able to understand the basic concept of Micro/nano scale heat transfer, micro and nano-fluids and thermal Energy storage and transport.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	I**NTRODUCTION**: Micro /nano scale phenomena, Basics of Micro/nano scale heat transfer and fluid mechanics, Miniaturization ,nano technology: contribution to modern technology. Difference with macro scale phenomenon. Impact of nano technology.Statistical Thermodynamics, Quantum Mechanics, Thermal Properties of Molecules, Kinetic Theory, and Micro/Nanofluidics.	**6**
2	**THERMAL TRANSPORT IN SOLID MICRO/NANOSTRUCTURES**: Electron and Phonon Scattering, Size Effects, Quantum Conductance, Electronic Band Theory, Tunneling, Non equilibrium Heat Conduction, and Analysis of Solid State Devices Such As Thermoelectric Refrigeration and Optoelectronics	**7**
3	**MICROSCALE AND NANO SCALE HEAT TRANSFER:** Fundamentals and Engineering Applications, Methods and observations of thermo physical phenomena in size-affected domains. Principal concepts and practical design engineering aspects of heat transfer. modern engineering applications, such as microchannel heat sinks, micro heat exchangers, and micro heat pipes, fundamentals of Nano scale thermal phenomena in fluids. numerical on microscale conduction, convective heat transfer, and radiation as well as nano scale thermal phenomena. Nanoscale Thermal Radiation and Radiative Properties of Nanomaterials, Radiation Temperature and Entropy, Surface Electromagnetic Waves, and Near-Field Radiation for Energy Conversion Devices	**9**
4	**THERMAL ENERGY STORAGE AND TRANSPORT:** by conduction in natural and fabricated structures. Thermal energy in two carriers, i.e. phonons and electrons , solid-state transport, the quantum of thermal conductance, ballistic interface resistance, and carrier scattering. Bulk material properties, such as thermal and electrical conductivity derived from particle transport theories, and the effects of spatial confinement on these properties .	**7**
5	**MICROFLUIDICS**: Fluids flowing in miniaturized systems. Applications in the pharmaceutical, biomedical and chemical engineering domains. Fluid mechanics of micro flows dispersion, electrical and thermal phenomena in miniaturized devices. Biological, chemical, physical and engineering perspectives. Concepts of micro fluidic systems. Introduction to Bio MEMS /Biosensors**,** Devices in microscale and nano scale. Nanotechnology, electrokinetics and flow theory. Benefits of microfluidics, state-of-the-art microfluidics technology and applications. fluid control devices, gas and fluid measurement devices, medical testing equipment, and implantable drug pumps.	**6**
6	**NANOFLUIDICS:** Introduction ,Fundamentals of Nanofluidics, Nanofluidic Energy Absorption: Converting Mechanical Energy to Thermal Energy, Nanofluidic Energy Tapping: Temporarily Storing Mechanical Energy, Nanofluidic Actuation: Converting Thermal/Electrical Energy to Mechanical Energy ,Nanofluidic Energy Harvesting: Converting Thermal/Mechanical Energy to Electrical Energy	**7**

Course Outcomes: At the end of this course, the students will be able to:	
1	Understand the basic concepts and applications of micro and nano-fluids .
2	Understand the various aspects of Microscale and Nano scale Heat Transfer.
3	Understand the concept of thermal energy storage and transport

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Microscale and Nanoscale Heat Transfer" , " Fundamentals and Engineering Applications Hardcover" , C.B. Sobhan , G.P. Peterson (CRC PRESS)	2008

2	"Microscale Heat Transfer", "Fundamentals and Applications in Biological and Microelectromechanical Systems " ,Cesme-Izmir, Turkey 18–30 July,e**ditors:**S. Kakaç, L.L. Vasiliev, Y. Bayazitoğlu, Y. Yener(SPRINGER)	2004
3	"Nano/Microscale Heat Transfer", (McGraw-Hill) , Zhuomin Zhang	2007
4	"Thermal Energy at the Nanoscale (Lessons from Nano science" A Lecture Notes Series) Timothy S Fisher	2013
5	"Micro fluidics and Nano fluidics", "Theory and Selected Applications" , Clement Kleinstreuer(wiley).	2013
6	"Introduction To Microfluidics" , Patrick Tabeling .(oxford)	2010
7	"Introduction to BioMEMS" , (CRC press) Albert Folch	2012

Course Name	**:**	**ADVANCED AND HYBRID MANUFACTURING**
Course Code	**:**	**MEN423**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
The student must have the basic knowledge of Advance Manufacturing Processes
To give the maximum knowledge about the application of advanced manufacturing in the engineering field
To give the knowledge on Hybrid Manufacturing Techniques being developed in engineering field

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** : Trends in modern manufacturing. An overview of modern machining methods.	**3**
2	**MECHANICAL METHODS :** Principle, process description, process capabilities, limitations. Applications of Ultrasonic Machining (USM), Abrasive Jet Machining (AJM), and Abrasive Water Jet Machining (AWJM) processes.	**6**
3	**ELECTROCHEMICAL & CHEMICAL METHODS :** Fundamental principle, process description, process capabilities, limitations. Applications and Methodology of Electrochemical Machining (ECM), Electrochemical Grinding (ECG), Electrochemical deburring. Electrochemical honing and Chemical Machining (CM) processes	**7**
4	**THERMAL METAL REMOVAL METHODS :** Fundamental principle, process description, process capabilities, limitations. Applications and methodology of Electrical Discharge Machining (EDM), Laser Beam Machining (LBM), Electron Beam Machining (EBM). Plasma Arc Machining (PAM), Plasma Arc welding (PAW), and Hot Machining (HM) processes**.**	**6**
5	**HYBRID MACHINING METHODS :** Concept, Classification. Common Hybrid Machining Methods ECSM, Vbration Assisted EDM, Electro Discharge Grinding, Process Specifications, Capabilities, limitations and applications	**5**
6	**MICROMACHINING :** Introduction to micro machining, micro-turning, micromilling, micro-drilling, micro EDM, micro- WEDM, micro ECM, etc.	**4**

List of Experiments:		**Number of Turns**
1	CNC programming and Machining of holes/micro holes using EDM process	2
2	Machining of deep holes in fast drill EDM process	2
3	Machining of difficult to machine materials using ECSM process	2
4	Machining of slits and profiles using WEDM process	2
5	Machining of a job using laser cutting machine	2

Course Outcomes: At the end of this course, the student should be able to :	
1	The student shall be able to describe the principles of various Advance Manufacturing Processes.
2	Shall be able to Classify the various Advance Manufacturing process
3	Shall be able to describe the working schematics of the various Advance Manufacturing Processes
4	Shall be able to apply the knowledge of the advance manufacturing processes to fabricate the different products
5	Shall be able to apply the innovative hybrid manufacturing techniques for the production of precision and micro parts.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Pandey P.C. and Shan H.S., "Modern Machining Processes", Tata McGraw Hill, New	
2	Jain V.K., "Advanced Machining Process", Allied Publishers, New Delhi,	2002
3	Groover M.P., "Fundamentals of Modern Manufacturing: Materials, Processes, andSystems", Wiley, New York,	2006.
4	Boothroyd G. and Knight W.A., "Fundamentals of Machining and Machine Tools",Marcel Dekker, New York,	2005.
5	Benedict G.F., "Non-traditional Manufacturing Processes", Marcel Dekker, New York,	1987

Course Name	**:**	**COMPUTATIONAL FLUID DYNAMICS**
Course Code	**:**	**MEN424**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of the course, the student should be able to introduce the foundations of fluid mechanics and Heat transfer, various formulations of governing equations, discretization and numerical solution of the partial differential equations, closure methods for the Navier-Stokes equations as applied to various fluid mechanics and Heat transfer problems and concepts of error and uncertainty and how they relate to the credible numerical solution of the partial differential equations encountered in computational fluid mechanics.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** History of CFD, Comparison of the three basic approaches in engineering problems solving – Analytical, Experimental and Computational Methods. Recent Advances in Computational Techniques.	**5**
2	**PROBLEM FORMULATION:** The standard procedure for formulating a problem physical and Mathematical classification of problems, Types of governing Differential equations and Boundary conditions.	**7**
3	**PARTIAL DIFFERENTIAL EQUATIONS:** Introduction, Physical classification, Mathematical classification, Well-posed problem system of equations other differential equation of interest.	**4**
4	**METHOD OF DISCRETISATION:** Basic of Finite Difference Method, Finite Element Method and Finite volume Method. Treatment of Boundary Condition.	**6**
5	**NUMERICAL SOLUTION TO HEAT CONDUCTION PROBLEM:** Steady state Problems (i) One dimensional Heat Conduction Transfer through a Pin-fin	**10**

	(ii) Two dimensional conduction through a plate Unsteady state Problem. (iii) One dimensional Transient Heat Conduction. Explicit and Implicit Method, Stability of numerical Method.	
6	**NUMERICAL SOLUTION TO FLUID FLOW PROBLEMS:** A type of fluid flow and their governing equations, Viscous Incompressible flows. Calculation of flow field using the stream function vorticity method, Calculation of boundary layers flow over a flat plate.	**10**

Course Outcomes: At the end of this course, the student will be able to :	
1	Demonstrate a critical awareness of the governing equations of fluid mechanics and Heat transfer, and their mathematical behavior, in various formulations of problems.
2	Demonstrate a critical awareness of the underlying principles of numerical analysis, concepts of stability, approximation and convergence and the numerical solution of systems of algebraic equations.
3	Demonstrate a critical awareness of different state-of-the-art CFD methods as used in engineering practice, research and development.
4	Recognize the potential sources of, and discriminate between, error and uncertainty in numerical simulations. Be aware of the tools that are available for the quantification of error and uncertainty in computational simulations. Be able to plan and perform credible computational simulations.
5	Demonstrate a systematic application of the requirements of grid generation for CFD applications.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Computation Fluid Dynamics : The basics with application by JD Ardersonn Jr.	1995
2	Numerical Heat Transfer and Flow by Suhas V. Patankar, Taylor & Francis.	1980
3	Principles of Computational Fluid Dynamics by P. Wesseling.	2009
4	An introduction to Computational Fluid Dynamics by H K Versteeg	1995
5	Computational Fluid Dynamics by Bose, T.K. Wiley, New York.	1988
6	Computational Fluid Dynamics: A Practical Approach by JiyuanTu	2008

Course Name	**:**	**INTERNAL COMBUSTION ENGINES**
Course Code	**:**	**MEN425**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to design and analyze the operating characteristics of different types of internal combustion engines, design and operation parameters of internal combustion engines affect their performance, fuel requirements, and environmental impact.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Internal and external combustion engines; classification of I.C. Engines, Cycles of operation in four stroke and two stroke I.C. Engines, Valve timings, Rotary (Wankel) Engines and their operation,	4
2	**AIR STANDARD CYCLES:** Assumptions made in air standard cycle; Otto cycle; diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles; sterling and Ericsson cycles; air standard efficiency, specific work output, specific weight; work ratio; mean effective	6

	pressure; deviation of actual engine cycle from ideal cycle.	
3	**CARBURETION, FUEL INJECTION AND IGNITION SYSTEMS:** Mixture requirements for various operating conditions in S.I. Engines; elementary carburetor, Requirements of a diesel injection system; types of injection systems; petrol injection, Requirements of ignition system; types of ignition systems ignition timing; spark plugs.	6
4	**COMBUSTION IN I.C. ENGINES:** S.I. engines; Ignition limits; stages of combustion in S.I. Engines; Ignition lag; velocity of flame propagation; detonation; effects of engine variables on detonation; theories of detonation; pre-ignition; octane rating of fuels, S.I. engine combustion chambers, Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers, , Super charging and turbo charging.	6
5	**LUBRICATION AND COOLING SYSTEMS:** Functions of a lubricating system, Types of lubrication system; mist, wet sump and dry sump systems; properties of lubricating oil; SAE rating of lubricants, engine performance and lubrication, Necessity of engine cooling; disadvantages of overcooling; cooling systems; air-cooling, water cooling; radiators.	4
6	**ENGINE TESTING AND PERFORMANCE:** Performance parameters: BHP, IHP, mechanical efficiency, brake mean effective pressure and indicative mean effective pressure, torque, volumetric efficiency; specific fuel consumption (BSFC, ISFC), thermal efficiency; heat balance; Basic engine measurements; fuel and air consumption, brake power, indicated power and friction power, heat lost to coolant and exhaust gases; performance curves	6
7	**AIR POLLUTION FROM I.C. ENGINE AND ITS REMEDIES:** Pollutants from S.I. and C.I. Engines, Methods of emission control; alternative fuels for I.C. Engines; the blending of fuels, Bio Diesel. Multi Point Fuel Injection System (MPFI), EURO- (1-4) series & BHARAT series.	4
8	**GAS TURBINES:** Brayton cycle; Components of a gas turbine plant; open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; multi stage compression with inter-cooling; multi stage expansion with reheating between stages; exhaust gas heat exchanger, Applications of gas turbines. Problems.	6

Course Outcomes: At the end of this course, the student will be able to :	
1	Differentiate among different internal combustion engine designs and understand the 'know how' of differences among the operating characteristics of different engine types and designs.
2	Students can predict and model the performance and fuel economy trends for a given engine.
3	Students can compare and contrast experimental results with theoretical trends, and to attribute observed discrepancies to either measurement error or modelling limitations.
4	Develop an understanding of real world engine design issues.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Internal Combustion Engines", V. Ganesan, Tata McGraw-Hill Education	2002
2	"Gas Turbines", V. Ganesan, Tata McGraw-Hill Education	2010
3	"3. Engineering fundamental of the I.C.Engine", Willard W. Pulkrabek, Prentice Hall	2003
4	"Internal Combustion Engines Fundamentals", John B. Heywood, McGraw Hill Science, New York	1988

Course Name	**:**	**MECHANICAL ENGINEERING DRAWING AND DESIGN**

Course Code	**:**	**MEN-431**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:
By the end of this course, student should be able to understand and develop basic skills for the design, drawing and analysis of mechanical components, preparation of assembly and production drawings for the designed components.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION:** Concepts of stresses and Strain, Combinations of Axial, Shear, Torsional and Bending loads; Theories of Failures: Distortion energy (von Mises), Maximum-Shear stress, Maximum Principal stress, Coulomb-Mohr Theory, Selection and Use of theories of failures; Factor of safety, Contact stresses, Crushing and Bearing stress. **Application Problems:** Eccentric Loading; Cotter and Knuckle Joints; Design and analysis of levers: Cranked, Bell crank, Foot, Rocker arm.	7
2	**BEAMS AND COLUMNS:** Different types of supports/ end conditions, Revision of Stresses in beams: Effect of Section, Orientation, and type of loading; Deflection of beams for different loading conditions. Compressive axial loading of columns and struts, Slenderness ratio, Compressive stress and Buckling of members, Effect of end conditions; Euler's Formula, Applications, validity and limitations; Rankine's Formula, Johnson's equation; Eccentric loading of long columns.	7
3	**SHAFTS, KEYS AND COUPLINGS:** Design of solid and hollow circular shafts subjected to torque and combined loading; Design of shaft for rigidity and stiffness; Design of Keys: Saddle, Sunk, Woodruff, Square, Flat, Kennedy key and Splines. Design of Couplings: Concept of rigid and flexible couplings, Design of Clamp, Rigid flange and Flexible couplings.	6
4	**POWER SCREWS AND THREADED JOINTS:** Forms of thread, Single and Multiple threaded screw, Terminology of power screw, Torque requirements of lifting/lowering, Self-locking, Efficiency of threads, coefficient of friction, design of screw and nut. Basic types of screw fastening, Cap and Set screw, Bolts of Uniform strength, locking devices, Terminology of Screw thread, Bolted Joint: Simple and Eccentric loading, Torque requirement for bolt tightening, Design of turnbuckle, Elastic analysis of bolted joints.	6
5	**WELDED AND RIVETED JOINTS:** Welded joints: stress relieving of welded joints, Strength of butt and fillet joint, Eccentric load in the plane of weld, Welded joint subjected to bending and torsion, Welding symbols. Riveted joints: rivet materials, types of failure, strength and efficiency of joint, Caulking and Fullering, Longitudinal and Circumferential lap joint, Eccentrically loaded riveted joint.	6
6	**TOLERANCES, LIMITS AND FITS:** Introduction, Basic Definitions, Maximum Metal Condition, Least Metal Condition, Grades of tolerance, Linear and Angular Tolerances, Fundamental deviations, Types of Fits and its basis, Gauge design.	3
7	**APPLICATION TO PRODUCTION/ASSEMBLY DRAWINGS**: Basic terminology of geometric dimensioning and tolerancing, Different tolerance characteristics, symbols and tolerance modifiers, Different aspects of datums, Parameters of surface texture and qualifications, Relation of surface roughness and various manufacturing processes, Surface Lay Indication. Assembly and dis-assembly drawing exercises on some of the following using drawing sheets as well as AutoCAD: Couplings, Clutches, Knuckle and cotter joints, Pipe and pipe fittings, IC engine parts, Machine tool parts, Boiler mountings, Bearings, Screw Jack, Drill press vice.	7

Course Outcomes: By the end of this course, student will be able to	
1	Analyse components subjected to various mechanical loads.
2	Analyse beams and columns for stresses and deflection.

3	Design and analyse shafts, keys and couplings.
4	Select fasteners and design welded / riveted joints.
5	Generate and interpret assembly and production drawings.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Design of Machine Elements by V B Bhandari	2010
2	Machine Design by Sharma and Aggarwal	2010
3	Machine Drawing by R. K. Dhawan	2012
4	Machine Design: Fundamentals and Applications by P C Gope	2012
5	Fundamentals of Machine Component Design by R C Juvinall	1992
6	Machine Design: An Integrated Approach by R L Norton	2013
7	Machine Drawing by K C John	2009

Course Name	**:**	**APPLIED THERMODYNAMICS**
Course Code	**:**	**MEN209**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of this course, the student should be able to develop an understanding of thermodynamics as it applies to real cycles, develop problem solving skill through the application of thermodynamics and use laboratory studies to rein force knowledge gained in theory classes

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**RECIPROCATING COMPRESSOR:** Use of compressed air in industry, classification of air compressors, work input and the best index of compression, Its thermal and polytropic efficiency, Effect of clearance and volumetric efficiency. Multi stage compression and its advantages.	**6**
2	**CENTRIFUGAL COMPRESSOR:** Principle of operation, components of a centrifugal compressor complete thermodynamics analysis of centrifugal compressor stage, isentropic and Isothermal efficiencies, work done and pressure rise. Velocity vector diagrams for centrifugal compressors and power calculation, preguide vanes and prerwhirl, slip factor, power input factor, degree of reaction and its derivation, energy transfer in backward, forward and radial vanes. Field of application of centrifugal compressor.	**6**
3	**AXIAL FLOW COMPRESSOR :** Component of axial flow compressor and their arrangement, Principle of operation, velocity vector diagrams, thermodynamics analysis and power calculation, Factors affecting stage pressure rise, work done factor, Degree of reaction and blade Efficiency and their derivation, Isentropic, Polytropic and isothermal efficiencies. Surging, choking and stalling in axial flow compressors. Characteristics curves for axial flow compressors.	**5**
4	**STEAM GENERATORS:** Classification of steam generators, Functions of Boiler mountings and accessories, Principles and operations of steam generators. Description of Cochran, Locomotive, Lancashire, Babcock and Wilcox boiler, Modern high pressure boilers with supercritical and sub critical operating temperatures, Characteristics and advantages of high pressure boilers, water treatment and chemical treatment of boilers, water and steam circulation in high pressure boilers ie feed water and condensate cycle, mountings and accessories in boilers, construction and working of generators, efficiency and heat balance sheet of power plant.	**5**

5	**STEAM ENGINE:** Thermodynamic refinement of Ranking cycle,. Derivation of work done with clearance and compression. Performance of simple steam engine, missing quantity. Compounding of steam engines. Estimation of cylinder dimensions.	**4**
6	**NOZZLES AND DIFFUSERS:** Types and utility of nozzles. Flow of steam through nozzles. Effect of friction. Nozzle efficiency. Critical pressure conditions for maximum discharge. Supersaturated flow. Classification of diffusers effect of friction and area change the converging – diverging super-sonic diffuser.	**4**
7	**STEAM TURBINES:** General description of Impulse and Reaction steam turbines, velocity diagrams & work done, Blade efficiency and its derivation, Reheat factor and condition curve, losses in steam turbines, stages in turbine system, the HP and LP bye-pass system, vacuum maintaining in a turbine, load and speed governing of turbine.	**2**
8	**CONDENSERS:** Utility of condenser. Elements of condensing plants. Brief description of different types of condensers. Dalton's law of partial pressure applied to condenser problems, condenser and vacuum efficiencies. Cooling water calculations. Effect of air leakage. Method of checking and preventing air infiltration. Description of air pump and calculation of its capacity	**5**
9	**ELEMENTS OF POWER PLANTS:** Types of power plants, Selection of site for steam power plants. Base load and peak load of power plants. Variable load, Heat balance, Economics of power generation. Elements of nuclear power production.	**3**

List of Experiments:		**Number of Turns**
1	To study the construction and operation of a two stroke and four stroke petrol & diesel engine.	**1**
2	To draw the valve timing diagram for a Diesel Engine.	**1**
3	To find the Volumetric Efficiency, Brake Thermal Efficiency Mechanical Efficiency, Frictional Power, Indicated Power Heat Balance sheet of Variable Compression Ratio Petrol Engine at different Compression Ratios and study its affect on various parameters.	**1**
4	To estimate the Indicated Power, Friction Power and Mechanical Efficiency of a multi-cylinder Petrol Engine when running at constant speed under constant settings of a carburetor by cutting one, the power of one cylinder each in turn (Morse test).	**1**
5	To find the Volumetric Efficiency, Brake Thermal Efficiency, Mechanical Efficiency, Frictional Power, Indicated Power, Heat Balance Sheet of Variable Compression Ratio Diesel Engine at different Compression Ratios and Study its effect on various parameters.	**2**
6	Trial of a steam engine from no load to full load. Determination I.H.P., B.H.P., mechanical efficiency, brake thermal efficiency and relative efficiency. Plot the variation of these efficiencies against B.H.P. and the power consumption curve (steam consumption and specific steam consumption). Also to draw up the heat balance sheet.	**2**
7	To obtain a power consumption curve, thermal and mechanical efficiency curve for a compound steam engine when tested over the range of power out put from no load to full load.	**1**
8	Study of fire tube boilers-its mountings and accessories.	**1**
9	Study of water tube boiler-its mountings and accessories.	**1**
10	Study of two stage reciprocating compressor.	**1**

Course Outcomes: At the end of this course, the student will be able to :	
1	Develop problem solving skills through the application of thermodynamic
2	Develop basic understanding of various devices like compressor steam generator and various Elements of Thermal Power Plant

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Heat Engineering, Metorpolitan Co. Pvt., Ltd., Delhi, Vasandani and Kumar.	2013
2	Thermal Engineering, Khanna Publisher Delhi, P.L. Ballaney	2005

3	Engineering Thermodynamics, Work and Heat Transfer, ELBS-Publication, Rogers and Mayhew.	1996
4	Thermodynamics and Heat Engines (Vols. I & II), Central Publishers, Allahabad, R. Yadav.	2000
5	Applied Thermodynamics, ELBS Publications, T.D. Eastop & Amc. Conkey.	1996

Course Name	**:**	**MANUFACTURING SCIENCE AND PROCESSES**
Course Code	**:**	**MEN433**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, student should be able to manufacturing processes, techniques, use of tools, tooling system, machine etc. To impart the knowledge about various machine tools and their applications, various conventional and nonconventional machining processes and techniques used in metal cutting. Knowledge about the various processes for finishing and polishing.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**MANUFACTURING:** Definition, classification. Introduction to product design, manufacturing activities inside and outside the factory, planning and process sheet, selection of raw materials and storing, heat treatment.	4
2	**FOUNDRY:** Raw materials, Patterns; allowances, colours scheme, applications. Moulding and mould making, Melting furnaces, gating system, runner and riser, fettling. Special Processes: carbon dioxide, plaster, shell and permanent moulding, precision, investment, die, centrifugal and continuous casting. Introduction of Casting of composites Inspection and Testing: introduction to Micro casting and applications.	6
3	**METAL FORMING:** Hot, cold, and special rolling, pipe and seamless tube manufacture. Extrusion, Wire, rod and tube drawing, metal spinning. Forging: smith, impression die, drop, closed and open die, upset, machine and press forging. draft angles, flash and gutter. Special processes: electro, hydraulic, magneto-electro and hybrid forming. Defects in forming and remedial actions. Introduction to micro forming.	6
4	**WELDING:** Arc welding: Principle, types, relative merits in use of AC & DC, Carbon, submerged, gas tungsten, tungsten inert gas and plasma arc welding. Electrodes: Types, classification and codification of electrodes, applications of electrodes Special welding: Atomic hydrogen, laser beam deposition, wet and dry welding. Gas welding: Types, different zone and temperature of flames, applications. Oxy-flame cutting, Brazing and soldering: Inspection and testing, Welding defect and their remedial action.	6
5	**METAL CUTTING**: Advanced cutting tool materials, Geometry of single point cutting tools, Multipoint cutting tools, Tool life, Machinability, Machining parameters, cutting fluid, Machine Tools: Lathe, Milling, Drilling Shaping, Slotting, Planning; Sawing, Broaching. Taper turning and thread cutting, Calculation of MRR. Machining of plastics.	8
6	**NONCONVENTIONAL AND ADVANCED MACHINING PROCESSES** Need and objective of nonconventional machining. ECM, EDM, WEDM, USM, EBM, LBM, AJM: Working principle, Process parameters, Applications. Introduction to hybrid machining processes.	7
7	**FINISHING PROCESSES** Grinding, types of Grinding machines, specification of grinding wheel. Honing, Lapping, Super finishing, Polishing, Buffing, Advanced finishing processes: AFF.	5

Course Outcomes: By the end of this course, student will be able to	
1	Clear the basic concepts and understand about the various manufacturing processes.
2	Realize the important of primary and secondary manufacturing operations and their actual applications in

	manufacturing
3	Understand about the tools, tooling, machine tools, and other related equipments used in manufacturing.
4	Come up with innovative conceptual idea about manufacturing processes and their industrial applications

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Manufacturing Engineering and Technology; Serope Kalpakjian and Steven R.Schmid-4th edition, Pearson Edition,	2013
2	Manufacturing Science; Amitava Ghosh and Asok Kumar Mallik,, East-West Press Pvt Ltd. New Delhi,	1993
3	Advance machining processes. Jain V K ; Allied publishers, New Delhi, India,	2002

Course Name	**:**	**REFRIGERATION AND AIRCONDITIONING**
Course Code	**:**	**MEN- 210**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to understand the basic principles of working of Refrigeration Systems & Air Conditioning System, the in and out constructional & working details of the various components of Refrigeration System like evaporators, compressor etc and to design the air conditioning load for a particular building.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**REFRIGERATION** : Refrigeration effect, cooling capacity and C.O.P. of a refrigerator, E.P.R. of heat pump, Reversed Carnot Cycle	2
2	**AIR CYCLE REFRIGERATION: ANALYSIS OF BELL COLEMAN CYCLE;** Need of aircraft refrigeration and air conditioning; Analysis of different Air Cycle Refrigeration Systems for aircraft.	4
3	**VAPOUR ABSORPTION REFRIGERATION**: (Only Introduction: No Derivation)Simple vapour absorption refrigeration; Modifications to simple vapour absorption refrigeration system; Actual vapour absorption refrigeration system Electrolux system; Lithium BromideWater absorption refrigeration system; Solid-Vapour absorption and absorption refrigeration system.	4
4	**VAPOUR COMPRESSION REFRIGERATION**: Vapour compression Cycle on P-V, P-H and T-S diagrams; Deviation of actual Cycle from theoretical one; Mathematical analysis of theoretical and actual vapour compression refrigeration cycle; effect of suction pressure, discharge pressure, sub-cooling, superheating and pressure drop in valves.	4
5	**MULTI-PRESSURE VAPOUR COMPRESSION REFRIGERATION** : Single load compound compression with single expansion and water intercooling; single load compound compression with individual expansion valve and flash intercooling; Multiple load systems with individual expansion valves and individual compressors; Single Load Compound Compression with flash tank and water intercooling; Single Load Compound with flash chamber as intercooler.	4
6	**CONVENTIONAL REFRIGERANTS AND THEIR ENVIRONMENTAL ASPECTS WITH CONSEQUENCES**: Refrigerants: Classification, designation, field of applications, thermodynamic, chemical and	4

	physical properties of refrigerant; comparison of commonly used refrigerants (e.g. Ammonia, R-11, R-12, R-22); Environmental aspects of conventional refrigerants and their consequences; Alternate refrigerants and the problems associated with their use.	
7	**NON-CONVENTIONAL REFRIGERANT SYSTEMS**: Steam Jet Refrigeration; Cascade Refrigeration System; Mixed Refrigeration System; Martinovsky Open Cycle; Vortex Tube Refrigeration; Thermoelectric Cooling, Modern Air Condition Systems like HVAC ,Variable refrigerant volume (VRV/VRF)	5
8	**CRYOGENICS**: Definition, Cryogenic fluids, storage and insulation; Linde-Hampson and Cloude Liquification Cycles (NO ANALYSIS); Adiabatic Demagnetization; Applications.	2
9	**AIR-CONDITIONING**: Definition, Applications; Psychometric properties of air; Dry bulb, wet bulb and dew point temperatures; Relative and specific humidity; Enthalpy of air and water vapours; Human requirements of comfort; Effective temperature.	5
10	**BASIC PROCESSES IN CONDITIONING OF AIR AND AIR CONDITIONING EQUIPMENT**: Sensible cooling and heating of air; simple humidification and dehumidification of air concept of bypass factor; cooling and dehumidification; Evaporative cooling; chemical dehumidification; air washer.	4
11	**LOAD CALCULATIONS AND SUPPLY AIR CONDITIONS**: Sources of heat load; sensible and latent heat load; sensible heat factor; apparatus dew point temperature; quality and state of supply air for air conditioning of various buildings; Load calculations for comfort and cold storage air conditioning.	4

Course Outcomes: At the end of this course, the student will be able to :	
1	Understand the basic principle of working of Refrigerator & Air conditioner.
2	Understand how to analyse the Refrigeration Cycles.
3	Understands the various air conditioning processes & their effect on Human Comfort.
4	Understands the various equipments used in Refrigerator.
5	Understands how to do the design load calculations for air conditioning a building.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Refrigeration and Air Conditioning - W.F. Stoecker, McGraw Hill.	1986
2	Refrigeration and Air Conditioning - Jordon and Priester, Prentice Hall of India	2009
3	Principles of Refrigeration - R.J. Dossat, Wiley Eastern	2001
4	Refrigeration and Air Conditioning - C.P.Arora, Tata McGraw Hill	1997
5	Refrigeration and Air Conditioning - Manohar Prasad New Age International (Pvt.) Ltd., Publishers.	2010
6	Refrigeration and Air Conditioning - P.L. Ballaney, Khanna Publishers	2012

Course Name	**:**	**AUTOMOBILE ENGINEERING**
Course Code	**:**	**MEN417**
Credits	**:**	**4**
L T P	**:**	**3 -1- 0**

Course Objectives:

At the end of this course, the student should be able to understand the systems of automobile such as cooling and lubrication system, fuel supply system, transmission system, braking system, suspension and steering system, ignition system emission control.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**COOLING AND LUBRICATION SYSTEMS**: cooling systems and their components, antifreeze mixtures. Lubrication purpose and various systems of lubrication, types and desirable properties of lubricants, components like oil filters, oil pumps, and oil pressure indicators, air supply system, air filters, turbo charger and super charger.	**5**
2	**FUEL SUPPLY SYSTEMS**: Fuel injection system for petrol and diesel engines, fuel pumps (mechanical and electrical), air fuel ratio requirements, carburetors: types and general operation throttle body and multipoint fuel injection systems, electronic control module and sensing devices.	**5**
3	**TRANSMISSION SYSTEMS** Clutch function and types, torque converters; manual and automatic transmission/ transaxles; sliding constantly & synchromesh gearboxes, epicyclic gearbox. differential. propeller shafts and universal joint front and rear axles.	**4**
4	**BRAKE SYSTEMS, WHEEL & TYRES**: Braking efficiency and stopping distances. Types of brakes, Drum and disc brakes. Detailed description of hydraulic and pneumatic brake. Mechanical, vacuum and electrical methods of brake actuation, servo brakes, ABS, type of wheels, tyres, type of tyres; cross ply, radial tubeless etc. specification of tyres.	**5**
5	**SUSPENSION SYSTEM**: Road springs, shock absorbers, independent suspension, road springs. air suspension, hydroelastic suspension.	**4**
6	**STEERING SYSTEM:** Steering geometry, details, correct steering angle, Ackerman steering mechanism. Cornering power, over steering and under steering. Worm wheel and Rack pinion types of steering gears. Safety steering columns, power steering.	**5**
7	**IGNITION SYSTEM:** Various ignition systems (coil and magneto) and detailed study of their components, electronic ignition system, distributor less ignition system	**4**
8	**BATTERY AND STARTING SYSTEMS:** Storage battery (lead acid type), Maintenance free batteries, various components, Charging system, starting motors, starting drives, Bendix drive, Electronic starter control, starting system trouble shooting.	**4**
9	**EMISSION CONTROL:** Emission norm like EURO and BHARAT norms, methods and devices to control emissions.	**3**
10	**MISCELLANEOUS TOPICS**: Automotive accessories, hydraulic single lever and two lever hydraulic systems for tractors, Technical specifications, controlling devices such as fuel gauge, temperature gauge, indicator lights speedometer odometer, HVAC Etc. .	**3**

Course Outcomes: At the end of this course, the student will be able to :	
1	Command over automotive engines and the recent development in the area of engines.
2	Command over automotive system and the recent development in the area.
3	Understand the constructional, working principle of various sub system of an automobile.
4	Understand various controlling systems
5	All theoretical information and about electrical components used in a vehicle.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Automobile Engg.", Vol I & II, Kirpal Singh, Standard Publication distributors, Delhi Vol. I & Vol. II	2009

2	"Automotive Mechanics", W.H.Grouse. Tata McGraw Hill Publishing Co.Ltd. New Delhi,	1993
3	"Automotive Mechanics", J.Haitner, Affiliated East West Press, N.Delhi,	1987
4	"Motor Vehicle Newton and Steed", Hiffee, London	1958

GENERAL SCIENCE COURSES (GSC)

Course Name	**:**	**ENVIRONMENTAL SCIENCES**
Course Code	**:**	**GSC101**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:
This course aims to acquaint students with the basics of Environmental Sciences.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Multi-discipline nature of environmental studies as applied to different engineering streams - Definitions, scopes and explanations.	6
2	Types of Ecosystems – System dynamics – Understanding ecosystems, Ecosystem degradation, Resource utilization, Ecosystem diversity, Habitat classification.	6
3	Natural Resources; Renewable and non-renewable- Natural resources and associated problems, Non-renewable resources, Renewable resources	6
4	Energy and Environment- Fossil fuel, Geothermal, tidal, nuclear, solar, wind, hydropower & biomass.	6
5	Environment pollution- Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Nuclear hazards	6
6	Cleaner Production and life cycle analysis: - LCA methodology, steps and tools, EIA and Environment audit	6
7	Environment Development and Society:- Emerging technology for sustainable development and environment management, public participation and provision in management and legislation.	6

Course Outcomes:	
1	Students will be able to relate the importance of Environmental Sciences for sustainable development of society.
2	Students will be able to understand the problems and remedies of Environmental Sciences.

Text Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Environmental Science Ceonage Learning Publication, Miller G.T. and Spool Mar
2	Environmental Studies, Tata McGraw Hill Pub., Banny Joseph

BASIC SCIENCE COURSES (BSC)

Course Name	**:**	**MATHEMATICS I**
Course Code	**:**	**MAN 101**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
To make the students understand the behavior of infinite series and their use. To make the students learn the concepts related to functions of several variables and their applications. To make the students learn the methods of evaluating multiple integrals and their applications to various problems. To make the students learn the methods to formulate and solve linear differential equations and apply them to solve engineering problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INFINITE SERIES** Infinite series and convergence, alternating series, power series and convergence. Taylor's and Maclaurin's Series. (Scope as in Chapter 8, Sections 8.1, 8.3 – 8.9 of Reference Book 1).	8
2	**MULTIVARIABLE FUNCTIONS** Limit, Continuity and Partial Derivatives; Euler's Theoem for Homogeneous functions; Differentiability, Linearization and Differentials; Chain rule; Extreme values and Saddle Points; Lagrange multipliers; Taylor's Formula**.** (Scope as in Chapter 12, Sections 12.1 – 12.6, 12.8 – 12.10 of Reference Book 1).	10
3	**SOLID GEOMETRY** Cylinders and Quadric surfaces, Cylindrical and Spherical Coordinates. (Scope as in Chapter10, Sections10.6 and 10.7 of Reference Book 1)	4
4	**INTEGRAL CALCULUS** Area between plane curves; Volumes of solids of revolution; Lengths of plane curves; Areas of surfaces of revolution. Double integrals in rectangular and Polar form, Triple integrals in Rectangular, Cylindrical and Spherical coordinates, Substitutions in Multiple Integrals. (Scope as in Chapter 5, Sections 5.1, 5.3, 5.5, 5.6 and Chapter 13 .Sections 13.1, 13.3, 13.4,13.6 and 13.7 of Reference Book 1).	8
5	**ORDINARY DIFFERENTIAL EQUATIONS** First order exact differential equations, Integrating factor, Orthogonal trajectories, Second and Higher order Linear Differential Equations with constant coefficients, Differential Operators, Methods of Variation of Parameters and Undetermined Coefficients, Euler Cauchy Equation, Wronskian. (Scope as in Chapter 1, Section 1.5, 1.8 Chapter 2, 2.1-2.4, 2.6, 2.9-2.10, 2.13- 2.15 of Reference Book 2).	12

Course Outcomes:	
1	The students are able to test the behavior of infinite series.
2	The students are able to analyze functions of several variables and their applications.
3	The students are able to evaluate multiple integrals and apply them to practical problems.
4	The students are able to solve linear differential equations.

Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	G. B. Thomas, R. L. Finney. Calculus and Analytic Geometry, Ninth Edition, Pearson Education.
2	E. Kreyszig. Advanced Engineering Mathematics, Eighth Edition, John Wiley.
3	B. V. Ramana. Higher Engineering Mathematics, Tata McGraw Hill.

Course Name	**:**	**PROBABILITY AND STATISTICS**
Course Code	**:**	**MAN 103**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to use statistical methods to collect and analyze the data. The students should be able to estimate unknown parameters of populations and apply the tests of hypotheses.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS** Random variables, Discrete, Continuous and Joint Probability distributions, Marginal and Conditional distributions, Independent random variables, Expectation, Variance and Covariance, Means and variances of linear combinations of random variables, Chebyshev's inequality, Binomial, Poisson, Uniform and Normal distributions, Normal and Poisson approximations to Binomial, Moments, Moment generating function.	20
2	**SAMPLING DISTRIBUTIONS & ESTIMATION** Population, Sample, Sampling distributions, Law of large numbers, Central limit theorem, Distribution of sample mean, Difference of means, Proportions and difference of proportions, Chi-square distribution, Student's t-distribution, Estimation of parameters, Point estimate, Confidence interval for mean, difference of means and proportions.	16
3	**TESTS OF HYPOTHESES** Hypothesis, Test statistic, Critical region, Significance level, Single Sample and Two Samples tests for mean.	6

Course Outcomes: By the end of this course, the student will be able to:	
1	Collect and analyze the data statistically.
2	Describe sampling distributions of sample means and sample proportions
3	Estimate unknown parameters of the population from a sample.
4	Construct confidence intervals for mean difference of means and proportions; and perform hypothesis tests for means.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Probability and statistics for Engineers and Scientists, Walpole, Myers, Myers and Ye, Pearson Education	2012
2	Introduction to Mathematical Statistics, Hogg and Craig, Pearson Education	2013
3	Miller and Freund's: Probability and Statistics for Engineers, Richard A. Johnson, Prentice Hall	2010
4	John E. Freund's: Mathematical statistics with Application, Miller and Miller, Pearson Education	2012

Course Name	**:**	**VECTOR CALCULUS, FOURIER SERIES AND LAPLACE TRANSFORM**
Course Code	**:**	**MAN105**

Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to use concepts of vector calculus to analyze scalar and vector fields and compute the gradient, divergence and curl. They should be able to evaluate line, surface and volume integrals. The students should be able to expand functions in a Fourier series and apply Harmonic analysis to numerical data. They should be able to evaluate Laplace transforms and inverse Laplace transform and apply Laplace transforms to solve ordinary differential equations.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**VECTOR CALCULUS** Gradient, Divergence and Curl – their physical interpretation and representation in cylindrical and spherical coordinates. Line, surface and volume integrals; Green's theorem in the plane, Stoke's theorem, Divergence theorem; Irrotational and Solenoidal Fields, Applications to Science and Engineering.	20
2	**FOURIER SERIES** Periodic functions, Trigonometric series, Fourier Series, Euler's formulae, Conditions for existence of Fourier series, Even and odd functions, Half range expansions, Complex Fourier series, Applications of Fourier series, Parseval's identity, Harmonic analysis.	12
3	**LAPLACE TRANSFORM** Laplace transform, Inverse transform, properties, Transforms of derivatives and integrals, Unit step function, Dirac's delta function, Differentiation and integration of transforms, Applications to differential equations.	10

Course Outcomes:	
1	Use vector calculus to analyze scalar and vector fields and compute the gradient, divergence and curl.
2	Evaluate line, surface and volume integrals.
3	Apply Green's Theorem, Divergence Theorem and Stoke's theorem to evaluate integrals..
4	Expand a function in terms of its Fourier series and to apply harmonic analysis to numerical data.
5	Evaluate Laplace transforms and inverse Laplace transforms of functions.
6	Apply Laplace transforms to solve ordinary differential equations arising in engineering problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Calculus and Analytic Geometry, G. B. Thomas and R. L. Finney, Pearson Education	2014
2	Advanced Engineering Mathematics, E. Kreyszig, John Wiley	2006
3	Advanced Engineering Mathematics, M.D. Greenberg, Pearson Education Asia	2010
4	Advanced Engineering Mathematics, Wylie and Barrett, McGraw Hill	2003

Course Name	**:**	**PARTIAL DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS**
Course Code	**:**	**MAN 106**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course, the students should be able to formulate and solve linear and nonlinear partial differential equations and apply partial differential equations to engineering problems. The students should be able to solve ordinary differential equations using series solutions, describe special functions as solutions to differential equations and expand functions in terms of eigenfunctions and to solve Sturm Liouville's problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**PARTIAL DIFFERENTIAL EQUATIONS** Formation and solution of first order partial differential equations, Linear equations of higher order with constant coefficients, Applications to Engineering problems**.**	17
2	**SPECIAL FUNCTIONS** Series solution of differential equations, Power series methods, Series solution of Legendre's differential equation Legendre's polynomial, generating functions, Recurrence relations, Frobenius method, Series solution of Bessel's differential equation, Bessel's functions, Modified Bessel's functions, generating functions, Recurrence relations, Equations reducible to Bessel's equation, Sturm Liouville's problem, Eigen function expansions.	25

Course Outcomes: By the end of the course, the students will be able to	
1	Formulate and solve linear and nonlinear partial differential equations
2	Apply partial differential equations to engineering problems.
3	Solve differential equations using series solutions.
4	Describe special functions as solutions to differential equations**.**
5	Expand functions in terms of eigenfunctions and to solve Sturm Liouville's problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics, E. Kreyszig, John Wiley	2006
2	Advanced Engineering Mathematics, Wylie and Barrett, McGraw Hill	**2003**
3	Elements of Partial differential equations, Sneddon, McGraw Hill	**2006**

Course Name	**:**	**NUMERICAL ANALYSIS**
Course Code	**:**	**MAN 109**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to describe errors involved in computations and to estimate these errors. The students should be able to solve equations, apply numerical methods to interpolate, extrapolate, differentiate and integrate functions. They should be able to solve differential equation using numerical methods and solve systems of equations.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ERRORS**	5

	Errors in numerical calculations, Absolute, relative and percentage errors, Round off and truncation errors, Error propagation, Loss of significant digits, Errors in series approximation, Speed of convergence.	
2	**SOLUTION OF EQUATIONS** Bisection method, Fixed point iteration and its convergence, Acceleration of convergence using Aitken's method; Regula-Falsi, Newton-Raphson, Generalized Newton's, Chebyshev's and Halley's methods.	7
3	**INTERPOLATION** Lagrange Interpolation, Newton's divided difference interpolation, Finite differences, Newton's, Bessel's, Stirling's and Guass' difference formulae.	10
4	**NUMERICAL DIFFERENTIATION & INTEGRATION** Differentiation using differences, Integration using Newton-cote's formulas with errors, Gaussian Quadrature.	8
5	**SOLUTION OF LINEAR SYSTEM OF EQUATIONS** Direct methods - Gauss elimination, Partial pivoting, Complete pivoting, Gauss-Jordan and factorization methods, Iterative methods-Gauss Siedal and Jacobi's methods.	6
6	**NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS** Solution of first order differential equations using Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4^{th} order, Predictor-Corrector methods (Adam's and Milne's method),	6

Course Outcomes:	
1	Describe errors involved in computations and to estimate the errors.
2	Solve algebraic and transcendental equations using Bisection method Regula-Falsi, Newton-Raphson,
3	Generalized Newton's, Chebyshev's and Halley's methods.
4	Apply numerical methods to interpolate, extrapolate differentiate and integrate functions.
5	Solve systems of equations.
6	Solve differential equation using numerical methods.(Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4^{th} order, Predictor-Corrector methods)

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics, E. Kreyszig, John Wiley	2006
2	Numerical Methods for Mathematics, Science and Engineering, Mathews, Prentice Hall	1992
3	An Introduction to Numerical Analysis, Atkinson, John Wiley	2012

Course Name	**:**	**OSCILLATIONS AND OPTICS**
Course Code	**:**	**PYN101**
Credits	**:**	**4**
L T P	**:**	**3 1/2 2/2**

Course Objectives:
To familiarize the students with Ultrasonics and their applications To acquaint the students with simple harmonic motion along with damping and driving forces

To refresh the basics of interference, diffraction and polarization and familiarize the students with their applications through lectures and experiments To teach the students the basic concepts of LASER and to familiarize them various kinds of lasers To acquaint the students with fundamentals of holography

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ULTRASONICS:** Production, detection and uses of ultrasonics, reverberation, sabine's formula (no derivation)	3
2	**SHM:** Review of basic kinematics (displacement, velocity, acceleration, time period and phase of vibration) and dynamics (restoring force and energetics) of simple harmonic motion, differential equation of SHM, superposition of two SHM in one dimension, charge oscillations in LC circuits	4
3	**DAMPED OSCILLATIONS:** Concept and cause of damping, differential equation of a damped oscillator and different kinds of damping, Methods of describing damping of an oscillator - logarithmic decrement, relaxation time, quality factor, band width. Series LCR circuit as a damped oscillator.	4
4	**FORCED OSCILLATIONS:** States of forced oscillations, differential equation of forced oscillator – its displacement, velocity and impedance, behaviour of displacement and velocity with driver's frequency, Power, bandwidth, Quality factor and amplification of forced oscillator, resonance in forced oscillators, forced oscillations in series LCR circuit	5
5	**WAVE MOTION:** Wave equation and its solution, characteristic impedance of a string, reflection and transmission of waves on a string at a boundary, reflection and transmission of energy, the matching of impedances	3
6	**INTERFERENCE:** Division of wave front and amplitude; Fresnel's biprism, Newton's rings, Michelson interferometer and its applications for determination of λ and $d\lambda$.	4
7	**DIFFRACTION:** Fresnel and Fraunhofer diffraction, qualitative changes in diffraction pattern on moving from single slit to double slit, plane transmission grating, dispersive power & resolving power of a grating.	5
8	**POLARIZATION:** Methods of polarization, analysis of polarized light, quarter and half wave plates, double refraction.	4
9	**LASERS:** Elementary idea of LASER production, spontaneous emission, stimulated emission, Einstein's coefficients, Helium-Neon, Ruby and semiconductor lasers, applications of lasers.	4
10	**FIBRE OPTICS:** Basics of optical fibre - its numerical aperture, coherent bundle, step index and graded index fibre, material dispersion, fibre Optics sensors, applications of optical fibre in communication systems.	4
11	**HOLOGRAPHY:** Basic principle, theory and requirements.	2

List of Experiments:	
1	To find the wavelength of sodium light using Fresnel's biprism.
2	(i) To determine the wavelength of He-Ne laser using transmission grating. (ii) To determine the slit width using the diffraction pattern.
3	To determine the wave length of sodium light by Newton's rings method.
4	To determine the wave length of sodium light using a diffraction grating.
5	To find the specific rotation of sugar solution using a Bi-quartz Polarimeter.
6	To design a hollow prism and used it find the refractive index of a given liquid

Course Outcomes:	
1	Students are aware of latest developments in certain areas of Physics which have important applications for societal needs.
2	Students learn about lasers and fibre optics which have important applications for societal needs.
3	Students are expected to develop capability to tackle problems in general and in the various areas covered in the course.

Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Physics for Engineers (Prentice Hall India) - N.K. Verma
2	Physics of Vibrations and Waves (5th Edition, John Wiley & Sons) – H.J.Pain
3	Optics – Ajoy Ghatak

Course Name	**:**	**CONDENSED MATTER PHYSICS**
Course Code	**:**	**PYN102**
Credits	**:**	**4**
L T P	**:**	**3 1/2 2/2**

Course Objectives:
To teach the students the basic concepts of crystal structure and defects To familiarize the students with the concepts of Free electron theory of metals and its applicability To acquaint the students with the concepts of Dielectric and Magnetics materials with their applications through lectures and experiments To impart to the students the concepts of superconductivity and nanotechnology To teach the students the basic concepts of crystal structure and defects

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CRYSTAL STRUCTURE:** Space lattices and their symmetries, crystal structures (cubic and hexagonal cells), assignment of coordinates, directions and planes in crystals, linear, planer and space densities in crystals, close packed morphology (Hexagonal and cubic close packing), single and polycrystalline structures, interstitial spaces (trigonal, tetrahedral and octahedral voids, crystal Structure analysis, X-ray diffraction and Bragg's law, crystal defects, Point, line, surface and volume imperfections	(11)
2	**THEORY OF METALS:** Free electron theory, electrical properties, thermal properties, motion in magnetic field (cyclotron resonance), Zone theory. Band theory of solids, Kronig-Penney Model (qualitative), conductors, insulators and semiconductors	(6)
3	**DIELECTRIC MATERIALS:** Review of basic formulas, dielectric constant and polarizability, sources of polarizability, classical treatment of dipolar, ionic and electronic polarizability, piezoelectricity, ferroelectrcity.	(5)
4	**MAGNETIC MATERIALS:** Review of basic formulas, magnetic susceptibility, classification of materials, Langevin diamagnetism, paramagnetism (only classical treatment), magnetism in metals, ferromagnetism in insulators, anti-ferromagnetism and ferrimagnetism, ferromagnetism in metals, ferromagnetic domains, hysteresis	(8)
5	**SUPERCONDUCTIVITY:** Zero resistance, occurrence of superconductivity, Meissner effect, critical field, thermodynamics of superconducting transitions, electrodynamics of superconductors, qualitative idea of BCS theory.	(4)
6	**SEMICONDUCTORS**: p-type and n-type semiconductors, statistics of electrons and holes, Hall effect (for single as well as both type of charge carriers)	(4)
7	**NANOTECHNOLOGY:** Introduction, Synthesis of Nanoparticles: Mechanical Method, Sputtering, Chemical Vapour Deposition, Sol-gel Technique, Applications of Nanotechnology	(4)

List of Experiments:	
1	To find the energy band gap of the given semiconductor by four probe method.
2	To study the Hall Effect of a given semiconductor.
3	To determine the dielectric constant of the given materials.

4	To study the B-H curve of the ferromagnetic materials.
5	To determine the value of e/m for electron by long solenoid (helical) method.
6	To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph.

Course Outcomes:	
1	Students learn about dielectric and magnetic materials which have important applications for societal needs.
2	Students learn about superconductivity and nanotechnology which have important applications.
3	Students are expected to develop capability to tackle problems in general and in the various areas covered in the course.

Suggested Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Material science and Engineering – An Introduction by William D Callister, Jr, Sixth Edition, John Wiley and Sons.
2	Material science and Engineering – A First Course by V.Raghvan Fourth Edition, Eastern Economy Edition
3	Solid State Physics (New Age Publishers) – S.O. Pillai
4	Introduction to Solids (Tata McGraw Hill, Third Edition) - Leonid V Azaroff

Course Name	**:**	**MECHANICS**
Course Code	**:**	**PYN - 105**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
To acquaint about the engineering aspects of Mechanics
To familiarize Kinematics and Kinetics of rigid body
To inculcate the application of Mechanic concepts in engineering
To familiarize the application of relative motion analysis in the design of energy system

Total No. of Lectures – 36

Lecture wise breakup		**Number of Lectures**
1	**KINEMATICS OF A PARTICLE**: Introduction. Rectilinear Kinematics: General Curvilinear Motion. Curvilinear Motion: Rectangular Components, Normal and Tangential Components, Cylindrical Components. Absolute Dependent Motion Analysis of Two Particles. Relative-Motion Analysis of Two Particles Using Translating Axes. Motion of a Projectile.	5
2	**KINETICS OF A PARTICLE: FORCE AND ACCELERATION**: Newton's Laws of Motion. The Equation of Motion. Equation of Motion for a System of Particles. Equations of Motion: Rectangular Coordinates, Normal and Tangential Coordinates, Cylindrical Coordinates. Central-Force Motion and Space Mechanics.	4
3	**KINETICS OF A PARTICLE: WORK AND ENERGY**: The Work of a Force. Principle of Work and Energy. Principle of Work and Energy for a System of Particles. Power and Efficiency. Conservative Forces and Potential Energy. Conservation of Energy.	3
4	**KINETICS OF A PARTICLE: IMPULSE AND MOMENTUM**: Principle of Linear Impulse and Momentum. Principle of Linear Impulse and Momentum for a System of Particles. Conservation of Linear Momentum for a System of Particles. Impact. Angular Momentum. Relation Between Moment of a Force and Angular Momentum. Angular Impulse and Momentum Principles.	4
5	**PLANAR KINEMATICS OF A RIGID BODY:** Rigid-Body Motion. Translation. Rotation About a Fixed Axis. Absolute General Plane Motion Analysis. Relative-Motion	4

	Analysis: Velocity, Instantaneous Center of Zero Velocity, Acceleration. Relative-Motion Analysis using Rotating Axes.	
6	**PLANAR KINETICS OF A RIGID BODY: FORCE AND ACCELERATION:** Moment of Inertia. Planar Kinetic Equations of Motion. Equations of Motion: Translation, Rotation About a Fixed Axis, and General Plane Motion.	4
7	**PLANAR KINETICS OF A RIGID BODY: WORK AND ENERGY:** Kinetic Energy. The Work of a Force. The Work of a Couple. Principle of Work and Energy. Conservation of Energy.	3
8	**PLANAR KINETICS OF A RIGID BODY: IMPULSE AND MOMENTUM:** Linear and Angular Momentum. Principle of Impulse and Momentum. Conservation of Momentum. Eccentric Impact.	3
9	**THREE-DIMENSIONAL KINEMATICS OF A RIGID BODY**: Rotation About a Fixed Point. The Time Derivative of a Vector Measured from a Fixed and Translating-Rotating System. General Motion. Relative-Motion Analysis using Translating and Rotating Axes.	3
10	**THREE-DIMENSIONAL KINETICS OF A RIGID BODY**: Moments and Products of Inertia. Angular Momentum. Kinetic Energy. Equations of Motion. Gyroscopic Motion. Torque-Free Motion.	3

Course Outcomes:	
1	The student will be able to understand the concepts of Mechanics.
2	The students will be able to apply the concepts of Mechanics in fluid of energy.
3	The students will be able to understand various types of motion characteristic and found characteristic of rigid body.

Suggested Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	R.C. Hibbeler, Dynamics (11th Ed) Pearson Publishers.
2	F.P. Beer et al. Dynamics (8th Ed) Mc GrawHill Publishers.
3	Merriam and Kraige; Dynamics (5th Ed) Wiley and Sons Publications Merriam and Kraige.
4	R.C. Hibbeler, Statics (11th Ed) Pearson Publishers.

Course Name	**:**	**ELECTROMAGNETIC THEORY**
Course Code	**:**	**PYN-106**
Credits	**:**	**4**
L T P	**:**	**3 1/2 2/2**

Course Objectives:
At the end of the course, the student should be able to understand the classification of the vector fields. The student should be able to apply the concepts of electrostatics and boundary value problems. The student should be able to understand concepts of electromagnetic wave propagation.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**VECTORS AND FIELDS:** Cartesian coordinate System, Cylindrical and Spherical coordinate Systems, Constant coordinate surfaces, Del operator, Gradient, Divergence of a Vector and Divergence Theorem, Curl of a vector and Stoke's theorem, Gradient, Divergence, Curl and Laplacian in the three coordinate Systems, Laplacian of a scalar, Scalar & Vector Fields, Classification of Vector field. Sinusoidally time-varying fields, Complex Numbers and Phasor technique.	10
2	**ELECTROSTATICS:**	10

	Field intensity, Gauss's law & its applications, Maxwell's 1st eqn. (Electrostatics), Electric Energy and potential, the line integral, Potential gradient, the dipole fields, Energy density in an electrostatic field. Current and current density, Continuity of current, Metallic conductors, Conductor properties and boundary conditions, the nature of Dielectric materials and related Boundary conditions, Capacitance, Capacitance of a two-wire line, Current analogies. Electrostatic boundary-value problems, Laplace's and Poisson's equations, Uniqueness theorem, General procedure for solving Laplace's and Poisson's equation , Resistance and capacitance, Method of images.	
3	**MAGNETOSTATICS:** Biot-Savart's law, Ampere's circuital law, Applications of Ampere's law, Magnetic flux and magnetic flux density-Maxwell's eqn., Maxwell's eqn. for static electromagnetic fields, Scalar and vector magnetic potentials. Magnetic dipole, Force due to Magnetic field on a differential current element, force between two differential current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Inductors and inductances, Magnetic energy, Magnetic circuits, Potential energy and force on magnetic materials.	11
4	**MAXWELL'S EQUATIONS AND ELECTROMAGNETIC WAVE PROPAGATION:** Faraday's law, Displacement current, Maxwell's equations in point form, Maxwell's equations in integral form, Kirchoff's Voltage law and Kirchoff's Current law from Maxwell's equations, EM waves in general, EM wave propagation in Lossy Dielectrics, Wave propagation in lossless dielectrics, Plane waves in free space, Plane waves in Good conductors, Power & Poynting Vector, Reflection of a plane wave at normal incidence, Reflection of a plane wave at oblique incidence.	11

List of Experiments:		**Number of Turns**
1	To design a method to draw equipotential lines with various geometries of electrodes kept at different potentials	1
2	To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph	1
3	To find the energy band gap of the given semiconductor by four probe method	1
4	To study the Hall effect of a given semiconductor	1
5	To determine the dielectric constant of the given materials	1
6	To study the B-H curve of the ferromagnetic materials	1

Course Outcomes:	
1	By the end of the course, the student will be equipped with the tools of electromagnetic theory.
2	The student will be able to solve numerical problems based on vector fields, electrostatics, magnetostatics and electromagnetic wave propagation.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Engineering Electromagnetics, William H Hyat, Jr., and John A. Buck, Tata McGraw Hill	2013 / 5th edition
2	Elements of Engineering Electromagnetics, Matthew N.O. Sadiku, Oxford University Press	2012 / 4th edition
3	Introduction to Electrodynamics, D.J. Griffiths, Prentice Hall	2012 / 4th edition

Course Name	**:**	**APPLIED CHEMISTRY**
Course Code	**:**	**CHN101**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives: Upon completion of this course, students will have fundamental knowledge of the following:
Concepts of water and its analysis, polymer chemistry, solid state chemistry, lubricants, coordination chemistry and substitution reactions as applied to various industries. Spectroscopic methods required for the characterization of engineering materials. Design and development of novel future engineering materials and processes. Experiments related to applications of analysis and chemical processes relevant to various Industries.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**WATER TREATMENT AND ITS ANALYSIS:** Boiler feed water and its problems, Water Softening techniques, Domestic Water treatment, Chemical Analysis and related numerical problems	7
2	**POLYMER CHEMISTRY:** Classification, Mechanism and methods of polymerization, preparation, properties and uses of few engineering.	5
3	**SOLID STATE CHEMISTRY**: Introduction to structure and bonding-ionic solids, crystal defects and applications of defect structure (transistors, rectifiers, photovoltaic cells and computer chips).Introduction to ceramics.	6
4	**LUBRICANTS/ FUEL CELL TECHNOLOGY/CORROSION:** Functions mechanism, classification, properties and analysis of Lubricants and related numerical problems. Introduction to electrochemistry, types of electrodes, Reference electrodes, Ion-selective electrodes, Concentration cells, Batteries, Fuel cells/ Types of corrosion, dry and wet corrosion and their mechanisms, types of electrochemical corrosion, factors influencing corrosion, Prevention of corrosion.	6
5	**ATOMIC AND MOLECULAR SPECTROSCOPY: AAS**- Principle, instrumentation and applications of UV,IR and NMR spectroscopy and related problems.	10
6	**COORDINATION CHEMISTRY:** Crystal Field Theory, Splitting of octahedral, tetrahedral and square planner complexes, Applications of crystal field theory.	4
7	**AROMATIC ELECTROPHILIC AND NUCLEOPHILIC SUBSTITUTION:** Reaction mechanisms and applications.	4

Course Outcomes: Students who complete the course will have demonstrated the ability to do the following:	
1	Apply the knowledge for water treatment and its analysis for processing and its disposal which is relevant to all Industries for efficient utilization of water as an essential industrial resource.
2	Develop and design new materials based on knowledge of polymers, solid chemistry and substitution reactions
3	Hands on experience for carrying out experiments with precision for characterization and estimation of materials by wet analysis.
4	Will be able to carry out Instrument based spectroscopic analysis of new materials and interpretation of relevant data.

Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Atkin's Physical Chemistry by Peter Atkins, Julio de Paula, 7th Edition, Oxford University Press.
2	Concise Inorganic Chemistry Vth Edition J D Lee 2003 (Chapman & Hall)
3	A Textbook of Engineering Chemistry by Shashi Chawla, Dhanpat Rai& Co. Pvt. Ltd.
4	Introductory Polymer Chemistry by G.S.Mishra, John Wiley & Sons, New York, 1993.
5	Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and P.L. Gaus, 3rd Ed., John Wiley & Sons.

6	Puri, Sharma and Pathania : Principles of Physical Chemistry, W.H. Freeman & Co, 2008.
7	Organic Chemistry by Joseph M.Hornback Brooke/Cole Publishing Company U.S.A.
8	D. S. Pavia, G.M. Lasmpman and G.S. Kriz : Introduction to Spectroscopy, 4th Edition, Thomson learning, Indian Edition 208.
9	Chemistry for environmental engineering by C. N. Sawyer, P. McCarty, G. F. Parkin, Mc Graw Hill Inc, New York.

Course Name	**:**	**PHYSICAL CHEMISTRY**
Course Code	**:**	**CHN-102**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Physical Chemistry required for indepth understanding of Physical phenomena of materials in relation to applications in Engineering .

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CHEMICAL EQUILIBRIUM :** General characteristics of chemical equilibrium, thermodynamic derivation of the law of chemical equilibrium, Van't Hoff reaction isotherm. Relation between Kp, Kc and Kx. Temperature dependence of equilibrium constant-Van't Hoff equation, Le Chatelier's principle.)	4
2	**SOLUTIONS**: Ideal and non-ideal solutions, Raoults's law, change of free energy, enthalpy, and entropy on mixing of liquids, distillation of binary solutions. Partially miscible liquids such as Phenol- water, triethylamine- water, and Nicotine- water systems. Henry's law, Nernst distribution law, Colligative properties of dilute solutions. Abnormal molar mass, degree of dissociation and association of solutes.	8
3	**CHEMICAL KINETICS:** Rate equation of reactions of various orders, rate mechanism, kinetics of complex reactions. Concept of energy barrier and energy of activation. Theories of reaction rates, measurement of extent of reaction, zero order reactions. Rates of flow systems. Lindemann theory of unimolecular reactions.	8
4	**SURFACE PHENOMENA:** Adsorption of gases by solids. Types of adsorption, adsorption isotherms, Langmuir's adsorption equation, B.E.T. equation for determination of surface area of adsorbents, applications of adsorption, catalysis, kinetics of surface reactions. Introduction to micelles, emulsions and gels.	6
5	**PHASE EQUILIBRIA** : Phase rule and its thermodynamic derivation. One component systems-water, sulphur, Two component systems, construction and interpretation of general phase diagrams for liquid-vapour, liquid-liquid and liquid-solid systems. Eutectics, freezing mixtures, ultra purity, zone refining.	6
6.	**ELECTROCHEMISTRY:** Conductance of electrolytic solutions, transference number and its determination, Kohlrausch's law of independent migration of ions, Interionic attraction theory, activity and activity coefficients of strong electrolytes, ionic equilibria. Ionizaton of water, ionization constants of weak acids and weak bases, hydrolysis, pH, common ion effect, solubility product and salt effect.	5
7.	**ELECTROCHEMICAL CELLS:** Reversible and irreversible cells, e.m.f. and its measurement, cell reactions and e.m.f., thermodynamics of electrode potentials, half- cell potential and its determination, Nernst equation, concentration cells, liquid junction potential, determination of activity co-efficient from cell potential data, potentiometric titrations.	4

List of Experiments:		Number of Turns
1	Determination of Surface tension of liquids using Stalagmometer.	2
2	Distribution of Iodine between water and carbon tetrachloride.	2
3	Kinetics of the hydrolysis of methyl acetate in the presence of hydrochloric acid.	3
4	Adsorption of acetic acid on activated charcoal.	2
5	Conductometric and Potentiometric titrations and Colorimetry.	4

Course Outcomes: By the end of this course, the student will be able to-	
1	Understand the phenomenon of chemical equilibrium, phase equilibria and effect of change of process parameters such as T, P, C etc both quantitatively and qualitatively.
2	Understand physical properties of solutions like change of free energy, entropy of mixing as applies to heat and mass transfer in chemical processes.
3	Analyse the kinetics of chemical processes that are useful in the design of reactors and optimisation of material processing and its implementation.
4	Apply concepts of various surface phenomenons for material coatings, separate technology and in catalytic processes.
5	Design the sensors based on the concepts of electrochemistry.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Principles of Physical Chemistry by Maron, Samuel H. Prutton, ; Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.	2002
2	Textbook of Physical Chemistry by Carl F. Glasstone, Samuel ; MacMillan and Co. Ltd. London	2010
3	Principles of Physical Chemistry by B.R Puri., L.R Sharma, and Pathania, S Madan,; S. Nagin &Co Jalandhar.	2013
4	Chemical Kinetics by Laidler , J Keith ;Tata McGraw-Hill Co. Ltd., New Delhi.	2002
5	A Text Book of Physical Chemistry by P.W Atkins; Oxford University Press.	2009
6	Findlay's Practical Physical Chemistry by B.P Lavitt. ; Longman Group Ltd.	1973

Course Name	**:**	**INORGANIC CHEMISTRY**
Course Code	**:**	**CHN-103**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives: *Upon completion of this course, students will have fundamental knowledge of the following:*
Concepts of structure and chemical bonding essential for understanding of molecular structure. Solid state chemistry for application in electronics, ceramics and other advanced materials. Magnetic behaviour and catalytic properties of co-ordination and organometallic compounds used in various industries. Interaction and role of metals in biological systems essential for bio-engineering applications.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**QUANTUM THEORY AND ATOMIC STRUCTURE:** Introduction to wave mechanics, the Schrodinger equation, the Schrodinger equation as applied to hydrogen atom, the origin of quantum numbers and shapes of orbitals.	4

2	**CHEMICAL BONDING:** Molecular orbital and valence bond theories of bond formation and application of molecular orbital theory to the formation of homonuclear and heteronuclear diatomic molecules.	7
3	**THE SOLID STATE:** A recapitulation of close packing of spheres, structures of NaCl, CsCl, ZnS, CaF2, crystal defects and applications of defect structures (transistors, rectifiers, photovoltaic cells and computer chips).	4
4	**COORDINATION COMPOUNDS:** Part 1:Werner's theory, effective atomic number, bonding of transition metal complexes: valence bond theory, crystal field theory, crystal field splitting in tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Thermodynamic aspects of coordination compounds (crystal field stabilization energies of octahedral and tetrahedral complexes, spectrochemical series).	6
5	**COORDINATION COMPOUNDS:** Part2: Kinetic aspects of coordination compounds (substitution reactions in complexes with coordination number 4 and 6 and their mechanism - **SN^1**, SN^2). Magnetic behaviour of complexes – Para magnetism, diamagnetism, ferromagnetism and antiferromagnetism and measurement ofmagnetic susceptibility of complexes by Guoy's method.	6
6	**ORGANOMETALLIC COMPOUNDS:** Nomenclature, types of ligands and bonding in organometallic compounds, use of organometallics in industry.	5
7	**INORGANIC POLYMERS: TYPES** of inorganic polymers, polyphosphazenes, polysiloxanes –their structures and properties.	5
8	**ROLE OF METALS IN BIOLOGICAL SYSTEMS:** Bio-inorganic Chemistry of Iron – Heme proteins & Non-Heme iron proteins; bioinorganic chemistry of cobalt-vitamin B12 and metalloenzymes.	5

Course Outcomes: Students who complete the course will have demonstrated the ability to do the following:	
1	Apply the knowledge of quantum theory, chemical bonding and solid state, to know the structure and bonding required for the development of new materials.
2	Design new inorganic materials with desired physical and chemical properties.
3	Carry out experiments with precision related to synthesis and characterization of new industrially important inorganic materials.

Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Sharpe, A. G. : Inorganic Chemistry, 3rd Edition, Longman Publishers ELBS, 1992.
2	Lee, J. D. : Concise: Inorganic Chemistry, 5th Edition, Chapman and Hall Publishers, 1996.
3	Cotton, F. A. & Wilkinson, G. : Advanced Inorganic Chemistry, 3rd Edition,Wiley Eastern Ltd., 1982.
4	Cotton, F. A. & Wilkinson, G. : Basic Inorganic Chemistry, Wiley EasternLtd., 1987. 12
5	Mark, J., West, R. & Allcock,H. : Inorganic Polymer, Prentice Hall, New Jersey Publishers, 1982.

Course Name	**:**	**PHYSICAL CHEMISTRY**
Course Code	**:**	**CHN-104**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives:
Concepts of chemical equilibria, solutions, chemical kinetics and electrochemistry to the physical phenomena occurring in various chemical processes. Surfaces modification of important industrial materials used in adsorption and separating technology. Phase equilibria for understanding the physical behaviour of various materials such as alloys and other biphasic and triphasic systems. Experiments related to the theoretical studies of different physical phenomena relevant to various industries.

Total No. of Lectures – 42

Lecture wise breakup	**Number of**

		Lectures
1	**CHEMICAL EQUILIBRIUM:** thermodynamic derivation of the law of chemical equilibrium, Van't Hoff reaction isotherm. Relation between Kp, Kc and Kx. Temperature dependence of equilibrium constant- Le Chatelier's principle.	5
2	**SOLUTIONS:** Raoults's law, change of free energy, enthalpy, and entropy on mixing of liquids, distillation of binary solutions. Partially miscible liquids Henry's law, Nernst distribution law, Colligative properties of dilute solutions. Abnormal molar mass, degree of dissociation and association of solutes.	8
3	**CHEMICAL KINETICS**: Rate equation of various orders, rate mechanism, kinetics of complex reactions. Theories of reaction rates, measurement of extent of reaction, Rates of flow systems. Lindemann theory of unimolecular reactions.	8
4	**SURFACE PHENOMENA**: Adsorption of gases by solids., adsorption isotherms., Langmuir's adsorption equation, B.E.T. equation for determination of surface area of adsorbents, applications of adsorption, catalysis, kinetics of surface reactions. Introduction to micelles, emulsions and gels.	6
5	**PHASE EQUILIBRIA** : Phase rule and its thermodynamic derivation. One component systems-water, sulphur, Two component systems, construction and interpretation of general phase diagrams for liquid-vapour, liquid-liquid and liquid-solid systems. Eutectics, freezing mixtures, ultra purity, zone refining.	6
6	**ELECTROCHEMISTRY:** transference number and its determination, Kohlrausch's law of independent migration of ions, Interionic attraction theory, activity and activity coefficients of strong electrolytes, ionic equilibria. Ionizaton of water, ionization constants of weak acids and weak bases, common ion effect, solubility product and salt effect.	5
7	**ELECTROCHEMICAL CELLS**: Reversible and irreversible cells, e.m.f. and its measurement, cell reactions and e.m.f., thermodynamics of electrode potentials, half- cell potential and its determination, Nernst equation, concentration cells, liquid junction potential, determination of activity co-efficient from cell potential data, potentiometric titrations.	4

Course Outcomes: Students who complete the course will have demonstrated the ability to do the following:	
1	Understand the relevance of the physical phenomena occurring in various materials and processes.
2	Modify the composition of various materials required for new technological applications.
3	Hands on experience for carry out experiments with precision related to chemical equilibria, surface phenomena and reaction kinetics required for designing various processes in Industry.

Suggested Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Maron, Samuel H. Prutton, Principles of Physical Chemistry, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
2	Carl F. Glasstone, Samuel Textbook of Physical Chemistry, MacMillan and Co. Ltd. London.
3	Puri,B.R.,Sharma,L.R.and Pathania,Madan,S. Principles of physical chemistry, S.Nagin & co Jalandhar.
4	Laidler, Keith J. Chemical Kinetics, Tata McGraw-Hill Co. Ltd., New Delhi.
5	Atkins, P.W. A Text Book of Physical Chemistry,Oxford University Press.

HUMANITIES, SOCIAL SCIENCES AND MANAGEMENT COURSES (HSSMEC)

Course Name	**:**	**ETHICS AND SELF AWARENESS**
Course Code	**:**	**HSS 101**
Credits	**:**	**2**
L T P	**:**	**2-0-0**

Course Objectives:
To provide basic knowledge about ethics, values, norms and standards and their importance in real life. To improve the personality of students by their self-assessment

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ETHICS** Concept of Ethics – Nature, Scope, Sources, Types, Functions and Factors influencing Ethics, Approaches to Ethics – Psychological, Philosophical and Social, Broader Ethical Issues in Society	**6**
2	**VALUES, NORMS, STANDARDS AND MORALITY** Concept and Role, Relation with Ethics, Psycho-Social Theories of Moral Development – Kohlberg and Carol Gilligan	**4**
3	**ETHICS AND BUSINESS** Concept of Business Ethics – Nature, Objectives and Factors influencing Business Ethics, 3 C's of Business Ethics, Ethics in Business Activities, Ethical Dilemmas in Business, Managing Ethics	**5**
4	**SELF-AWARENESS** Concept of Self Awareness – Need, Elements, Self Assessment – SWOT Analysis, Self Concepts – Self-Knowledge, Assertiveness and Self-Confidence, Self-Esteem	**4**
5	**SELF-DEVELOPMENT** Concept of Self-Development, Social Intelligence, Emotional Intelligence, Managing Time and Stress, Positive Human Qualities (Self-Efficacy, Empathy, Gratitude, Compassion, Forgiveness and Motivation), Personality Development Models – Johari Window, Transactional Analysis, Myers Briggs Type Indicator, Self-Awareness and Self-Development Exercises	**9**

Course Outcomes:	
1	Helps to distinguish between right and wrong in both personal and professional life
2	Students learn about their strengths, weaknesses, opportunities & threats and work enthusiastically to transform weaknesses into strengths and threats into opportunities

Reference Books:	
1	Murthy, C.S.V., "Business Ethics – Text and Cases", Himalaya Publishing House
2	Hartman, Laura P. and Chatterjee, Abha, "Business Ethics", Tata McGraw Hill
3	Rao, A.B., "Business Ethics and Professional Values", Excel Books
4	Velasquez, Manuel G., "Business Ethics – Concepts and Cases", Prentice Hall
5	Corey, G., Schneider, Corey M., and Callanan, P., "Issues and Ethics in the Helping Professions", Brooks/Cole
6	Hall, Calvin S., Lindzey, Dardner and Cambell, John B., "Theories of Personality", Hamilton Printing Company
7	Leary, M.R., "The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Oxford University Press

Course Name	**:**	**COMMUNICATION SKILLS (BASIC)**

Course Code	**:**	**HSS 102**
Credits	**:**	**2**
L T P	**:**	**1-0-2**

Course Objectives:
The main aim of the course is to build competence in English grammar and vocabulary and to enhance effective communication by developing Reading, Writing, Listening and Speaking skills of students.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**FUNDAMENTALS OF COMMUNICATION SKILLS** Scope and Significance of Communication Skills, Listening, Speaking, Reading and Writing	**3**
2	**WRITING SKILLS** Basics of Grammar – Placing of Subject and Verb, Parts of Speech, Uses of Tenses, Active-Passive, Narration	**3**
3	**VOCABULARY BUILDING AND WRITING** Word Formation & Synonyms, Antonyms, Words Often Confused, One-Word Substitutes, Idioms and Phrasal Verbs, Abbreviations of Scientific and Technical Words	**3**
4	**SPEAKING SKILLS** Introduction to Phonetic Sounds & Articulation, Word Accent, Rhythm and Intonation	**3**
5	**READING AND COMPREHENSION** Two comprehensive prose passages	**2**

List of Experiments:		**Number of Turns**
1	Introducing Oneself, Exercise on Parts of Speech & Exercise on Tense	**2**
2	Exercise on Agreement, Narration, Active Passive Voice & Dialogue Conversation	**2**
3	Exercise on Writing Skills and Listening Comprehension (Audio CD)	**2**
4	Practice of Phonemes, Word Accent, Intonation, JAM Session	**2**
5	Individual Presentation, Extempore and Picture Interpretation	**2**
6	Vocabulary Building Exercises (One Word Substitute, Synonyms, Antonyms, Words Often Confused etc.) & Group Discussion	**2**
7	Reading Comprehension & Organizational Correspondence and Debate	**2**

Course Outcomes:	
1	The students will be able to perform better in their academic and professional life.
2	The student will gain self-confidence with improved command over English.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"The Essence of Effective Communication", Ludlow R. and Panton F., Pubs: Prentice Hall.	1992
2	"A University Grammar of English", Quirk R. and Sidney G., 3rd Edition, Pubs: Pearson Education.	2008
3	"High School English Grammar", Wren and Martin, Pubs: S. Chand & Company Ltd.	2007
4	"Essentials of Business Communication", Guffrey M.E., 8th Edition, Pubs: South-Western College Publishing.	2009
5	"Technical Communication: Principles and Practice", Raman M. and Sharma S., 2nd Edition, Pubs: Oxford University Press.	2012
6	"Effective Business Communication", Rodrigues M.V., Pubs: Concept Publishing Company, Delhi.	2003
7	"English Vocabulary in Use", McCarthy M. and Felicity O' Dell, 2nd Edition, Pubs:	2010

	Cambridge University Press.	
8	"The Pronunciation of English", Jones D., Pubs: Universal Book Stall.	1992

Course Name	**:**	**COMMUNICATION SKILLS (ADVANCED)**
Course Code	**:**	**HSS 103**
Credits	**:**	**2**
L T P	**:**	**1-0-2**

Course Objectives:
The main aim of the course is to enhance communication skills of students for better performance in professional life and to improve their overall personality with the use of advanced techniques in speaking and writing and also to train them in using both verbal and non-verbal communication effectively.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO COMMUNICATION PROCESS** Scope, Significance, Types and Levels, Technical Communication, Tools of Effective Communication	**3**
2	**SPEAKING SKILLS AND PERSONALITY DEVELOPMENT** Interpersonal Communication, Oral Presentation, Body Language and Voice Modulation (Para linguistics and Non- Verbal), Negotiation and Persuasion, Group Discussion, Interview Techniques (Telephonic and Video Conferencing)	**6**
3	**ADVANCED Technical Writing** Job Application, CV Writing, Business Letters, Memos, Minutes, Notices, Report Writing & Structure, E-mail Etiquette, Blog Writing	**4**
4	**COMMUNICATION AND MEDIA** Social and Political Context of Communication, Recent Developments in Media	**1**

List of Experiments:		**Number of Turns**
1	**ORGANIZATIONAL COMMUNICATION** Verbal and Non-Verbal Communication at different levels of organization, Role Play, Case Studies	**2**
2	**SPEAKING TECHNIQUES** Mock Interviews, Participation in Group Discussions, Making and Presenting Power Point	**4**
3	**STANDARD ENGLISH & PRACTICE SESSION** Intonation and Pronunciation, Exposure to Standard English, Sounds, Stress and Rhythm, Comprehension on British and American English	**4**
4	**PRACTICE ON TECHNICAL WRITING** Writing Letters, Memos, Minutes, CV, Job Applications, Reports and e-mails	**4**

Course Outcomes:	
1	The students will gain proficiency in English language for both professional and personal life.
2	The students will learn technical aspects of communication for better performance in extra-curricular activities, recruitment process and prospective jobs.
3	The students will be able to refine their personality through a grip over advanced techniques of language.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**

1	"Effective Technical Communication", Rizvi M.A., 5th Reprint, Pubs: McGraw Hill Education (India).	2007
2	"Technical Communication: Principles and Practice", Raman M. and Sharma, S., 2nd Edition, Pubs: Oxford University Press.	2012
3	"Business Communication Today", Bovee C.L. and Thill J.V., 9th Edition, Pubs: Pearson Education Asia, New Delhi.	2009
4	"Business Correspondence and Report Writing", Sharma R.C. and Mohan K., Pubs: McGraw Hill	1994
5	"Communication for Professional Engineers", Scott B., 2nd Edition, Pubs: Thomas Teleford Ltd.	1997
6	"Handbook for Technical Writing", McMurrey D.A. and Buckley J., Pubs: Cengage Learning.	2012
7	"Student Activities for taking charge of your Career Direction and Job Search", Lock R., 3rd Edition, Pubs: Cole Publishing	1996
8	"The Definitive Book of Body Language", Pease A. and Pease B., Pubs: Manjul Publishing House Pvt. Ltd.	2005

Course Name	**:**	**ECONOMICS**
Course Code	**:**	**HSS 201**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:

The main aim of this course is to make students understand how society manages its scarce resources for achieving maximum satisfaction and to make them learn about economic aspects related to a consumer, firm, market and economy.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ECONOMICS** Nature of Economics, Economic Thoughts, Economic Activities, Relationship of Economics with other Social Sciences and Engineering	**3**
2	**THEORY OF CONSUMER BEHAVIOUR** Demand: Types, Law of Demand, Demand Supply Curve, Determinants of Demand and Change in Demand (Movement of Demand and Shift of Demand) with Case Studies Elasticity of Demand: Nature, Degrees, Types, Factors Affecting Elasticity of Demand and its Application in present scenario Laws of Consumption: Concept and Applicability of Law of Diminishing Marginal Utility and Law of Equi-Marginal Utility	**9**
3	**THEORY OF PRODUCTION AND COST** Cost: Concept and Types Production: Concept, Scale of Production, Law of Variable Proportion Returns to Factor and Returns to Scale: Causes and Implications Economies and Diseconomies of Scale: Concept and Types Relevance of Production and Cost Concept in present context	**5**
4	**THEORY OF MARKET** Market: Concept and Types (Perfect Competition, Monopoly and Monopolistic Competition), Nature and Relevance of different Markets in present scenario – Case Study	**5**
5	**BASIC CONCEPTS OF MACRO ECONOMICS** National Income: Concept and Measurement Methods, Determination of Equilibrium of Income	**6**

	Inflation: Concept, Causes and Effect of Inflation, Measures to Control Inflation, Case Study on Impact of Inflation	

Course Outcomes:	
1	The students are expected to apply engineering knowledge to maximize profit, satisfaction and welfare.
2	The students are able to identify the forces that affect the economy.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Modern Economics", Ahuja H. L., Pubs: Sultan Chand and Co. Ltd, New Delhi.	2012
2	"Economics For Engineers", Gupta M. L. and Gupta S.P., Pubs: ESS PEE Publications.	
3	"Business Economics", Ahuja H. L., Pubs: Sultan Chand and Co. Ltd, New Delhi.	2010
4	"Macro Economic Theory", Jhingan M.L., Pubs: Konark Publisher Pvt. Ltd., New Delhi.	1986
5	"Principles of Microeconomics", Stiglitz J.E. and Walsh C.E., 4th Edition, Pubs: W.W. Norton & Company.	2006
6	"Principles of Macroeconomics", Stiglitz J.E. and Walsh C.E., 4th Edition, Pubs: W.W. Norton & Company.	2006
7	"Principles of Economics", Mankiw N.G., 7th Edition, Pubs: Cengage Learning	2014
8	"Economics", Samuelson P.A. and Nordhaus W.D., 18th Edition, Pubs: McGraw Hill.	2004

Course Name	**:**	**PSYCHOLOGY**
Course Code	**:**	**HSS 202**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of the course is to provide knowledge and understanding about important concepts in Psychology which will help the students in learning the applications of principles of psychology in personal and professional life.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO PSYCHOLOGY** Concept, Nature and Scope Methods of Studying Human Behaviour – Introspection Method, Observation Method, Experimental Method, Case History Method, Survey Method, Psychological Test Use Relevance of these Methods in present context	**4**
2	**INTELLIGENCE** Concept and Determinants of Intelligence Theories of Intelligence and its Application: Spearman, Thurston, Guilford.	**4**
3	**PERSONALITY** Personality: Concept, Determinants of Personality, Trait Paradigm (Eysenck), Psychodynamic Paradigm (Freud), Measurement of Personality – Self Report Measures (EPQ), Projective Measures (TAT), Hypothetical Measurement of Personality	**4**
4	**MENTAL HEALTH AND STRESS** Mental Health: Concept and Factors Affecting Mental Health Stress: Nature, Rections to Stress, Outcomes of Stress, Stress Management Case Study	**4**

5	**LEARNING AND MEMORY** Learning: Concept, Reinforcement Principle and Learning, Managerial Implications Memory: Concept, Long Term Memory, Short Term Memory, Episodic Memory, Methods to Improve Memory	**3**
6	**MOTIVATION** Nature and Types of Motivation: Extrinsic and Intrinsic Theories of Motivation and its Application: Humanistic and Need Theories Factors Affecting Motivation	**3**
7	**GROUP BEHAVIOUR AND DYNAMICS** Concept and Importance, Types of Groups, Group Development, Group Performance Factors, Conflict: Nature, Conflict Resolution, Case Study	**4**
8	**LEADERSHIP** Leadership: Nature and Importance, Leadership Styles: Authoritarian, Democratic, Paternalistic, Laissez faire, Transactional, Transformational, Case Study	**2**

Course Outcomes:	
1	The students will learn the causes and dynamics of human behavior.
2	The students will be able to apply psychological principles to enhance their personal and professional life.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Psychology", Ciccarelli S.K. and Meyer G.E., Pubs: Pearson India.	2007
2	"Introduction to Psychology", Morgan C.T., Weiss J.R., King R.A. and Schopler J., 7th Edition, Pubs: McGraw-Hill Education.	2004
3	"An Introduction to Psychology", Mangal S.K., 1st Edition, Pubs: Sterling Publishers Pvt. Ltd., New Delhi.	2009
4	"Fundamentals of Social Psychology", Baron R.A., Branscombe N.R., Byrne D. and Bhardwaj G., 1st Edition, Pubs: Pearson India.	2011
5	"Organizational Behaviour", Parikh M. and Gupta R., Pubs: McGraw Hill Education.	2010
6	"Organizational Behavior", Robbins S.P., Pubs: Prentice Hall of India.	2003

Course Name	**:**	**SOCIOLOGY**	
Course Code	**:**	**HSS 203**	
Credits	**:**	**3**	
L T P	**:**	**2-1-0**	

Course Objectives:
The main aim of the course is to make the students understand the role of theory in social sciences and to explain them how social problems interact and react with the larger society. This course also intends to make them learn whether the problem is evaluated on the macro or micro perspective and their cause and effect patterns.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO SOCIOLOGY** Sociology as a Science, Impact of Industrial and French Revolution on the Emergence of Sociology, Contribution of Karl Marx, Emile Durkheim, Max Weber, Alwin Toeffler to Sociology and its Application in present scenario, Relevance of Sociology for Engineering	**5**
2	**BASIC CONCEPTS** Society, Association, Institution, Culture Relativism, Social Structure, Social System,	**2**

	Socialization, Competition, Conflict, Accommodation, Social Mobility	
3	**SOCIETY AND ECONOMY** Evolution of Society: Primitive, Agrarian, Industrial and Post-Industrial, Economic Systems of Simple and Complex Societies, Sociological Dimensions of Economic Life, Market (free) Economy and Controlled (planned) Economy	**4**
4	**INDUSTRIAL SOCIOLOGY** Nature and Scope of Industrial Sociology, Pre-Conditions and Consequences of Industrialization, Impact of Automation and Industrialization on Society with Case Study	**3**
5	**SCIENCE AND TECHNOLOGY** Ethos of Science and Social Responsibility of Science	**2**
6	**SOCIAL CHANGE** Theories of Change and its Application to Sociology, Factors of Change, Directed Social Change, Social Policy and Social Development, Social Cost Benefit Analysis, Role of Engineers in Development	**4**
7	**INDIAN SOCIETY** Traditional Hindu Social Organization, Caste System, Agrarian Society in India, Social Consequences of Land Reforms and Green Revolution, Working of the Democratic Political System in a Traditional Society, Problem of Education in India, Gender Discrimination, Economic Reforms: Liberalization, Privatization and Globalization, Strategies for Development in India, Case Studies	**6**
8	**SOCIAL PROBLEMS** Concept of AIDS, Alcoholism, Drug Addiction, Corruption with Case Study	**2**

Course Outcomes:	
1	The students will be able to identify the function and application of sociology theory in social sciences.
2	The students will be able to understand how social class affects individual life chances.
3	The students will learn about social structure and how it shapes and influences social interactions.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Sociology: Themes and Perspective", Haralambos M. and Holborn M., Pubs: Collins Educational Publications.	2008
2	"Sociology of Indian Society", Rao C.N.S., 2nd Edition, Pubs: Sultan Chand and Co., New Delhi.	2004
3	"Introduction to Sociology", Bhushan V. and Sachdeva D.R., Pubs: Kitab Mahal Publications.	2002
4	"An Introduction to Sociology", Dassgupta S. and Saha P., Pubs: Dorling Kindersley (India) Pvt. Ltd.	2012
5	"Social Change in Modern India", Srinivas M.N., 1st Edition, Pubs: Orient Longman.	2010
6	"Sociology and Modern Social Problems", Ellwood C.A., Pubs: Bastian Books.	2008
7	"Industrial Sociology", Singh N., 1st Edition, Pubs: McGraw Hill Education (India).	2012
8	"Society in India: Concepts, Theories and Recent Trends", Ahuja R., 1st Edition, Pubs: Rawat Publications.	2011

Course Name	**:**	**FRENCH**
Course Code	**:**	**HSS 204**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:

The main aim of this course is to introduce students with basics of a foreign language and make them learn how to communicate in a new language.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	Introductions: introduce yourself or someone else	**2**
2	Greetings	**2**
3	Alphabet / numbers	**3**
4	Communication in a class	**3**
5	Asking and answering basic questions: name – age – nationality – profession – family, friends, acquaintances	**3**
6	Giving the date / day / season / time / frequency of an event	**2**
7	Locating a place / describing a city or a locality / giving information about one's region, city or country	**4**
8	Expressing quantities	**2**
9	Expressing one's preferences / talk about one's leisure time activities	**3**
10	Describing a person / talking about his/her nature	**4**

Course Outcomes:	
1	The students will be able to express themselves in the foreign language.
2	The students will be able to make use of this language in their professional life in the globalized world.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Learn French Through English in 30 Days", Chopra B., 1st Edition, Pubs: Diamond Books.	2009
2	"Complete French", Graham G., Pubs: Hodder & Stoughton.	2012
3	"French Made Easy", Verma R., 1st Edition, Pubs: Goodwill Publishing House, New Delhi.	2012
4	"Learn French for Beginners", Schell R., Pubs: Maanu Graphics.	
5	"French Made Easy", Khan F., Pubs: Lotus Press.	2010
6	"French Course Grammar", Bertenshaw T.H., 1st Edition, Pubs: Orient Blackswan.	1998

Course Name	**:**	**PRINCIPLES OF MANAGEMENT**
Course Code	**:**	**HSM 401**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to make students understand the management process and principles along with its application in practical life and to help them manage different jobs and situations with the help of management functions.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO MANAGEMENT** Nature of Management: Art or Science, Principles and Functions of Management	**3**
2	**EVOLUTION OF MANAGEMENT THOUGHT** Classical Theories: Bureaucratic, Scientific and Administrative Approach	**6**

	Neo-Classical Theories: Human Relations and Human Behaviour Approach Modern Theories of Management Relevance of Management Thought in present scenario – Management Cases	
3	**PLANNING** Nature of Planning, Planning Process, Application of Planning Process in a Hypothetical Situation, Types of Planning, Types of Plans, Management by Objective (MBO)	**4**
4	**ORGANIZING** Concept of Organization, Departmentation, Forms of Organization Structure Analysis of Organization Structure – Case Studies Hypothetical Formation of an Organization	**4**
5	**STAFFING** Human Resource Planning: HRP Process, Job Analysis: Job Description, Job Specifications and Used of Job Analysis Recruitment: Sources and Methods Selection: Selection Process, Role Playing and Case Study on Selection Tests and Interviews Training and Development: Techniques, Performance Appraisal: Methods Case Study on Staffing Practices	**6**
6	**DIRECTING** Concept, Leadership: Importance and Styles, Motivation: Theories and their relevance in present scenario, Communication: Process, Types and Barriers of Communication Management Game on Leadership, Motivation and Communication	**3**
7	**CONTROLLING** Nature and Process of Controlling, Requirements for Effective Controlling	**2**

Course Outcomes:	
1	The students will be able to apply management concepts and principles in daily life and thus, will be able to manage things efficiently and effectively.
2	The students will learn how to get work done easily by using management knowledge and functions.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Principles and Practices of Management", Rao V.S.P. and Narayana P.S., Pubs: Konark Publishers.	1987
2	"Principles & Practice of Management", Prasad L.M., 8th Edition, Pubs: Sultan Chand & Sons.	2012
3	"Essentials of Management: International and Leadership Perspective", Weihrich H. and Koontz H., 9th Edition, Pubs: McGraw Hill.	2012
4	"The New Era of Management", Daft R.L., 11th Edition, Pubs: Cengage Learning.	2014
5	"Management: Text and Cases", Rao V.S.P. and Krishna V.H., Pubs: Excel Books.	2008
6	"Fundamentals of Management: Essential Concepts and Applications", Robbins S.P, DeCenzo D.A., Bhattacharya S. and Agarwal M.N., 6th Edition, Pubs: Pearson India.	2009

Course Name	**:**	**BUSINESS ENVIRONMENT AND BUSINESS LAWS**
Course Code	**:**	**HSM 402**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:

The main aim of this course is to make students understand different types of environment influencing business decisions and to provide knowledge about different laws that needs to be followed for initiating and managing business.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO BUSINESS** Scope and Characteristics of Business, Classification of Business Activities Forms of Ownership of Business: Sole Proprietorship, Partnership and Company	**5**
2	**BUSINESS ENVIRONMENT** Internal Environment: Concept and Elements (Value System, Vision Mission Objectives, Management Structure, Human Resources, Company Image etc.) SWOT Analysis: Concept and Case Study External Environment: Micro Environment (Suppliers, Customers, Competitors, Market Intermediaries etc.) and Macro Environment – PESTEL Analysis (Political, Economic, Social, Technological, Ecological and Legal), Case Study on Impact of Environment on Business	**7**
3	**GLOBALIZATION** Concept, Pros and Cons of Globalization, Impact of Global Environment on Business Globalization of Company – Case Study	**4**
4	**CORPORATE SOCIAL RESPONSIBILITY** Concept, Social Responsibility towards different stakeholders, Rationale for CSR CSR – Case Studies	**2**
5	**CORPORATE GOVERNANCE** Concept, Elements and Essentials of Good Governance	**3**
6	**CONTRACT LAW** Concept, Types and Essentials Elements of Contract	**3**
7	**PARTNERSHIP LAW** Nature of Partnership, Provisions of Partnership Act, Issues Related to Partnership Firm, Hypothetical Formation of a Partnership Firm	**2**
8	**COMPANY LAW** Nature of Company, Provisions of Company Act, Issues Related to Incorporation of Company, Hypothetical Formation of a Company	**2**

Course Outcomes:	
1	The students will be able to analyze the impact of environment on business and formulate appropriate business strategies to compete in the competitive world.
2	The students will learn how companies follow corporate governance and social responsibility practices along with fulfilling economic objectives.
3	The students will gain knowledge about application and implementation of various business laws in practice.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Business Environment: Text and Cases", Cherunilam F., 22nd Edition, Pubs: Himalaya Publications.	2013
2	"Legal Aspects of Business", Pathak A., 5th Edition, Pubs: McGraw Hill Education.	2013
3	"Essential of Business Environment: Text, Cases and Exercises", Aswathappa K., 11th Edition, Pubs: Himalaya Publication.	2011
4	"Business Law Including Company Law", Gulshan S.S. and Kapoor G.K., 15th Edition, Pubs: New Age International (p) Ltd.	2011

5	"Business Law and Corporate Laws", Tulsian P.C., 1st Edition, Pubs: Sultan Chand Publishing.	2011
6	"Fundamentals of Business Organization & Management", Bhushan Y.K., 19th Edition, Pubs: Sultan Chand & Sons.	2013
7	"Corporate Governance: Principles, Policies and Practices", Fernando A.C., 2nd Edition, Pubs: Pearson India.	2011

Course Name	**:**	**ENTREPRENEURSHIP AND PROJECT MANAGEMENT**
Course Code	**:**	**HSM 403**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:

The main aim of this course is to make prospective engineers familiar with the concept of entrepreneurship and MSMEs and to provide knowledge about different aspects to be considered while formulating the business plan for a new entrepreneurial venture. This course also intends to create awareness among students about financial and marketing functions that is required for a new venture.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ENTREPRENEURSHIP** Concept of Entrepreneurship, Characteristics and Functions of Entrepreneur Forms of Ownership of Business, Factors Affecting Entrepreneurship Case Studies of Entrepreneurs	**6**
2	**WOMEN ENTREPRENEURSHIP** Nature of Women Entrepreneurship, Problems of Women Entrepreneurs, Institutional Initiatives for Promotion of Women Entrepreneurs	**2**
3	**MICRO, SMALL AND MEDIUM ENTERPRISES (MSMES)** Concept of MSMEs, Schemes of MSMEs Functions of Entrepreneurial Development Programmes (EDPs)	**2**
4	**PROJECT IDENTIFICATION** Idea Generation, Project Life Cycle, Concept of SWOT Analysis SWOT Analysis of Selected Project	**2**
5	**PROJECT PLANNING AND FORMULATION** Elements of Project Formulation: Product, Technical (Location, Scale, Technology, Production Process, Layout, Manpower, Resources etc.), Market, Finance and Economic Aspects Feasibility Analysis: Financial Viability and Profitability, and Socio-Economic Desirability	**7**
6	**PROJECT REPORT** Formulation of Business Plan and Project Report, Hypothetical Example of a Real-Life Project	**2**
7	**FINANCE AND MARKETING FUNCTION** Concept of Finance, Finance Related Terminologies, Sources of Finance, Cost Estimations Marketing Mix: Product, Place, Price, Promotion, People, Process and Physical Evidence Marketing Segmentation Targeting and Positioning	**5**
8	**DISCUSSIONS ON ADDITIONAL READING** (any one of the following in the semester) - The New Age Entrepreneurs - The $100 Startup: Fire your Boss, Do what you Love and Work Better to Live More - A Guide to Entrepreneurship - Dhandha: How Gujaratis Do Business - Rokda: How Baniyas Do Business	**2**

	- Take Me Home - Business Families of Ludhiana	

Course Outcomes:	
1	The students will be able to apply engineering knowledge effectively in the field of entrepreneurship development.
2	The students can make effective use of entrepreneurial knowledge to start and manage their venture.
3	The students will learn to check the feasibility of a new project to maintain its long run sustainability.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Dynamics of Entrepreneurial Development & Management", Desai V., 5th Edition, Pubs: Himalaya Publishing House.	
2	"Projects: Planning, Analysis, Selection, Financing, Implementation and Review", Chandra P., 8th Edition, Pubs: McGraw-Hill Education (India).	2014
3	"Entrepreneur's Toolkit", Harvard Business School, Pubs: Harvard University Press.	2004
4	"Entrepreneurship", Hisrich R.D., Peters M.P. and Shepherd D.A., Pubs: McGraw Hill Education.	2006
5	"Essentials of Project Management", Ramakrishna K, Pubs: PHI Learning.	
6	"Entrepreneurship", Roy R., 2nd Edition, Pubs: Oxford University Press	2011
7	"Entrepreneurship Development in India", Gupta C.B. and Srinivasan N.P., Pubs: Sultan Chand and Sons.	2013

Course Name	**:**	**FINANCIAL MANAGEMENT**
Course Code	**:**	**HSM 404**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to make students learn different financial decisions i.e. investing, financing and dividend, required to be taken by a company and provide knowledge about the functioning of the financial system (financial markets, financial institutions, financial services and financial instruments) of the country.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO FINANCIAL MANAGEMENT** Concept of Finance, Terminology Related to Finance, Financial Decisions, Factors Affecting Financial Decisions, Risk-Return Trade-Off	**3**
2	**FINANCIAL SYSTEM** Concept and Role of Financial System in Indian Economy	**2**
3	**FINANCIAL MARKETS AND INSTRUMENTS** Concept and Relevance of Money Market and Capital Market Money Market Instruments: Call Money, Treasury Bills, Commercial Papers, Certificate of Deposits Capital Market Instruments: Equity Shares, Preference Shares and Debentures Hypothetical Trading in Financial Markets	**5**
4	**FINANCIAL SERVICES** Nature and Functions of Financial Services: Merchant Banking, Mutual Funds, Factoring, Forfaiting, Credit Rating	**6**

	Case Study on Financial Services	
5	**FINANCIAL INSTITUTIONS** Nature and Functions of Financial Institutions: Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), Discount and Finance House of India (DFHI)	**2**
6	**LONG TERM INVESTMENT DECISIONS** Capital Budgeting: Concept, Importance, Factors Techniques/Methods with Numerical Applications (Pay Back Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return and Profitability Index), Case Study	**3**
7	**SHORT TERM INVESTMENT DECISIONS** Working Capital: Nature, Type and Factors Affecting the Requirement of Working Capital, Case Study	**2**
8	**FINANCING DECISIONS** Capital Structure: Essentials and Approaches of Capital Structure Sources of Finance (long-term and short-term), Financial Leverage: Concept and Numerical Application, Case Study	**3**
9	**DIVIDEND DECISIONS** Types of Dividend, Dividend Policy: Nature and Factors Affecting Dividend Policy, Case Study	**2**

Course Outcomes:	
1	The students will learn to make best combination of financial decisions by considering risk and return trade-off.
2	The students will identify how business can gain maximum through the financial system.
3	The students will understand how to manage funds effectively so as to maximize returns.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Financial Management", Shah P., 2nd Edition, Pubs: Dreamtech Press	2009
2	"Financial Markets and Services", Gordon E. and Natarajan K., 3rd Edition, Pubs: Himalaya Publishing House.	2006
3	"Financial Management: Theory and Practice", Chandra P., 8th Edition, Pubs: McGraw Hill Education (India).	2012
4	"Financial Management", Pandey I.M., 10th Edition, Pubs: Vikas Publishing House Pvt. Ltd., Noida.	2010
5	"Cases in Financial Management", Pandey I.M. and Bhat R., 3rd Edition, Pubs: McGraw Hill Education (India).	2012
6	"Financial Institutions and Markets: Structure, Growth and Innovations", Bhole L.M. and Mahakud J., 5th Edition, Pubs: McGraw Hill Education (India).	2009
7	"The Indian Financial System: Markets, Institutions and Services", Pathak B.V., 3rd Edition, Pubs: Pearson India.	2010
8	"Financial Management and Policy", Horne J.C.V. and Dhamija S., 12th Edition, Pubs: Pearson India.	2011

Course Name	**:**	**MARKETING MANAGEMENT**
Course Code	**:**	**HSM 405**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:

The main aim of this course is to make students understand about the marketing concepts to be applied in real life and the marketing process for delivering value to customers.

Total No. of Lectures –28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO MARKETING** Concepts, Role, Scope and Types of Marketing, Case Study on Marketing Management	**3**
2	**MARKETING RESEARCH** Scope and Process of Marketing Research, Hypothetical Marketing Research Analysis	**3**
3	**CONSUMER AND BUSINESS MARKETS** Types of Markets, Building Customer Value Consumer and Business Buying Behaviour: Factors Influencing Behaviour and Buying Decision Process	**4**
4	**SELECTION OF MARKETS** Segmentation: Factors and Bases, Targeting and Positioning Preparation of STP of Selected Product	**3**
5	**MARKETING MIX** 7 P's of Marketing Mix: Product, Price, Physical Distribution, Promotion, People, Process and Physical Evidence Formulation of Marketing Mix of Selected Product	**3**
6	**PRODUCT DECISIONS** Product (Good or Service) Characteristics, Product Life-Cycle, Packaging and Branding, Product Development and Management	**3**
7	**PRICING DECISIONS** Pricing Policies and Strategies, Factors Influencing Pricing	**3**
8	**PHYSICAL DISTRIBUTION DECISIONS** Marketing Channels, Channel Players, Physical Distribution, Managing Distribution, Analysis of Supply Chain Management – Case Studies	**3**
9	**PROMOTION DECISIONS** Nature of Promotion Decisions, Managing Mass Communication and Personal Communication Analysis of Promotional Strategies – Case Studies	**3**

Course Outcomes:	
1	The students will learn how to market goods and services effectively to different segments so as to deliver value to customers.
2	The students will be able to formulate marketing mix and marketing strategies for different products and different sets of customers.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Marketing Management: Concepts, Cases, Challenges and Trends", Govindarajan M, 2nd Edition, Pubs: PHI Learning.	2009
2	"Marketing Management", Kotler P., Keller K.L., Koshy A. and Jha M., 14th Edition, Pubs: Pearson India.	2012
3	"Marketing Concepts and Strategies", Dibb S., Simkin L., Pride W.M. and Ferrell O.C., Pubs: Cengage Learning.	2012
4	"Marketing Management", Kumar A. and Meenakshi N., 2nd Edition, Pubs: Vikas Publishing House Pvt. Ltd., Noida.	2011
5	"Marketing Management", Saxena R., 4th Edition, Pubs: McGraw Hill Education (India).	2013
6	"Marketing: Managerial Introduction", Gandhi J.C., 1st Edition, Pubs: McGraw Hill	1987

	Education.	
7	"Marketing", Etzel M.J., Walker B.J., Stanton W.J. and Pandit A., 14th Edition, Pubs: McGraw Hill Education (India).	2010
8	"Super Marketwala: Secrets to Winning Consumer India", Mall D., 1st Edition, Pubs: Random House India.	2014

Course Name	**:**	**HUMAN RESOURCE MANAGEMENT**
Course Code	**:**	**HSM 406**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to provide an overview of HRM, keeping the Indian business scenario in the background and to acquaint the students with the strategic role of HRM in managing an organization.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO HUMAN RESOURCE MANAGEMENT** HRM: Nature, Scope, Functions, HRM Practices and Problems in India with Case Studies	**4**
2	**HUMAN RESOURCE PLANNING (HRP)** Concept and Process of HRP, Factors Affecting HRP	**3**
3	**JOB ANALYSIS AND DESIGNING** Uses and Process of Job Analysis, Job Description and Job Specification: Features and Hypothetical Formulation, Job Designing: Job Enrichment, Job Enlargement	**3**
4	**RECRUITMENT AND SELECTION** Recruitment: Sources and Methods Selection: Selection Process, Selection Tests, Types and Nature of Interviews Role Playing and Case Study on Selection Process, Tests and Interview	**4**
5	**INDUCTION AND INTERNAL MOBILITY** Induction Programme, Need and Scope of Internal Mobility: Transfer, Promotion, Demotion	**3**
6	**TRAINING AND DEVELOPMENT** Training: Need and Methods, Management Development: Need, Methods and Management Development Programme HRM Games for Development of Employees	**4**
7	**PERFORMANCE APPRAISAL AND COMPENSATION** Nature and Methods of Performance Appraisal, Hypothetical Performance Appraisal Compensation: Financial and Non-Financial Benefits	**4**
8	**EMPLOYEE HEALTH AND SAFETY** Concept, Issues related to Health and Safety, Workplace Health Hazards	**3**

Course Outcomes:	
1	The students will develop the ability to solve problems in area of HRM in organizations.
2	The students will become aware of latest developments in HRM practices which are essential for effective management in organization.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Human Resource Management: Text and Cases", Rao V.S.P., Pubs: Excel Books.	2002

2	"Human Resource Management", Dessler G. and Varkkey B., 12th Edition, Pubs: Pearson India.	2011
3	"Human Resource Management: Text and Cases", Aswathappa K., 7th Edition, Pubs: McGraw Hill Education (India).	2013
4	"Human Resource Management: Text and Cases", Gupta C.B., 14th Edition, Pubs: Sultan Chand and Sons.	2012
5	"Human Resource Management: Text and Cases", Bedi S.P.S. and Ghai R.K., Pubs: Bharti Publications.	2012
6	"Human Resource Management Applications: Cases, Exercises, Incidents and Skill Builders", Fottler M.D., McAfee R.B. and Nkomo S.M., 7th Edition, Pubs: Cengage Learning.	2013

ENGINEERING SCIENCE COURSES

Course Name	**:**	**COMPUTER PROGRAMMING (BASIC)**
Course Code	**:**	**CSN104**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
To develop logical skills so that students should be able to solve basic computing problems. To learn the syntax and usage of C programming constructs.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO PROGRAMMING** Evolution of languages: Machine languages, Assembly languages, High-level languages. Software requirements for programming: System softwares like operating system, compiler, linker, loader; Application programs like editor. Algorithm, specification of algorithm. Flowcharts.	4
2	**PROGRAMMING IN C** Data types in C, Formatted input-output for printing integer, floating point numbers, characters and strings.	2
3	**OPERATORS AND EXPRESSION** Expressions in C and their evaluation. Precedence and associativity rules. Operators: arithmetic operators, relational operators, logical operations, bitwise operators, miscellaneous operators.	6
4	**STATEMENTS** Decision making structures: if, if-else, nested if and if-else, switch. Control structures: for, while, do-while. Role of statements like break, continue, goto.	6
5	**ARRAYS** Concept and use of arrays, declaration and usage of arrays, 2-dimensional arrays.	6
6	**FUNCTIONS** Advantage of modularizing C program into functions, function definition and function invocation. Methods of passing parameters to a function: call-by-value, call-by-reference; Passing arrays to functions, Recursion, Library functions.	4
7	**POINTERS** Pointer declaration and initialization, constant pointers, pointers to constant objects, pointer arithmetic, relationship between pointer and arrays.	4
8	**SCOPE AND LIFETIMES** Scope and lifetime of a variable, storage classes: auto and typedef.	2
	USER-DEFINED DATA TYPES Structures- definition, declaration, use, accessing structure members directly or through pointer structure, structure having arrays and pointers as members, self referential structures, passing structures to functions. Unions: definition, declaration, use, accessing union members directly or through pointer structure.	6
	FILES Concepts of files and basic file operations.	2

Course Outcomes:	
1	The student will demonstrate proficiency in C programming language.

Text Books:	
1	Let Us C, Yashwant Kanetkar, BPB Publications
2	Programming in C: A practical approach, Ajay Mittal, Pearson Education

Reference Books:

1	The C programming language, Kernighan Ritchie, Pearson Education
2	Programming in ANSI C, Balaguruswamy, Tata McRaw Hill
3	Computing Fundamentals, Peter Nortan, Tata McRaw Hill

Course Name	**:**	**COMPUTER PROGRAMMING (ADVANCED)**
Course Code	**:**	**CSN105**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
To develop logical skills so that students should be able to solve basic computing problems. To learn the syntax and usage of C programming constructs at advanced level.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO STRUCTURED PROGRAMMING** Introduction to topics: decision making, Iteration, functions: functions with variable number of arguments, multiple file programs, concept of linking.	6
2	**ARRAYS** Array declaration and use, Two-dimensional arrays and multi-dimensional arrays. Strings and Character arrays. Operations on arrays such as insertion, searching, sorting, merging.	6
3	**POINTERS** Pointer expression, pointer arithmetic, pointer to array, pointer to functions, dynamic memory allocation, dynamic allocation of arrays. Call functions through function pointers, Accessing members of arrays through pointers.	6
4	**PREPROCESSOR DIRECTIVES** Introduction, Various preprocessor directives, macros with and without arguments, conditional compilation.	6
5	**STRUCTURE, UNION, ENUMERATION AND BIT-FIELDS** Definition, declaration and initialization, structures containing arrays, array of structures, structure having structures, pointers to structures, self-referential structures, dynamic allocation of structures; Unions: Definition, declaration and initialization. Concepts of interrupts interrupt programming, enumerations and bit-fields.	8
6	**FILES** Concept of file, file operations, text mode and binary mode, command line arguments.	4
7	**INTRODUCTION TO OBJECT ORIENTED PROGRAMMING** Classes and objects, basic features of object oriented programming like encapsulation, abstraction, polymorphism, etc.	3
8	**APPLICATIONS** Projects related to the development of Terminate and Stay resident (TSRs), graphical applications, text-editors, etc.	3

Course Outcomes:	
1	The student will demonstrate proficiency in C programming language.

Text Books:	
1	Let Us C, Yashwant Kanetkar, BPB Publications
2	Programming in C: A practical approach, Ajay Mittal, Pearson Education

Reference Books:	
1	The C programming language, Kernighan Ritchie, Pearson Education
2	Programming in ANSI C, Balaguruswamy, Tata McRaw Hill

3	Computing Fundamentals, Peter Nortan, Tata McRaw Hill

Course Name	**:**	**ENGINEERING DRAWING**
Course Code	**:**	**ESC 101**
Credits	**:**	**4**
L T P	**:**	**2-0 -4**

Course Objectives:
At the end of this course, the student should be able to understand the basic concepts of Engineering Drawing. The student should be able to visualize and draw the two and three dimensional objects. The student should also be able to apply drafting softwares in various types of problems.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	Introduction to Engg. Graphics, System of Projections, Orthographic projections, Lettering, Dimensioning rules	2
2	Projections of points and lines, Projection of lines on different planes, Traces and true length of the lines	2
3	Projections of planes/laminae on reference planes, classification of Primary and secondary planes, examples	2
4	Classification of solids, Projections of solids on the basis of positions of the axis of various solids on reference planes	3
5	Sectioning of solids, True and apparent sections, sectioning on the basis of position of section planes	3
6	Developments of surfaces, Parallel line, Radial line and Triangulation methods of development of right and oblique solids	3
7	General introduction to Perspective projection, isometric views, Isometric lines & Axes, Four centre and off set method of drawing ellipse from circle, conversion of orthographic views to isometric views and vise-versa	3
8	Introduction to AutoCAD software for drawing of 2D projections, practical exercises on points, lines, planes and solids	10

List of Experiments:		**Number of Turns**
1	Exercises on projection of Points on drawing sheets	1
2	Exercises on projection of lines on drawing sheets	1
3	Exercises on projection of planes on drawing sheets	1
4	Exercises on projection of solids on drawing sheets	2
5	Exercises on sections of solids on drawing sheets	1
6	Exercises on Developments of surfaces and Isometric projections on drawing sheets	2
7	Practice of exercises on points and lines using AutoCAD software	1
8	Practice of exercises on planes using AutoCAD software	2
9	Practice of exercises on solids and developments using AutoCAD software	2
10	Practice of exercises on isometric projections using AutoCAD software	1

Course Outcomes: At the end of this course, the students will be able to:	
1	Understand the basic concepts of Engineering Graphics.
2	Visualize the actual objects and convert them in to readable drawings.
3	Understand the drawing standards, conventions and symbols that are in common usage.
4	Draw the common Engineering drawings using available drafting softwares.
5	Come up with innovative conceptual ideas by using Drafting softwares.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Engineering Drawing", P. S. Gill, S.K. Kataria & Sons	2012
2	"Engineering Drawing", D.A. Jolhe, Tata McGraw Hill	2010
3	"Engineering Graphics with Auto CAD", James Bethune, Prentice Hall, India	2003

Course Name	**:**	**FLUID MECHANICS**	
Course Code	**:**	**ESC102**	
Credits	**:**	**4**	
L T P	**:**	**3 0 2**	

Course Objectives:
To learn the basic concept of fluid mechanics. To understand the analytical method of solving fluid mechanics problem

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Fluids, Brief history of Fluid Mechanics, Properties of Fluid, Viscosity, Capillarity, Surface Tension, Compressibility, Normal and Shear Stresses in Fluid Flows, Regimes of Flow	4
2	**FLUID STATICS** Pascal's Law of measurement of pressure, Types of forces on a fluid system, manometers and gauges, forces on partially and fully submerged bodies including that on curved surfaces, Buoyancy, stability of floating bodies, centre of gravity, Metacentric height.	**6**
3	**KINEMATICS OF FLUID FLOW** Langrangian and Eulerian methods, description of properties in a moving fluid, local and convective acceleration, Streamlines, Path lines, Streak lines, Laplace equation, Stream function, velocity potential and flownets.	**4**
4	**DYNAMICS OF FLUID FLOW** Equation of conservation of mass, differential form of continuity equation. External forces, Euler's equation of motion, Bernoulli's equation, simple application to one dimensional flow, linear momentum and angular momentum, momentum theorem, moment of momentum theorem	**8**
5	**VISCOUS FLOW** Pressure gradient in steady uniform flow, flow between parallel plates, Qualitative aspects of viscous flows, Hagen-Poiseulli's flow, Transition from laminar to turbulent flow, turbulent flow in circular pipe, Navier Stokes equation (without derivation).	**5**
6	**FLOW THROUGH PIPES** Introduction, energy and hydraulics grade line, non-dimensional formulation of the pipe flow problem, head losses in pipes & pipe fittings, pipe in series & parallel, reservoir problem.	**5**
7	**DIMENSIONAL ANALYSIS AND SIMILITUDE** Buckingham's Theorem, non-dimensional groups, Geometric, Kinematic and Dynamic Similarity, Hydraulic Models.	**4**
8	**FLOW MEASUREMENT** Venturimeter, orifice meter, Pitot tube, Orifices, mouth pieces, notches, weirs, Current meter.	**6**

List of Experiments:

1	Flow Measurement by Orifice Meter
2	Flow Measurement by Venturimeter
3	Flow Measurement by V Notche
4	Computation of various coefficients involving in through orifice.
5	Determination of friction factors of pipes Minor losses in pipes
6	Determination of friction factors of pipes
7	Verification of Bernoulli's theorem
8	To determination of the metacentric height of a given vessel under unloaded condition.

Course Outcomes:	
1	To apply the learned techniques in real life problems related to fluid mechanics.

Text Books:	
1	G.L. Asawa, "Experimental Fluid Mechanics-Volume I" Nem Chand & Brothers
2	B. S. Kapoor, "Manual of Fluid Mechanics" Khanna Publishers
3	S. Singh, "Experiments in Fluid Mechanics-Second Edition" PHI Publications

Reference Books:	
1	Frank M. White, "Fluid Mechanics", McGraw Hill.
2	H. Rouse , "Elementary Mechanics of Fluids"
3	Streeter, V.L.,"Fluid Mechanics" McGraw Hill Co
4	Lewitt, E.H.,"Hydraulics and the Mechanics of Fluids" Pitman

Course Name	**:**	**INTRODUCTION TO MANUFACTURING**
Course Code	**:**	**ESC 103**
Credits	**:**	**4**
L T P	**:**	**2-0-4**

Course Objectives:
At the end of the course the students should be able to describe the properties of engineering materials and different manufacturing processes. The students should be able to select appropriate manufacturing process and manufacture a job in the different shops and areas of applications.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Classification of manufacturing processes, classification of engineering materials, comparison of material properties of metals, ceramics and plastics, crystal structures, strain hardening effects, stress-strain curves. Safety measures in workshop.	3
2	**MATERIALS AND HEAT TREATMENT** Objective of heat treatment, classification of heat treatment, annealing, normalizing, hardening & tempering, case hardening, carburizing, nitriding, flame hardening, induction hardening, applications of heat treatment.	4
3	**FOUNDRY** Pattern, properties of pattern material, types of pattern, cores. Types of sand, moulding sand ingredients. Types of moulding processes. Types of casting processes: sand casting, shell casting, investment casting and centrifugal casting. Casting defects & remedies. Case studies and applications.	4
4	**FORMING** Metal forming, types and applications, hot & cold working, forging, drawing, rolling and sheet metal operations.	3

5	**MACHINING** Metal removal processes, machines, single-point tool, cutting tool geometry, lathe - types, elements and main parts of lathe, drilling, milling and grinding machines. Applications.	3
6	**FINISHING** Surface finishing processes, principle and applications, lapping, honing, super finishing, polishing, buffing, electroplating, galvanizing.	2
7	**WELDING** Classification of welding processes, mechanism of arc formation, arc welding processes, gas welding, and resistance welding, principles and applications, welding defects, causes and remedies. Soldering and brazing. Applications and case studies in welding.	3
8	**PLASTICS MANUFACTURING** Types and properties of plastics, thermosetting and thermoplastic resins, elastomers. Fabrications of plastics, injection moulding, blow moulding, extrusion moulding etc.	2
9	**MODERN MANUFACTURING PROCESSES** Introduction, classification, electric discharge machining (EDM), electro chemical machining (ECM), laser beam machining (LBM) and Rapid Prototyping Techniques. Case studies on modern and hybrid manufacturing processes.	2
10	**CASE STUDIES** Considerations of selecting manufacturing processes for industrial products like compact disc, PCB and emerging technological applications.	2

List of Experiments:		**Number of Turns**
1	To prepare half lap T & L joint in the carpentry shop.	1
2	To prepare the pattern of half nut in carpentry shop.	1
3	To prepare cube from a piece of round bar in forging shop.	1
4	To study the lathe, milling, planer, and shaper operations.	1
5	To manufacture a multi-operational job on lathe/milling in the machining shop.	1
6	To prepare series and parallel wiring connections in the electrical shops.	1
7	To prepare the butt joint by SMAW in welding shop.	1
8	To prepare the mould of a given pattern in foundry shop.	1
9	To cast the prepared mould in foundry shop.	1
10	To prepare a square job in the fitting shop.	1
11	To prepare rectangular box in sheet-metal shops.	1
12	To prepare different joints in the sheet-metal shop.	1

Course Outcomes: By the end of this course, the students will be able to:	
1	Compare the properties of the engineering materials.
2	Select the appropriate manufacturing process for a given job/ application.
3	Identify the advantages and limitations of different manufacturing processes.
4	
5	

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Manufacturing Engineering and Technology", Serope Kalpakjian and Steven Schmid, Pearson Publications.	2009
2	"A Textbook of Production Technology: Manufacturing Processes", P. C. Sharma, S. Chand & Company Ltd.	2004
3	"Foundry, Forming and Welding", P.N. Rao, Tata M/C Graw Hill Publication.	2007
4	DeGarmo, Materials and Processes In Manufacturing, John Wiley & Sons	2011

Course Name	**:**	**THERMODYNAMICS**
Course Code	**:**	**ESC 201**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to, Understand the basic principles of Thermodynamics and to give students a feel for how Thermodynamics is applied in Engineering practices.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BASIC CONCEPTS :**Macroscopic and Microscopic Approach, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Thermodynamic Equilibrium, State, Path, Process, cycle, Quasi-static Process, Reversible and Irreversible Process, Working Substance. Thermodynamic Properties like Pressure, Volume and Temperature, Zeroth Law of Thermodynamics. Temperature Scales, Concept of Heat and work in Thermodynamics.	**8**
2	**FIRST LAW OF THERMODYNAMICS:** Joule's Paddle wheel Experiment; Mechanical Equivalent of Heat, First Law for a closed system undergoing a Cycle, First Law for a closed system undergoing a change of state. Different forms of stored Energy, Enthalpy, Energy of An isolated System, Perpetual Motion Machine of First kind.	**6**
3	**FIRST LAW APPLIED TO FLOW PROCESSES:** Flow Process and Control Volume, flow work, Steady and Unsteady Flow Process, Steady Flow Energy Equation, Engineering Applications of Steady Flow Energy Equation, Throttling Process, Flow Work and Non Flow work, Variable flow Processes, Limitation of First Law.	**5**
4	**SECOND and THIRD LAW OF THERMODYNAMICS:** Qualitative Difference between Heat and Work, Thermal Reservoir, Statements of 2nd Law by Max.Planck and Claussius, Equivalence between two statements, Energy Analysis of Heat Engine, Refrigerator and Heat Pump Reversibility and Irreversibility, Causes of Irreversibility Carnot Theorem, Carnot cycle, Absolute Thermodynamic Temperature, Scale, Efficiency of the Reversible Heat Engine, Equality of Ideal Gas Temperature and Kelvin Temperature.	**8**
5	**ENTROPY**: Classius Theorem, Classius Inequality and concept of Entropy, Entropy change in an Irreversible Process, Application of Entropy Principle, Entropy Transfer with Heat Flow, Entropy generation in closed and open System, Thermodynamics Equations relating properties of System, Reversible Adiabatic work in a Steady flow System. Entropy and direction, Entropy and disorder.	**5**
6	**PROPERTIES OF GASES AND GAS MIXTURE** : Equation of state of a gas, Properties of Mixture of gases, Internal Energy, Enthalpy and Specific heat of gas, mixtures, Entropy of gas Mixtures.	**3**
7	**STEAM GENERATORS:** Classification of steam generators, Boiler mountings and accessories. Principles and operations of steam accumulators. Description of Cochran, Locomotive, Lancashire, Babcock and Wilcox boiler, Modern high pressure boilers, Characteristics and advantages of high pressure boilers.	**7**
8	**BASIC CONCEPTS :**Macroscopic and Microscopic Approach, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Thermodynamic Equilibrium, State, Path, Process, cycle, Quasi-static Process, Reversible and Irreversible Process, Working Substance. Thermodynamic Properties like Pressure, Volume and Temperature, Zeroth Law of Thermodynamics. Temperature Scales, Concept of Heat and work in Thermodynamics.	**8**
9	**FIRST LAW OF THERMODYNAMICS:** Joule's Paddle wheel Experiment; Mechanical Equivalent of Heat, First Law for a closed system undergoing a Cycle, First Law for a closed system undergoing a change of state. Different forms of stored Energy, Enthalpy, Energy of An isolated System, Perpetual Motion Machine of First kind.	**6**

Course Outcomes:	
1	A fundamental understanding of various Laws of thermodynamics and their applications.
2	Understand the efficiencies of Heat Engines and other Engineering Devices.
3	Understand the working principles and applications of various types of steam generators.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Engineering Thermodynamics", Gordon Rogers & Yon Machew	2006
2	"Thermodynamics", Yunus Cengel and Mike Boles	2006
3	"Thermodynamics", Arora.	2005
4	"Engineering Thermodynamics", P.K. Nag	2010
5	"Thermo dynamics", Dr. D.S. Kumar	2012

Course Name	**:**	**ESSENTIALS OF INFORMATION TECHNOLOGY**
Course Code	**:**	**ESC202**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The students should be able to understand the concepts of networking, RBMS, Software Engineering and Web Technology.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**NETWORKING AND COMMUNICATION** Introduction to digital communication: Signal propagation, signal types, signal parameters, Channel effect on transmission. Physical layer characterization: Types of transmission media, physical layer interfaces. Data transmission mechanisms: Communication modes, transmission modes, synchronization, introduction to packet switching, multiplexing, error control methods. Network architectures: Introduction to computer networks, Network topologies, Types of networks: LAN, WAN, MAN, layered network model. Internet Protocols: Introduction, Transport layer protocols: TCP, UDP. Application layer protocols: DNS, SMTP, POP, IMAP. Practical aspects of networking.	**12**
2	**RELATIONAL DATABASE MANAGEMENT SYSTEM** RDBMS- data processing – the database technology – data models- ER modeling concept – notations – converting ER diagram into relational schema - Logical database design - normalization (1NF, 2NF and 3NF). SQL – DDL statements – DML statements – DCL statements - Joins - Sub queries – Views - Database design Issues – SQL fine tuning.	**10**
3	**WEB TECHNOLOGIES AND INTRODUCTION TO USER INTERFACE AND WEB TECHNOLOGIES :** web fundamentals – types web content – HTML – text formatting tags in HTML – HTML form elements - and tags - text formatting using CSS : embedded CSS, inline CSS and external CSS – JavaScript and its features.	**10**
4	**SOFTWARE ENGINEERING** Software Engineering : Definition – role of software and software crisis – SDLC models : waterfall model, incremental model and spiral model – software testing – static & dynamic testing – types testing : unit testing, integration testing, system testing, performance testing and regression testing.	**10**

Course Outcomes:

1	Document artifacts using common quality standards
2	Design simple data store using RDBMS concepts

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Thomas Powell, HTML and CSS: The complete reference, 5th Edition	2010
2	Henry F Korth, Abraham Silberschatz, "Database system concepts", Second ed., McGraw-Hill International editions, Computer Science series	2006
3	A. Tanenbaum, Computer Networks, 5th Edition	2010
4	William Stallings, Data and Computer Communications, 10th Edition	2013

Course Name	**:**	**MATERIALS SCIENCE**
Course Code	**:**	**ESC 203**
Credits	**:**	**04**
L T P	**:**	**3 1 0**

Course Objectives:
The student will be able to know the concepts of atomic bonding, crystal structures, imperfections, diffusion, mechanical properties, electron energy, and dislocations as related to processing and performance of engineering material

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Historical perspective, Scope of Materials Science and engineering, Geometry of crystals, Structure determination by X-Ray Diffraction, Atomic structure and chemical bonding, Structure of solids	10
2	**IMPERFECTIONS IN ATOMIC AND IONIC ARRANGEMENTS** Point defects, Dislocations, Significance of Dislocations, Influence of Crystal structure, Surface defects, Importance of defects	4
3	**PHASE DIAGRAMS** Phase rule, Single component systems, Binary Phase diagrams, Microstructural changes during cooling, The lever rule, Some typical phase diagrams, Other applications of Phase diagrams	4
4	**DIFFUSION IN SOLIDS** Applications of Diffusion, Stability of atoms and ions, Mechanism for Diffusion, Activation energy for Diffusion, Rate of Diffusion (Fick's First Law), Factors affecting Diffusion, Composition Profile (Fick's Second Law), Diffusion and Materials Processing	4
5	**SOLIDIFICATION** Nucleation, Applications of Controlled Nucleation, Growth mechanisms, Solidification time and Dendrite size, Cast structure, Solidification defects, Solidification of Polymers and Inorganic glasses	4
6	**ELASTIC, ANELASTIC AND VISCOELASTIC BEHAVIOUR** Atomic model of elastic behaviour, The modulus as a parameter in design, Rubber-like elasticity, Relaxation processes, Spring-Dashpot model	4
7	**MECHANICAL BEHAVIOUR OF MATERIALS** Plastic deformations and creep in crystalline materials, Fracture	4
8	**ELECTRONIC AND MAGNETIC BEHAVIOUR OF MATERIALS** Conductivity of metals and alloys, Superconductivity, Semiconductors and their applications, Insulators and Dielectrics, Classification of magnetic materials, Magnetization,	4

	Permeability and magnetic field, Applications of magnetic materials	
9	**OVERVIEW OF MATERIALS** Metals, Ceramics, polymers and composites	4

Course Outcomes:	
1	The student will be able to develop structure-processing-properties co-relationsof materials.
2	The student will be able to describe various phenomena based on the concepts of solidification, Diffusion, mechanical behaviour of materials and compare characteristics of different types of materials such as metals, ceramics, polymers and composite

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Materials Science and Engineering-A First course/ V Raghavan/PHI	2013
2	Materials Science and Engineering, an Introduction/William D. Callister/ John Willey and Sons Inc. Singapore.	2007
3	Principles of Materials Science and Engineering/William Fortune Smith/TataMcGraw- Hill	1990
4	The Science and Engineering of Materials, Donald R Askeland&Pradeep P Phule/ Cengage Learning	2006

Course Name	**:**	**SOLID MECHANICS**
Course Code	**:**	**ESC 204**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course the student will be able to understand the basic concepts of behavior of the materials and analysis the basic structural elements like beams, columns, trusses and circular shafts. The student will be able to apply this knowledge for the design of various civil engineering structures.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**PROPERTIES OF MATERIALS** Introduction, uni-axial tension test, idealized stress- strain diagrams, isotropic, linear, elastic, visco-elastic and plastic materials, compression test, impact test, fatigue test, torsion and bending test.	4
2	**SIMPLE STRESSES & STRAINS** Concept of stresses and strains, relationship between elastic constants, extension of uniform bar & tapered bar under its own weight and due to load applied, stresses produced in compound bars due to axial loads, thermal stresses,	4
3	**COMPOUND STRESSES:** General state of stress, resultant stress and strain circle, prinicipal stresses and principal strains, Mohercircle for compound stresses and strais	4
4	**SHEAR FORCE AND BENDING MOMENT IN BEAMS** Shear force, bending moment, Relation between load, SF and BM, SFD , BMD and axial force diagram for determinate beams under various types of loading.	6
5	**BENDING AND SHEAR STRESSES IN BEAMS** Pure bending ,bending stresses, eccentric loading combined bending and direct stresses , Middle Third rule, composite beams, Variation of shear stresses for various cross-sections of a beam.	5

6	**ANALYSIS OF PLANE TRUSSES** Different types of trusses, Analysis of plane trusses by method of joints and method of sections.	5
7	**TORSION** Torsion equation for circular shaft , shafts under action of varying torque, torsion of composite shafts.	4
8	**COLUMNS & STRUTS** Criteria for stability of columns, Buckling of columns, Euler's theory for various end restraints, Rankine's formula, eccentrically loaded struts, struts with initial curvature, struts with lateral loading.	5
9	**DEFLECTION OF BEAMS** Slope and Deflection in beams by double integration method, Macaulay's method, Moment area method under the action of various loading conditions; slope and deflection in built in and propped beams.	5

Course Outcomes: By the end of this course the student will be able to:	
1	Analysis the simple civil engineering structures under different loading conditions.
2	Understand the behaviour of basic structural elements.
3	Apply this knowledge for the design of various civil engineering structures.
4	
5	

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"An introduction to the Mechanics of Solids", Crandall & Dahi, McGrawHill.	1978
2	"Strength of Material", G.H. Ryder, MacMillan.	2002
3	"Mechanics of Solids", E.P. Popov, Pearson Education.	1978
4	"Mechanics of Materials", E.J. Hearn, Elsevier Publications.	2001
5	"Mechanics of Materials", Punmia and Jain, Laxmi Publications (P) Ltd.	2013
6	"Mechanics of Materials", R.C.Hibbeler, Pearson Higher education.	2013
7	"Strength of Materials", S. Ramammurtham and R. Narayanan, Dhanpat Rai Publishing Comp	2014

Course Name	**:**	**INTRODUCTION TO ELECTRONICS**
Course Code	**:**	**ESC 205**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course, the student should be able to

1. Identify active and passive components and to solve simple electronic circuits.
2. Explain the fundamental concepts of basic semiconductor devices & digital electronics.
3. Describe the basic principle of operational amplifier along with its applications, A/D, D/A conversion and architecture of 8085 microprocessor.
4. Define the communication system and list the various modulation techniques.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ELECTRONICS:** Need and application of electronics in different areas, Basic elements of electronic system (Active and Passive elements, Sources,	3

	Dependent Sources), KVL and KCL	
2	**SEMICONDUCTOR DEVICES:** Concept of active and passive devices, Semiconductor Devices: Structure, principle of operation, characteristics and applications of PN-Junction (Rectifier, Clipper and Clamper), BJT, Current Components in BJT, Input & Output characteristics Common Emitter (CE), Common Base (CB), Common Collector (CC) configurations, BJT as an amplifier, Construction, working principle and characteristics of FET and MOSFET, Concept of feedback amplifier, Barkhuasen criteria, Oscillators, 555 timer as multivibrator, Four layer devices- SCR, DIAC and TRIAC (Construction, operation and characteristics)	15
3	**DIGITAL PRINCIPLES:** Digital waveforms, digital logic, moving and storing digital information, digital operations, digital integrated circuits	3
4	**OPERATIONAL AMPLIFIER AND ITS APPLICATIONS:** Block diagram, characteristics, inverting and non inverting configurations, Opamp as summing amplifier, difference amplifier, integrator, differentiator	5
5	**A/D AND D/A CONVERTERS:** Basic principle and characteristics, Weighted resistor D/A converter, Binary ladder D/A converter, counter ramp type A/D Converter	4
6	**INTRODUCTION TO MICROPROCESSOR:** Pin diagram, Architecture of 8085 Microprocessor, Concept of Microcontroller and its applications	3
7	**COMMUNICATION SYSTEMS**: Introduction to communication system, communication time line, Various frequency bands used for communication, Block diagram of Analog and Digital communication, need of modulation, Analog modulation techniques (Amplitude and frequency), Digital modulation techniques (PCM,PWM,PPM, PAM, ASK,FSK,PSK, QAM), Introduction to advanced communication systems (Optical and wireless).	9

Course Outcomes: By the end of the course the students will be able to	
1	Identify the various electronic devices and predict their behavior in an electronic system.
2	Draw the architecture of Microprocessor.
3	Differentiate between various modulation techniques in a communication system and relate them to practical systems.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Electronics Devices & Circuit Theory, RL Boylestead & L Nashelsky (PHI)	2009
2	Digital principles & applications, Malvino Leach, TMH	2011
3	Microprocessor Architecture programming and Applications with 8085 by R Gaonkar, Penram International Publishing Pvt ltd.	2002
4	Circuits and Networks: Analysis and Synthesis, Sudhakar and ShyamMohan, TMH	2009
5	Electronic Communication Systems by G. Kennedy, Mc Graw Hill, 4th Edition	2008
6	Electronic Communications, 4th Edition, Roddy & Coolen.	2009

Course Name	**:**	**BASIC ELECTRICAL SCIENCES**
Course Code	**:**	**ESC 206**
Credits	**:**	**04**
L T P	**:**	**3- 0-2**

Course Objectives:

At the end of this course, the student should be able to acquire knowledge of analytical techniques to solve electrical circuits, basic electrical machines, and electrical measuring instruments.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**BASIC DEFINITIONS AND NETWORK THEOREMS** Basic definitions of voltage, current, power and energy. Nodes, branches, loops, mesh, Kirchhoff 's laws, nodal & mesh analysis. Circuit theorems: linearity, superposition, Norton, thevenin, max power transfer.	8
2	**AC CIRCUITS** Introduction, Generation of alternating voltage, sinusoidal waveform, phasor diagram, power relations in AC circuits, single phase AC circuits, Steady State Analysis: Nodal and Mesh analysis, Thevenin's, Norton's, Maximum Power Transfer theorems. AC Power Analysis: Instantaneous and average power, max average power transfer, RMS value, apparent power and power factor, complex power, conservation of AC power. THREE PHASE CIRCUITS**:** Phase sequence, Star and delta connection, Relation between line and phase voltages and currents in balanced systems, Analysis of balanced and Unbalanced three phase circuits, Measurement of active and reactive power.	10
3	**MAGNETICALLY COUPLED CIRCUITS** Mutual Inductance, Energy in a coupled circuit. Transformer : construction, equivalent circuit, voltage regulation, efficiency, OC and SC tests.	5
4	**DC MACHINES** Construction, emf and torque equations, circuit model, methods of excitation, characteristics of generators and motors, starting and speed control of dc motors, starters, losses, efficiency.	5
5	**AC MACHINES** Rotating magnetic field theory, three phase induction machines: General construction features, per phase equivalent circuit, approximate equivalent circuit, production of torque, slip, torque speed characteristics, no load and blocked rotor test to determine performance parameters, Starting: rotor rheostat starter, reduced voltage starting, star delta starting, centrifugal start. Synchronous motors: types, salient pole and cylindrical rotor, emf equation. Principle of operation of single phase induction motor, types and applications.	10
6	**BASIC MEASURING INSTRUMENTS** Introduction, Classification of instruments, essential features and operating principles, moving coil and moving iron instruments.	4

List of Experiments:		Number of Turns
1	Verification KCL and KVL	01
2	Verification of Ohm's Law	01
3	Verification of the principle of , superposition with ac and dc sources	01
4	Verification of Thevenin, and Nortan theorems.	01
5	Verification of maximum power transfer theorem in dc circuit.	01
6	To study resonance in series and parallel RLC circuits and plot various responses.	01
7	To verify the line voltage and phase voltage , and line current and phase current relationship in a star and delta three phase balanced circuit.	01
8	Measurement of active and reactive power in single-phase ac circuit.	01
9	To perform open and short circuit test on a 1-phase transformer and determine its equivalent circuit and efficiency	01
10	To study dc machine and determine open circuit characteristic.	02
11	To perform open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.	01
12	To perform load test on D.C. shunt motor.	01

Course Outcomes: By the end of this course, the student will be able to:	
1	Apply different techniques to solve electrical circuits.
2	Acquire the knowledge of electrical machines and electrical measuring instruments.
3	Design and conduct experiments, as well as analyze and interpret data.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Fundamentals of Electric Circuits by Charles K Alexander and Matthew N O Sadiku, Mc Graw Hill Higher Education, 5th edition, ISBN 0073380571.	2012
2	Network Analysis & Synthesis by FF Kuo, Wiley International	1966
3	Electric Machinery and Transformers by Bhag S Guru & Huseyin R Hiziroglu, Oxford University Press, ISBN 0195138902.	1988
4	Semiconductor Physics and Devices: Basic Principles by Donald A Neamen, Irwin Professional Publishing, 3rd Revised edition, ISBN 0256242143	2006

Course Name	**:**	**MECHATRONICS**
Course Code	**:**	**ESC 207**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course the student should be able to have basic knowledge of mechatronics and its interdisciplinary applications i.e. integration of Mechanical engineering with Electrical& Electronics Engineering and Computer Technology. He should be able to design and conduct experiments as well as to analyze and interpret data.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION TO MECHATRONICS** Understanding Mechatronics. Key Elements of Mechatronics, Components of Mechatronics ,Human Being and Mechatronic System, Conventional and Mechatronic Approach, Advantages of Mechatronic Systems. Definition of System, Classification of System, Mechanistic System, Mechatronic System Intelligence.	04
2	**SENSOR AND TRANSDUCERS: PRINCIPLES AND APPLICATIONS** Role of Sensors and transducers in Mechatronics System , selection of sensors based on performance characteristics, static and dynamic characteristics); calibration; types of sensors , resistive transducers, inductive ,capacitive ,optical , thermal Transducer and their applications ,Measurement of : linear , angular position, displacement, rotational speed, force, pressure, strain, flow rate, temperature etc..	08
3	**SIGNAL CONDITIONING DEVICES** Role of signal conditioning **Processes** and devices in mechatronics, passive elements (RLC), semiconductors devices (PN junction diodes, AC rectification, Zener diode, Power supplies, transistors, Transistor (common emitter characteristics, emitter, follower circuit, FET); thyristor, TRIAC,DIAC, operational amplifiers (inverting, unity gain, non-inverting, C/V and V/C amplifiers, differential amplifier, instrumentation amplifier).Filters types of filters. **SIGNAL CONVERTING DEVICES**: Digital to analog converter (DAC) and Analog to Digital Converter (ADC), multiplexer.	09
4	**DIGITAL ELECTRONICS** Boolean algebra; digital electronic gates; combination logic systems (simple gates, NAND and NOR gates, latches, positive and negative logic, tri-state logic); sequential logic systems (J-K flip-flop, registers and counter, timers and pulse circuits).	05
5	**MICROPROCESSORS , MICROCONTROLLERS AND PLC'S** Fundamentals of microprocessor , the 8085, concept of interfacing memory, input /output devices , fundamentals of Microcontroller, T he 8051, PLC Hardware, PLC Memory structure, application	07

6	**ACTUATORS** Role of actuators in mechatronics, types of actuators, electrical actuators Physical principles; solenoid-type devices; DC machines; AC machines; stepper motors .Drive Technology Applications: Linear motors; voice coil motors; electro-pneumatic and electro-hydraulic actuators. Mechanical actuators :Rotary to linear motion conversion; power transmission, Electromechanical System Applications, Coupling, gearing, belts, pulleys, bearings.	07
7	**CASE STUDIES** Washing Machines, auto focusing camera, pick and place robot.	02

List of Experiments:		**Number of Turns**
1	To study various types of Resistors, Inductors, Capacitors, Diodes, Transistors, LED.	01
2	To study CRO, Function generator, Power Supply.	01
3	To study various components of Induction Machine and Synchronous Machine	01
4	To study various components of DC Machines and Transformers.	01
5	To obtain output voltage waveforms of half wave and full wave uncontrolled rectifier with and without filter capacitor.	02
6	To design a voltage regulator using Zener Diode and analyze the performance of the regulator for various loads. Also compare the performance with a linear voltage regulator.	02
7	To verify truth-tables of various flip-flops (J-K, D, Toggle etc.)	01
8	To study the characteristics of LVDT using linear displacement trainer Kit & compare with ideal characteristics.	01
9	To measure the strain of the metal strip using strain gauge trainer kit & compare with ideal characteristics.	01
10	To measure the angular displacement of resistive & capacitive transducer using angular displacement trainer kit & compare with ideal characteristics.	01
11	To obtain the characteristics of RTD, Thermistor, thermocouple with hot and cold junction thermal trainer kit & compare with ideal characteristics.	01

Course Outcomes: By the end of this course, the student will be able to:	
1	Students were able to have basic knowledge of mechatronics and its interdisciplinary applications i.e. integration of Mechanical engineering with Electronics
2	Students were able to design and conduct experiments

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Mechatronics, fourth edition, by W Bolton. ISBN 978-81-317-3253-3	2013
2	Dan Necsulescu Mechatronics published by Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 FIE, Patparganj, Delhi India.	2001
3	Book by H M T Limited, Mechatronics Tata McGraw Hill Publishing Company Limited, New Delhi.	1988
4	Mechatronics Principles, Concepts & Applications by Nitaigour P Mahalik published by TMH	2003

Course Name	**:**	**MECHANICAL ENGINEERING DRAWING**
Course Code	**:**	**ESC**
Credits	**:**	**4**
L T P	**:**	**2-0-4**

Course Objectives:

At the end of this course, the student should be able to visualize objects and their graphical representations, understand the various engineering drawing symbols, conventions and other requirements of assembly and dis-assembly of mechanical engineering parts and materials and should be able to draw clear and understandable production drawings.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ENGINEERING GRAPHICS:** System of Projections. Technical lettering. Drawing conventions, Orthographic projections. 3-views. Projection of oblique areas. Circular features. Dimensioning, Rules of dimensioning.	3
2	**ISOMETRIC PROJECTIONS:** General introduction to Isometric Projections. Conversion from orthographic to isometric projections and vice-versa. Freehand sketching.	3
3	Projections of Points, Lines and Planes. Geometrical Constructions.	5
4	Projection of Solids, sectioning. Auxiliary planes and views.	3
5	**REQUIREMENTS OF MECHANICAL ENGINEERING DRAWINGS:** Conventional representation, Layout of drawing sheet, symbols of standard tolerances, machining symbols. Introduction and familiarization of the code IS:296.	3
6	**FASTENERS:** Temporary and Permanent fasteners. Various types of screw threads, nuts and bolts, screws, welding joints and riveted joints.	3
7	**INTRODUCTION TO AUTOCAD:** Basic commands and features, simple exercises of points, lines, planes and solids on AutoCAD.	3
8	**ASSEMBLY AND DIS-ASSEMBLY DRAWING EXERCISES ON SOME OF THE FOLLOWING USING DRAWING SHEETS AS WELL AS AUTOCAD:** Couplings, Clutches, Knuckle and cotter joints, Pipe and pipe fittings, IC engine parts, Machine tool parts, Bearings, Screw Jack, Drill press vice.	5

List of Experiments:		**Number of Turns**
1	Drawing exercises on lettering, dimensioning, points, lines and planes	3
2	Drawing exercises on solids, sectioning and auxiliary planes	3
3	Drawing exercises on isometric and orthographic projections	2
4	Introduction to AutoCAD, familiarization with basic commands and features	2
5	Simple exercises of points, lines, planes, solids and sectioning of solids on AutoCAD	2
6	Drawing of machine parts on AutoCAD	2

Course Outcomes: By the end of this course, student will be able to	
1	Have knowledge of drawing symbols, conventions and methods of graphical representations.
2	Understand various machine components, their working and functions.
3	Able to read and understand mechanical engineering drawings.
4	Have working knowledge of the drafting package AutoCAD.
5	Able to understand and draw mechanical engineering drawings on AutoCAD.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Engineering Drawing by R. K. Dhawan	2012
2	Machine Drawing by R. K. Dhawan	2012
3	Engineering Drawing by P. S. Gill	2013
4	Machine Drawing by P. S. Gill	2013
5	Fundamentals of Engineering Drawing by Luzadder and Duff	2009
6	Engineering Graphics with AutoCAD by James D. Bethune	2011

TECHNICAL COMMUNICATION

Course Name	**:**	**TECHNICAL COMMUNICATION**
Course Code	**:**	**XXX-205**
Credits	**:**	**2**
L T P	**:**	**0-0-3**

Course Objectives:
At the end of the course the students should be able to effectively communicate as per their professional requirements.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Need for Effective Communication, Overview of Technical and Professional communication	**3**
2	Listening Skills, Reading Skills, Writing Skills	**3**
3	Writing Letters, Official E-mails, Job Applications, Resumes, Cover Letters, Notes. Case Studies	**6**
4	Overview of Research Writing. Information Gathering; Using the Library and Internet Modes, Organizing and Presenting According to Audience and Purpose. Writing Research Proposals, Project Technical Report/ Dissertation/Theses Writing. Case Studies.	**12**
5	Presentation Skills, Interview Skills, Group Discussion skills, Case Studies.	**9**
6	Technology Based Communication- Use of Visuals and Audio to Communicate Effectively.	**3**
7	Ethics, Attitude and Team Communication	**3**
8	Social Media/ Online Communication, Public Speaking; Developing an Authorial Voice	**3**

Course Outcomes: By the end of this course the student will be able to	
1	Develop effective technical communication.
2	Write technical documents in a professional manner.
3	Present professional requirements in an effective manner

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Meenakshi Raman and Sangeeta Sharma, "Fundamentals of Technical Communication", Oxford University Press, India	2014
2	Barun K Mitra, "Effective Technical Communication- A Guide for Scientists and Engineers" ,Oxford University Press, India	2006
3	David f Beer and David McMurrey, " Guide to Writing as an Engineer" ,2nd ed., Wiley	2004
4	Diane Hacker, " Pocket Style Manual", Bedford/St martin's.	2003

Course Name	**:**	**OPERATIONS RESEARCH**
Course Code	**:**	**MAN 401**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course , the students should be able to describe the need of Operations Research, develop the ability to form Mathematical models of Optimization problems, identify and solve linear models of Optimization problems, apply and to describe the limitations of classical methods to solve non-linear models of Optimization problems, apply and to describe the limitations of The Transportation Model ,Decision theory, Queuing Model.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Development of Operations Research, Definition of Operations Research, Characteristics of Operations Research, Scientific method in Operations Research, Necessity of Operations Research in industry, Scope of Operations Research	6
2	Formulation of Linear Programming problem , Graphical Solution, Simplex Method, Unrestricted variables, Artificial variables, M-Method, Dual Phase method	12
3	Introduction to the Transportation model, Assumption in the Transportation Model, Definition of the Transportation Model, Matrix terminology, Formulation and solution of Transportation Model	6
4	Decision theory, Steps in Decision theory approach, Decision making environments, Decision making under conditions of certainty, Decision making under conditions of uncertainty, Decision making under conditions of risk, Maximum likelihood criterion	6
5	Queuing Model, Introduction, Application of Queuing Model, Elements of Queuing System, Operating characteristics of Queuing System, Waiting time and idle time costs.	6
6	Non – Linear Programming, Introduction , Local and Global optimum, Concave and Convex functions, Types of non-linear programming problems.	6

Course Outcomes: By the end of this course, the students will be able to :	
1	Form Mathematical model of Optimization problems
2	Distinguish between linear and non-linear models
3	Solve simple problems of The Transportation Model
4	Solve simple problems of Decision theory
5	Solve simple problems of Queuing Model

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Operations Research" , Ravindran , Phillips , and Solberg , 2nd edition, John Wiley & sons .	2000
2	"Engineering Optimization" , S S Rao , 3nd edition, New Age .	2000
3	"Operations Research", Kantiswarup, Gupta P.K. & Sultan Chand & Sons .	2007
4	"Operations Research", Sharma S.D., Kedarnath, Ramnath & Company .	1994
5	"Operations Research", Bronson R, Shaum's Outline Series .	1997

Course Name	**:**	**OPTIMIZATION TECHNIQUES**
Course Code	**:**	**MAN 402**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student shoule be able to describe the need of Optimization Techniques , develop the ability to form mathematical model of optimization problems , identify and solve linear models of optimization problems , apply and to describe the limitations of classical methods to solve nonlinear models for optimization problems , apply and to describe the limitations of gradient based and direct iterative methods to solve nonlinear problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**LINEAR PROGRAMMING** Formulation, Graphical solution, Simplex method , Relation between Graphical and Simplex method, Unrestricted variables, Artificial variables, M-Method and Dual Phase method	**(14)**
2	**OPTIMIZATION TECHNIQUES** **UNCONSTRAINED PROBLEMS -** (Single and multivariable optimization) Necessary and sufficient conditions for extreme points **CONSTRAINED PROBLEMS - (**multivariable optimization) Equality constraints , Jacobian and Lagrangean methods , Application of Jacobian method to linear problems	**(12)**
3	**NON-LINEAR PROGRAMMING PROBLEMS** Geometric Programming **UNCONSTRAINED ALGORITHMS –** Direct methods, Dichotomous and Golden search ; Univariate and Hooke and Jeeves search methods ; Gradient methods , Cauchy's steepest ascent method and Newton's method.	**(12)**
4	**PROGRAMMING TECHNIQUES** Separable programming ,Geometric Programming	**(4)**

Course Outcomes:	
1	Form mathematical model of optimization problems
2	Distinguish between linear and nonlinear models .
3	Solve simple problems using classical / iterative methods .

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Operations Research , Ravindran , Phillips , and Solberg, 2nd edition 2000 , John Wiley & sons .	2000
2	Operations Research by Hamady Taha, 8th edition	
3	Engineering Optimization , S S Rao , 3rd edition 2000 , New Age .	2000
4	Operations Research 9th Edition, Kantiswarup, Gupta P.K. & Sultan Chand & Sons .	
5	Operations Research 8th Edition, Sharma S.D., Kedarnath, Ramnath & Company .	
6	Operations Research 2nd Edition, Bronson R, Shaum's Outline Series .	
7	P. Sankara Iyer, "Operations Research", Tata McGraw-Hill, 2008.	2008
8	J K Sharma., "Operations Research Theory & Applications , 3e", Macmillan India Ltd, 2007	2007
9	P. K. Gupta and D. S. Hira, "Operations Research", S. Chand & co., 2007.	2007

Course Name	**:**	**ADVANCED PHYSICS**
Course Code	**:**	**PYN-401**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems in Nuclear and Solid State physics.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Quantum theory of light, X-rays - production, spectrum & diffraction(Bragg's Law), photoelectric effect, compton effect, pair production, photons & gravity, black holes, de-Broglie hypothesis, particle diffraction, uncertainty principle and applications. Postulates of quantum mechanics, Schrodinger theory, time-dependent and time-independent Schrodinger equation, wave function, Born interpretation and normalization, expectation values.	10
2	Particle in a box (infinite well potential), finite potential step and barrier problems, tunneling, linear harmonic oscillator (one-dimensional). Hydrogen atom, radiative transitions and selection rules, electron spin, Stern-Gerlach experiment, Spin-orbit coupling, exclusion principle, symmetric and anti-symmetric wave functions. Alpha decay, Zeeman Effect, Correspondence Principle, Angular Momentum in Quantum Mechanics.	10
3	Natural radioactivity, successive radioactive transformations, radioactive equilibrium, radioactive series, radiometric dating. Nuclear force and its characteristics, Elementary description of shell model, explanation of magic numbers, liquid drop model and semi-empirical binding energy formula. Nuclear fission, fission products, mass and energy distribution of fission products, neutron emission and energy distribution of neutrons emitted in fission, theory of fission process, nuclear reactors - classification, neutron cycle in thermal reactors and four-factor formula for neutron reproduction, nuclear fission - controlled thermonuclear reactions. Artificial radioactivity and its application, Beta-decay (energy spectrum & discovery of neutrino), fusion reactions in stars.	10
4	Band theory of solids, Kronig-Penney Model (qualitative), conductors, insulators and semiconductors, p-type and n-type semiconductors, statistics of electrons and holes, Hall effect (for single as well as both type of charge carriers).	6
5	Occurrence of superconductivity, destruction of superconductivity, Meissner effect, type I and type II superconductors, heat capacity, isotope effect, thermodynamical considerations, London equations & penetration depth, coherence length, BCS theory (elementary description), applications of superconductors. High temperature superconductivity, Josephson junctions.	6

Course Outcomes: By the end of this course:	
1	Students will be able to solve numerical problems in Quantum Mechanics, Nuclear and Solid State Physics.
2	Students will be aware of latest developments in certain areas of Physics like condensed matter physics, superconductivity etc. which have important applications for societal needs.
3	Students will be able to correlate the various phenomena with quantum mechanical concepts.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Concepts of Modern Physics", Arthur Beiser, McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013

3	"Introductary Nuclear Physics", Kenneth S Krane, Wiley India Pvt. Ltd., New Delhi	2014
4	"Modern Physics", J. Bernstein, P.M. Fishbane and S.G. Gasiorowicz, Pearson, Education India Pvt. Ltd., New Delhi	2009

Course Name	**:**	**CRYSTAL PHYSICS**
Course Code	**:**	**PYN-402**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
During this course students will understand basics of crystal structure and correlate the same with different material properties. They will be able to describe the concepts of lattice dynamics and crystal binding forces and correlate the same with thermal properties.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CRYSTAL STRUCTURES** - Periodic array of atoms, Lattice, basis, primitive cell, two and three dimensional lattice types, miller indices, examples of crystal structures (NaCl, CsCl structures), Hexagonal closed packed, diamond, zinc sulfide structures, x-ray diffraction of crystal, Bragg's Law, reciprocal lattice, diffraction condition, Laue equation, structure factor, atomic form factor.	12
2	**CRYSTAL BINDING** - van der waals interaction, repulsive interaction, equilibrium lattice constant, cohesive energy, ionic crystals, covalent crystals, electrostatic energy, Madelung constant.	10
3	**PHONONS AND CRYSTAL VIBRATIONS** - monoatomic basis, first Brillouin zone, dispersion relation, two atoms per primitive basis, quantization of elastic waves, phonon momentum, inelastic scattering by phonon.	10
4	**THERMAL PROPERTIES** - phonon heat capacity, density of states, Einstein model, Debye model of heat capacity, inharmonic crystal interaction, thermal expansion. Thermal conductivity, Umklapp Processes.	10

Course Outcomes: By the end of the course	
1	Students will be able to solve the problems based on crystal structure and thermal properties of solids
2	Understand and apply the basic concepts of crystal binding and crystal vibrations in different phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Introduction to Solid State Physics", Charles Kittel, Wiley India Pvt. Ltd., New Delhi	2012
2	"Solid State Physics", S.O. Pillai, New Age International (P) Limited, New Delhi	2010
3	"Crystallography Applied to Solid State Physics", Verma and Srivastava, New Age International (P) Limited, New Delhi	2012

Course Name	**:**	**SOLID STATE PHYSICS**
Course Code	**:**	**PYN-403**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
During this course students will understand basics of free electron theory. They will study the origin of energy gaps on the basis of quantum mechanics approach. They will cover advance topics in dielectrics. Superconductivity will also be covered and student's interest will be created in possibility of high temperature superconductivity.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Free electron theory, energy levels in one dimension, free electron gas in three dimension, heat capacity of electron gas, electrical conductivity and ohm's law, experimental electrical resistivity of metals, Hall Effect.	12
2	Energy bands, origin of energy gap, bloch functions, Kronig-Penny model, brillouin zones, metals and insulators.	10
3	Dielectric function of the electron gas, plasma optics, dispersion relation of electromagnetic wave, transverse optical modes in plasma, longitudinal plasma oscillations, polaritons, electron-phonon interaction polarons, optical processes and excitons.	12
4	Occurrence of superconductivity, destruction of superconductivity, Meissner effect, type I and type II superconductors, heat capacity, isotope effect, thermodynamical considerations, London equations & penetration depth, coherence length, BCS theory (elementary description), applications of superconductors. High temperature superconductivity, Josephson junctions.	8

Course Outcomes: By the end of the course, student will be able to	
1	Solve the problems based on free electron theory and band theory of solids.
2	Understand and apply the basic concepts of plasma optics and superconductivity in different phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Introduction to Solid State Physics", Charles Kittel, Wiley India Pvt. Ltd., New Delhi	2012
2	"Solid State Physics", S.O. Pillai, New Age International (P) Limited, New Delhi	2010
3	"Crystallography Applied to Solid State Physics", Verma and Srivastava, New Age International (P) Limited, New Delhi	2012

Course Name	**:**	**MODERN INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS**
Course Code	**:**	**CHN 401**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course, the student should be able to introduce the principles of chemical analysis, matrix effects, detailed instrumentation, operation and interpretation of data, error analysis and statistical methods of data handling.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**SPECTROSCOPIC TECHNIQUES:** UV – Visible, Infra red, NMR, and Mass Spectroscopy-Principles Instrumentation and Applications	10
2	**ATOMIC ABSORPTION SPECTROMETRY AND EMISSION SPECTROMETRY:** Inductively coupled plasma atomic emission spectroscopy (ICP-AES) - Principles	8

	Instrumentation and Applications	
3	**OPTICAL MICROSCOPY**: Scanning Electron Microscopy (SEM),Transmission Electron Microscopy (TEM) and Scanning Transmission Electron Microcopy (STEM) -Principles and Applications	6
4	**X-RAY TECHNIQUES**: XRD, XRF, XPS-Principles and Applications	8
5	**THERMAL ANALYSIS**: DTA, TGA- Principles Instrumentation and Applications	5
6	**CHROMATOGRAPHIC ANALYSIS**: GC, HPLC- Principles Instrumentation and Applications	5

Course Outcomes: By the end of this course, the student will be able to:	
1	Handle the analysis of mg, ppm and ppb levels of analyte by appropriate instrumental methods.
2	Carry out Chemical analysis of hazardous materials, environmental samples, inorganic, organic and biomaterials at trace and ultra trace quantities.
3	Differentiate among molecular absorption, atomic absorption and atomic emission spectrometry.
4	Carry out hands on experiments in the field related to analysis of materials required for technological developments and in advanced research in Engineering.
5	Differentiate between classical and instrumental methods of Chemical analysis.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Interpretation of Mass Spectra", McLafferty F.W., 3rd Edition, Pubs: W.A. Benzamine, New York.	1993
2	"Spectrometric Identification of Organic Compounds", Silverstein R.M. and Bassler G.S., 5th Edition, Pubs: John Wiley.	1991
3	"Instrumental Analysis", Willard H.H., Merritt L.L. and Dean J.A., 7th Edition, Pubs: Van Nostran Reinhold.	1998
4	"Instrumental Analysis", Skooq D.A. Holler F. J. and Crouch S. R., Pubs: Brooks/Cole.	2007
5	"Analytical Chemistry", Christian G.D., 5th Edition, Pubs: John Wiley.	1994
6	"X-ray structure determination a practical guide", Stout G.H. and Jeansen L.H., Pubs: John Wiley & Sons, New York.	1989
7	"Crystal structure analysis for chemists and biologists", Glusker J.P., Lewis M, Pubs: VCH Publisher inc., New York.	1994
8	"Structure Determination by X-ray crystallography", Ladd, M.F.C. and Palmer R.A., Pubs: Plenum Press, New York.	1994

Course Name	**:**	**PRINCIPLES OF MANAGEMENT**
Course Code	**:**	**HSM 401**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:

The main aim of this course is to make students understand the management process and principles along with its application in practical life and to help them manage different jobs and situations with the help of management functions.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO MANAGEMENT** Nature of Management: Art or Science, Principles and Functions of Management	**3**
2	**EVOLUTION OF MANAGEMENT THOUGHT** Classical Theories: Bureaucratic, Scientific and Administrative Approach	**6**

	Neo-Classical Theories: Human Relations and Human Behaviour Approach Modern Theories of Management Relevance of Management Thought in present scenario – Management Cases	
3	**PLANNING** Nature of Planning, Planning Process, Application of Planning Process in a Hypothetical Situation, Types of Planning, Types of Plans, Management by Objective (MBO)	**4**
4	**ORGANIZING** Concept of Organization, Departmentation, Forms of Organization Structure Analysis of Organization Structure – Case Studies Hypothetical Formation of an Organization	**4**
5	**STAFFING** Human Resource Planning: HRP Process, Job Analysis: Job Description, Job Specifications and Used of Job Analysis Recruitment: Sources and Methods Selection: Selection Process, Role Playing and Case Study on Selection Tests and Interviews Training and Development: Techniques, Performance Appraisal: Methods Case Study on Staffing Practices	**6**
6	**DIRECTING** Concept, Leadership: Importance and Styles, Motivation: Theories and their relevance in present scenario, Communication: Process, Types and Barriers of Communication Management Game on Leadership, Motivation and Communication	**3**
7	**CONTROLLING** Nature and Process of Controlling, Requirements for Effective Controlling	**2**

Course Outcomes:	
1	The students will be able to apply management concepts and principles in daily life and thus, will be able to manage things efficiently and effectively.
2	The students will learn how to get work done easily by using management knowledge and functions.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Principles and Practices of Management", Rao V.S.P. and Narayana P.S., Pubs: Konark Publishers.	1987
2	"Principles & Practice of Management", Prasad L.M., 8th Edition, Pubs: Sultan Chand & Sons.	2012
3	"Essentials of Management: International and Leadership Perspective", Weihrich H. and Koontz H., 9th Edition, Pubs: McGraw Hill.	2012
4	"The New Era of Management", Daft R.L., 11th Edition, Pubs: Cengage Learning.	2014
5	"Management: Text and Cases", Rao V.S.P. and Krishna V.H., Pubs: Excel Books.	2008
6	"Fundamentals of Management: Essential Concepts and Applications", Robbins S.P, DeCenzo D.A., Bhattacharya S. and Agarwal M.N., 6th Edition, Pubs: Pearson India.	2009

Course Name	**:**	**BUSINESS ENVIRONMENT AND BUSINESS LAWS**
Course Code	**:**	**HSM 402**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:

The main aim of this course is to make students understand different types of environment influencing business decisions and to provide knowledge about different laws that needs to be followed for initiating and managing business.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO BUSINESS** Scope and Characteristics of Business, Classification of Business Activities Forms of Ownership of Business: Sole Proprietorship, Partnership and Company	**5**
2	**BUSINESS ENVIRONMENT** Internal Environment: Concept and Elements (Value System, Vision Mission Objectives, Management Structure, Human Resources, Company Image etc.) SWOT Analysis: Concept and Case Study External Environment: Micro Environment (Suppliers, Customers, Competitors, Market Intermediaries etc.) and Macro Environment – PESTEL Analysis (Political, Economic, Social, Technological, Ecological and Legal), Case Study on Impact of Environment on Business	**7**
3	**GLOBALIZATION** Concept, Pros and Cons of Globalization, Impact of Global Environment on Business Globalization of Company – Case Study	**4**
4	**CORPORATE SOCIAL RESPONSIBILITY** Concept, Social Responsibility towards different stakeholders, Rationale for CSR CSR – Case Studies	**2**
5	**CORPORATE GOVERNANCE** Concept, Elements and Essentials of Good Governance	**3**
6	**CONTRACT LAW** Concept, Types and Essentials Elements of Contract	**3**
7	**PARTNERSHIP LAW** Nature of Partnership, Provisions of Partnership Act, Issues Related to Partnership Firm, Hypothetical Formation of a Partnership Firm	**2**
8	**COMPANY LAW** Nature of Company, Provisions of Company Act, Issues Related to Incorporation of Company, Hypothetical Formation of a Company	**2**

Course Outcomes:	
1	The students will be able to analyze the impact of environment on business and formulate appropriate business strategies to compete in the competitive world.
2	The students will learn how companies follow corporate governance and social responsibility practices along with fulfilling economic objectives.
3	The students will gain knowledge about application and implementation of various business laws in practice.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Business Environment: Text and Cases", Cherunilam F., 22nd Edition, Pubs: Himalaya Publications.	2013
2	"Legal Aspects of Business", Pathak A., 5th Edition, Pubs: McGraw Hill Education.	2013
3	"Essential of Business Environment: Text, Cases and Exercises", Aswathappa K., 11th Edition, Pubs: Himalaya Publication.	2011
4	"Business Law Including Company Law", Gulshan S.S. and Kapoor G.K., 15th Edition, Pubs: New Age International (p) Ltd.	2011

5	"Business Law and Corporate Laws", Tulsian P.C., 1st Edition, Pubs: Sultan Chand Publishing.	2011
6	"Fundamentals of Business Organization & Management", Bhushan Y.K., 19th Edition, Pubs: Sultan Chand & Sons.	2013
7	"Corporate Governance: Principles, Policies and Practices", Fernando A.C., 2nd Edition, Pubs: Pearson India.	2011

Course Name	**:**	**FINANCIAL MANAGEMENT**
Course Code	**:**	**HSM 404**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students learn different financial decisions i.e. investing, financing and dividend, required to be taken by a company and provide knowledge about the functioning of the financial system (financial markets, financial institutions, financial services and financial instruments) of the country.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO FINANCIAL MANAGEMENT** Concept of Finance, Terminology Related to Finance, Financial Decisions, Factors Affecting Financial Decisions, Risk-Return Trade-Off	**3**
2	**FINANCIAL SYSTEM** Concept and Role of Financial System in Indian Economy	**2**
3	**FINANCIAL MARKETS AND INSTRUMENTS** Concept and Relevance of Money Market and Capital Market Money Market Instruments: Call Money, Treasury Bills, Commercial Papers, Certificate of Deposits Capital Market Instruments: Equity Shares, Preference Shares and Debentures Hypothetical Trading in Financial Markets	**5**
4	**FINANCIAL SERVICES** Nature and Functions of Financial Services: Merchant Banking, Mutual Funds, Factoring, Forfaiting, Credit Rating Case Study on Financial Services	**6**
5	**FINANCIAL INSTITUTIONS** Nature and Functions of Financial Institutions: Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), Discount and Finance House of India (DFHI)	**2**
6	**LONG TERM INVESTMENT DECISIONS** Capital Budgeting: Concept, Importance, Factors Techniques/Methods with Numerical Applications (Pay Back Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return and Profitability Index), Case Study	**3**
7	**SHORT TERM INVESTMENT DECISIONS** Working Capital: Nature, Type and Factors Affecting the Requirement of Working Capital, Case Study	**2**
8	**FINANCING DECISIONS** Capital Structure: Essentials and Approaches of Capital Structure Sources of Finance (long-term and short-term), Financial Leverage: Concept and Numerical Application, Case Study	**3**
9	**DIVIDEND DECISIONS** Types of Dividend, Dividend Policy: Nature and Factors Affecting Dividend Policy, Case Study	**2**

Course Outcomes:	
1	The students will learn to make best combination of financial decisions by considering risk and return trade-off.
2	The students will identify how business can gain maximum through the financial system.
3	The students will understand how to manage funds effectively so as to maximize returns.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Financial Management", Shah P., 2nd Edition, Pubs: Dreamtech Press	2009
2	"Financial Markets and Services", Gordon E. and Natarajan K., 3rd Edition, Pubs: Himalaya Publishing House.	2006
3	"Financial Management: Theory and Practice", Chandra P., 8th Edition, Pubs: McGraw Hill Education (India).	2012
4	"Financial Management", Pandey I.M., 10th Edition, Pubs: Vikas Publishing House Pvt. Ltd., Noida.	2010
5	"Cases in Financial Management", Pandey I.M. and Bhat R., 3rd Edition, Pubs: McGraw Hill Education (India).	2012
6	"Financial Institutions and Markets: Structure, Growth and Innovations", Bhole L.M. and Mahakud J., 5th Edition, Pubs: McGraw Hill Education (India).	2009
7	"The Indian Financial System: Markets, Institutions and Services", Pathak B.V., 3rd Edition, Pubs: Pearson India.	2010
8	"Financial Management and Policy", Horne J.C.V. and Dhamija S., 12th Edition, Pubs: Pearson India.	2011

Course Name	**:**	**MARKETING MANAGEMENT**
Course Code	**:**	**HSM 405**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students understand about the marketing concepts to be applied in real life and the marketing process for delivering value to customers.

Total No. of Lectures –28

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION TO MARKETING** Concepts, Role, Scope and Types of Marketing, Case Study on Marketing Management	**3**
2	**MARKETING RESEARCH** Scope and Process of Marketing Research, Hypothetical Marketing Research Analysis	**3**
3	**CONSUMER AND BUSINESS MARKETS** Types of Markets, Building Customer Value Consumer and Business Buying Behaviour: Factors Influencing Behaviour and Buying Decision Process	**4**
4	**SELECTION OF MARKETS** Segmentation: Factors and Bases, Targeting and Positioning Preparation of STP of Selected Product	**3**
5	**MARKETING MIX** 7 P's of Marketing Mix: Product, Price, Physical Distribution, Promotion, People, Process	**3**

	and Physical Evidence Formulation of Marketing Mix of Selected Product	
6	**PRODUCT DECISIONS** Product (Good or Service) Characteristics, Product Life-Cycle, Packaging and Branding, Product Development and Management	**3**
7	**PRICING DECISIONS** Pricing Policies and Strategies, Factors Influencing Pricing	**3**
8	**PHYSICAL DISTRIBUTION DECISIONS** Marketing Channels, Channel Players, Physical Distribution, Managing Distribution, Analysis of Supply Chain Management – Case Studies	**3**
9	**PROMOTION DECISIONS** Nature of Promotion Decisions, Managing Mass Communication and Personal Communication Analysis of Promotional Strategies – Case Studies	**3**

Course Outcomes:	
1	The students will learn how to market goods and services effectively to different segments so as to deliver value to customers.
2	The students will be able to formulate marketing mix and marketing strategies for different products and different sets of customers.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Marketing Management: Concepts, Cases, Challenges and Trends", Govindarajan M, 2nd Edition, Pubs: PHI Learning.	2009
2	"Marketing Management", Kotler P., Keller K.L., Koshy A. and Jha M., 14th Edition, Pubs: Pearson India.	2012
3	"Marketing Concepts and Strategies", Dibb S., Simkin L., Pride W.M. and Ferrell O.C., Pubs: Cengage Learning.	2012
4	"Marketing Management", Kumar A. and Meenakshi N., 2nd Edition, Pubs: Vikas Publishing House Pvt. Ltd., Noida.	2011
5	"Marketing Management", Saxena R., 4th Edition, Pubs: McGraw Hill Education (India).	2013
6	"Marketing: Managerial Introduction", Gandhi J.C., 1st Edition, Pubs: McGraw Hill Education.	1987
7	"Marketing", Etzel M.J., Walker B.J., Stanton W.J. and Pandit A., 14th Edition, Pubs: McGraw Hill Education (India).	2010
8	"Super Marketwala: Secrets to Winning Consumer India", Mall D., 1st Edition, Pubs: Random House India.	2014

Course Name	**:**	**HUMAN RESOURCE MANAGEMENT**
Course Code	**:**	**HSM 406**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to provide an overview of HRM, keeping the Indian business scenario in the background and to acquaint the students with the strategic role of HRM in managing an organization.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO HUMAN RESOURCE MANAGEMENT** HRM: Nature, Scope, Functions, HRM Practices and Problems in India with Case Studies	**4**

2	**HUMAN RESOURCE PLANNING (HRP)** Concept and Process of HRP, Factors Affecting HRP	**3**
3	**JOB ANALYSIS AND DESIGNING** Uses and Process of Job Analysis, Job Description and Job Specification: Features and Hypothetical Formulation, Job Designing: Job Enrichment, Job Enlargement	**3**
4	**RECRUITMENT AND SELECTION** Recruitment: Sources and Methods Selection: Selection Process, Selection Tests, Types and Nature of Interviews Role Playing and Case Study on Selection Process, Tests and Interview	**4**
5	**INDUCTION AND INTERNAL MOBILITY** Induction Programme, Need and Scope of Internal Mobility: Transfer, Promotion, Demotion	**3**
6	**TRAINING AND DEVELOPMENT** Training: Need and Methods, Management Development: Need, Methods and Management Development Programme HRM Games for Development of Employees	**4**
7	**PERFORMANCE APPRAISAL AND COMPENSATION** Nature and Methods of Performance Appraisal, Hypothetical Performance Appraisal Compensation: Financial and Non-Financial Benefits	**4**
8	**EMPLOYEE HEALTH AND SAFETY** Concept, Issues related to Health and Safety, Workplace Health Hazards	**3**

Course Outcomes:	
1	The students will develop the ability to solve problems in area of HRM in organizations.
2	The students will become aware of latest developments in HRM practices which are essential for effective management in organization.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Human Resource Management: Text and Cases", Rao V.S.P., Pubs: Excel Books.	2002
2	"Human Resource Management", Dessler G. and Varkkey B., 12th Edition, Pubs: Pearson India.	2011
3	"Human Resource Management: Text and Cases", Aswathappa K., 7th Edition, Pubs: McGraw Hill Education (India).	2013
4	"Human Resource Management: Text and Cases", Gupta C.B., 14th Edition, Pubs: Sultan Chand and Sons.	2012
5	"Human Resource Management: Text and Cases", Bedi S.P.S. and Ghai R.K., Pubs: Bharti Publications.	2012
6	"Human Resource Management Applications: Cases, Exercises, Incidents and Skill Builders", Fottler M.D., McAfee R.B. and Nkomo S.M., 7th Edition, Pubs: Cengage Learning.	2013

Course Name	**:**	**MANAGING INNOVATION AND CHANGE**
Course Code	**:**	**HSM 431**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students learn how to manage innovation and change in organizations and understand how innovation and change can contribute to business success.

Total No. of Lectures – 28

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION TO INNOVATION AND CHANGE** Concept, Types, Sources, Components, Invention vs. Innovation	4
2	**INNOVATION IN ORGANIZATION** Innovation in Managerial Functions (Planning, Organizing, Staffing, Directing and Controlling), Innovation in Operational Functions (Marketing, Human Resource and Finance) Case Studies and Brainstorming Sessions	3
3	**INNOVATION POLICY** Innovation Cluster, National Innovation Systems	3
4	**INNOVATION MANAGEMENT** Innovation Management: Innovation Strategies, Models, Processes and Structures Case Study on Innovation Management	4
5	**REACTIONS TO CHANGE** Process of Planned Change, Responses to Change, Reasons for Resistance to Change, Change Agents, Stages in Reaction to Change	5
6	**CHANGE MANAGEMENT** Key Dimensions and Factors, Organizational Change, Approaches to Change Management Case Study on Change Management	4
7	**INTELLECTUAL PROPERTY RIGHT (IPR)** Patents, Copyrights and Trademarks	3
8	**DISCUSSIONS ON ADDITIONAL READING** (any one of the following in the semester) - 8 Steps to Innovation – Going from Jugaad to Excellence - Innovation Secrets of Indian CEOs - Jugaad Innovation: A Frugal and Flexible Approach to Innovation for the 21st Century - The Ten Faces of Innovation	2

Course Outcomes:	
1	The student will learn the technological, human, economic, organizational, social and other dimensions of innovation.
2	The students will understand how to encourage, manage and implement innovation and change in organization and how to take a new idea to the stage where it can be implemented.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Managing Change and Transition", Harvard Business School, Pubs: Harvard University Press.	2003
2	"Managing Creativity and Innovation", Harvard Business School, Pubs: Harvard University Press.	2003
3	"Managing Change, Creativity and Innovation", Dawson P. and Andriopoulos C., Pubs: Sage Publications.	2014
4	"Managing Strategic Innovation and Change", Tushman M.L. and Anderson P., 2nd Edition, Pubs: Oxford University Press.	2004
5	"The International Handbook of Innovation", Larisa V.S., Pubs: Elsevier Science.	2003
6	"Managing Innovation and Change", Mayle D., 3rd Edition, Pubs: Sage Publications.	2006
7	"Managing Technology and Innovation for Competitive Advantage", Narayanan V.K., Pubs: Pearson India.	2002
8	"Managing Technological Innovation, Competitive Advantage from Change", Betz F., Pubs: Wiley.	2011

Course Name	**:**	**BUSINESS RESEARCH**
Course Code	**:**	**HSM 432**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students understand the concepts of business research and learn the methods to formulate, analyze and interpret the business problems.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO BUSINESS RESEARCH** Concept and Types of Business Research	3
2	**PROBLEM IDENTIFICATION** Defining Problem, Literature Review: Essentials of Literature Review and Writing of Review, Research Objectives: Essentials of Research Objectives and its Formulation	3
3	**FRAMEWORK FOR BUSINESS RESEARCH** Research Questions, Hypothesis: Essentials of Hypothesis and its Formulation, Types of Variables	2
4	**INTRODUCTION TO RESEARCH DESIGN** Purpose and Scope of Research Design, Research Proposal: Elements and Framing a Research Proposal	2
5	**MEASUREMENT SCALES** Rating Scales, Ranking Scales, Reliability, Validity, Questionnaire: Essentials of Questionnaire, Developing a Questionnaire on a Hypothetical Research Problem	4
6	**SAMPLING DESIGN** Concept, Process and Techniques of Sampling, Framing of Sampling Design	3
7	**DATA COLLECTION** Sources and Methods of Data Collection	3
8	**PRESENTATION AND ANALYSIS OF DATA** Tabular, Graphic and Diagrammatic Presentation of Data, Statistical Data Analysis, Presentations and Analysis of Data using MS Excel	5
9	**RESEARCH REPORT** Contents and Characteristics of Project Report, Formulation of Project Report	3

Course Outcomes:	
1	The students will develop ability to tackle problems in business by following research techniques.
2	The students will learn to collect the right data and to analyze and present the data in the right way.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Research Methods for Business: A Skill Building Approach", Sekaran U. and Bougie R., 5th Edition, Pubs: Wiley India Pvt. Ltd., New Delhi.	2011
2	"Research Methodology: Methods and Techniques", Kothari C.R. and Garg G., 3rd Edition, Pubs: New Age International.	2014
3	"Business Research Methods", Bryman A. and Bell E., 2nd Edition, Pubs: Oxford University Press.	2010
4	"Business Statistics", Beri G.C., 3rd Edition, Pubs: McGraw Hill Education (India).	2009
5	"Statistics for Management", Levin R.I., Rubin D.S., Rastogi S. and Siddiqui M.H., 7th Edition, Pubs: Pearson India.	2012

6	"Business Research Methods and Statistics using SPSS", Burns R.P. and Burns R., 1st Edition, Pubs: Sage Publications.	2008
7	"Statistics for Management", Srivastava T.N. and Rego S., 2nd Edition, Pubs: McGraw Hill Education (India).	2012

Course Name	**:**	**ALGEBRA - I**
Course Code	**:**	**MAN 431**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to describe the basic results of Group Theory. They should be able to recognise examples of groups. They should know the definitions of basic terms and should be able to write elements of the symmetric group as cycles or products of transpositions, should know simple uses of Lagrange's Theorem, quotients and products of groups. They should know difference between finding a proof from the axioms that works for all groups, and finding a counter example.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Definition of a group, examples, some preliminary lemmas, Subgroups, examples, Cosets, Order of a group, Lagrange's Theorem,Euler's Theorem, A counting principle.	10
2	Normal subgroups and quotient groups, Homomorphism, Cauchy's Theorem, Sylows Theorem, Automorphism, Cayley's Theorem, Permutation groups, Conjugacy classes, Sylow subgroups and Sylow's Theorem,	16
3	Direct products, Finite abelian groups.	6
4	Vector Spaces: Elementary basic concepts, Linear independence and bases, Dual Spaces.	10

Course Outcomes:	
1	By the end of the course, the students will be able to describe the basic results of Group Theory, recognise examples of groups, know the definitions of basic terms, such as: order of a group, order of an element, subgroup, cyclic group and isomorphism. They will also be able to prove simple consequences, write elements of the symmetric group as cycles or products of transpositions, describe quotients and products of groups.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Topics in Algebra", Herstein, I.N., Wiley Eastern Limited, New Delhi.	1981
2	"Modern Algebra", Singh, S and Zameeruddin, Q ,Vikas Publishing House, New Delhi	2015
3	"Rings and Modules", Musili, C, Narosa Publishing House, (Second Revised Edition),New Delhi.	1994.
4	"Algebra", Artin, M. Prentice Hall of India, New Delhi.	1994
5	"The Theory of Groups of Finite Order", Burnside, W. (2nd Ed.), Dover, New York.	1955

Course Name	**:**	**NUMBER THEORY**
Course Code	**:**	**MAN 432**

Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to describe the fundamental properties of integers and to prove basic theorems. They should be able to solve congruences and Diophantine equations. They should also be able to approximate reals by rationals.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Introduction, Divisibility, Greatest common divisor, The Euclidean algorithm, primes, Fundamental theorem of Arithmetic,	8
2	Congruences, Residue classes and reduced residue classes, Fermat's theorem, Euler's theorem, Wilson Theorem, Solution of congruences , congruences of degree1, Chinese Remainder theorem with applications. Euler's φ-function,	12
3	Congruences of higher degree, prime power modulii, prime modulus, Primitive roots, Indices and their applications, power residues, Quadratic residues, Quadratic reciprocity, Legendre Symbol, Euler's criterion, Gauss's Lemma, Quadratic reciprocity law, Jacobi symbol,	10
4	Greatest integer function, arithmetic function, Mobius inversion formula, Diophantine equations Farey sequences,Continued fractions, approximations of reals by rationals.	12

Course Outcomes: By the end of the course, the students will be able to	
1	Describe the fundamental properties of integers.
2	Prove basic theorems.
3	Solve congruences.
4	Sove Diophantine equations
5	Approximate reals by rationals

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"An introduction to theory of numbers", Niven I., Zuckerman S. H. and Montgomary L. H.John Wiley and Sons .	1991
2	"Theory of Numbers", Hardy and Wright W. H.Oxford University Press	1979
3	"Higher arithmetic", Davenport H.Cambridge University Press .	1999.
4	"Elementary Number Theory", David M. Burton, Wm.C.brown Publishers, Dubuque, Ivova .	1989

Course Name	**:**	**FOURIER SERIES AND INTEGRAL TRANSFORMS**
Course Code	**:**	**MAN 433**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to expand functions in Fourier series, Fourier Integrals and learn Fourier sine and cosine Transforms, Harmonic analysis and their applications. The students should be able to evaluate Laplace transforms and Inverse Laplace transform. The students should be able to apply Laplace transforms to solve ordinary differential equations.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Periodic functions, Trigonometric series, Fourier Series, Euler's formulae, Conditions for existence of Fourier series, Functions of any period p = 2L, Even and odd functions, Half range expansions, Complex Fourier series, Applications of Fourier series, Parseval's identity, Harmonic analysis. Approximation by Trigonometric Polynomials	12
2	Fourier Integral, Fourier Sine and Cosine Integrals ,Evaluation of Integrals, Fourier Transforms, Fourier Cosine Transform, Fourier Sine Transform, Properties of Fourier Transform, Linearity ,Symmetry, change of Time Scale, Time Shifting , Frequency Shifting , Fourier Transform of derivatives, integrals, convolution , Properties of Fourier cosine and sine Transforms, Parseval Identity for Fourier Transform , Finite Fourier Cosine and Sine Transform	18
3	Laplace transform, Inverse transform, properties, Transforms of derivatives and integrals, s-Shifting ,t-Shifting, Unit step function, Dirac's delta function, Differentiation and integration of transforms, Applications to differential equations. Convolution Theorem ,Integral Equations	12

Course Outcomes:	
1	By the end of this course the students will be able to expand a function in terms of its Fourier Series ,Fourier Integrals, Fourier Transforms and apply harmonic analysis to numerical data.
2	The students will be able to evaluate Laplace transforms and inverse Laplace transforms.
3	The students will be able to use Laplace transform to solve ordinary differential equations arising in engineering problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Higher Engineering Mathematics", B V Ramana, Tata McGraw -Hill	2006
2	"Advanced Engineering Mathematics", E. Kreyszig, John Wiley.	2006
3	"Advanced Engineering Mathematics", Wylie and Barrett, McGraw Hill.	2003

Course Name	**:**	**CALCULUS OF VARIATIONS**
Course Code	**:**	**MAN 434**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of the course the students should be able to understand the concept of functional, extremum, Euler's equations, the concepts of transversality conditions, Weirstress-Endmann corner condition and canonical form of Euler equations, canonical transformations and Rayleigh Ritz method,They should be able to apply direct methods in calculus of variations Euler's finite difference methods, use Rayleigh Ritz method and Sturm-Liouville to solve differential equations.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Variation of a functional. A necessary condition for an extremum, Euler's equation. Some classical problems. Fixed end point problems for unknown functions. Variational problems	10

	with subsidary conditions.	
2	General variation of a functional. Variable end point problems, transversality conditions. Transversal theorem. Weirstress-Endmann corner condition. Canonical form of Euler equations and their first integrals. Canonical transformations. Weather's theorem. The principle of the least action. Censervation laws. Hamilton-Jacobi equations. Jacobi's theorem.	14
3	The second variation of a functional and the formula for second variation. Legendre's necessary condition. Iaoobi's necessary condition. Conjugate points, Sufficient condition for a weak extremum. General definition of a field and field of a functional. Hilberts invariant integral. The weierstrass E-functional. Sufficient conditions for a strong minimum. Direct methods in calculus of variations Euler's finite difference methods and the Rayleigh Ritz method. Applications to sturm-Liouville problem.	18

Course Outcomes:	
1	At the end of the course the students will be able to understand the concept of functional, extremum, Euler's equations.
2	They will be able to learn the concepts of transversality conditions, Weirstress-Endmann corner condition and to evaluate canonical form of Euler equations, canonical transformations and Rayleigh Ritz method.
3	They will be able to apply direct methods in calculus of variations Euler's finite difference methods, use Rayleigh Ritz method and Sturm-Liouville to solve differential equations.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Calculus of variations", I M. Gelfand and S. V. Fomin	1963
2	"Calculus of variations", L.E. Elsgolc.	1962

Course Name	**:**	**ALGEBRAIC CODING THEORY**
Course Code	**:**	**MAN 435**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to translate fundamental problems of coding theory into mathematical problems and then solve them by using the theory of finite fields, polynomial rings and finite groups.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO CODING THEORY** Source and Channel coding, Error detecting and error correcting codes	2
2	**ERROR DETECTION, ERROR CORRECTION AND DECODING** Communication Channels, maximum likelihood decoding, Hamming distance, Nearest neighbour/ minimum distance decoding, distance of a code	6
3	**FINITE FIELDS** Fields, Polynomial rings, Structure of finite fields, Minimal polynomials	10
4	**LINEAR CODES** Vector spaces over finite fields, Linear Codes, Hamming weight, Bases for linear codes Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome Decoding, Weight Enumerator of a Code, Macwilliam's Identity,	16

5	**CYCLIC CODES** Definition, Generator polynomials, Generator matrix and parity check matrix, Decoding of linear codes.	8

Course Outcomes: By the end of the course, the students will be able to	
1	Translate fundamental problems of coding theory into mathematical problems and then solve them by using the theory of finite fields, polynomial rings and finite groups.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Coding Theory", San Ling & Chaoping Xing , Cambridge University Press	2004
2	"Introduction to the 'Theory of Error Correcting Codes", Vera Pless, Cambridge University Press	2003
3	"Introduction to Error Correcting Codes", Raymond Hill, Clarendon Press, Oxford	1986
4	"Theory of Error Correcting Codes Part I & II", F.J.Macwilliams & NJA Sloane	1977

Course Name	**:**	**QUANTUM MECHANICS**
Course Code	**:**	**PYN-431**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems related to hydrogen atom.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Blackbody radiation, photoelectric effect, X-rays, X-ray diffraction, Compton effect, Pair production	7
2	Inadequacy of classical physics, Bohr-Sommerfield quantization rules, Quantum-Mechanical viewpoint.	4
3	De Broglie waves, phase and group velocities, particle diffraction, Uncertainty Principle, limitations on experiment, wave packets.	7
4	One-dimensional Schrodinger wave equation, extension to three dimensional statistical interpretation of wave function, Normalization, expectation value.	6
5	Separation of wave equation, one-dimensional square well potential, perfectly rigid wall, finite potential step, tunnel effect.	8
6	Linear harmonic oscillator, three-dimensional square well potential, the hydrogen atom, separation of variables, quantum numbers, principal quantum number, orbital quantum number, magnetic quantum number, Zeeman effect.	10

Course Outcomes: By the end of the course, student will be able to	
1	Solve the problems based on Quantum Mechanics.
2	Apply the concepts of Quantum Mechanics in different phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/**

		Reprint
1	"Concepts of Modern Physics", Arthur Beiser, McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013
3	"Modern Physics", J. Bernstein, P.M. Fishbane and S.G. Gasiorowicz, Pearson, Education India Pvt. Ltd., New Delhi	2009

Course Name	**:**	**STATISTICAL PHYSICS**
Course Code	**:**	**PYN-432**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The students will be able to describe and implement concepts and principles of Statistical Mechanics required for in depth understanding of Physical phenomena in solid state, nuclear physics.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Laws of Thermodynamics - First Law of Thermodynamics, Second Law of Thermodynamics, Entropy, Third Law of Thermodynamics.	6
	Phase Transitions, Kinetic Theory, Vander waal equation of state, Boltzmann transport equation, Maxwell-Boltzman Distribution, the method of most probable distribution.	8
2	Classical Statistical Mechanics, Microcanonical ensemble, Cnonical ensemble, Grand Canonical ensemble, Chemical Potential.	7
	Distribution function, Ideal Fermi Gas, Degenerate and non-degenerate states, Theory of white dwarf stars, Landau Diamagnetism.	7
3	Equation of state for ideal Fermi gas, quantized Hall effect, Pauli paramagnetism, Ideal Bose gas, Bose-Einstein distribution, Derivation of Planck's Law.	7
	Phonons, Specific heat, superfluids, Landau's theory, superfuid flow, superfluid velocity, Bose-Einstein Condensation.	7

Course Outcomes:	
1	Solve the problems based on Statistical Mechanics.
2	Understand the importance of statistical physics in describing various natural phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Statistical Mechanics" , K. Huang, Wiley India Private Ltd., New Delhi	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013
3	"Concepts of Modern Physics", Arthur Beiser, McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2013

Course Name	**:**	**NUCLEAR PHYSICS**
Course Code	**:**	**PYN-433**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems related to hydrogen atom.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Mass, charge and constituents of nucleus, Nuclear size and distribution of nucleons, Energies of Nucleons, Nucleus as a quantum system, nuclear force, properties of nucleus.	10
2	Particle in a one-dimensional square well, particle in a three-dimensional square well, vector model for addition of angular momentum.	10
3	Bound states of two nucleons - Deuteron nucleus, Meson theory of nuclear forces. Shell theory of nucleus, shell theory potential, allowed orbits, filling of allowed orbits, non-spherical nucleus.	10
4	Natural radioactivity, successive radioactive transformations, radioactive equilibrium, radioactive series, radiometric dating. Nuclear force and its characteristics, Elementary description of shell model, explanation of magic numbers, liquid drop model and semi-empirical binding energy formula. Nuclear fission, fission products, mass and energy distribution of fission products, neutron emission and energy distribution of neutrons emitted in fission, theory of fission process, nuclear reactors - classification, neutron cycle in thermal reactors and four-factor formula for neutron reproduction, nuclear fission - controlled thermonuclear reactions.	12

Course Outcomes: By the end of the course, student will be able to	
1	Solve the problems based on Nuclear Physics.
2	Understand and apply the basic concepts of nuclear physics in different nuclear phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Concepts of Nuclear Physics" , B.L. Cohen, Tata Mcgraw Hill, New Delhi	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013
3	"Introductary Nuclear Physics", Kenneth S Krane, Wiley India Pvt. Ltd., New Delhi	2014

Course Name	**:**	**EXPERIMENTAL NUCLEAR PHYSICS**
Course Code	**:**	**PYN-434**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems related to hydrogen atom.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Experimental Nuclear Physics** Binding energies of nuclei, semi-empirical mass formula, magnetic dipole moment, electric quadrupole moment, Beta decay, nucleon emission, decay laws.	10
2	Experimental method in nuclear physics, interaction of charged particle with matter, detectors for energetic charged particles, detectors which make tracks visually observable, scintillation detectors, charge collection detectors, mass spectrometer.	10
3	Accelerators, linear accelerator, cyclic accelerator, synchrocyclotron.	10
4	Natural radioactivity, successive radioactive transformations, radioactive equilibrium, radioactive series, radiometric dating. Nuclear force and its characteristics, Elementary description of shell model, explanation of magic numbers, liquid drop model and semi-empirical binding energy formula. Nuclear fission, fission products, mass and energy distribution of fission products, neutron emission and energy distribution of neutrons emitted in fission, theory of fission process, nuclear reactors - classification, neutron cycle in thermal reactors and four-factor formula for neutron reproduction, nuclear fission - controlled thermonuclear reactions.	12

Course Outcomes: By the end of the course, student will be able to	
1	Solve the problems based on experimental Nuclear Physics.
2	Predict that which type of detector or accelerator is suitable for particular application.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Concepts of Nuclear Physics" , B.L. Cohen, Tata Mcgraw Hill, New Delhi	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013
3	"Introductary Nuclear Physics", Kenneth S Krane, Wiley India Pvt. Ltd., New Delhi	2014

Course Name	**:**	**X-Ray Crystallography**
Course Code	**:**	**PYN-435**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of the course, student will become familiar with the applications of X-ray crystallography in the determination of molecular structure. On the basis of structure, student will be able to explain the experimental observed properties.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Bonding in Solids, Ionic bonding, Covalent, metallic bonding, intermolecular bond, dispersion bond, hydrogen bond. General features of crystals, basis and crystal structure, unit cell and lattice parameters, external symmetry of crystals, seven crystal systems, thirty two crystal classes, Miller indices, space lattice, symmetry elements, space group.	12
2	General description of scattering process, Thomson scattering, Compton scattering, scattering of X-rays by atoms.	10

3	Diffraction from one-dimensional and three-dimensional array of atoms, reciprocal lattice, Ewald sphere, Laue equation, structure factor, Diffraction by periodic distribution, electron-density equation, Patterson method. Powder camera, oscillation camera, Weissenberg camera.	10
4	Relevance of crystallography in the studies of theory of solids, influence of translational periodicity on the physical behavior of solids, tight binding approximation, density of states,	10

Course Outcomes:	
1	Solve the problems based on crystal systems.
2	Apply X-ray crystallography in the determination of molecular structure.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"An introduction to X-Ray Crystallography" by M.M. Woolfson Vikas Publishing House, Cambridge University Press, New Delhi	2012
2	"Solid State Physics", S.O. Pillai, New Age International (P) Limited, New Delhi	2010
3	"Crystallography Applied to Solid State Physics", Verma and Srivastava, New Age International (P) Limited, New Delhi	2012

Course Name	**:**	**INORGANIC CHEMISTRY**
Course Code	**:**	**CHN-431**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives:
At the end of this course, the students should be able to describe concepts of Inorganic chemistry related to structure, properties & applications of inorganic and organometallic compounds.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**QUANTUM THEORY AND ATOMIC STRUCTURE:** Introduction to wave mechanics, the Schrodinger equation, the Schrodinger equation as applied to hydrogen atom, the origin of quantum numbers and shapes of orbitals.	4
2	**CHEMICAL BONDING:** Molecular orbital and valence bond theories of bond formation and application of molecular orbital theory to the formation of homonuclear and heteronuclear diatomic molecules.	7
3	**THE SOLID STATE:** A recapitulation of close packing of spheres, structures of NaCl, CsCl, ZnS, CaF2, crystal defects and applications of defect structures (transistors, rectifiers, photovoltaic cells and computer chips).	4
4	**COORDINATION COMPOUNDS:** Part 1: Werner's theory, effective atomic number, bonding of transition metal complexes: valence bond theory, crystal field theory, crystal field splitting in tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Thermodynamic aspects of coordination compounds (crystal field stabilization energies of octahedral and tetrahedral complexes, spectrochemical series).	6
5	**COORDINATION COMPOUNDS:** Part2: Kinetic aspects of coordination compounds (substitution reactions in complexes with coordination number 4 and 6 and their mechanism - SN^1, SN^2). Magnetic behaviour of	6

	complexes – Para magnetism, diamagnetism, ferromagnetism and antiferromagnetism	
6	**ORGANOMETALLIC COMPOUNDS:** Nomenclature, types of ligands and bonding in organometallic compounds, use of organometallics in industry.	5
7	**INORGANIC POLYMERS:** Types of inorganic polymers, polyphosphazenes, polysiloxanes –their structures and properties.	5
8	**ROLE OF METALS IN BIOLOGICAL SYSTEMS:** Bio-inorganic Chemistry of Iron – Heme proteins & Non-Heme iron proteins; bioinorganic chemistry of cobalt-vitamin B12 and metalloenzymes.	5

List of Experiments:		**Number of Turns**
1	Estimation of oxalate using potassium permagnate.	1
2	Estimation of Fe^{2+} and Fe^{3+} using potassium dichromate.	1
3	Estimation of Cu^{2+} and AsO_3^{3-} iodimetrically.	2
4	Determination of Zn by EDTA titration.	1
5	Estimation of Ba^{2+}/SO_4^{2-} by as $BaSO_4$ gravimetrically.	1
6	Estimation of Fe^{2+} and Fe^{3+} as Fe_2O_3 gravimetrically.	2
7	Preparation and characterization of inorganic complexes (2 nos.).	2
8	Preparation and characterization of organometallic compound.	1
9	Crystallization techniques for purification of inorganic complexes.	1
10	Melting point determination of few inorganic compounds.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Understand the structure of atom based on quantum theory, concept of chemical bonding in homo- and hetro-atomic molecules & structure of advanced materials along with their applications in electronic fields.
2	Apply the thermodynamic, kinetic, magnetic and mechanistic aspects to coordination compounds.
3	Develope organometallic compounds to study the interaction and role of metals in biological systems essential for bio-engineering applications.
4	Design new inorganic materials with in-depth understanding of their structures and properties.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Inorganic Chemistry", A. G. Sharpe., 3rd Edition, Longman Publishers ELBS.	1992
2	"Inorganic Chemistry", J. D. Lee, 5th Edition, Chapman and Hall Publishers.	1996
3	"Advanced Inorganic Chemistry", F. A. Cotton & G. Wilkinson,3rd Edition, Wiley Eastern Ltd.	1982
4	"Basic Inorganic Chemistry", F. A. Cotton & G. Wilkinson; Wiley Eastern Ltd.	1987
5	"Inorganic Polymer", J. Mark, R. West & H. Allcock, Prentice Hall, New Jersey Publishers.	1982
6	"Vogel's Qualitative Inorganic Analysis", G. Svehla, 7th Edition Pearson Education.	2002

Course Name	**:**	
Course Code	**:**	
Credits	**:**	
L T P	**:**	

Course Objectives:

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Ultrasonics** Production, detection and uses of ultrasonics, reverberation, sabine's formula (no derivation)	(3)
2		
3		
4		

List of Experiments:		**Number of Turns**
1		
2		
3		
4		
5		

Course Outcomes:	
1	
2	
3	
4	
5	

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	" Computer Graphics", Donald Hearn and M. Pauline Baker, Pearson Education	2012
2		
3		
4		
5		

Course Name	**:**	**ANALYTICAL CHEMISTRY**
Course Code	**:**	**CHN-433**
Credits	**:**	**4**
L T P	**:**	**310**

Course Objectives:
At the end of this course, the student should be able to develop sufficient knowledge about the major instrumental methods of chemical analysis so that they can determine what technique should be used for study of structural aspects of all kinds of materials. The student will be able to analyze the advances in instrumentation which have been made, especially those made as a result of problems encountered with the method. Students will gain practical knowledge of experimental methods and analytical instrumentation for carrying out analytical separations using gas and liquid chromatography.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**COMPLEXOMETRIC TITRATIONS :** Complexes-formation constants; chelates – EDTA, Chelon Effect, EDTA equilibria, effect of pH on EDTA equilibria, EDTA titration curves, endpoint – detection and indicators; Importance of complexometric titrations.	4
2	**SOLVENT EXTRACTION :** Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, and classification of solvent extraction systems. Advantages and applications of solvent extraction.	6
3	**CHROMATOGRAPHY:** Introduction to chromatography, principles, classification of chromatographic techniques, thin layer and paper chromatography – principle and technique. Column Chromatography – Factors affecting column efficiency and applications. Gas – liquid chromatography – theory, instrumentation and applications. HPLC – instrumentation, method, column efficiency and applications.	8
4	**THERMOANALYTICAL METHODS :** Principle, classification of methods. TGA –Instrumentation, factors affecting results and analysis of data. Applications. DTG – Instrumentation, analysis of data and applications. DTA – Principle, Instrumentation and applications.	8
5	**SPECTROSCOPIC TECHNIQUES:** UV Introduction to spectroscopy, Lambert Beer s law, instrumentation and applications ,IR Introduction, basic principles, factors affecting IR group frequencies , Instrumentation and Applications ,NMR Basic principles, elementary ideas and instrumentation chemical shifts, spin-spin coupling.	10
6	**ELECTRON MICROSCOPY:** Scanning electron microscopy (SEM), Transmission Electron Microscopy (TEM) and Scanning Transmission Electron Microcopy (STEM) Principles and Applications	6

Course Outcomes: By the end of this course, the student will be able to:	
1	Address the problems of analyzing complex samples. This would include defining the problem, determining any constraints, choosing the best methodology, and determining how to test the methodology to prove its merits. Where there are alternatives the student should be able to define the advantages and disadvantages of each.
2	Interpret data from analytical separation methods and will understand approaches for the validation of these analytical.
3	Carry out hands on experiments in the field related to analysis of materials required for technological developments and in advanced research in Engineering.
4	Apply various analytical techniques for analysis of organic and inorganic materials.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Principles of Instrumental Analysis", by Skoog, D. A. & West D. M., 5th Edition, Saunders College Publishers, USA.	1998
2	"Fundamentals of Analytical Chemistry", Skoog, D. A. & West D. M., 7th Edition, Saunders College Publishers, USA.	2000
3	"Industrial Methods of Analysis", Willard, Merritt, Dean &Settle, 7th Edition.	1989
4	"Industrial Methods of Chemical Analysis", Galen W. Ewing, 5th Edition.	1985
5	"Spectrometric identification of Organic Compounds", Silverstein R. M. &Webster F.X., 6th Edition, John Wiley and Sons, Inc., USA	2005
6	"Quantitative Inorganic Analysis", A.I, Vogel, 5th Edition.	1989

Course Name	**:**	**ENVIRONMENTAL CHEMISTRY**	
Course Code	**:**	**CHN-434**	
Credits	**:**	**4**	
L T P	**:**	**3 1 0**	

Course Objectives:
At the end of this course, the student should be able to understand the basic knowledge of environmental chemistry, such as chemistry of atmosphere, hydrosphere, pedosphere and biosphere. The student will be able to apply basic theories and methods of chemistry to study the environmental issues caused by chemical substances (pollutants).

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	CHEMICAL COMPOSITION OF AIR : Classification of elements, chemical speciation. Particles, ions, and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Sources of trace gases in the atmosphere; Thermo-chemical and photochemical reactions in the atmosphere. Tropospheric oxidation chemistry; Oxygen and ozone chemistry. Chemistry of air pollutants. Role of hydrocarbons; Sulphur chemistry; Halogen Chemistry in the atmosphere.	8
2	WATER CHEMISTRY: Chemistry of water, dissolution / precipitation reactions; complexation reactions; concept of DO, BOD, COD; concept of salinity; composition of sea water and physic-chemical speciation in oceans; Suspended particles; concept of sedimentation, coagulation, filtration,	8
3	SOIL POLLUTION : Pollutants in soil, Agricultural Pollution, Role of Micro nutrients in soil, Ion exchange reaction in soil, Pesticide (Classifications & Degradation), Path of Pesticides in Environment, Monitoring techniques.	8
4	ENVIRONMENTAL TOXICOLOGY AND ITS EVALUATION: Emergence as a science; concepts and definitions; Factors affecting toxicity, Evaluation of LC50, LD50, LCIC and IT.	5
5	TOXIC CHEMICAL IN THE ENVIRONMENT : Metals and other inorganic contaminants; Organic contaminants; Fate of organic contaminants; Pesticides; Biochemical aspects of arsenic, cadmium, lead, mercury, carbon monoxide, ozone and PAN Pesticides; Insecticides, MIC, carcinogens in the air. Photochemistry of Brominated Flame Retardants (BFR) Gene toxicity of toxic chemicals.	8
6	GREEN CHEMISTRY FOR SUSTAINABLE FUTURE : Reagents, Media, Special Importance of Solvents, Water the Greenest Solvents, Synthetic and Processing Pathways, Role of Catalyst, Biological Alternatives, Biopolymers, Principles and Application of Green Chemistry.	5

Course Outcomes: By the end of this course, the student will be able to:	
1	Describe the chemical composition (and the main elements' occurrence forms) of the geosphere, the atmosphere, the hydrosphere, and the biosphere and to explain how interactions between these spheres and the techno sphere affect the environment.
2	Know the basic chemical features of some environmental concerns of today and their societal origin, with specific focus on acidification, eutrophication, ozone, nuclear wastes, heavy metals, organic pollutants, and climate change issues.
3	Develop integrated technologies to support the recycling of carbon and plant nutrients from agricultural crops, bio-based industries and municipal water treatment plants.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Environmental Chemistry", Banerji, S.K, 2nd Edition, Prentice-Hall, New Delhi, India.	1999
2	"Environmental Chemistry", A. K. De, 4th Edition, New Age International (P) Ltd., New Delhi, India.	2000
3	"Introductory Chemistry for the Environment Science", Harrison, R. M. and de Mora, S. J. 2nd Edition, Cambridge University Press, New Delhi.	1996
4	"Introduction to Atmospheric Chemistry", Hobbes, P.B. Cambridge University Press, UK.	2000
5	"Principles of Environmental Chemistry", Kothandaaman, H. and Swaminathan, G. B.I. Publications, Chennai, India.	1997
6	"Fundamentals of Environmental Chemistry", Manahan, S. E. 2nd Edition, CRC Press, Inc., USA.	2001

Course Name	**:**	**RECENT ADVANCES IN CHEMICAL SCIENCES**
Course Code	**:**	**CHN-435**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course, the student should be able to use molecular building blocks to design functional supramolecular constructs and nano-structured materials by using the principles of Supramolecular Chemistry. The student will be able to understand chemical and physical phenomena particular to surfaces and interfaces and reduce chemical pollutants flowing to the environment by using principles of Green Chemistry.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**SUPRAMOLECULES:** Concepts of supramolecular chemistry- Thermodymanics of molecular recognition, solvation, multivalency, Molecular Recognition: Cations,Anions and Neutral guests, Self processes - Self-assembly, Supramolecular -devices and Sensors, Molecular logic, photo switching materials, Supramolecular -material Chemistry Crystal engineering, MOFs and coordination polymers, templates for biomineralisation	8
2	**CHEMISTRY OF NANOMATERIALS:** Synthesis of nanoparticles by chemical routes and characterization techniques: Thermodynamics and kinetics of nucleation; Growth of polyhedral particles by surface reaction, Ostwald ripening, size distribution; Properties of nanostructured materials : Optical properties; magnetic properties;	9
3	**HOMOGENEOUS CATALYSIS :** Stoichiometric reaction for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reations involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction) oxopalladation reactions, activation of C-H bond.	8
4	**SURFACTANT AGGREGATION:** Micelles, Surface active agents, Classification of surface active agents, Micellization, Hydrophobic interaction, Critical micellar concentration (cmc), Factors affecting the concentration of surfactants, Counter-ion binding of micelle, Thermodynamics of micellization, Phase separation and Mass action models, Solubilization Emulsions, Mechanism of formation of microemulsion and their stability, Phase maps, Physical techniques, Applications..	9

5	**GREEN CHEMICAL PROCESSES:** An introduction to the tools of green chemistry and its fundamental principles. Use of Renewable Raw Materials. Evaluating feedstock and starting materials -commodity chemicals from glucose Greener Solvents: The use of supercritical fluids, and aqueous systems Greener reagents and products. Methods of designing safer chemicals Examples of greener reagents replacement of phosgene, methylations using dimethylcarbonate,	8

Course Outcomes: By the end of this course, the student will be able to:	
1	Exploit supramolecular engineering to design structures with adapted morphologies and properties.
2	Initiate self-assembly processes in bimolecular systems and the basis of bio-inspired chemistry.
3	Understand the interactions between surfaces and gases, liquids or solutions, and how interfaces are important in many technological a biological processes..
4	Identify the new advancements and approaches of chemical sciences for technological leads in various fields of sciences and Engineering.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"The Organometallic Chemistry of the Transition Metals", Crabtree, R.G. 4th Edition, John Wiley.	2005
2	"Wilkinson Advanced Inorganic Chemistry", Cotton, F.A.; 6th Edition, John Wiley.	1999
3	"Supramolecular Chemistry",Steed J. W. and Atwood J. L., John Wiley and Sons, Ltd.	2000
4	"Green Chemistry and Catalysis",Roger Arthur Sheldon, Dr. Isabel W. C. E. Arends, Dr. Ulf Hanefeld, Wiley-VCH Verlag GmbH & Co. KGaA.	2007
5	"Physical Chemistry of Surfaces", Adamson A.W., Pubs: John Willey, New York.	1982
6	"Surfactant Science and Technology", Myers D., Pubs: VCH Publishers.	1988