


**OBJECTIVE:**

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

**TOTAL: 300 PERIODS****OUTCOME:**

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

  
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**OBJECTIVE:**

- The aim of this course is to make the students to know and understand the constructional details operating characteristics and vehicle design aspects

**UNIT I THE POWER UNIT**

9

Two stroke and four stroke SI & CI engine Construction and Working, merits and demerits, Symmetrical and unsymmetrical valve & port timing diagrams. Scavenging process.

**UNIT II FUEL AND IGNITION SYSTEMS**

9

Fuel system - Different circuits in two wheeler fuel systems, fuel injection system. Lubrication system, Ignition systems - Magneto coil and battery coil spark ignition system, Electronic ignition System, Starting system - Kick starter system - Self starter system. Recent technologies.

**UNIT III CHASSIS AND SUB-SYSTEMS** 9 Main frame for two and three wheelers, its types, Chassis and different drive systems for two wheelers, Single, multiple plates and centrifugal clutches, Gear box and its and various gear controls in two wheelers. Front and rear suspension systems. Shock absorbers. Panel meters and controls on handle bar, Freewheeling devices

**UNIT IV BRAKES AND WHEELS**

8

Drum brakes & Disc brakes Construction and Working and its Types, Front and Rear brake links layouts. Brake actuation mechanism. Spoked wheel, cast wheel, Disc wheel & its merits and demerits. Tyres and tubes Construction & its Types. Steering geometry.

**UNIT V TWO & THREE WHEELERS – CASE STUDY**

10

Case study of Sports bike, Motor cycles, Scooters and Mopeds - Auto rickshaws, Pick up van, Delivery van and Trailer. Servicing and maintenance. Recent developments.

**TOTAL : 45 PERIODS****OUTCOME:**


- The students can able to understand the various subsystem of two and three wheeler and also know how it is different from light motors and heavy motor vehicles.

**TEXT BOOK:**

1. Irving,P.E., " Motor cycle Engineering", Temple Press Book, London, 1992.

**REFERENCES:**

- Bryaut, R.V., Vespa "Maintenance and Repair series".
- Marshall Cavendish, Encyclopedia of Motor cycling, 20 volumes, New York and London, 1989.
- Ramalingam. K. K., "Two Wheelers", Scitech publications, Chennai,2009
- Raymond Broad Lambretta - "A practical guide to maintenance and repair", 1987.
- The Cycle Motor Manual, Temple Press Ltd., London, 1990.

  
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**OBJECTIVE:**

- To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

**UNIT I ALLOYS AND PHASE DIAGRAMS 9**

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron - carbon equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

**UNIT II HEAT TREATMENT 9**

Definition - Full annealing, stress relief, recrystallisation and spheroidising - normalising, hardening and Tempering of steel. Isothermal transformation diagrams - cooling curves superimposed on I.T. diagram CCR - Hardenability, Jominy end quench test - Austempering, martempering - case hardening, carburizing, Nitriding, cyaniding, carbonitriding - Flame and Induction hardening - Vacuum and Plasma hardening. .

**UNIT III FERROUS AND NON-FERROUS METALS 9**

Effect of alloying additions on steel-  $\alpha$  and  $\beta$  stabilisers- stainless and tool steels - HSLA, Maraging steels - Cast Iron - Grey, white, malleable, spheroidal - alloy cast irons, Copper and copper alloys - Brass, Bronze and Cupronickel - Aluminium and Al-Cu - precipitation strengthening treatment - Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

**UNIT IV NON-METALLIC MATERIALS 9**

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI,PAI, PPO, PPS, PEEK, PTFE, Polymers - Urea and Phenol formaldehydes)- Engineering Ceramics - Properties and applications of Al<sub>2</sub>O<sub>3</sub>, SiC, Si<sub>3</sub>N<sub>4</sub>, PSZ and SIALON -Composites-Classifications- Metal Matrix and FRP - Applications of Composites.

**UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 9**

Mechanisms of plastic deformation, slip and twinning - Types of fracture - Testing of materials under tension, compression and shear loads - Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Impact test Izod and charpy, fatigue and creep failure mechanisms.

**TOTAL: 45 PERIODS****OUTCOMES**

**Upon the completion of this course the students will be able to**

- CO1 Explain alloys and phase diagram, Iron-Iron carbide diagram and steel classification.
- CO2 Explain isothermal transformation, continuous cooling diagrams and different heat treatment processes.
- CO3 Summarize the mechanism of plastic deformation and testing mechanical properties.
- CO4 Clarify the effect of alloying elements on ferrous and non-ferrous metals.
- CO5 Differentiate different non-metallic materials.



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**TEXT BOOKS:**

1. Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Company, 1997.
2. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, Revised Indian Edition 2014

**REFERENCES:**

1. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 2010.
2. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., 2015.
3. U.C.Jindal : Material Science and Metallurgy, "Engineering Materials and Metallurgy", First Edition, Dorling Kindersley, 2012
4. Upadhyay. G.S. and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt.Ltd., New Delhi, 2006.



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**OBJECTIVE:**

- To know about the various methods of maintaining vehicles and their subsystems.

**UNIT I MAINTENANCE, WORKSHOP PRACTICES, SAFETY AND TOOLS 10**

Maintenance - Need, importance, primary and secondary functions, policies - classification of maintenance work - vehicle insurance - basic problem diagnosis. Automotive service procedures - workshop operations - workshop manual - vehicle identification. Safety - Personnel, machines and equipment, vehicles, fire safety - First aid. Basic tools - special service tools - measuring instruments - condition checking of seals, gaskets and sealants. Scheduled maintenance services - service intervals - Towing and recovering.

**UNIT II ENGINE AND ENGINE SUBSYSTEM MAINTENANCE 8**

General Engine service- Dismantling of Engine components- Engine repair- working on the underside, front, top, ancillaries- Service of basic engine parts, cooling and lubricating system, fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection and engine management service - fault diagnosis- servicing emission controls

**UNIT III TRANSMISSION AND DRIVELINE MAINTENANCE 8**

Clutch- general checks, adjustment and service- Dismantling, identifying, checking and reassembling transmission, transaxle- road testing- Removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joints- Rear axle service points- removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

**UNIT IV STEERING, BRAKE, SUSPENSION, WHEEL MAINTENANCE 10**

Inspection, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, Parking brake. Bleeding of brakes. Inspection, Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Dismantling and assembly procedures. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection, Maintenance and Service of steering linkage, steering column, Rack and pinion steering, Recirculating ball steering service- Worm type steering, power steering system

**UNIT V AUTO ELECTRICAL AND AIR CONDITIONING MAINTENANCE 9**

Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Replacement of hoses- Leak detection- AC Charging- Fault diagnosis Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

**TOTAL : 45 PERIODS****OUTCOME:**


- Upon the completion of the course, the student can able to understand the importance of maintenance and also the step by step procedure for maintain the various automotive sub systems

**TEXT BOOKS:**

- Ed May, "Automotive Mechanics Volume One" and Two , Mc Graw Hill Publications, 2003
- Vehicle Service Manuals of reputed manufacturers

**REFERENCE:**

- Bosch Automotive Handbook, Sixth Edition, 2004

  
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**OBJECTIVES:**

- To understand the fundamentals of composite material strength and its mechanical behavior
- Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
- Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

**UNIT I INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING 9**

Definition -Need - General Characteristics, Applications. Fibers - Glass, Carbon, Ceramic and Aramid fibers. Matrices - Polymer, Graphite, Ceramic and Metal Matrices - Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions - Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina - Isotropic limit case, Orthotropic Stiffness matrix ( $Q_{ij}$ ), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina -Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding Compression Moulding - Pultrusion - Filament Winding - Other Manufacturing Processes

**UNIT II FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 9**

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations — Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

**UNIT III LAMINA STRENGTH ANALYSIS 9**

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

**UNIT IV THERMAL ANALYSIS 9**

Assumption of Constant C.T.E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations — Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi- Isotropic Laminates

**UNIT V ANALYSIS OF LAMINATED FLAT PLATES 9**

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations — Natural Frequencies

**TOTAL: 45 PERIODS****OUTCOMES:**

**Upon the completion of this course the students will be able to**

- CO1 Summarize the various types of Fibers, Equations and manufacturing methods for Composite materials
- CO2 Derive Flat plate Laminate equations
- CO3 Analyze Lamina strength
- CO4 Analyze the thermal behavior of Composite laminates
- CO5 Analyze Laminate flat plates

**TEXT BOOKS:**

1. Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw-Hill, CRC press in progress, 1994, -.
2. Hyer, M.W., "Stress Analysis of Fiber - Reinforced Composite Materials", McGraw Hill, 1998

**REFERENCES:**

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
2. Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber, "Reinforced Composites: Materials, Manufacturing and Design", Maneeel Dekker Inc, 1993.
5. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.



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**OBJECTIVE:**

- The automobile components such as piston, connecting rod, crankshaft, engine block, front axle, frame, body etc., are manufactured by various types of production processes involving casting, welding, machining, metal forming, power metallurgy etc. Hence B.E. Automobile Engineering students must study this course Production Technology.

**UNIT I CASTING**

8

Casting types, procedure to make sand mould, types of core making, moulding tools, machine moulding, special moulding processes – CO<sub>2</sub> moulding; shell moulding, investment moulding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting, casting defects.

**UNIT II WELDING**

8

Classification of welding processes. Principles of Oxy-acetylene gas welding. A.C metal arc welding, resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, plasma arc welding, thermit welding, electron beam welding, laser beam welding, defects in welding, soldering and brazing.

**UNIT III MACHINING**

13

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Cylindrical grinding machine, Capstan and Turret lathe. Basics of CNC machines. General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Electron beam machining and Laser beam machining.

**UNIT IV FORMING AND SHAPING OF PLASTICS**

7

Types of plastics - Characteristics of the forming and shaping processes – Moulding of Thermoplastics - Working principles and typical applications of - Injection moulding - Plunger and screw machines - Blow moulding - Rotational moulding - Film blowing - Extrusion - Typical industrial applications - Thermoforming - Processing of Thermosets - Working principles and typical applications - Compression moulding - Transfer moulding - Bonding of Thermoplastics - Fusion and solvent methods - Induction and Ultrasonic methods

**UNIT V METAL FORMING AND POWDER METALLURGY**

9

Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning, Powder metallurgy - Principal steps involved advantages, disadvantages and limitations of powder metallurgy.

**TOTAL: 45 PERIODS****OUTCOME:**

- The Students can able to use different manufacturing process and use this in industry for component production

**TEXT BOOKS**

- Hajra Choudhury, "Elements of Workshop Technology", Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005.
- Nagendra Parashar B.S. and Mittal R.K., "Elements of Manufacturing Processes", Prentice-Hall of India Private Limited, 2007

**REFERENCES**

- Adithan. M and Gupta. A.B., "Manufacturing Technology", New Age, 2006.
- "H.M.T. Production Technology - Handbook", Tata McGraw-Hill, 2000.
- Jain. R.K. and S.C. Gupta, "Production Technology", Khanna Publishers. 16<sup>th</sup> Edition, 2001.
- Roy. A. Linberg, "Process and Materials of Manufacture", PHI, 2000.
- SeropeKalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials", Fourth Edition, Pearson Education, Inc. 2007.

**OBJECTIVE:**

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

**STRATEGY:**

The student works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction. The student will be evaluated based on the report and the viva voce examination by a team of examiners including one external examiner.

**TOTAL: 300 PERIODS****OUTCOME:**

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

  
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**OBJECTIVE:**

- The students will acquire knowledge in estimation, tender practices, contract procedures, and valuation and will be able to prepare estimates, call for tenders and execute works.

**UNIT I QUANTITY ESTIMATION**

9

Philosophy - Purpose - Methods of estimation - Types of estimates - Approximate estimates - Detailed estimate - Estimation of quantities for buildings, bituminous and cement concrete roads, septic tank, soak pit, retaining walls - culverts (additional practice in class room using computer softwares)

**UNIT II RATE ANALYSIS AND COSTING**

9

Standard Data - Observed Data - Schedule of rates - Market rates - Standard Data for Man Hours and Machineries for common civil works - Rate Analysis for all Building works, canals, and Roads- Cost Estimates (additional practice in class room using Computer softwares) - (Analysis of rates for the item of work asked, the data regarding labour, rates of material and rates of labour to be given in the Examination Question Paper)

**UNIT III SPECIFICATIONS, REPORTS AND TENDERS**

9

Specifications - Detailed and general specifications - Constructions - Sources - Types of specifications - Principles for report preparation - report on estimate of residential building - Culvert - Roads - TTT Act 2000 - Tender notices - types - tender procedures - Drafting model tenders , E-tendering-Digital signature certificates- Encrypting -Decrypting - Reverse auctions.

**UNIT IV CONTRACTS**

9

Contract - Types of contracts - Formation of contract - Contract conditions - Contract for labour, material, design, construction - Drafting of contract documents based on IBRD / MORTH Standard bidding documents - Construction contracts - Contract problems - Arbitration and legal requirements.

**UNIT V VALUATION**

9

Definitions - Various types of valuations - Valuation methods - Necessity - Capitalised value - Depreciation - Escalation - Valuation of land - Buildings - Calculation of Standard rent - Mortgage - Lease

**TOTAL: 45 PERIODS****OUTCOMES:**

The student will be able to

- Estimate the quantities for buildings,
- Rate Analysis for all Building works, canals, and Roads and Cost Estimate.
- Understand types of specifications, principles for report preparation, tender notices types.
- Gain knowledge on types of contracts
- Evaluate valuation for building and land.

**TEXTBOOKS:**

- B.N Dutta 'Estimating and Costing in Civil Engineering', UBS Publishers & Distributors (P) Ltd, 2010.
- B.S.Patil, 'Civil Engineering Contracts and Estimates', University Press, 2006
- D.N. Banerjee, 'Principles and Practices of Valuation', V Edition, Eastern Law House, 1998

**REFERENCES:**

- Hand Book of Consolidated Data - 8/2000, Vol.1, TNPWD
- Tamil Nadu Transparencies in Tenders Act, 1998
- Arbitration and Conciliation Act, 1996
- Standard Bid Evaluation Form, Procurement of Good or Works, The World Bank, April 1996
- Standard Data Book for Analysis and Rates, IRC, New Delhi, 2003

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**OBJECTIVE:**

- To impart knowledge to plan and execute a detail site investigation programme, to select geotechnical design parameters and type of foundations. Also to familiarize the students for the geotechnical design of different type of foundations and retaining walls.

**UNIT I SITE INVESTIGATION AND SELECTION OF FOUNDATION 9**

Scope and objectives - Methods of exploration - Auguring and boring - Wash boring and rotary drilling - Depth and spacing of bore holes - Soil samples - Representative and undisturbed - Sampling methods - Split spoon sampler, Thin wall sampler, Stationary piston sampler - Penetration tests (SPT and SCPT) - Data interpretation - Strength parameters - Bore log report and Selection of foundation.

**UNIT II SHALLOW FOUNDATION 9**

Location and depth of foundation - Codal provisions - Bearing capacity of shallow foundation on homogeneous deposits - Terzaghi's formula and BIS formula - Factors affecting bearing capacity - Bearing capacity from in-situ tests (SPT, SCPT and plate load) - Allowable bearing pressure - Seismic considerations in bearing capacity evaluation. Determination of Settlement of foundations on granular and clay deposits - Total and differential settlement - Allowable settlements - Codal provision - Methods of minimizing total and differential settlements.

**UNIT III FOOTINGS AND RAFTS 9**

Types of Isolated footing, Combined footing, Mat foundation - Contact pressure and settlement distribution - Proportioning of foundations for conventional rigid behaviour - Minimum thickness for rigid behaviour - Applications - Compensated foundation - Codal provision

**UNIT IV PILE FOUNDATION 9**

Types of piles and their functions - Factors influencing the selection of pile - Carrying capacity of single pile in granular and cohesive soil - Static formula - Dynamic formulae (Engineering news and Hileys) - Capacity from insitu tests (SPT and SCPT) - Negative skin friction - Uplift capacity - Group capacity by different methods (Feld's rule, Converse - Labarra formula and block failure criterion) - Settlement of pile groups - Interpretation of pile load test (routine test only), Under reamed piles - Capacity under compression and uplift - Cohesive - expansive - non expansive - Cohesionless soils - Codal provisions.

**UNIT V RETAINING WALLS 9**

Plastic equilibrium in soils - Active and passive states - Rankine's theory - Cohesionless and cohesive soil - Coulomb's wedge theory - Condition for critical failure plane - Earth pressure on retaining walls of simple configurations - Culmann's Graphical method - Pressure on the wall due to line load - Stability analysis of retaining walls - Codal provisions.

**TOTAL: 45 PERIODS****OUTCOMES:**

Students will be able to

- Understand the site investigation, methods and sampling.
- Get knowledge on bearing capacity and testing methods.
- Design shallow footings.
- Determine the load carrying capacity, settlement of pile foundation.
- Determine the earth pressure on retaining walls and analysis for stability.

**TEXTBOOKS:**

- Murthy, V.N.S., "Text book of Soil Mechanics and Foundation Engineering", CBS Publishers Distribution Ltd., New Delhi, 2014.
- Arora, K.R., "Soil Mechanics and Foundation Engineering", Standard Publishers and Distributors, New Delhi, 7<sup>th</sup> Edition, 2017 (Reprint).
- Punmia, B.C., "Soil Mechanics and Foundations", Laxmi Publications Pvt. Ltd. New Delhi, 16<sup>th</sup> Edition 2017.

**REFERENCES:**

- Braja M Das, "Principles of Foundation Engineering" (Eighth edition), Cengage Learning 2014.
- Kaniraj, S.R. "Design aids in Soil Mechanics and Foundation Engineering", Tata McGraw-Hill publishing company Ltd., New Delhi, 2014.
- Joseph E bowles, "Foundation Analysis and design", McGraw Hill Education, 5<sup>th</sup> Edition 28<sup>th</sup> August 2015.
- IS Code 6403 : 1981 (Reaffirmed 1997) "Bearing capacity of shallow foundation", Bureau of Indian Standards, New Delhi.

**OBJECTIVES:**

- To introduce the different types of philosophies related to design of basic structural elements such as slab, beam, column and footing which form part of any structural system with reference to Indian standard code of practice.

**UNIT I INTRODUCTION**

9+6

Objective of structural design-Steps in RCC Structural Design Process- Type of Loads on Structures and Load combinations- Code of practices and Specifications - Concept of Working Stress Method, Ultimate Load Design and Limit State Design Methods for RCC -Properties of Concrete and Reinforcing Steel - Analysis and Design of Singly reinforced Rectangular beams by working stress method - Limit State philosophy as detailed in IS code - Advantages of Limit State Method over other methods - Analysis and design of singly and doubly reinforced rectangular beams by Limit State Method.

**UNIT II DESIGN OF BEAMS**

9+6

Analysis and design of Flanged beams for – Use of design aids for Flexure - Behaviour of RC members in Shear, Bond and Anchorage - Design requirements as per current code - Behaviour of rectangular RC beams in shear and torsion - Design of RC members for combined Bending, Shear and Torsion.

**UNIT III DESIGN OF SLABS AND STAIRCASE**

9+6

Analysis and design of cantilever, one way simply supported and continuous slabs and supporting beams- Two way slab- Design of simply supported and continuous slabs using IS code coefficients- Types of Staircases – Design of dog-legged Staircase.

**UNIT IV DESIGN OF COLUMNS**

9+6

Types of columns -Axially Loaded columns – Design of short Rectangular Square and circular columns - Design of Slender columns- Design for Uniaxial and Biaxial bending using Column Curves

**UNIT V DESIGN OF FOOTINGS**

9+6

Concepts of Proportioning footings and foundations based on soil properties-Design of wall footing – Design of axially and eccentrically loaded Square, Rectangular pad and sloped footings – Design of Combined Rectangular footing for two columns only.

**TOTAL: 75 PERIODS****OUTCOMES:**

Students will be able to

- Understand the various design methodologies for the design of RC elements.
- Know the analysis and design of flanged beams by limit state method and sign of beams for shear, bond and torsion.
- design the various types of slabs and staircase by limit state method.
- Design columns for axial, uniaxial and biaxial eccentric loadings.
- Design of footing by limit state method.

**TEXT BOOKS:**

- Varghese, P.C., "Limit State Design of Reinforced Concrete", Prentice Hall of India, Pvt.Ltd., New Delhi, 2002.
- Gambhir. M.L., "Fundamentals of Reinforced Concrete Design", Prentice Hall of India Private Limited, New Delhi, 2006.
- Subramanian, N., "Design of Reinforced Concrete Structures", Oxford University Press, New Delhi, 2013.

**REFERENCES:**

- Jain, A.K., "Limit State Design of RC Structures", Nemchand Publications, Roorkee, 1998
- Sinha, S.N., "Reinforced Concrete Design", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2002
- Unnikrishna Pillai, S., Devdas Menon, "Reinforced Concrete Design" Tata McGraw Hill Publishing Company Ltd., 2009
- Punmia. B.C., Ashok Kumar Jain, Arun Kumar Jain, "Limit State Design of Reinforced Concrete", Laxmi Publication Pvt. Ltd., New Delhi, 2007.

**OBJECTIVE:**

- To impart knowledge to classify the soil based on index properties and to assess their engineering properties based on the classification. To familiarize the students about the fundamental concepts of compaction, flow through soil, stress transformation, stress distribution, consolidation and shear strength of soils. To impart knowledge of design of both finite and infinite slopes.

**UNIT I SOIL CLASSIFICATION AND COMPACTION 9**

History - formation and types of soil - composition - Index properties - clay mineralogy structural arrangement of grains - description - Classification - BIS - US - phase relationship - Compaction - theory - laboratory and field technology - field Compaction method - factors influencing compaction.

**UNIT II EFFECTIVE STRESS AND PERMEABILITY 9**

Soil - water - Static pressure in water - Effective stress concepts in soils - Capillary phenomena - Permeability - Darcy's law - Determination of Permeability - Laboratory Determination (Constant head and falling head methods) and field measurement pumping out in unconfined and confined aquifer - Factors influencing permeability of soils - Seepage - Two dimensional flow - Laplace's equation - Introduction to flow nets - Simple problems Sheet pile and wier.

**UNIT III STRESS DISTRIBUTION AND SETTLEMENT 9**

Stress distribution in homogeneous and isotropic medium - Boussines of theory - (Point load, Line load and ud) Use of Newmarks influence chart -Components of settlement - Immediate and consolidation settlement - Factors influencing settlement - Terzaghi's one dimensional consolidation theory - Computation of rate of settlement. -  $\sqrt{t}$  and  $\log t$  methods.  $e$ - $\log p$  relationship consolidation settlement N-C clays - O.C clays - Computation.

**UNIT IV SHEAR STRENGTH 9**

Shear strength of cohesive and cohesion less soils - Mohr-Coulomb failure theory - shear strength - Direct shear, Triaxial compression, UCC and Vane shear tests - Pore pressure parameters - Factors influences shear strength of soil.

**UNIT V SLOPE STABILITY 9**

Infinite slopes and finite slopes - Friction circle method - Use of stability number -Guidelines for location of critical slope surface in cohesive and c - soil - Slope protection measures.

**TOTAL: 45 PERIODS****OUTCOMES:**

Students will be able to

- classify the soil and assess the engineering properties, based on index properties.
- Understand the stress concepts in soils
- Understand and identify the settlement in soils.
- Determine the shear strength of soil
- Analyze both finite and infinite slopes.

**TEXTBOOKS:**

- Murthy, V.N.S., "Text book of Soil Mechanics and Foundation Engineering", CBS Publishers Distribution Ltd., New Delhi. 2014
- Arora, K.R., "Soil Mechanics and Foundation Engineering", Standard Publishers and Distributors, New Delhi, 7<sup>th</sup> Edition, 2017(Reprint).
- Gopal Ranjan, A S R Rao, "Basic and Applied Soil Mechanics" New Age International Publication, 3<sup>rd</sup> Edition, 2016.
- Punmia, B.C., "Soil Mechanics and Foundations", Laxmi Publications Pvt. Ltd. New Delhi, 16<sup>th</sup> Edition, 2017.

**REFERENCES:**

- McCarthy, D.F., "Essentials of Soil Mechanics and Foundations: Basic Geotechnics". Prentice-Hall, 2006.
- Coduto, D.P., "Geotechnical Engineering - Principles and Practices", Prentice Hall of India Pvt. Ltd. New Delhi, 2010.
- Braja M Das, "Principles of Geotechnical Engineering", Cengage Learning India Private Limited, 8<sup>th</sup> Edition, 2014.

**OBJECTIVE:**

- To equip the students with the principles and design of water treatment units and distribution system.

**UNIT I SOURCES OF WATER 9**

Public water supply system - Planning, Objectives, Design period, Population forecasting; Water demand - Sources of water and their characteristics, Surface and Groundwater - Impounding Reservoir - Development and selection of source - Source Water quality - Characterization - Significance - Drinking Water quality standards.

**UNIT II CONVEYANCE FROM THE SOURCE 9**

Water supply - intake structures - Functions; Pipes and conduits for water - Pipe materials - Hydraulics of flow in pipes - Transmission main design - Laying, jointing and testing of pipes - appurtenances - Types and capacity of pumps - Selection of pumps and pipe materials.

**UNIT III WATER TREATMENT 9**

Objectives - Unit operations and processes - Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation - Clarifloccuator - Plate and tube settlers - Pulsator clarifier - sand filters - Disinfection - Residue Management - Construction, Operation and Maintenance aspects.

**UNIT IV ADVANCED WATER TREATMENT 9**

Water softening - Desalination - R.O. Plant - demineralization - Adsorption - Ion exchange - Membrane Systems - RO Reject Management - Iron and Manganese removal - Defluoridation - Construction and Operation & Maintenance aspects - Recent advances - MBR process

**UNIT V WATER DISTRIBUTION AND SUPPLY 9**

Requirements of water distribution - Components - Selection of pipe material - Service reservoirs - Functions - Network design - Economics - Analysis of distribution networks - Computer applications - Appurtenances - Leak detection. Principles of design of water supply in buildings - House service connection - Fixtures and fittings, systems of plumbing and types of plumbing.

**TOTAL: 45 PERIODS****OUTCOMES:**

The students completing the course will have

- an insight into the structure of drinking water supply systems, including water transport, treatment and distribution
- the knowledge in various unit operations and processes in water treatment
- an ability to design the various functional units in water treatment
- an understanding of water quality criteria and standards, and their relation to public health
- the ability to design and evaluate water supply project alternatives on basis of chosen criteria.

**TEXTBOOKS:**

- Garg, S.K. Environmental Engineering, Vol.I Khanna Publishers, New Delhi, 2010.
- Modi, P.N., Water Supply Engineering, Vol.I Standard Book House, New Delhi, 2010.
- Punmia, B.C., Ashok Jain and Arun Jain, Water Supply Engineering, Laxmi Publications (P) Ltd., New Delhi, 2014.

**REFERENCES:**

- Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
- Syed R. Qasim and Edward M. Motley Guang Zhu, Water Works Engineering Planning, Design and Operation, Prentice Hall of India Learning Private Limited, New Delhi, 2009.

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**OBJECTIVES:**

- To understand the fundamentals of object modeling
- To understand and differentiate Unified Process from other approaches.
- To design with static UML diagrams.
- To design with the UML dynamic and implementation diagrams.
- To improve the software design with design patterns.
- To test the software against its requirements specification

**UNIT I UNIFIED PROCESS AND USE CASE DIAGRAMS 9**

Introduction to OOAD with OO Basics - Unified Process - UML diagrams - Use Case - Case study - the Next Gen POS system, Inception - Use case Modelling - Relating Use cases - include, extend and generalization - When to use Use-cases

**UNIT II STATIC UML DIAGRAMS 9**

Class Diagram - Elaboration - Domain Model - Finding conceptual classes and description classes - Associations - Attributes - Domain model refinement - Finding conceptual class Hierarchies - Aggregation and Composition - Relationship between sequence diagrams and use cases - When to use Class Diagrams

**UNIT III DYNAMIC AND IMPLEMENTATION UML DIAGRAMS 9**

**Dynamic Diagrams** - UML interaction diagrams - System sequence diagram - Collaboration diagram - When to use Communication Diagrams - State machine diagram and Modelling - When to use State Diagrams - Activity diagram - When to use activity diagrams

**Implementation Diagrams** - UML package diagram - When to use package diagrams - Component and Deployment Diagrams - When to use Component and Deployment diagrams

**UNIT IV DESIGN PATTERNS 9**

**GRASP:** Designing objects with responsibilities - Creator - Information expert - Low Coupling - High Cohesion - Controller **Design Patterns** - **creational** - factory method - **structural** - Bridge - Adapter - **behavioural** - Strategy - observer - Applying GoF design patterns - Mapping design to code

**UNIT V TESTING 9**

Object Oriented Methodologies - Software Quality Assurance - Impact of object orientation

on Testing—Develop Test Cases and Test Plans

**TOTAL:45PERIODS**

**OUTCOMES:**

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


- Express software design with UML diagrams
- Design software applications using OO concepts.
- Identify various scenarios based on software requirements
- Transform UML based software design into pattern based design using design patterns
- Understand the various testing methodologies for OO software

**TEXTBOOKS:**

1. Craig Larman,—Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, Third Edition, Pearson Education, 2005.
2. Ali Bahrami-Object Oriented Systems Development -McGrawHill International Edition-1999

**REFERENCES:**

1. Erich Gamma, and Richard Helm, Ralph Johnson, John Vlissides,—Design patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley, 1995.
2. Martin Fowler,—UML Distilled: A Brief Guide to the Standard Object Modeling Language, Third Edition, Addison Wesley, 2003.

  
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CS8792

CRYPTOGRAPHY AND NETWORK SECURITY

L T P C

3 0 0 3

**OBJECTIVES:**

- To understand Cryptography Theories, Algorithms and Systems.
- To understand necessary Approaches and Techniques to build protection mechanisms in order to secure computer networks.

**UNIT I INTRODUCTION 9**

Security trends - Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies - Model of network security - Security attacks, services and mechanisms - OSI security architecture - Classical encryption techniques: substitution techniques, transposition techniques, steganography - Foundations of modern cryptography: perfect security - information theory - product cryptosystem - cryptanalysis.

**UNIT II SYMMETRIC KEY CRYPTOGRAPHY 9**

MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY: Algebraic structures - Modular arithmetic - Euclid's algorithm - Congruence and matrices - Groups, Rings, Fields - Finite fields - SYMMETRIC KEY CIPHERS: SDES - Block cipher Principle of DES - Strength of DES - Differential and linear cryptanalysis - Block cipher design principles - Block cipher mode of operation - Evaluation criteria for AES - Advanced Encryption Standard - RC4 - Key distribution.

**UNIT III PUBLIC KEY CRYPTOGRAPHY 9**


MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes - Primality Testing - Factorization - Euler's totient function, Fermat's and Euler's Theorem - Chinese Remainder Theorem - Exponentiation and Algorithm - ASYMMETRIC KEY CIPHERS: RSA cryptosystem - Key distribution - Key management - Diffie Hellman key exchange - ElGamal cryptosystem - Elliptic curve arithmetic - Elliptic curve cryptography.

**UNIT IV MESSAGE AUTHENTICATION AND INTEGRITY 9**

Authentication requirement - Authentication function - MAC - Hash function - Security of hash function and MAC - SHA - Digital signature and authentication protocols - DSS - Entity Authentication: Biometrics, Passwords, Challenge Response protocols - Authentication applications - Kerberos, X.509

**UNIT V SECURITY PRACTICE AND SYSTEM SECURITY 9**

Electronic Mail security - PGP, S/MIME - IP security - Web Security -

  
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SYSTEM SECURITY: Intruders–Malicious software–viruses–Firewalls.

TOTAL 45 PERIODS

**OUTCOMES:**

**At the end of the course, the student should be able to:**


- Understand the fundamentals of network security, security architecture, threats and vulnerabilities
- Apply the different cryptographic operations of symmetric cryptographic algorithms
- Apply the different cryptographic operations of public key cryptography
- Apply the various Authentication schemes to simulated different applications.
- Understand various Security practices and System security standards

**TEXTBOOK:**

1. William Stallings, Cryptography and Network Security: Principles and Practice, PHI 3rd Edition, 2006.

**REFERENCES:**

1. C K Shyamala, N Harini and Dr. T R Padmanabhan: Cryptography and Network Security, Wiley India Pvt. Ltd
2. Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw Hill 2007.
3. Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: PRIVATE Communication in a PUBLIC World, Prentice Hall, ISBN 0-13-046019-2

  
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CS8601

MOBILE COMPUTING


L T P C  
3 0 0 3

**OBJECTIVES:**

- To understand the basic concepts of mobile computing.
- To learn the basics of mobile telecommunication system.
- To be familiar with the network layer protocols and Ad-Hoc networks.
- To know the basis of transport and application layer protocols.
- To gain knowledge about different mobile platforms and application development.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Introduction to Mobile Computing – Applications of Mobile Computing- Generations of Mobile Communication Technologies- Multiplexing – Spread spectrum -MAC Protocols –SDMA-TDMA-FDMA-CDMA		
<b>UNIT II</b>	<b>MOBILE TELECOMMUNICATIONS SYSTEM</b>	<b>9</b>
Introduction to Cellular Systems-GSM-Services & Architecture-Protocols- Connection Establishment-Frequency Allocation-Routing-Mobility Management-Security-GPRS-UMTS-Architecture-Handover-Security		
<b>UNIT III</b>	<b>MOBILE NETWORK LAYER</b>	<b>9</b>
Mobile IP-DHCP-AdHoc-Proactive protocol-DSDV, Reactive Routing Protocols-DSR,AODV,Hybrid routing-ZRP,Multicast Routing-ODMRP,Vehicular AdHoc networks(VANET)-MANETVsVANET-Security.		
<b>UNIT IV</b>	<b>MOBILE TRANSPORT AND APPLICATION LAYER</b>	<b>9</b>
Mobile TCP-WAP-Architecture-WDP-WTLS-WTP-WSP-WAE-WTA Architecture -WML		
<b>UNIT V</b>	<b>MOBILE PLATFORMS AND APPLICATIONS</b>	<b>9</b>
Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone-MCommerce-Structure-Pros & Cons- Mobile Payment System-Security Issues		

TOTAL 45 PERIODS

  
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## OUTCOMES:

At the end of the course, the students should be able to:


- Explain the basics of mobile telecommunication systems
- Illustrate the generations of telecommunication systems in wireless networks
- Determine the functionality of MAC, network layer and Identify a routing protocol for a given Ad hoc network
- Explain the functionality of Transport and Application layers
- Develop a mobile application using android/blackberry/ios/Windows SDK

## TEXTBOOKS:

1. Jochen Schiller, — Mobile Communications I, PHI, Second Edition, 2003.
2. Prasant Kumar Pattnaik, Rajib Mall, — Fundamentals of Mobile Computing I, PHI Learning Pvt. Ltd, New Delhi—2012

## REFERENCES

1. Dharma Prakash Agarwal, Qing and An Zeng, "Introduction to Wireless and Mobile systems", Thomson Asia Pvt Ltd, 2005.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, — Principles of Mobile Computing I, Springer, 2003.
3. William. C. Y. Lee, — Mobile Cellular Telecommunications - Analog and Digital Systems I, Second Edition, Tata McGraw Hill Edition, 2006.
4. C.K. Toh, — Ad Hoc Mobile Wireless Networks I, First Edition, Pearson Education, 2002.
5. Android Developers: <http://developer.android.com/index.html>
6. Apple Developer: <https://developer.apple.com/>
7. Windows Phone DevCenter: <http://developer.windowsphone.com>
8. Black Berry Developer: <http://developer.blackberry.com>

  
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**OBJECTIVES:**

- To understand the concept of cloud computing.
- To appreciate the evolution of cloud from the existing technologies.
- To have knowledge on the various issues in cloud computing.
- To be familiar with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.

**UNIT I INTRODUCTION**

9

Introduction to Cloud Computing — Definition of Cloud — Evolution of Cloud Computing — Underlying Principles of Parallel and Distributed Computing — Cloud Characteristics — Elasticity in Cloud — On-demand Provisioning.

**UNIT II CLOUD ENABLING TECHNOLOGIES**

10

Service Oriented Architecture — REST and Systems of Systems — Web Services — Publish-Subscribe Model — Basics of Virtualization — Types of Virtualization — Implementation Levels of Virtualization — Virtualization Structures — Tools and Mechanisms — Virtualization of CPU — Memory — I/O Devices — Virtualization Support and Disaster Recovery.

**UNIT III CLOUD ARCHITECTURE, SERVICES AND STORAGE**

8

Layered Cloud Architecture Design — NIST Cloud Computing Reference Architecture — Public, Private and Hybrid Clouds - IaaS — PaaS — SaaS — Architectural Design Challenges — Cloud Storage — Storage-as-a-Service — Advantages of Cloud Storage — Cloud Storage Providers — S3.

**UNIT IV RESOURCE MANAGEMENT AND SECURITY IN CLOUD**

10


Inter Cloud Resource Management — Resource Provisioning and Resource Provisioning Methods — Global Exchange of Cloud Resources — Security Overview — Cloud Security Challenges — Software-as-a-Service Security — Security Governance — Virtual Machine Security — IAM — Security Standards.

**UNIT V CLOUD TECHNOLOGIES AND ADVANCEMENTS**

8

Hadoop — MapReduce — Virtual Box — Google App Engine — Programming Environment for Google App Engine — Open Stack — Federation in the Cloud — Four Levels of Federation — Federated Services and Applications — Future of Federation.

**TOTAL: 45 PERIODS**

  
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## **OUTCOMES:**

**On Completion of the course, the students should be able to:**


- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Learn the key and enabling technologies that help in the development of cloud.
- Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
- Explain the core issues of cloud computing such as resource management and security.
- Be able to install and use current cloud technologies.
- Evaluate and choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

## **TEXTBOOKS:**

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, —Cloud Computing: Implementation, Management and Security, CRC Press, 2017.

## **REFERENCES:**

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, —Mastering Cloud Computing, Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing- A Practical Approach", Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud : Transactional Systems for EC2 and Beyond (Theory in Practice)", O'Reilly, 2009.

  
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CS8691

ARTIFICIAL INTELLIGENCE

L T P C

3 0 0 3

**OBJECTIVES:**

- To understand the various characteristics of Intelligent agents
- To learn the different search strategies in AI
- To learn to represent knowledge in solving AI problems
- To understand the different ways of designing software agents
- To know about the various applications of AI.

**UNIT I INTRODUCTION**

9

Introduction–Definition-Future of Artificial Intelligence–Characteristics of Intelligent Agents– Typical Intelligent Agents– Problem Solving Approach to Typical AI problems.

**UNIT II PROBLEM SOLVING METHODS**

9

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems- Searching with Partial Observations- Constraint Satisfaction Problems—Constraint Propagation-Backtracking Search-Game Playing- Optimal Decisions in Games–Alpha-Beta Pruning-Stochastic Games

**UNIT III KNOWLEDGE REPRESENTATION**

9

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining- Backward Chaining – Resolution – Knowledge Representation - Ontological Engineering- Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories -Reasoning with Default Information

**UNIT IV SOFTWARE AGENTS**

9

Architecture for Intelligent Agents–Agent communication–Negotiation and Bargaining– Argumentation among Agents–Trust and Reputation in Multi-agents systems.

**UNIT V APPLICATIONS**

9

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing - Machine Translation – Speech Recognition – Robot – Hardware – Perception–Planning–Moving

**TOTAL: 45 PERIODS**

**OUTCOMES:**

Up on completion of the course, the students will be able to:

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- Use appropriate search algorithms for any AI problem
- Represent a problem using first order and predicate logic
- Provide the apt agent strategy to solve a given problem
- Design software agents to solve a problem
- Design applications for NLP that use Artificial Intelligence.

**TEXTBOOKS:**

1. S.Russell and P.Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Third Edition, 2009.
2. I.Bratko, —Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

**REFERENCES:**

1. M.Tim Jones, —Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2008
2. Nils J.Nilsson, —The Quest for Artificial Intelligence, Cambridge University Press, 2009.
3. William F.Clocks in and Christopher S.Mellish, —Programming in Prolog: Using the ISO Standard, Fifth Edition, Springer, 2003.
4. Gerhard Weiss, —Multi Agent Systems, Second Edition, MIT Press, 2013.
5. David L.Poole and Alan K.Mackworth, —Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.

  
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**OBJECTIVES:**

- To understand the phases in a software project
- To understand fundamental concepts of requirements engineering and Analysis Modeling.
- To understand the various software design methodologies
- To learn various testing and maintenance measures

**UNIT I SOFTWARE PROCESS AND AGILE DEVELOPMENT 9**

Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models—Introduction to Agility-Agile process-Extreme programming-XP Process.

**UNIT II REQUIREMENTS ANALYSIS AND SPECIFICATION 9**

Software Requirements: Functional and Non-Functional, User requirements, System requirements, Software Requirements Document Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis, requirements validation, requirements management-Classical analysis: Structured system Analysis, Petri Nets-Data Dictionary.

**UNIT III SOFTWARE DESIGN 9**

Design process — Design Concepts-Design Model— Design Heuristic — Architectural Design -Architectural styles, Architectural Design, Architectural Mapping using Data Flow- User Interface Design: Interface analysis, Interface Design —Component level Design: Designing Class based components, traditional Components.


**UNIT IV TESTING AND MAINTENANCE 9**

Software testing fundamentals-Internal and external views of Testing-white box testing - basis path testing-control structure testing-black box testing- Regression Testing — Unit Testing — Integration Testing— Validation Testing— System Testing And Debugging—Software Implementation Techniques: Coding practices-Refactoring-Maintenance and Reengineering-BPR model-Reengineering process model-Reverse and Forward Engineering.

**UNIT V PROJECT MANAGEMENT 9**

Software Project Management: Estimation — LOC, FP Based Estimation, Make/Buy Decision COCOMO I & II Model — Project Scheduling — Scheduling, Earned Value Analysis Planning —Project Plan, Planning Process, RFP Risk Management — Identification, Projection - Risk Management-Risk Identification-RMMM Plan-CASE TOOLS

**TOTAL: 45 PERIODS****OUTCOMES:**

  
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**On Completion of the course, the students should be able to:**

- Identify the key activities in managing a software project.
- Compare different process models.
- Concepts of requirements engineering and Analysis Modeling.
- Apply systematic procedure for software design and deployment.
- Compare and contrast the various testing and maintenance.
- Manage project schedule, estimate project cost and effort required.

**TEXTBOOKS:**

1. Roger S. Pressman, —Software Engineering— A Practitioner's Approach, Seventh Edition, McGraw-Hill International Edition, 2010.
2. Ian Sommerville, —Software Engineering, 9th Edition, Pearson Education Asia, 2011.

**REFERENCES:**

1. Rajib Mall, —Fundamentals of Software Engineering, Third Edition, PHI Learning Private Limited, 2009.
2. Pankaj Jalote, —Software Engineering, A Precise Approach, Wiley India, 2010.
3. Kelkar S. A., —Software Engineering, Prentice Hall of India Pvt Ltd, 2007.
4. Stephen R. Schach, —Software Engineering, Tata McGraw-Hill Publishing Company Limited, 2007.
5. <http://nptel.ac.in/>.



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**OBJECTIVES:**

- To understand the protocol layering and physical level communication.
- To analyze the performance of a network.
- To understand the various components required to build different networks.
- To learn the functions of network layer and the various routing protocols.
- To familiarize the functions and protocols of the Transport layer.

**UNIT I INTRODUCTION AND PHYSICAL LAYER 9**

Networks – Network Types – Protocol Layering – TCP/IP Protocol suite – OSI Model – Physical Layer: Performance – Transmission media – Switching – Circuit-switched Networks – Packet Switching.

**UNIT II DATA-LINK LAYER & MEDIA ACCESS 9**

Introduction – Link-Layer Addressing – DLC Services – Data-Link Layer Protocols – HDLC – PPP – Media Access Control – Wired LANs: Ethernet – Wireless LANs – Introduction – IEEE 802.11, Bluetooth – Connecting Devices.

**UNIT III NETWORK LAYER 9**

Network Layer Services – Packet switching – Performance – IPv4 Addresses – Forwarding of IP Packets – Network Layer Protocols: IP, ICMP v4 – Unicast Routing Algorithms – Protocols – Multicasting Basics – IPv6 Addressing – IPv6 Protocol.

**UNIT IV TRANSPORT LAYER 9**

Introduction – Transport Layer Protocols – Services – Port Numbers – User Datagram Protocol – Transmission Control Protocol – SCTP.

**UNIT V APPLICATION LAYER 9**


WWW and HTTP – FTP – Email – Telnet – SSH – DNS – SNMP.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**On Completion of the course, the students should be able to:**

- Understand the basic layers and its functions in computer networks.
- Evaluate the performance of a network.
- Understand the basics of how data flows from one node to another.
- Analyze and design routing algorithms.
- Design protocols for various functions in the network.
- Understand the working of various application layer protocols


  
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**TEXTBOOK:**

1. Behrouz A. Forouzan, Data Communications and Networking, Fifth Edition  
TMH,2013.

**REFERENCES**

1. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc.,2012.
2. William Stallings, Data and Computer Communications, Tenth Edition, PearsonEducation,2013.
3. NaderF.Mir,ComputerandCommunicationNetworks,SecondEdition,Prentice Hall,2014.
4. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, Computer Networks: An OpenSourceApproach,McGrawHillPublisher,2011.
5. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down ApproachFeaturingthe Internet, SixthEdition,PearsonEducation,2013.

  
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EE8811

PROJECT WORK

L T P C

0 0 20 10

**OBJECTIVES:**

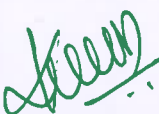
- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

**TOTAL: 300 PERIODS**

**OUTCOMES:**

On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology

  
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**EE8015 ELECTRIC ENERGY GENERATION, UTILIZATION AND CONSERVATION**

L T P C  
3 0 0 3

**OBJECTIVES:**

To impart knowledge on the following Topics

- To study the generation, conservation of electrical power and energy efficient equipments.
- To understand the principle, design of illumination systems and energy efficiency lamps.
- To study the methods of industrial heating and welding.
- To understand the electric traction systems and their performance.

**UNIT I ILLUMINATION 9**

Importance of lighting – properties of good lighting scheme – laws of illumination – photometry -types of lamps – lighting calculations – basic design of illumination schemes for residential, commercial, street lighting, factory lighting and flood lighting – LED lighting and energy efficient lamps.

**UNIT II REFRIGERATION AND AIR CONDITIONING 9**

Refrigeration-Domestic refrigerator and water coolers - Air-Conditioning-Variou types of air-conditioning system and their applications, smart air conditioning units – Energy Efficient motors: Standard motor efficiency, need for efficient motors, Motor life cycle, Direct Savings and payback analysis, efficiency evaluation factor.

**UNIT III HEATING AND WELDING 9**

Role of electric heating for industrial applications – resistance heating – induction heating –dielectric heating - electric arc furnaces. Brief introduction to electric welding – welding generator, welding transformer and the characteristics.

**UNIT IV TRACTION 9**

Merits of electric traction – requirements of electric traction system – supply systems –mechanics of train movement – traction motors and control – braking – recent trends in electric traction.

**UNIT V DOMESTIC UTILIZATION OF ELECTRICAL ENERGY 9**

Domestic utilization of electrical energy – House wiring. Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing –Domestic, Industrial and Substation.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- To understand the main aspects of generation, utilization and conservation.
- To identify an appropriate method of heating for any particular industrial application



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EE8702

**POWER SYSTEM OPERATION AND CONTROL**

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**OBJECTIVES:**

To impart knowledge on the following topics

- Significance of power system operation and control.
- Real power-frequency interaction and design of power-frequency controller.
- Reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.
- Economic operation of power system.

**UNIT I PRELIMINARIES ON POWER SYSTEM OPERATION AND CONTROL 9**

Power scenario in Indian grid – National and Regional load dispatching centers – requirements of good power system - necessity of voltage and frequency regulation - real power vs frequency and reactive power vs voltage control loops - system load variation, load curves and basic concepts of load dispatching - load forecasting - Basics of speed governing mechanisms and modeling - speed load characteristics - regulation of two generators in parallel.

**UNIT II REAL POWER - FREQUENCY CONTROL 9**

Load Frequency Control (LFC) of single area system-static and dynamic analysis of uncontrolled and controlled cases - LFC of two area system - tie line modeling - block diagram representation of two area system - static and dynamic analysis - tie line with frequency bias control – state variability model - integration of economic dispatch control with LFC.

**UNIT III REACTIVE POWER – VOLTAGE CONTROL 9**

Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator (AVR) – brushless AC excitation system – block diagram representation of AVR loop - static and dynamic analysis – stability compensation – voltage drop in transmission line - methods of reactive power injection - tap changing transformer, SVC (TCR + TSC) and STATCOM for voltage control.

**UNIT IV ECONOMIC OPERATION OF POWER SYSTEM 9**

Statement of economic dispatch problem - input and output characteristics of thermal plant - incremental cost curve - optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) - base point and participation factors method - statement of unit commitment (UC) problem - constraints on UC problem - solution of UC problem using priority list – special aspects of short term and long term hydrothermal problems.

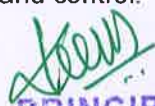
**UNIT V COMPUTER CONTROL OF POWER SYSTEMS 9**

Need of computer control of power systems-concept of energy control centers and functions – PMU - system monitoring, data acquisition and controls - System hardware configurations - SCADA and EMS functions - state estimation problem – measurements and errors - weighted least square estimation - various operating states - state transition diagram.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Ability to understand the day-to-day operation of electric power system.
- Ability to understand the significance of power system operation and control.

  
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EE8703

**RENEWABLE ENERGY SYSTEMS**

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**OBJECTIVES:**

To impart knowledge on the following Topics

- Awareness about renewable Energy Sources and technologies.
- Adequate inputs on a variety of issues in harnessing renewable Energy.
- Recognize current and possible future role of renewable energy sources.

**UNIT I RENEWABLE ENERGY (RE) SOURCES 9**

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

**UNIT II WIND ENERGY 9**

Power in the Wind – Types of Wind Power Plants(WPPs)–Components of WPPs–Working of WPPs- Siting of WPPs–Grid integration issues of WPPs.

**UNIT III SOLAR PV AND THERMAL SYSTEMS 9**

Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds.- Thermal Energy storage system with PCM- Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.

**UNIT IV BIOMASS ENERGY 9**

Introduction-Bio mass resources –Energy from Bio mass: conversion processes-Biomass Cogeneration-Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

**UNIT V OTHER ENERGY SOURCES 9**

Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage- Fuel cell : Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Ability to create awareness about renewable Energy Sources and technologies.
- Ability to get adequate inputs on a variety of issues in harnessing renewable Energy.

  
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EE8701

HIGH VOLTAGE ENGINEERING

L T P C  
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**OBJECTIVES:**

To impart knowledge on the following Topics

- Various types of over voltages in power system and protection methods.
- Generation of over voltages in laboratories.
- Measurement of over voltages.
- Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
- Testing of power apparatus and insulation coordination

**UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9**

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages, Corona and its effects – Bewley lattice diagram- Protection against over voltages.

**UNIT II DIELECTRIC BREAKDOWN 9**

Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipments.

**UNIT III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9**

Generation of High DC voltage: Rectifiers, voltage multipliers, vandigriff generator: generation of high impulse voltage: single and multistage Marx circuits – generation of high AC voltages: cascaded transformers, resonant transformer and tesla coil- generation of switching surges – generation of impulse currents - Triggering and control of impulse generators.

**UNIT IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS 9**

High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.

**UNIT V HIGH VOLTAGE TESTING & INSULATION COORDINATION 9**

High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers- Insulation Coordination& testing of capabilities.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Ability to understand Transients in power system.
- Ability to understand Generation and measurement of high voltage.

  
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EE8602

PROTECTION AND SWITCHGEAR

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**OBJECTIVES:**

To impart knowledge on the following Topics

- Causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- Characteristics and functions of relays and protection schemes.
- Apparatus protection, static and numerical relays
- Functioning of circuit breaker

**UNIT I PROTECTION SCHEMES**

9

Principles and need for protective schemes – nature and causes of faults – types of faults – Methods of Grounding - Zones of protection and essential qualities of protection – Protection scheme

**UNIT II ELECTROMAGNETIC RELAYS**

9

Operating principles of relays - the Universal relay – Torque equation – R-X diagram –Electromagnetic Relays – Over current, Directional, Distance, Differential, Negative sequence and Under frequency relays.

**UNIT III APPARATUS PROTECTION**

9

Current transformers and Potential transformers and their applications in protection schemes -Protection of transformer, generator, motor, bus bars and transmission line.

**UNIT IV STATIC RELAYS AND NUMERICAL PROTECTION**

9

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, distant protection of transmission lines.

**UNIT V CIRCUIT BREAKERS**

9

Physics of arcing phenomenon and arc interruption - DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching – current chopping - interruption of capacitive current - Types of circuit breakers – air blast, air break, oil,SF6, MCBs, MCCBs and vacuum circuit breakers – comparison of different circuit breakers –Rating and selection of Circuit breakers.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Ability to understand and analyze Electromagnetic and Static Relays.
- Ability to suggest suitability circuit breaker.



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EE8551

**MICROPROCESSORS AND MICROCONTROLLERS**

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**OBJECTIVES:**

To impart knowledge on the following Topics

- Architecture of  $\mu$ P8085 &  $\mu$ C 8051
- Addressing modes & instruction set of 8085 & 8051.
- Need & use of Interrupt structure 8085 & 8051.
- Simple applications development with programming 8085 & 8051

**UNIT I 8085 PROCESSOR 9**

Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.

**UNIT II PROGRAMMING OF 8085 PROCESSOR 9**

Instruction -format and addressing modes – Assembly language format – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions - stack.

**UNIT III 8051 MICRO CONTROLLER 9**

Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts- Data Transfer, Manipulation, Control Algorithms & I/O instructions, Comparison to Programming concepts with 8085.

**UNIT IV PERIPHERAL INTERFACING 9**

Study on need, Architecture, configuration and interfacing, with ICs: 8255, 8259, 8254, 8279, - A/D and D/A converters & Interfacing with 8085 & 8051.

**UNIT V MICRO CONTROLLER PROGRAMMING & APPLICATIONS 9**

Simple programming exercises- key board and display interface – Control of servo motor- stepper motor control- Application to automation systems.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Ability to acquire knowledge in Addressing modes & instruction set of 8085 & 8051.

  
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POWER ELECTRONICS

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**OBJECTIVES:**

To impart knowledge on the following Topics

- Different types of power semiconductor devices and their switching
- Operation, characteristics and performance parameters of controlled rectifiers
- Operation, switching techniques and basics topologies of DC-DC switching regulators.
- Different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- Operation of AC voltage controller and various configurations.

**UNIT I POWER SEMI-CONDUCTOR DEVICES 9**

Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT-Static characteristics: SCR, MOSFET and IGBT - Triggering and commutation circuit for SCR-Introduction to Driver and snubber circuits.

**UNIT II PHASE-CONTROLLED CONVERTERS 9**

2-pulse, 3-pulse and 6-pulse converters— performance parameters —Effect of source inductance— Firing Schemes for converter—Dual converters, Applications-light dimmer, Excitation system, Solar PV systems.

**UNIT III DC TO DC CONVERTERS 9**

Step-down and step-up chopper-control strategy— Introduction to types of choppers-A, B, C, D and E -Switched mode regulators- Buck, Boost, Buck- Boost regulator, Introduction to Resonant Converters, Applications-Battery operated vehicles.

**UNIT IV INVERTERS 9**

Single phase and three phase voltage source inverters (both 120° mode and 180° mode)—Voltage & harmonic control—PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM — Introduction to space vector modulation —Current source inverter, Applications-Induction heating, UPS.

**UNIT V AC TO AC CONVERTERS 9**

Single phase and Three phase AC voltage controllers—Control strategy- Power Factor Control — Multistage sequence control —single phase and three phase cyclo converters —Introduction to Matrix converters, Applications —welding .

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Ability to analyse AC-AC and DC-DC and DC-AC converters.
- Ability to choose the converters for real time applications.

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**OBJECTIVES:**

- To study the structure of electric power system and to develop expressions for the computation of transmission line parameters.
- To obtain the equivalent circuits for the transmission lines based on distance and to determine voltage regulation and efficiency.
- To understand the mechanical design of transmission lines and to analyze the voltage distribution in insulator strings to improve the efficiency.

**UNIT I TRANSMISSION LINE PARAMETERS 9**

Structure of Power System - Parameters of single and three phase transmission lines with single and double circuits -Resistance, inductance and capacitance of solid, stranded and bundled conductors, Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects -Typical configurations, conductor types and electrical parameters of EHV lines.

**UNIT II MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9**

Performance of Transmission lines - short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance -transmission efficiency and voltage regulation, real and reactive power flow in lines – Power Circle diagrams - Formation of Corona – Critical Voltages – Effect on Line Performance.

**UNIT III MECHANICAL DESIGN OF LINES 9**

Mechanical design of OH lines – Line Supports –Types of towers – Stress and Sag Calculation – Effects of Wind and Ice loading. Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators.

**UNIT IV UNDER GROUND CABILITIES 9**

Underground capabilities - Types of capabilities – Construction of single core and 3 core Capabilities -Insulation Resistance – Potential Gradient - Capacitance of Single-core and 3 core capabilities- Grading of capabilities - Power factor and heating of capabilities– DC capabilities.

**UNIT V DISTRIBUTION SYSTEMS 9**

Distribution Systems – General Aspects – Kelvin's Law – AC and DC distributions -Techniques of Voltage Control and Power factor improvement – Distribution Loss –Types of Substations -Methods of Grounding – Trends in Transmission and Distribution: EHVAC, HVDC and FACTS (Qualitative treatment only).

**TOTAL : 45 PERIODS****OUTCOMES:**

- To understand the importance and the functioning of transmission line parameters.
- To understand the concepts of Lines and Insulators.



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**OBJECTIVES:**

- To understand the concept about Wireless networks, protocol stack and standards
- To understand and analyse the network layer solutions for Wireless networks
- To study about fundamentals of 3G Services, its protocols and applications
- To have in depth knowledge on internetworking of WLAN and WWAN
- To learn about evolution of 4G Networks, its architecture and applications

**UNIT I WIRELESS LAN 9**

Introduction-WLAN technologies: - IEEE802.11: System architecture, protocol architecture, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, WPAN – IEEE 802.15.4, Wireless USB, Zigbee, 6LoWPAN, WirelessHART

**UNIT II MOBILE NETWORK LAYER 9**

Introduction - Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6- Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing: Destination Sequence distance vector, IoT: CoAP

**UNIT III 3G OVERVIEW 9**

Overview of UMTS Terrestrial Radio access network-UMTS Core network Architecture: 3GPP Architecture, User equipment, CDMA2000 overview- Radio and Network components, Network structure, Radio Network, TD-CDMA, TD – SCDMA.

**UNIT IV INTERNETWORKING BETWEEN WLANS AND WWANS 9**

Internetworking objectives and requirements, Schemes to connect WLANS and 3G Networks, Session Mobility, Internetworking Architecture for WLAN and GPRS, System Description, Local Multipoint Distribution Service, Multichannel Multipoint Distribution System.

**UNIT V 4G & Beyond 9**

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, IMS Architecture, LTE, Advanced Broadband Wireless Access and Services, MVNO.

**TOTAL:45 PERIODS****OUTCOMES:**

Upon completion of the course, the student would be able to:

- Conversant with the latest 3G/4G networks and its architecture
- Design and implement wireless network environment for any application using latest wireless protocols and standards
- Ability to select the suitable network depending on the availability and requirement
- Implement different type of applications for smart phones and mobile devices with latest network strategies


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**OBJECTIVES:**

The student should be made to:

- Understand the basics of satellite orbits
- Understand the satellite segment and earth segment
- Analyze the various methods of satellite access
- Understand the applications of satellites
- Understand the basics of satellite Networks

**UNIT I SATELLITE ORBITS**

9

Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility – eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion.

**UNIT II SPACE SEGMENT**

9

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command-Transponders-The Antenna Subsystem.

**UNIT III SATELLITE LINK DESIGN**

9

Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse.

**UNIT IV SATELLITE ACCESS AND CODING METHODS**

9

Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, DAMA Assignment Methods, compression – encryption, Coding Schemes.

**UNIT V SATELLITE APPLICATIONS**


9

INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. GPS Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS/DTH).

**TOTAL:45 PERIODS****OUTCOMES:**

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

- Analyze the satellite orbits
- Analyze the earth segment and space segment
- Analyze the satellite Link design
- Design various satellite applications

  
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**OBJECTIVES :**

- To introduce the basic building blocks of linear integrated circuits
- To learn the linear and non-linear applications of operational amplifiers
- To introduce the theory and applications of analog multipliers and PLL
- To learn the theory of ADC and DAC
- To introduce the concepts of waveform generation and introduce some special function ICs

**UNIT I BASICS OF OPERATIONAL AMPLIFIERS****9**

Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal Operational Amplifier - General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations – JFET Operational Amplifiers – LF155 and TL082.

**UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS****9**

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

**UNIT III ANALOG MULTIPLIER AND PLL****9**

Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell – Variable transconductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronisation.

**UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS****9**

Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R - 2R Ladder types - switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope type - A/D Converter using Voltage-to-Time Conversion - Over-sampling A/D Converters, Sigma – Delta converters.

**UNIT V WAVEFORM GENERATORS AND SPECIAL FUNCTION ICs****9**

Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Monolithic switching regulator, Low Drop – Out(LDO) Regulators - Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC.

**TOTAL:45 PERIODS****OUTCOMES:**

Upon completion of the course, the student should be able to:

- Design linear and non linear applications of OP – AMPS
- Design applications using analog multiplier and PLL
- Design ADC and DAC using OP – AMPS
- Generate waveforms using OP – AMP Circuits
- Analyze special function ICs


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**OBJECTIVES:**

- To understand the Architecture of 8086 microprocessor.
- To learn the design aspects of I/O and Memory Interfacing circuits.
- To interface microprocessors with supporting chips.
- To study the Architecture of 8051 microcontroller.
- To design a microcontroller based system

**UNIT I THE 8086 MICROPROCESSOR 9**

Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

**UNIT II 8086 SYSTEM BUS STRUCTURE 9**

8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

**UNIT III I/O INTERFACING 9**

Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.

**UNIT IV MICROCONTROLLER 9**

Architecture of 8051 – Special Function Registers(SFRs) - I/O Pins Ports and Circuits - Instruction set - Addressing modes - Assembly language programming.


**UNIT V INTERFACING MICROCONTROLLER 9**

Programming 8051 Timers - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation - Comparison of Microprocessor, Microcontroller, PIC and ARM processors.

**TOTAL: 45 PERIODS****OUTCOMES:**

**At the end of the course, the students should be able to:**

- Understand and execute programs based on 8086 microprocessor.
- Design Memory Interfacing circuits.
- Design and interface I/O circuits.
- Design and implement 8051 microcontroller based systems.

  
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**OBJECTIVES:**

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

**TOTAL: 300 PERIODS**

**OUTCOME:**

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

  
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**OBJECTIVES:**

- To acquaint the students with the construction, theory and operation of the basic electronic devices such as PN junction diode, Bipolar and Field effect Transistors, Power control devices, LED, LCD and other Opto-electronic devices

**UNIT I SEMICONDUCTOR DIODE 9**  
PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes.

**UNIT II BIPOLAR JUNCTION TRANSISTORS 9**  
NPN -PNP -Operations-Early effect-Current equations – Input and Output characteristics of CE, CB, CC - Hybrid - $\pi$  model - h-parameter model, Ebers Moll Model- Gummel Poon-model, Multi Emitter Transistor.

**UNIT III FIELD EFFECT TRANSISTORS 9**  
JFETs – Drain and Transfer characteristics, -Current equations-Pinch off voltage and its significance- MOSFET- Characteristics- Threshold voltage -Channel length modulation, D- MOSFET, E- MOSFET- Characteristics – Comparison of MOSFET with JFET.

**UNIT IV SPECIAL SEMICONDUCTOR DEVICES 9**  
Metal-Semiconductor Junction- MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Schottky barrier diode-Zener diode-Varactor diode –Tunnel diode- Gallium Arsenide device, LASER diode, LDR.

**UNIT V POWER DEVICES AND DISPLAY DEVICES 9**  
UJT, SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Photo transistor, Opto Coupler, Solar cell, CCD.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

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

- Explain the V-I characteristic of diode, UJT and SCR
- Describe the equivalence circuits of transistors
- Operate the basic electronic devices such as PN junction diode, Bipolar and Field effect Transistors, Power control devices, LED, LCD and other Opto-electronic devices

  
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EC8073

MEDICAL ELECTRONICS

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**OBJECTIVES:**

**The student should be made:**

- To gain knowledge about the various physiological parameters both electrical and non electrical and the methods of recording and also the method of transmitting these parameters
- To study about the various assist devices used in the hospitals
- To gain knowledge about equipment used for physical medicine and the various recently developed diagnostic and therapeutic techniques.

**UNIT I ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING 9**

Sources of bio medical signals, Bio-potentials, Biopotential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, typical waveforms and signal characteristics

**UNIT II BIO-CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT 9**

pH, PO<sub>2</sub>, PCO<sub>2</sub>, Colorimeter, Blood flow meter, Cardiac output, respiratory, blood pressure, temperature and pulse measurement, Blood Cell Counters.

**UNIT III ASSIST DEVICES 9**

Cardiac pacemakers, DC Defibrillator, Dialyser, Ventilators, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems.

**UNIT IV PHYSICAL MEDICINE AND BIOTELEMETRY 9**

Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy, Biotelemetry.

**UNIT V RECENT TRENDS IN MEDICAL INSTRUMENTATION 9**


Telemedicine, Insulin Pumps, Radio pill, Endomicroscopy, Brain machine interface, Lab on a chip.

**TOTAL:45 PERIODS**

**OUTCOMES:**

**On successful completion of this course, the student should be able to:**

- Know the human body electro- physiological parameters and recording of bio-potentials
- Comprehend the non-electrical physiological parameters and their measurement – body temperature, blood pressure, pulse, blood cell count, blood flow meter etc.
- Interpret the various assist devices used in the hospitals viz. pacemakers, defibrillators, dialyzers and ventilators
- Comprehend physical medicine methods eg. ultrasonic, shortwave, microwave surgical diathermies , and bio-telemetry principles and methods
- Know about recent trends in medical instrumentation

  
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**OBJECTIVES:**

The student should be made to:

- Understand the concepts of embedded system design and analysis
- Learn the architecture and programming of ARM processor
- Be exposed to the basic concepts of embedded programming
- Learn the real time operating systems

**UNIT I INTRODUCTION TO EMBEDDED SYSTEM DESIGN 9**

Complex systems and micro processors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows - Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques - Designing with computing platforms – consumer electronics architecture – platform-level performance analysis.

**UNIT II ARM PROCESSOR AND PERIPHERALS 9**

ARM Architecture Versions – ARM Architecture – Instruction Set – Stacks and Subroutines – Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.

**UNIT III EMBEDDED PROGRAMMING 9**

Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

**UNIT IV REAL TIME SYSTEMS 9**

Structure of a Real Time System — Estimating program run times – Task Assignment and Scheduling – Fault Tolerance Techniques – Reliability, Evaluation – Clock Synchronisation.

**UNIT V PROCESSES AND OPERATING SYSTEMS 9**

Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive real-time operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE. - Distributed embedded systems – MPSoCs and shared memory multiprocessors. – Design Example - Audio player, Engine control unit – Video accelerator.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- Describe the architecture and programming of ARM processor
- Outline the concepts of embedded systems
- Explain the basic concepts of real time operating system design
- Model real-time applications using embedded-system concepts

  
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**OBJECTIVE:**

- To familiarize the students to understand the fundamentals of thermodynamics and to perform thermal analysis on their behavior and performance.  
(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart permitted)

**UNIT I BASIC CONCEPTS AND FIRST LAW**

9+6

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive, total and specific quantities. System and their types. Thermodynamic Equilibrium State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work. P-V diagram. Zeroth law of thermodynamics - concept of temperature and thermal equilibrium - relationship between temperature scales - new temperature scales. First law of thermodynamics - application to closed and open systems - steady and unsteady flow processes.

**UNIT II SECOND LAW AND AVAILABILITY ANALYSIS**

9+6

Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. Applications of II Law. High and low grade energy. Available and non-available energy of a source and finite body. Energy and irreversibility. Expressions for the energy of a closed system and open systems. Energy balance and entropy generation. Irreversibility. I and II law Efficiency.

**UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE**

9+6

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles.

**UNIT IV IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS**

9+6

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties. Compressibility factor- Principle of Corresponding states. -Generalised Compressibility Chart and its use-. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations.

**UNIT V GAS MIXTURES AND PSYCHROMETRY**

9+6

Mole and Mass fraction, Dalton's and Amagat's Law. Properties of gas mixture - Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function. Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process - adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

**TOTAL : 75 PERIODS****OUTCOMES:****Upon the completion of this course the students will be able to**

- Apply the first law of thermodynamics for simple open and closed systems under steady, Apply second law of thermodynamics to open and closed systems and calculate entropy, Apply Rankine cycle to steam power plant and compare few cycle improvement methods, Derive simple thermodynamic relations of ideal and real gases, Calculate the properties of gas mixtures and moist air and its use in psychrometric processes

**TEXT BOOKS :**

- R.K.Rajput, "A Text Book Of Engineering Thermodynamics", Fifth Edition, 2017.
- Yunus a. Cengel & Michael a. Boles, "Thermodynamics", 8th edition 2015.

**REFERENCES:**

- Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
- Borgnakke & Sonntag, "Fundamental of Thermodynamics", 8th Edition, 2016.
- Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
- Michael J. Moran, Howard N. Shapiro, "Fundamentals of Engineering Thermodynamics", 8th Edition.
- Nag.P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, New Delhi, 2013.

  
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## THERMAL ENGINEERING - I

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**OBJECTIVES:**

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
  - To apply the thermodynamic concepts into various thermal application like IC engines, Steam.
  - Turbines, Compressors and Refrigeration and Air conditioning systems
- (Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

**UNIT I GAS AND STEAM POWER CYCLES 9**

Air Standard Cycles - Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison – Rankine, reheat and regenerative cycle.

**UNIT II RECIPROCATING AIR COMPRESSOR 9**

Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors.

**UNIT III INTERNAL COMBUSTION ENGINES AND COMBUSTION 9**

IC engine – Classification, working, components and their functions. Ideal and actual : Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines – comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control.

**UNIT IV INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS 9**

Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common Rail Direct Injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms.

**UNIT V GAS TURBINES 9**

Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations. Materials for Turbines.

**TOTAL:45 PERIODS****OUTCOMES:**

**Upon the completion of this course the students will be able to**

- CO1 Apply thermodynamic concepts to different air standard cycles and solve problems. CO2 Solve problems in single stage and multistage air compressors
- CO3 Explain the functioning and features of IC engines, components and auxiliaries. CO4 Calculate performance parameters of IC Engines.
- CO5 Explain the flow in Gas turbines and solve problems.

**TEXT BOOKS:**

1. Kothandaraman.C.P., Domkundwar. S,Domkundwar. A.V., “A course in thermal Engineering”, Fifth Edition, ”Dhanpat Rai & sons , 2016
2. Rajput. R. K., “Thermal Engineering” S.Chand Publishers, 2017

**REFERENCES:**

1. Arora.C.P, ”Refrigeration and Air Conditioning ,” Tata McGraw-Hill Publishers 2008
2. Ganesan V..” Internal Combustion Engines” , Third Edition, Tata Mcgraw-Hill 2012
3. Ramalingam. K.K., ”Thermal Engineering”, SCITECH Publications (India) Pvt. Ltd., 2009.
4. Rudramoorthy, R, “Thermal Engineering “,Tata McGraw-Hill, New Delhi,2003
5. Sarkar, B.K, ”Thermal Engineering” Tata McGraw-Hill Publishers, 2007

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**OBJECTIVES**

- The properties of fluids and concept of control volume are studied
- The applications of the conservation laws to flow through pipes are studied.
- To understand the importance of dimensional analysis
- To understand the importance of various types of flow in pumps.
- To understand the importance of various types of flow in turbines.

**UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 12**

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume – application of continuity equation, energy equation and momentum equation.

**UNIT II FLOW THROUGH CIRCULAR CONDUITS 12**

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli- Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation – friction factor- Moody diagram- commercial pipes- minor losses – Flow through pipes in series and parallel.

**UNIT III DIMENSIONAL ANALYSIS 12**

Need for dimensional analysis – methods of dimensional analysis – Similitude – types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

**UNIT IV PUMPS 12**

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles- Centrifugal pumps – working principle - work done by the impeller - performance curves - Reciprocating pump- working principle – Rotary pumps – classification.

**UNIT V TURBINES 12**

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner- draft tube. Specific speed- unit quantities – performance curves for turbines – governing of turbines.

**TOTAL: 60 PERIODS****OUTCOMES:**

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

- Apply mathematical knowledge to predict the properties and characteristics of a fluid.
- Can analyse and calculate major and minor losses associated with pipe flow in piping networks.
- Can mathematically predict the nature of physical quantities
- Can critically analyse the performance of pumps
- Can critically analyse the performance of turbines.

**TEXT BOOK:**

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2013.

**REFERENCES:**

1. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "Fluid Mechanics and Machinery", 2011.
4. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010

  
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**OBJECTIVE:**

- To introduce the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components.

**UNIT I METALCASTING PROCESSES 9**

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO<sub>2</sub> process – Stir casting; Defects in Sandcasting

**UNIT II JOINING PROCESSES 9**

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding  
- Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.

**UNIT III METALFORMING PROCESSES 9**

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion.

**UNIT IV SHEET METAL PROCESSES 9**

Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes–Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Microforming

**UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9**

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

**TOTAL: 45 PERIODS****OUTCOMES:**

- CO1 Explain different metal casting processes, associated defects, merits and demerits CO2  
Compare different metal joining processes.
- CO3 Summarize various hot working and cold working methods of metals. CO4  
Explain various sheet metal making processes.
- CO5 Distinguish various methods of manufacturing plastic components.

**TEXT BOOKS:**

- Hajra Choudhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008
- Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2013

**REFERENCES:**

- Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, 2008
- Paul Degarma E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" Eight Edition, Prentice – Hall of India, 1997.
- Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4<sup>th</sup> Edition, TMH-2013
- Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
- Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.



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**OBJECTIVES:**

- To understand the basic components and layout of linkages in the assembly of a system machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

**UNIT I BASICS OF MECHANISMS 9**

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle – Description of some common mechanisms – Quick return mechanisms, Straight line generators, Universal Joint – rocker mechanisms.

**UNIT II KINEMATICS OF LINKAGE MECHANISMS 9**

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method – Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration – Introduction to linkage synthesis problem.

**UNIT III KINEMATICS OF CAM MECHANISMS 9**

Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.

**UNIT IV GEARS AND GEAR TRAINS 9**

Law of toothed gearing – Involute and cycloidal tooth profiles – Spur Gear terminology and definitions – Gear tooth action – contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains.

**UNIT V FRICTION IN MACHINE ELEMENTS 9**

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes- Band and Block brakes.

**TOTAL: 45 PERIODS****OUTCOMES:**

**Upon the completion of this course the students will be able to**

- CO1 Discuss the basics of mechanism  
 CO2 Calculate velocity and acceleration in simple mechanisms  
 CO3 Develop CAM profiles  
 CO4 Solve problems on gears and gear trains  
 CO5 Examine friction in machine elements

**TEXTBOOKS:**

1. F.B. Sayyad, "Kinematics of Machinery", MacMillan Publishers Pvt Ltd., Tech-max Educational resources, 2011.
2. Rattan, S.S, "Theory of Machines", 4<sup>th</sup> Edition, Tata McGraw-Hill, 2014.
3. Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms",

**REFERENCES:**

1. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 1961
2. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2014
3. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3<sup>rd</sup> Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
4. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low-Prices Student Edition, 1999.
5. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.



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**OBJECTIVES:**

- To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching.
- To understand the basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming

**UNIT I THEORY OF METAL CUTTING 9**

Mechanics of chip formation, single point cutting tool, forces in machining, Types of chip, cutting tools– nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

**UNIT II TURNING MACHINES 9**

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi automatic – single spindle : Swiss type, automatic screw type – multispindle:

**UNIT III SHAPER, MILLING AND GEAR CUTTING MACHINES 9**

Shaper - Types of operations. Drilling, reaming, boring, Tapping. Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling, hobbing and gear shaping processes – finishing of gears.

**UNIT IV ABRASIVE PROCESS AND BROACHING 9**

Abrasive processes: grinding wheel – specifications and selection, types of grinding process– cylindrical grinding, surface grinding, centreless grinding and internal grinding- Typical applications – concepts of surface integrity, broaching machines: broach construction – push, pull, surface and continuous broaching machines

**UNIT V CNC MACHINING 9**

Numerical Control (NC) machine tools – CNC types, constructional details, special features, machining centre, part programming fundamentals CNC – manual part programming – micromachining – wafer machining.

**TOTAL : 45 PERIODS****OUTCOMES:**

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


- CO1 Explain the mechanism of material removal processes.
- CO2 Describe the constructional and operational features of centre lathe and other special purpose lathes.
- CO3 Describe the constructional and operational features of shaper, planner, milling, drilling, sawing and broaching machines.
- CO4 Explain the types of grinding and other super finishing processes apart from gear manufacturing processes.
- CO5 Summarize numerical control of machine tools and write a part program.

**TEXT BOOKS:**

- Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters 2014
- Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 3<sup>rd</sup> Edition, Tata McGraw-Hill, New Delhi, 2013.

**REFERENCES:**

- Richard R Kibbe, John E. Neely, Roland O. Merges and Warren J. White "Machine Tool Practices", Prentice Hall of India, 1998
- Geoffrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984
- HMT, "Production Technology", Tata McGraw Hill, 1998.
- Roy. A. Lindberg, "Process and Materials of Manufacture," Fourth Edition, PHI/Pearson Education 2006.

  
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**OBJECTIVE:**

- To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

**UNIT I ALLOYS AND PHASE DIAGRAMS 9**

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – carbon equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

**UNIT II HEAT TREATMENT 9**

Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test - Austempering, martempering – case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening .

**UNIT III FERROUS AND NON-FERROUS METALS 9**

Effect of alloying additions on steel-  $\alpha$  and  $\beta$  stabilisers– stainless and tool steels – HSLA, Maraging steels–Cast Iron–Grey, white, malleable, spheroidal–alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

**UNIT IV NON-METALLIC MATERIALS 9**

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of  $Al_2O_3$ , SiC,  $Si_3N_4$ , PSZ and SIALON –Composites- Classifications- Metal Matrix and FRP - Applications of Composites.

**UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 9**

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Impact test Izod and Charpy, fatigue and creep failure mechanisms.

**TOTAL: 45 PERIODS****OUTCOMES**

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

- CO1 Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.  
 CO2 Explain isothermal transformation, continuous cooling diagrams and different heat treatment processes.  
 CO3 Clarify the effect of alloying elements on ferrous and non-ferrous metals CO4  
 Summarize the properties and applications of non metallic materials.  
 CO5 Explain the testing of mechanical properties..

**TEXT BOOKS:**

- Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Company, 1997.
- Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, Revised Indian Edition 2014

**REFERENCES:**

- Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 2010.
- Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., 2015.
- U.C. Jindal : Material Science and Metallurgy, "Engineering Materials and Metallurgy", First Edition, Dorling Kindersley, 2012
- Upadhyay. G.S. and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt. Ltd., New Delhi, 2006.

  
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**OBJECTIVES:**

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

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**UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS**

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

**UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM**

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending – bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

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**UNIT III TORSION**

Torsion formulation stresses and deformation in circular and hollow shafts – Stepped shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

**UNIT IV DEFLECTION OF BEAMS**

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

**UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS**

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lamé's theorem.

**TOTAL: 45 PERIODS****OUTCOMES**

Students will be able to


- Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
- Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical spring
- Calculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures.

**TEXT BOOKS:**

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

**REFERENCES:**

1. Egor. P. Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
2. Ferdinand P. Beer, Russell Johnson, J.R. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
4. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

  
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ME8593

DESIGN OF MACHINE ELEMENTS

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OBJECTIVES

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components
- (Use of P S G Design Data Book is permitted)

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and ‘C’ frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT II SHAFTS AND COUPLINGS 9

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings.

UNIT III TEMPORARY AND PERMANENT JOINTS 9

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

UNIT IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Various types of springs, optimization of helical springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT V BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.

TOTAL: 45 PERIODS

OUTCOMES:

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


- CO1 Explain the influence of steady and variable stresses in machine component design. CO2 Apply the concepts of design to shafts, keys and couplings.  
CO3 Apply the concepts of design to temporary and permanent joints.  
CO4 Apply the concepts of design to energy absorbing members, connecting rod and crank shaft.  
CO5 Apply the concepts of design to bearings.

TEXT BOOKS:

1. Bhandari V, “Design of Machine Elements”, 4<sup>th</sup> Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 9<sup>th</sup> Edition, Tata McGraw-Hill, 2011.

REFERENCES:

1. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co. (Schaum’s Outline), 2010
2. Ansel Ugural, “Mechanical Design Co, 2003. An Integral Approach”, 1<sup>st</sup> Edition, Tata McGraw-Hill Book
3. P.C. Gope, “Machine Design – Fundamental and Application”, PHI learning private ltd, New Delhi, 2012.
4. R.B. Patel, “Design of Machine Elements”, MacMillan Publishers India P Ltd.,

  
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**OBJECTIVES:**

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues (Use of P S G Design Data Book permitted)

**UNIT I DESIGN OF FLEXIBLE ELEMENTS** 9  
Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

**UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS** 9  
Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

**UNIT III BEVEL, WORM AND CROSS HELICAL GEARS** 9  
Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

**UNIT IV GEAR BOXES** 9  
Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

**UNIT V CAMS, CLUTCHES AND BRAKES** 9  
Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches- Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

**TOTAL : 45 PERIODS****OUTCOMES:****Upon the completion of this course the students will be able to**


- CO1 apply the concepts of design to belts, chains and rope drives.  
CO2 apply the concepts of design to spur, helical gears.  
CO3 apply the concepts of design to worm and bevel gears. apply the  
CO4 concepts of design to gear boxes .

**TEXT BOOKS:**

1. Bhandari V, "Design of Machine Elements", 4<sup>th</sup> Edition, Tata McGraw-Hill Book Co,2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8<sup>th</sup> Edition, Tata McGraw-Hill,2008.

**REFERENCES:**

1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8<sup>th</sup> Edition, Printice Hall,2003.
2. Orthwein W, "Machine Component Design", Jaico Publishing Co,2003.
3. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.<sup>th</sup>
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4<sup>th</sup> Edition, Wiley, 2005
5. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai,2003.

  
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**OBJECTIVES:**

- To provide an overview of how computers are being used in mechanical component design
- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

**UNIT I INTRODUCTION**

9

Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - Line drawing -Clipping- viewing transformation-Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM –CAD/CAM concepts —Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance

**UNIT II GEOMETRIC MODELING**

9

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep

**UNIT III CAD STANDARDS**

9

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

**UNIT IV FUNDAMENTAL OF CNC AND PART PROGRAMMING**

9

Introduction to NC systems and CNC - Machine axis and Co-ordinate system- CNC machine tools- Principle of operation CNC- Construction features including structure- Drives and CNC controllers- 2D and 3D machining on CNC- Introduction of Part Programming, types - Detailed Manual part programming on Lathe & Milling machines using G codes and M codes- Cutting Cycles, Loops, Sub program and Macros- Introduction of CAM package.

**UNIT V CELLULAR MANUFACTURING AND FLEXIBLE**

9

**MANUFACTURING SYSTEM (FMS)**

Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS

**TOTAL : 45 PERIODS****OUTCOMES:**

**Upon the completion of this course the students will be able to**


- CO1 Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics
- CO2 Explain the fundamentals of parametric curves, surfaces and Solids CO3 Summarize the different types of Standard systems used in CAD
- CO4 Apply NC & CNC programming concepts to develop part programme for Lathe & Milling Machines
- CO5 Summarize the different types of techniques used in Cellular Manufacturing and FMS

**TEXT BOOKS:**

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co. 2007
2. Mikell P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008.
3. Radhakrishnan P, Subramanyan S. and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

**REFERENCES:**

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles”, “Practice and Manufacturing management “ Second Edition, Pearson Education, 1999.
2. Donald Hearn and M. Pauline Baker “Computer Graphics”. Prentice Hall, Inc, 1992.
3. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education - 2003
4. William M Neumann and Robert F. Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

  
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ME8811

**PROJECT WORK**

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**OBJECTIVE:**

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

**TOTAL: 30 PERIODS**

**OUTCOME:**

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.



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**OBJECTIVES:**

- To understand the protocol layering and physical level communication.
- To analyze the performance of a network.
- To understand the various components required to build different networks.
- To learn the functions of network layer and the various routing protocols.
- To familiarize the functions and protocols of the Transport layer.

**UNIT I INTRODUCTION AND PHYSICAL LAYER 9**

Networks — Network Types — Protocol Layering — TCP/IP Protocol suite — OSI Model — Physical Layer: Performance — Transmission media — Switching — Circuit-switched Networks — Packet Switching.

**UNIT II DATA-LINK LAYER & MEDIA ACCESS 9**

Introduction — Link-Layer Addressing — DLC Services — Data-Link Layer Protocols — HDLC — PPP — Media Access Control — Wired LANs: Ethernet — Wireless LANs — Introduction — IEEE 802.11, Bluetooth — Connecting Devices.

**UNIT III NETWORK LAYER 9**

Network Layer Services — Packet switching — Performance — IPv4 Addresses — Forwarding of IP Packets — Network Layer Protocols: IP, ICMP v4 — Unicast Routing Algorithms — Protocols — Multicasting Basics — IPv6 Addressing — IPv6 Protocol.

**UNIT IV TRANSPORT LAYER 9**

Introduction — Transport Layer Protocols — Services — Port Numbers — User Datagram Protocol — Transmission Control Protocol — SCTP.


**UNIT V APPLICATION LAYER 9**

WWW and HTTP — FTP — Email — Telnet — SSH — DNS — SNMP.

**TOTAL: 45 PERIODS****OUTCOMES:**

**On Completion of the course, the students should be able to:**

- Understand the basic layers and its functions in computer networks.
- Evaluate the performance of a network.
- Understand the basics of how data flows from one node to another.
- Analyze and design routing algorithms.
- Design protocols for various functions in the network.
- Understand the working of various application layer protocols

  
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**OBJECTIVES:**

- To understand the fundamentals of object modeling
- To understand and differentiate Unified Process from other approaches.
- To design with static UML diagrams.
- To design with the UML dynamic and implementation diagrams.
- To improve the software design with design patterns.
- To test the software against its requirements specification

**UNIT I UNIFIED PROCESS AND USE CASE DIAGRAMS 9**

Introduction to OOAD with OO Basics - Unified Process - UML diagrams - Use Case - Case study - the Next Gen POS system, Inception - Use case Modelling - Relating Use cases - include, extend and generalization - When to use Use-cases

**UNIT II STATIC UML DIAGRAMS 9**

Class Diagram - Elaboration - Domain Model - Finding conceptual classes and description classes - Associations - Attributes - Domain model refinement - Finding conceptual class Hierarchies - Aggregation and Composition - Relationship between sequenced diagrams and use cases - When to use Class Diagrams

**UNIT III DYNAMIC AND IMPLEMENTATION UML DIAGRAMS 9**

**Dynamic Diagrams** - UML interaction diagrams - System sequence diagram - Collaboration diagram - When to use Communication Diagrams - State machine diagram and Modelling - When to use State Diagrams - Activity diagram - When to use activity diagrams

**Implementation Diagrams** - UML package diagram - When to use package diagrams - Component and Deployment Diagrams - When to use Component and Deployment diagrams

**UNIT IV DESIGN PATTERNS 9**

**GRASP:** Designing objects with responsibilities - Creator - Information expert - Low Coupling - High Cohesion - Controller **Design Patterns** - **creational** - factory method - **structural** - Bridge - Adapter - **behavioural** - Strategy - observer - Applying GoF design patterns - Mapping design to code

**UNIT V TESTING 9**

Object Oriented Methodologies - Software Quality Assurance - Impact of Object Orientation

on Testing—Develop Test Cases and Test Plans

**TOTAL:45PERIODS**

**OUTCOMES:**

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

- Express software design with UML diagrams
- Design software applications using OO concepts.
- Identify various scenarios based on software requirements
- Transform UML based software design into pattern based design using design patterns
- Understand the various testing methodologies for OO software

**TEXTBOOKS:**

1. Craig Larman,—Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, Third Edition, Pearson Education, 2005.
2. Ali Bahrami-Object Oriented Systems Development -McGraw Hill International Edition-1999

**REFERENCES:**

1. Erich Gamma, and Richard Helm, Ralph Johnson, John Vlissides,—Design patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley, 1995.
2. Martin Fowler,—UML Distilled: A Brief Guide to the Standard Object Modeling Language, Third Edition, Addison Wesley, 2003.

  
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**OBJECTIVES:**

- To understand Cryptography Theories, Algorithms and Systems.
- To understand necessary Approaches and Techniques to build protection mechanisms in order to secure computer networks.

**UNIT I INTRODUCTION 9**

Security trends - Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security Policies - Model of network security - Security attacks, services and mechanisms - OSI security architecture - Classical encryption techniques: substitution techniques, transposition techniques, steganography - Foundations of modern cryptography: perfect security - information theory - product cryptosystem - cryptanalysis.

**UNIT II SYMMETRIC KEY CRYPTOGRAPHY 9**

MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY: Algebraic structures - Modular arithmetic - Euclid's algorithm - Congruence and matrices - Groups, Rings, Fields - Finite fields - SYMMETRIC KEY CIPHERS: DES - Block cipher Principle of DES - Strength of DES - Differential and linear cryptanalysis - Block cipher design principles - Block cipher mode of operation - Evaluation criteria for AES - Advanced Encryption Standard - RC4 - Key distribution.

**UNIT III PUBLIC KEY CRYPTOGRAPHY 9**

MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes - Primality Testing - Factorization - Euler's totient function, Fermat's and Euler's Theorem - Chinese Remainder Theorem - Exponentiation and Algorithm - ASYMMETRIC KEY CIPHERS: RSA cryptosystem - Key distribution - Key management - Diffie Hellman key exchange - ElGamal cryptosystem - Elliptic curve arithmetic - Elliptic curve cryptography.

**UNIT IV MESSAGE AUTHENTICATION AND INTEGRITY 9**

Authentication requirement - Authentication function - MAC - Hash function - Security of hash function and MAC - SHA - Digital signature and authentication protocols - DSS - Entity Authentication: Biometrics, Passwords, Challenge Response protocols - Authentication applications - Kerberos, X.509

**UNIT V SECURITY PRACTICE AND SYSTEM SECURITY 9**

Electronic Mail security - PGP, S/MIME - IP security - Web Security -

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SYSTEM SECURITY: Intruders–Malicious software–viruses–Firewalls.

TOTAL 45 PERIODS

**OUTCOMES:**

**At the end of the course, the student should be able to:**

- Understand the fundamentals of network security, security architecture, threats and vulnerabilities
- Apply the different cryptographic operations of symmetric cryptographic algorithms
- Apply the different cryptographic operations of public key cryptography
- Apply the various Authentication schemes to simulated different applications.
- Understand various Security practices and System security standards

**TEXTBOOK:**

1. William Stallings, Cryptography and Network Security: Principles and Practice, PHI 3rd Edition, 2006.

**REFERENCES:**

1. C K Shyamala, N Harini and Dr. T R Padmanabhan: Cryptography and Network Security, Wiley India Pvt. Ltd
2. Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw Hill 2007.
3. Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: PRIVATE Communication in a PUBLIC World, Prentice Hall, ISBN 0-13-046019-2

  
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**OBJECTIVES:**

- To understand the phases in a software project
- To understand fundamental concepts of requirements engineering and Analysis Modeling.
- To understand the various software design methodologies
- To learn various testing and maintenance measures

**UNIT I SOFTWARE PROCESS AND AGILE DEVELOPMENT 9**

Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models—Introduction to Agility-Agile process-Extreme programming-XP Process.

**UNIT II REQUIREMENTS ANALYSIS AND SPECIFICATION 9**

Software Requirements: Functional and Non-Functional, User requirements, System requirements, Software Requirements Document Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis, requirements validation, requirements management-Classical analysis: Structured system Analysis, Petri Nets-Data Dictionary.

**UNIT III SOFTWARE DESIGN 9**

Design process — Design Concepts-Design Model— Design Heuristic — Architectural Design -Architectural styles, Architectural Design, Architectural Mapping using Data Flow- User Interface Design: Interface analysis, Interface Design –Component level Design: Designing Class based components, traditional Components.


**UNIT IV TESTING AND MAINTENANCE 9**

Software testing fundamentals-Internal and external views of Testing-white box testing - basis path testing-control structure testing-black box testing- Regression Testing — Unit Testing — Integration Testing— Validation Testing— System Testing And Debugging—Software Implementation Techniques: Coding practices-Refactoring-Maintenance and Reengineering-BPR model-Reengineering process model-Reverse and Forward Engineering.

**UNIT V PROJECT MANAGEMENT 9**

Software Project Management: Estimation – LOC, FP Based Estimation, Make/Buy Decision COCOMO I & II Model – Project Scheduling – Scheduling, Earned Value Analysis Planning –Project Plan, Planning Process, RFP Risk Management – Identification, Projection - Risk Management-Risk Identification-RMMM Plan-CASE TOOLS

**TOTAL: 45 PERIODS****OUTCOMES:**

  
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**On Completion of the course, the students should be able to:**

- Identify the key activities in managing a software project.
- Compare different process models.
- Concepts of requirements engineering and Analysis Modeling.
- Apply systematic procedure for software design and deployment.
- Compare and contrast the various testing and maintenance.
- Manage project schedule, estimate project cost and effort required.

**TEXTBOOKS:**

1. Roger S. Pressman, —Software Engineering— A Practitioner's Approach I, Seventh Edition, McGraw-Hill International Edition, 2010.
2. Ian Sommerville, —Software Engineering I, 9th Edition, Pearson Education Asia, 2011.

**REFERENCES:**

1. Rajib Mall, —Fundamentals of Software Engineering I, Third Edition, PHI Learning Private Limited, 2009.
2. Pankaj Jalote, —Software Engineering, A Precise Approach I, Wiley India, 2010.
3. Kelkar S. A., —Software Engineering I, Prentice Hall of India Pvt Ltd, 2007.
4. Stephen R. Schach, —Software Engineering I, Tata McGraw-Hill Publishing Company Limited, 2007.
5. <http://nptel.ac.in/>.



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CS8691

ARTIFICIALINTELLIGENCE

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**OBJECTIVES:**

- To understand the various characteristics of Intelligent agents
- To learn the different search strategies in AI
- To learn to represent knowledge in solving AI problems
- To understand the different ways of designing software agents
- To know about the various applications of AI.

**UNIT I INTRODUCTION**

9

Introduction–Definition–FutureofArtificialIntelligence–CharacteristicsofIntelligentAgents–  
TypicalIntelligentAgents–ProblemSolvingApproachtoTypicalAIproblems.

**UNIT II PROBLEMSOLVINGMETHODS**

9

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local  
SearchAlgorithmsandOptimizationProblems-SearchingwithPartialObservations-  
ConstraintSatisfactionProblems—ConstraintPropagation-BacktrackingSearch-GamePlaying-  
Optimal Decisions in Games–Alpha-Beta Pruning-Stochastic Games

**UNIT III KNOWLEDGEREPRESENTATION**

9

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-  
Backward Chaining – Resolution – Knowledge Representation - Ontological Engineering-  
Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for  
Categories -Reasoning with Default Information

**UNIT IV SOFTWAREAGENTS**

9

ArchitectureforIntelligentAgents–Agentcommunication–NegotiationandBargaining–  
ArgumentationamongAgents–TrustandReputationinMulti-agentsystems.

**UNIT V APPLICATIONS**

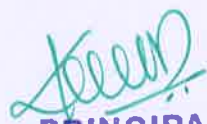
9

AI applications – Language Models – Information Retrieval- Information Extraction – Natural  
Language Processing - Machine Translation – Speech Recognition – Robot – Hardware –  
Perception–Planning–Moving

**TOTAL:45PERIODS**

**OUTCOMES:**

Up on completion of the course, the students will be able to:

  
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- Use appropriate search algorithms for any AI problem
- Represent a problem using first order and predicate logic
- Provide the apt agent strategy to solve a given problem
- Design software agents to solve a problem
- Design applications for NLP that use Artificial Intelligence.

**TEXTBOOKS:**

- 1 S.Russell and P.Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Third Edition, 2009.
- 2 I.Bratko, —Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

**REFERENCES:**

1. M.Tim Jones, —Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2008
2. Nils J.Nilsson, —The Quest for Artificial Intelligence, Cambridge University Press, 2009.
3. William F.Clocks in and Christopher S.Mellish, —Programming in Prolog: Using the ISO Standard, Fifth Edition, Springer, 2003.
4. Gerhard Weiss, —Multi Agent Systems, Second Edition, MIT Press, 2013.
5. David L.Poole and Alan K.Mackworth, —Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.

  
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**OBJECTIVES:**

- To understand the concept of cloud computing.
- To appreciate the evolution of cloud from the existing technologies.
- To have knowledge on the various issues in cloud computing.
- To be familiar with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.

**UNIT I INTRODUCTION**

9

Introduction to Cloud Computing — Definition of Cloud — Evolution of Cloud Computing — Underlying Principles of Parallel and Distributed Computing — Cloud Characteristics — Elasticity in Cloud — On-demand Provisioning.

**UNIT II CLOUD ENABLING TECHNOLOGIES**

10

Service Oriented Architecture — REST and Systems of Systems — Web Services — Publish-Subscribe Model — Basics of Virtualization — Types of Virtualization — Implementation Levels of Virtualization — Virtualization Structures — Tools and Mechanisms — Virtualization of CPU — Memory — I/O Devices — Virtualization Support and Disaster Recovery.

**UNIT III CLOUD ARCHITECTURE, SERVICES AND STORAGE**

8

Layered Cloud Architecture Design — NIST Cloud Computing Reference Architecture — Public, Private and Hybrid Clouds - IaaS — PaaS — SaaS — Architectural Design Challenges — Cloud Storage — Storage-as-a-Service — Advantages of Cloud Storage — Cloud Storage Providers — S3.

**UNIT IV RESOURCE MANAGEMENT AND SECURITY IN CLOUD**

10


Inter Cloud Resource Management — Resource Provisioning and Resource Provisioning Methods — Global Exchange of Cloud Resources — Security Overview — Cloud Security Challenges — Software-as-a-Service Security — Security Governance — Virtual Machine Security — IAM — Security Standards.

**UNIT V CLOUD TECHNOLOGIES AND ADVANCEMENTS**

8

Hadoop — MapReduce — Virtual Box — Google App Engine — Programming Environment for Google App Engine — Open Stack — Federation in the Cloud — Four Levels of Federation — Federated Services and Applications — Future of Federation.

**TOTAL: 45 PERIODS**

  
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## **OUTCOMES:**

**On Completion of the course, the students should be able to:**


- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Learn the key and enabling technologies that help in the development of cloud.
- Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
- Explain the core issues of cloud computing such as resource management and security.
- Be able to install and use current cloud technologies.
- Evaluate and choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

## **TEXTBOOKS:**

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, — Cloud Computing: Implementation, Management and Security, CRC Press, 2017.

## **REFERENCES:**

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, — Mastering Cloud Computing, Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach", Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud : Transactional Systems for EC2 and Beyond (Theory in Practice)", O'Reilly, 2009.

  
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CS8601

MOBILE COMPUTING

L T P C

3 0 0 3

**OBJECTIVES:**

- To understand the basic concepts of mobile computing.
- To learn the basics of mobile telecommunications system.
- To be familiar with the network layer protocols and Ad-Hoc networks.
- To know the basis of transport and application layer protocols.
- To gain knowledge about different mobile platforms and application development.

**UNIT I INTRODUCTION 9**

Introduction to Mobile Computing – Applications of Mobile Computing- Generations of Mobile Communication Technologies- Multiplexing – Spread spectrum -MAC Protocols –SDMA-TDMA-FDMA-CDMA

**UNIT II MOBILE TELECOMMUNICATIONS SYSTEM 9**

Introduction to Cellular Systems-GSM-Services & Architecture-Protocols- Connection Establishment-Frequency Allocation-Routing-Mobility Management-Security-GPRS-UMTS-Architecture-Handover-Security

**UNIT III MOBILE NETWORK LAYER 9**

Mobile IP-DHCP-AdHoc-Proactive protocol-DSDV, Reactive Routing Protocols-DSR, AODV, Hybrid routing-ZRP, Multicast Routing-ODMRP, Vehicular AdHoc networks (VANET)-MANET vs VANET-Security.

**UNIT IV MOBILE TRANSPORT AND APPLICATION LAYER 9**

Mobile TCP-WAP-Architecture-WDP-WTLS-WTP-WSP-WAE-WTA Architecture -WML

**UNIT V MOBILE PLATFORMS AND APPLICATIONS 9**

Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone-MCommerce-Structure-Pros & Cons-Mobile Payment System-Security Issues

**TOTAL 45 PERIODS**

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## OUTCOMES:

At the end of the course, the students should be able to:

- Explain the basics of mobile telecommunication systems
- Illustrate the generation of telecommunication systems in wireless networks
- Determine the functionality of MAC, network layer and Identify a routing protocol for a given Ad hoc network
- Explain the functionality of Transport and Application layers
- Develop a mobile application using android/blackberry/ios/Windows SDK

## TEXTBOOKS:

1. Jochen Schiller, — Mobile Communications I, PHI, Second Edition, 2003.
2. Prasant Kumar Pattnaik, Rajib Mall, — Fundamentals of Mobile Computing I, PHI Learning Pvt. Ltd, New Delhi—2012

## REFERENCES

1. Dharma Prakash Agarwal, Qing and An Zeng, "Introduction to Wireless and Mobile systems", Thomson Asia Pvt Ltd, 2005.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, — Principles of Mobile Computing I, Springer, 2003.
3. William C. Y. Lee, — Mobile Cellular Telecommunications - Analog and Digital Systems I, Second Edition, Tata McGraw Hill Edition, 2006.
4. C.K. Toh, — Ad Hoc Mobile Wireless Networks I, First Edition, Pearson Education, 2002.
5. Android Developers: <http://developer.android.com/index.html>
6. Apple Developer: <https://developer.apple.com/>
7. Windows Phone DevCenter: <http://developer.windowsphone.com>
8. Black Berry Developer: <http://developer.blackberry.com>



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**COURSE OBJECTIVES:**

- To acquire the fundamental knowledge and to expose to the field of semiconductor theory and devices and their applications.
- To gain adequate understanding of semiconductor device modelling aspects, designing devices for electronic applications
- To acquire the fundamental knowledge of different semiconductor device modelling aspects.

**UNIT I MOS CAPACITORS**

9

Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in an MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Nonequilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon-Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown.

**UNIT II MOSFET DEVICES**

9

Long-Channel MOSFETs, Drain-Current Model, MOSFET I-V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source-Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields

**UNIT III CMOS DEVICE DESIGN**

9

CMOS Scaling, Constant-Field Scaling, Generalized Scaling, Nonscaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel Length, Physical Meaning of Effective Channel Length, Extraction of Channel Length by C-V Measurements.

**UNIT IV BIPOLAR DEVICES**

9

n-p-n Transistors, Basic Operation of a Bipolar Transistor, Modifying the Simple Diode Theory for Describing Bipolar Transistors, Ideal Current-Voltage Characteristics, Collector Current, Base Current, Current Gains, Ideal IC-VCE Characteristics, Characteristics of a Typical n-p-n Transistor, Effect of Emitter and Base Series Resistances, Effect of Base-Collector Voltage on Collector Current, Collector Current Falloff at High Currents, Nonideal Base Current at Low Currents, Bipolar Device Models for Circuit and Time-Dependent Analyses Basic dc Model, Basic ac Model, Small-Signal Equivalent-Circuit Model, Emitter Diffusion Capacitance, Charge-Control Analysis, Breakdown Voltages, Common-Base Current Gain in the Presence of Base-Collector Junction Avalanche, Saturation Currents in a Transistor.

**UNIT V MATHEMATICAL TECHNIQUES FOR DEVICE SIMULATIONS**

Poisson equation, continuity equation, drift-diffusion equation, Schrodinger equation, hydrodynamic equations, trap rate, finite difference solutions to these equations in 1D and 2D space, grid



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generation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1:** Explore the properties of MOS capacitors.

**CO2:** Analyze the various characteristics of MOSFET devices.

**CO3:** Describe the various CMOS design parameters and their impact on performance of the device.

**CO4:** Discuss the device level characteristics of BJT transistors.

**CO5:** Identify the suitable mathematical technique for simulation.



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**COURSE OBJECTIVES:**

- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using IoT
- To apply the concept of IOT in the real world scenario

**UNIT I INTRODUCTION AND ARCHITECTURE OF IoT 9**  
Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs - Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack.

**UNIT II INDUSTRIAL IoT 9**  
IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

**UNIT III IIOT ANALYTICS 9**  
Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop

**UNIT IV IOT SECURITY 9**  
Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT

**UNIT V CASE STUDY 9**  
Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, student will be able to

**CO1:** Understand the basic concepts and Architectures of Internet of Things.

**CO2:** Understand various IoT Layers and their relative importance.

**CO3:** Realize the importance of Data Analytics in IoT.

**CO4:** Study various IoT platforms and Security

**CO5:** Understand the concepts of Design Thinking.

  
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**COURSE OBJECTIVES:**

- Learn Embedded design challenges and design methodologies
- Study general and single purpose processor
- Understand bus structures
- Design a state machine and concurrent process models
- Know about Embedded software development tools and RTOS.

**UNIT I                    EMBEDDED SYSTEM OVERVIEW                    9**

Embedded System Overview, Design Challenges – Optimizing Design Metrics, Design Methodology, RT-Level Combinational and Sequential Components, Optimizing Custom Single-Purpose Processors.

**UNIT II                    GENERAL AND SINGLE PURPOSE PROCESSOR                    9**

Basic Architecture, Pipelining, Superscalar and VLIW architectures, Programmer's view, Development Environment, Application-Specific Instruction-Set Processors (ASIPs) Microcontrollers, Timers, Counters and watchdog Timer, UART, LCD Controllers and Analog-to-Digital Converters, Memory Concepts.

**UNIT III                    BUS STRUCTURES                    9**

Basic Protocol Concepts, Microprocessor Interfacing – I/O Addressing, Port and Bus-Based I/O, Arbitration, Serial Protocols, I2C, CAN and USB, Parallel Protocols - PCI and ARM Bus, Wireless Protocols - IrDA, Bluetooth, IEEE 802.11.

**UNIT IV                    STATE MACHINE AND CONCURRENT PROCESS MODELS                    9**


Basic State Machine Model, Finite-State Machine with Datapath Model, Capturing State Machine in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, Dataflow Model, Real-time Systems, Automation: Synthesis, Verification : Hardware/Software Co-Simulation, Reuse: Intellectual Property Cores, Design Process Models

**UNIT V                    EMBEDDED SOFTWARE DEVELOPMENT TOOLS AND RTOS                    9**

Compilation Process – Libraries – Porting kernels – C extensions for embedded systems – emulation and debugging techniques - RTOS - System design using RTOS.

**TOTAL : 45 PERIODS****SUGGESTED ACTIVITIES:**

- 1: Insist students to write a requirements form for a smart phone
- 2: Compare the use of different Microcontrollers for a particular ESD.
- 3: Application of a protocol for a specified application.
- 4: Write a Embedded C code for a given task.
- 5: design an embedded system for any type of real time application

  
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## PRACTICAL LIST:

### Exercise - 1

Comparative study of software development tools and design steps with respect to FPGA based and Non - FPGA based (defined logic) embedded system development.

(For Example: consider any Spartan FPGA board for FPGA based Embedded System Consider any cortex- M based board for Non - FPGA based Embedded system)

### Exercise - 2

Implement adder and decoder logic blocks in any one of the FPGA chip based development board.

### Exercise - 3

Design and development of UART protocol logic block in any one of FPGA chip based development board.

### Exercise - 4

Consider on board LEDS ( any four) and timer logic block of cortex- M board. Write a program which enables LEDS to glow in different timing.

### Exercise - 5

Consider on board switches and (2x16) LCD display develop a program which displays the status of switch activation.

### Exercise - 6

Demonstrate GPIO based I/O interfacing by considering LM 35 temperature sensor and cortex- M board.

### Exercise - 7

Development of one interfacing scheme which transmits data from one cortex- M board to another cortex- M board using on chip CAN logic blocks.

### Exercise - 8

Consider on board EPROM IC of Cortex- M board by utilizing on chip I2c logic block transmit data to EPROM IC and receive stored data from EPROM IC.

### Exercise - 9

Consider on board LEDs (4 Nos) of Cortex - M board. Demonstrate time management service concept of RTOS for glowing all four LEDS in different timings.

### Exercise - 10

Consider two ultrasonic sensors which are interfaced with cortex- M board. Both are located some distance ( 2 meters) apart vertically so that the system can identify the movement of object in term of distance. consider data reception and display of each sensor as two different tasks by RTOS. Establish a RTOS based system to recognize the height of moving object.

Objective:

- a. Able to understand embedded system design flow in FPGA chip based and Non - FPGA chip based embedded development boards.
- b. Able to create simple logic blocks in FPGA chip based boards.
- c. Able to understand interfacing scheme for Non - FPGA board scheme for Non - FPGA board
- d. Able to utilize RTOS functions for interfacing practice


## COURSE OUTCOMES:

At the end of the course the student will be:

**CO1:** Able to design an Embedded system

**CO2:** Understand a general and single purpose processor

**CO3:** Explain different protocols

  
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**COURSE OBJECTIVES:**

- To learn the core fundamentals of system and web security concepts
- To have thorough understanding in these security concepts related to networks
- To deploy these security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related issues

**UNIT I SYSTEM SECURITY 9**

Model of network security – Security attacks, services and mechanisms – OSI security architecture - A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications-Case study:OWASP-Top10WebApplicationSecurityRisks.

**UNIT II NETWORK SECURITY 9**

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

**UNIT III SECURITY MANAGEMENT 9**

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

**UNIT IV CYBER SECURITY AND CLOUD SECURITY 9**

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics–Mobile Forensics–Email Forensics-Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

**UNIT V PRIVACY AND STORAGE SECURITY 9**

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

**COURSE OUTCOMES:**

- CO1:** Understand the core fundamentals of system security  
**CO2:** Apply these security concepts to wired and wireless networks  
**CO3:** Implement and Manage these security essentials in IT Sector  
**CO4:** Explain the concepts of Cyber Security and Cyber forensics  
**CO5:** Be aware of Privacy and Storage security Issues.

**TOTAL: 45 PERIODS****REFERENCES**

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022

3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K. Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, "The Basics of Digital Forensics - The Primer for Getting Started in Digital Forensics", Syngress, 2012
6. Cory Altheide and Harlan Carvey, "Digital Forensics with Open Source Tools", 2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.



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**COURSE OBJECTIVES:**

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming models of Hadoop and Aneka

**UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines – Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization – Management Virtualization – Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization – Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

**UNIT II CLOUD PLATFORM ARCHITECTURE 12**

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software - A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

**UNIT III AWS CLOUD PLATFORM - IAAS 9**

**Amazon Web Services:** AWS Infrastructure - AWS API - AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes - AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS Code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS Control Tower, Cloud Formation, Cloud Trail, AWS License Manager

**UNIT IV PAAS CLOUD PLATFORM 9**

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure - Service Model and Managing Services: Definition and Configuration, Service runtime API - Windows Azure Developer Portal - Service Management API - Windows Azure Storage Characteristics - Storage Services - REST API - Blobs

**UNIT V PROGRAMMING MODEL 9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job – Developing Map Reduce Applications - Design of Hadoop file system – Setting up Hadoop Cluster - Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

### **COURSE OUTCOMES:**

- CO1:** Employ the concepts of virtualization in the cloud computing
- CO2:** Identify the architecture, infrastructure and delivery models of cloud computing
- CO3:** Develop the Cloud Application in AWS platform
- CO4:** Apply the concepts of Windows Azure to design Cloud Application
- CO5:** Develop services using various Cloud computing programming models.

**TOTAL: 45 PERIODS**

### **REFERENCES**

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia-Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly, 2010.
4. Rajkumar Buyya, Christian Vacchiola, S. Thamarai Selvi, Mastering Cloud Computing, McGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner's Guide, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W. Rittinghouse and James F. Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

### **COURSE OUTCOMES:**

- CO1:** Identify various concepts of mobile programming that make it unique from programming for other platforms
- CO2:** Create, test and debug Android application by setting up Android development
- CO3:** Demonstrate methods in storing, sharing and retrieving data in Android applications
- CO4:** Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces
- CO5:** Create interactive applications in Android using databases with multiple activities including audio, video and notifications and deploy them in marketplace

**TOTAL: 75 PERIODS**

### **REFERENCES**

1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)
2. Google Developer Training, "Android Developer Fundamentals Course—Concept Reference", Google Developer Training Team, 2017.
3. Prasanth Kumar Pattnaik, Rajib Mall, "Fundamentals of Mobile Computing", PHI Learning Pvt. Ltd, New Delhi-2012
4. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd, 2010
5. Mark L. Murphy, "Beginning Android", Wiley India Pvt Ltd, 2009
6. Dawn Griffiths and David Griffiths, "Head First Android Development", 1st Edition, O'Reilly SPD Publishers, 2015. ISBN-13: 978-9352131341

7. Erik Hellman, "Android Programming—Pushing the Limits", 1st Edition, Wiley India Pvt Ltd, 2014. ISBN-13: 978-8126547197.
8. Bill Phillips, Chris Stewart and Kristin Marsicano, "Android Programming: The Big Nerd Ranch Guide", 4th Edition, Big Nerd Ranch Guides, 2019. ISBN-13: 978-0134706054



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CP4151

**ADVANCED DATA STRUCTURES AND ALGORITHMS**

LTPC  
3003

**COURSE OBJECTIVES:**

- To understand the usage of algorithms in computing
- To learn and use hierarchical data structures and its operations
- To learn the usage of graphs and its applications
- To select and design data structures and algorithms that is appropriate for problems
- To study about NP Completeness of problems.

**UNIT I      ROLE OF ALGORITHMS IN COMPUTING & COMPLEXITY ANALYSIS      9**

Algorithms – Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic analysis- Average and worst-case analysis-Asymptotic notation-Importance of efficient algorithms- Program performance measurement - Recurrences: The Substitution Method – The Recursion-Tree Method-Data structures and algorithms.

**UNIT II      HIERARCHICAL DATA STRUCTURES      9**

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion - B-Trees: Definition of B-trees – Basic operations on B-Trees – Deleting a key from a B-Tree-Heap – Heap Implementation – Disjoint Sets - Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node- Bounding the maximum degree.

**UNIT III      GRAPHS      9**

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm

**UNIT IV      ALGORITHM DESIGN TECHNIQUES      9**

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

**UNIT V      NP COMPLETE AND NP HARD      9**

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP-Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

**TOTAL: 45 PERIODS**

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### SUGGESTED ACTIVITIES:

1. Write an algorithm for Towers of Hanoi problem using recursion and analyze the complexity (No of disc-4)
2. Write any one real time application of hierarchical data structure
3. Write a program to implement Make\_Set, Find\_Set and Union functions for Disjoint Set Data Structure for a given undirected graph  $G(V,E)$  using the linked list representation with simple implementation of Union operation
4. Find the minimum cost to reach last cell of the matrix from its first cell
5. Discuss about any NP completeness problem

### COURSE OUTCOMES:

**CO1:** Design data structures and algorithms to solve computing problems.


**CO2:** Choose and implement efficient data structures and apply them to solve problems. **CO3:** Design algorithms using graph structure and various string-matching algorithms to solve real-life problems.

**CO4:** Design one's own algorithm for an unknown problem.

**CO5:** Apply suitable design strategy for problem solving.

### REFERENCES

1. S. Sridhar, "Design and Analysis of Algorithms", Oxford University Press, 1st Edition, 2014.
2. Adam Drozdex, "Data Structures and Algorithms in C++", Cengage Learning, 4th Edition, 2013.
3. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, "Introduction to Algorithms", Prentice Hall of India, 3rd Edition, 2012.
4. Mark Allen Weiss, "Data Structures and Algorithms in C++", Pearson Education, 3rd Edition, 2009.
5. E. Horowitz, S. Sahni and S. Rajasekaran, "Fundamentals of Computer Algorithms", University Press, 2nd Edition, 2008.
6. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.

  
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**COURSE OBJECTIVES**

- Describe the fundamental elements of relational database management systems
- Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
- Understand query processing in a distributed database system
- Understand the basics of XML and create well-formed and valid XML documents.
- Distinguish the different types of NoSQL databases
- To understand the different models involved in database security and their applications in real time world to protect the database and information associated with them.

**UNIT I RELATIONAL DATA MODEL**

15

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization.

**Suggested Activities:**

Data Definition Language

- Create, Alter and Drop
- Enforce Primary Key, Foreign Key, Check, Unique and Not Null Constraints
- Creating Views

Data Manipulation Language

- Insert, Delete, Update
- Cartesian Product, Equi Join, Left Outer Join, Right Outer Join and Full Outer Join
- Aggregate Functions
- Set Operations
- Nested

Queries

Transaction Control Language

Language

- Commit, Rollback and Save Points

**UNIT II DISTRIBUTED DATABASES, ACTIVE DATABASES AND OPEN DATABASE CONNECTIVITY**

15

Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Event Condition Action Model – Design and Implementation Issues for Active Databases – Open Database Connectivity.

**Suggested Activities:**

- Distributed Database Design and Implementation
- Row Level and Statement Level Triggers
- Accessing a Relational Database using PHP, Python and R

**UNIT III XML DATABASES**

15

Structured, Semistructured, and Unstructured Data—XML Hierarchical Data Model—XML Documents—DocumentTypeDefinition—XMLSchema—XMLDocumentsandDatabases— XMLQuerying—XPath—XQuery

**SuggestedActivities:**

- Creating XML Documents, Document Type Definition and XMLSchema
- Using a Relational Database to store the XML documents as text
- Using a Relational Database to store the XML documents as data elements
- Creating or publishing customized XML documents from pre-existing relational databases
- Extracting XML Documents from Relational Databases
- XML Querying

**UNITIV NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS**

15

NoSQL—Categories of NoSQL Systems—CAP Theorem—Document-Based NoSQL Systems and MongoDB – MongoDB Data Model – MongoDB Distributed Systems Characteristics – NoSQL Key-Value Stores – DynamoDB Overview – Voldemort Key-Value Distributed Data Store – Wide Column NoSQL Systems—Hbase Data Model—Hbase Crud Operations—Hbase Storage and Distributed System Concepts –NoSQL Graph Databases and Neo4j – Cypher Query Language of Neo4j—BigData—MapReduce—Hadoop—YARN.

**SuggestedActivities:**

- Creating Databases using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j. Writing simple queries to access databases created using MongoDB, DynamoDB, Voldemort Key-Value Distributed Data Store Hbase and Neo4j.

**UNITV DATABASE SECURITY**

15

Database Security Issues—Discretionary Access Control Based on Granting and Revoking Privileges –Mandatory Access Control and Role-Based Access Control for Multilevel Security – SQL Injection—Statistical Database Security—Flow Control—Encryption and Public Key Infrastructures—Preserving Data Privacy—Challenges to Maintaining Database Security— Database Survivability – Oracle Label-Based Security.

**SuggestedActivities:**

Implementing Access Control in Relational Databases

**TOTAL: 75 PERIODS**

**COURSE OUTCOMES**

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

**CO1:** Convert the ER-model to relational tables, populate relational databases and formulate SQL queries on data.

**CO2:** Understand and write well-formed XML documents

**CO3:** Be able to apply methods and techniques for distributed query processing.

**CO4:** Design and implement secured database systems.

**CO5:** Use the data control, definition, and manipulation languages of the NoSQL databases

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**REFERENCES:**

1. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education 2016.
2. HenryF.Korth,AbrahamSilberschatz,S.Sudharshan,"DatabaseSystemConcepts", Seventh Edition, McGraw Hill, 2019.
3. C.J.Date,A.Kannan,S.Swamynathan,"AnIntroductiontoDatabaseSystems,Eighth Edition, Pearson Education, 2006
4. RaghuRamakrishnan , JohannesGehrke  
"DatabaseManagementSystems",Fourth Edition, McGraw Hill Education, 2015.
5. Harrison, Guy, "Next Generation Databases, NoSQL and Big Data" , First Edition, Apresspublishers, 2015
6. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Sixth Edition, Pearson Education, 2015



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CP4153

**NETWORK TECHNOLOGIES**

LTPC  
3003

**COURSE OBJECTIVES:**

- To understand the basic concepts of networks
- To explore various technologies in the wireless domain
- To study about 4G and 5G cellular networks
- To learn about Network Function Virtualization
- To understand the paradigm of Software defined networks

**UNIT I NETWORKING CONCEPTS 9**

Peer To Peer Vs Client-Server Networks. Network Devices. Network Terminology. Network Speeds. Network throughput, delay. Osi Model. Packets, Frames, And Headers. Collision And Broadcast Domains. LAN Vs WAN. Network Adapter. Hub. Switch. Router. Firewall, IP addressing.

**UNIT II WIRELESS NETWORKS 9**

Wireless access techniques- IEEE 802.11a, 802.11g, 802.11e, 802.11n/ac/ax/ay/ba/be, QoS – Bluetooth – Protocol Stack – Security – Profiles – zigbee

**UNIT III MOBILE DATA NETWORKS 9**

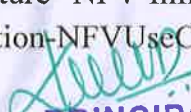
4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Concepts of 5G – channel access – air interface – Cognitive Radio spectrum management – C-RAN architecture - Vehicular communications-protocol – Network slicing – MIMO, mmWave, Introduction to 6G.

**UNIT IV SOFTWARE DEFINED NETWORKS 9**

SDN Architecture. Characteristics of Software-Defined Networking. SDN- and NFV-Related Standards. SDN Data Plane. Data Plane Functions. Data Plane Protocols. OpenFlow Logical Network Device. Flow Table Structure. Flow Table Pipeline. The Use of Multiple Tables. Group Table. OpenFlow Protocol. SDN Control Plane Architecture. Control Plane Functions. Southbound Interface. Northbound Interface. Routing. ITU-T Model. OpenDaylight. OpenDaylight Architecture. OpenDaylight Helium. SDN Application Plane Architecture. Northbound Interface. Network Services Abstraction Layer. Network Applications. User Interface.

**UNIT V NETWORK FUNCTIONS VIRTUALIZATION 9**

Motivation-Virtual Machines –NFV benefits-requirements–architecture- NFV Infrastructure - Virtualized Network Functions-NFV Management and Orchestration-NFV Use Cases-NFV and SDN–Network virtualization –VLAN and VPN

  
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**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

CO1: Explain basic networking concepts

CO2: Compare different wireless networking protocols

CO3: Describe the developments in each generation of mobile data networks CO4:

Explain and develop SDN based applications

CO5: Explain the concepts of network function virtualization

**SUGGESTED ACTIVITIES:**

1. Execute various network utilities such as traceroute, pathping, ipconfig
2. Implement the Software Defined Networking using Mininet
3. Implement routing in Mininet
4. Install a virtual machine and study network virtualization
5. Simulate various network topologies in Network Simulator

**REFERENCES**

1. James Bernstein, "Networking made Easy", 2018. (UNIT1)
2. Houda Labiod, Costantinode Santis, Hossam Afifi "Wi-Fi, Bluetooth, Zigbee and WiMax", Springer 2007 ( UNIT2)
3. Erik Dahlman, Stefan Parkvall, Johan Skold, 4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2013 (UNIT3)



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**COURSE OBJECTIVES:**

- To Understand the Architectural Overview of IoT
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To Understand the various IoT levels
- To understand the basics of cloud architecture
- To gain experience in Raspberry Pi and experiments simple IoT application on it

**UNIT I INTRODUCTION**

9+6

Internet of Things- Domain Specific IoTs - IoT and M2M-Sensors for IoT Applications-Structure of IoT-IoT Map Device-IoT System Management with NETCONF-YANG

**UNIT II IOT ARCHITECTURE, GENERATIONS AND PROTOCOLS**

9+6

IETF architecture for IoT - IoT reference architecture -First Generation-Description & Characteristics-Advanced Generation - Description & Characteristics-Integrated IoT Sensors - Description & Characteristics

**UNIT III IOT PROTOCOLS AND TECHNOLOGY**

9+6

SCADA and RFID Protocols-BACnet Protocol-Zigbee Architecture-6LowPAN-CoAP-Wireless Sensor Structure-Energy Storage Module-Power Management Module-RF Module-Sensing Module

**UNIT IV CLOUD ARCHITECTURE BASICS**

9+6

The Cloud types; IaaS, PaaS, SaaS.-Development environments for service development; Amazon, Azure, Google App cloud platform in industry

**UNIT V IOT PROJECTS ON RASPBERRY PI**

9+6

Building IOT with RASPBERRY PI- Creating the sensor project - Preparing Raspberry Pi - Clayster libraries-Hardware Interacting with the hardware -Interfacing the hardware-Internal representation of sensor values - Persisting data - External representation of sensor values - Exporting sensor data

**SUGGESTED ACTIVITIES:**

1. Develop an application for LED Blink and Pattern using Arduino or Raspberry Pi
2. Develop an application for LED Pattern with Push Button Control using Arduino or Raspberry Pi
3. Develop an application for LM35 Temperature Sensor to display temperature values using arduino or Raspberry Pi
4. Develop an application for Forest fire detection end node using Raspberry Pi device and sensor
5. Develop an application for home intrusion detection web application
6. Develop an application for Smart parking application using python and Django for web application




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**COURSE OUTCOMES:**

- CO1:** Understand the various concepts of the IoT and their technologies  
**CO2:** Develop the IoT application using different hardware platforms  
**CO3:** Implement the various IoT Protocols  
**CO4:** Understand the basic principles of cloud computing  
**CO5:** Develop and deploy the IoT application into a cloud environment

**TOTAL: 75 PERIODS****REFERENCES:**

1. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on approach, Universities Press, 2015
2. Dieter Uckelmann, Mark Harrison, Florian Michahelles (Eds), Architecting the Internet of Things, Springer, 2011
3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
4. Ovidiu Vermesan, Peter Friess, 'Internet of Things—From Research and Innovation to Market Deployment', River Publishers, 2014
5. N. Ida, Sensors, Actuators and Their Interfaces: A Multidisciplinary Introduction, 2nd Edition Scitech Publishers, 202014
6. Reese, G. (2009). Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. Sebastopol, CA: O'Reilly Media, Inc. (2009)



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**COURSE OBJECTIVES:**

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

**UNIT I INTRODUCTION AND MATHEMATICAL FOUNDATIONS**

9

What is Machine Learning? Need—History—Definitions—Applications-Advantages, Disadvantages & Challenges-Types of Machine Learning Problems—Mathematical Foundations- Linear Algebra & Analytical Geometry -Probability and Statistics- Bayesian Conditional Probability- Vector Calculus & Optimization-Decision Theory-Information theory

**UNIT II SUPERVISED LEARNING**

9

Introduction-Discriminative and Generative Models-Linear Regression-Least Squares-Under-fitting /Overfitting -Cross-Validation—Lasso Regression-Classification -Logistic Regression-Gradient Linear Models -Support Vector Machines -Kernel Methods -Instance based Methods - K-Nearest Neighbors - Tree based Methods -Decision Trees -ID3—CART - Ensemble Methods -Random Forest-Evaluation of Classification Algorithms

**UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING**

9

I  
Introduction - Clustering Algorithms -K—Means—Hierarchical Clustering - Cluster Validity - Dimensionality Reduction -Principal Component Analysis—Recommendation Systems -EM algorithm.Reinforcement Learning—Elements-Model based Learning—Temporal Difference Learning

**UNIT IV PROBABILISTIC METHODS FOR LEARNING**

9

V  
Introduction-Naïve Bayes Algorithm-Maximum Likelihood-Maximum A priori-Bayesian Belief Networks-Probabilistic Modelling of Problems-Inference in Bayesian Belief Networks—Probability Density Estimation - Sequence Models - Markov Models - Hidden Markov Models

**UNIT V NEURAL NETWORKS AND DEEP LEARNING**

9

Neural Networks—Biological Motivation-Perceptron—Multi-layer Perceptron—Feed Forward Network - Back Propagation-Activation and Loss Functions- Limitations of Machine Learning - Deep Learning— Convolution Neural Networks - Recurrent Neural Networks - Use cases

**45 PERIODS****SUGGESTED ACTIVITIES:**


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1. Give an example from our daily life for each type of machine learning problem
2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN

**PRACTICAL EXERCISES:**

**30 PERIODS**

1. Implement a Linear Regression with a Real Dataset (<https://www.kaggle.com/harrywang/housing>). Experiment with different features in building a model. Tune the model's hyperparameters.
2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?" (use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.
3. Classification with Nearest Neighbors. In this question, you will use the scikit-learn's KNN classifier to classify real vs. fake news headlines. The aim of this question is for you to read the scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset
4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5. Implement the k-means algorithm using <https://archive.ics.uci.edu/ml/datasets/Codon+usage+dataset>
6. Implement the Naïve Bayes Classifier using <https://archive.ics.uci.edu/ml/datasets/Gait+Classification+dataset>
7. Project-(in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.
  - a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.
  - b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.
  - c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
  - d. You must properly provide references to any work that is not your own in the write-up.
  - e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.



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List of Projects (datasets available)

1. Sentiment Analysis of Product Reviews
2. Stock Prediction
3. Sales Forecasting
4. Music Recommendation
5. Handwriting Digit Classification
6. Fake News Detection
7. Sports Prediction
8. Object Detection
9. Disease Prediction

**COURSE OUTCOMES:**

**Upon the completion of course, students will be able to**

**CO1:** Understand and outline problems for each type of machine learning

**CO2:** Design a Decision tree and Random forest for an application

**CO3:** Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.


**CO4:** Use a tool to implement typical Clustering algorithms for different types of applications.

**CO5:** Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification.

**TOTAL: 75 PERIODS**

**REFERENCES**

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.
2. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
3. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
4. Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
5. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
6. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015
7. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
8. Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
9. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online)
10. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition", O'Reilly, (2017)

  
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**COURSE OBJECTIVES:**

- To understand the rationale for software development process models
- To understand why the architectural design of software is important;
- To understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience.
- To understand the basic notions of a web service, web service standards, and service-oriented architecture;
- To understand the different stages of testing from testing during development of a software system

**UNIT I SOFTWARE PROCESS & MODELING 9**

Prescriptive Process Models – Agility and Process – Scrum – XP – Kanban – DevOps – Prototype Construction – Prototype Evaluation – Prototype Evolution – Modelling – Principles – Requirements Engineering – Scenario-based Modelling – Class-based Modelling – Functional Modelling – Behavioural Modelling.

**UNIT II SOFTWARE DESIGN 9**

Design Concepts – Design Model – Software Architecture – Architectural Styles – Architectural Design – Component-Level Design – User Experience Design – Design for Mobility – Pattern-Based Design.

**UNIT III SYSTEM DEPENDABILITY AND SECURITY 9**

Dependable Systems – Dependability Properties – Sociotechnical Systems – Redundancy and Diversity – Dependable Processes – Formal Methods and Dependability – Reliability Engineering – Availability and Reliability – Reliability Requirements – Fault-tolerant Architectures – Programming for Reliability – Reliability Measurement – Safety Engineering – Safety-critical Systems – Safety Requirements – Safety Engineering Processes – Safety Cases – Security Engineering – Security and Dependability – Safety and Organizations – Security Requirements – Secure System Design – Security Testing and Assurance – Resilience Engineering – Cybersecurity – Sociotechnical Resilience – Resilient Systems Design.

**UNIT IV SERVICE-ORIENTED SOFTWARE ENGINEERING, SYSTEMS ENGINEERING AND REAL-TIME SOFTWARE ENGINEERING 9**

Service-oriented Architecture – RESTful Services – Service Engineering – Service Composition – Systems Engineering – Sociotechnical Systems – Conceptual Design – System Procurement – System Development – System Operation and Evolution – Real-time Software Engineering – Embedded System Design – Architectural Patterns for Real-time Software – Timing Analysis – Real-time Operating Systems.

**UNIT V SOFTWARE TESTING AND SOFTWARE CONFIGURATION MANAGEMENT 9**

Software Testing Strategy – Unit Testing – Integration Testing – Validation Testing – System

Testing—Debugging—White-Box Testing—Basis Path Testing—Control Structure Testing—Black-Box Testing—Software Configuration Management (SCM)—SCM Repository—SCM Process – Configuration Management for Web and Mobile Apps.

### SUGGESTED ACTIVITIES

1. Comparatively analysing different Agile methodologies.
2. Describing the scenarios where 'Scrum' and 'Kanban' are used.
3. Mapping the data flow into suitable software architecture.
4. Developing behavioural representations for a class or component.
5. Implementing simple applications as RESTful service.

**TOTAL: 45 PERIODS**

### COURSE OUTCOMES:

The Students will be able to

**CO1:** Identify appropriate process models based on the Project requirements

**CO2:** Understand the importance of having a good Software Architecture.


**CO3:** Understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience.

**CO4:** Understand the basic notions of a web service, web service standards, and service-oriented architecture;

**CO5:** Be familiar with various levels of Software testing

### REFERENCES:

1. Software Engineering: A Practitioner's Approach, 9<sup>th</sup> Edition. Roger Pressman and Bruce Maxim, McGraw-Hill 2019.
2. Software Engineering, 10<sup>th</sup> Edition, Ian Sommerville, Pearson Education Asia 2016.
3. Software Architecture In Practice, 3<sup>rd</sup> Edition, Len Bass, Paul Clements and Rick Kazman, Pearson India 2018
4. An integrated approach to Software Engineering, 3<sup>rd</sup> Edition, Pankaj Jalote, Narosa Publishing House, 2018
5. Fundamentals of Software Engineering, 5<sup>th</sup> Edition, Rajib Mall, PHI Learning Private Ltd, 2018

  
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MF5101

**ADVANCES IN MANUFACTURING TECHNOLOGY**

**L T P C**  
**3 0 0 3**

**OBJECTIVE:**

- The students are expected to understand special machining processes, unconventional machining processes, micro machining process, nano fabrication processes and rapid prototyping.

**UNIT I UNCONVENTIONAL MACHINING 10**

Introduction-Bulk processes - surface processes- Plasma Arc Machining- Laser Beam Machining- Electron Beam Machining-Electrical Discharge Machining – Electro chemical Machining-Ultrasonic Machining- Water Jet Machining-Electro Gel Machining-Anisotropic machining-Isotropic machining-Elastic Emission machining – Ion Beam Machining.

**UNIT II PRECISION MACHINING: 10**

Ultra Precision turning and grinding: Chemical Mechanical Polishing (CMP) - ELID process – Partial ductile mode grinding-Ultra precision grinding- Binderless wheel – Free form optics. aspherical surface generation Grinding wheel- Design and selection of grinding wheel-High-speed grinding-High-speed milling- Diamond turning.

**UNIT III ADVANCES IN METAL FORMING 7**

Orbital forging, Isothermal forging, Warm forging, Overview of Powder Metal techniques –Hot and Cold isostatic pressing - high speed extrusion, rubber pad forming, Hydroforming, Superplastic forming, Peen forming-micro blanking –Powder rolling – Tooling and process parameters.

**UNIT IV MICRO MACHINING AND NANO FABRICATION 10**

Theory of micromachining-Chip formation-size effect in micromachining-microturning, micromilling, microdrilling- Micromachining tool design-Micro EDM-Microwire EDM-Nano fabrication:LIGA, Ion beam etching, Molecular manufacturing techniques –Atomic machining- Nano machining techniques – Top/Bottom up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum dot fabrication techniques – MOCVD – Epitaxy techniques.

**UNIT V RAPID PROTOTYPING AND SURFACE MODIFICATION TECHNIQUES 8**

Introduction – Classification – Principle advantages limitations and applications- Stereo lithography – Selective laser sintering –FDM, SGC, LOM, 3D Printing-Surface modification Techniques: Sputtering-CVD-PVD-Diamond like carbon coating-Plasma Spraying Technique.-Diffusion coatings-Pulsed layer deposition.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of this course the students are expected

1. to produce useful research output in machining of various materials
2. use this knowledge to develop hybrid machining techniques
3. Application of this knowledge to manage shop floor problems

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**OBJECTIVES:**

This course will enable the Student

- To gain knowledge about the basic fundamental of CAD.
- To gain knowledge on how computers are integrated at various levels of planning and manufacturing understand computer aided planning and control and computer monitoring.

**UNIT I COMPUTER AIDED DESIGN**

9

Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate, typical CAD command structure, wire frame modeling, surface modeling and solid modeling (concepts only) in relation to popular CAD packages.

**UNIT II COMPONENTS OF CIM**

9

CIM as a concept and a technology, CASA/Sme model of CIM, CIM II, benefits of CIM, communication matrix in CIM, fundamentals of computer communication in CIM – CIM data transmission methods – serial, parallel, asynchronous, synchronous, modulation, demodulation, simplex and duplex. Types of communication in CIM – point to point (PTP), star and multiplexing. Computer networking in CIM – the seven layer OSI model, LAN model, MAP model, network topologies – star, ring and bus, advantages of networks in CIM

**UNIT III GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING**

9

History Of Group Technology – role of G.T in CAD/CAM Integration – part families- classification and coding – DCLASS and MCLASS and OPTIZ coding systems – facility design using G.T – benefits of G.T – cellular manufacturing. Process planning - role of process planning in CAD/CAM

**UNIT IV SHOP FLOOR CONTROL AND INTRODUCTION TO FMS**

9

Shop floor control – phases – factory data collection system – automatic identification methods – Bar code technology – automated data collection system.  
FMS – components of FMS – types – FMS workstation – material handling and storage system – FMS layout- computer control systems – applications and benefits.

**UNIT V COMPUTER AIDED PLANNING AND CONTROL AND COMPUTER MONITORING**

9

Production planning and control – cost planning and control – inventory management – material requirements planning (MRP) – shop floor control. Lean and Agile Manufacturing. Types of production monitoring systems – structure model of manufacturing – process control and strategies – direct digital control.


**OUTCOMES:**

At the end of this course the students are expected

1. to produce useful research output in computer integrated manufacturing
2. use this knowledge to develop computer techniques
3. Application of this knowledge to functionalise computer aided planning.

**TOTAL: 45 PERIODS****REFERENCES:**

1. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education second edition, 2005. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice hall of India Pvt. Ltd., 2005.
2. James A. Regh and Henry W. Kreabber, "Computer Integrated Manufacturing", Pearson Education second edition, 2005.
3. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education 2001.

  
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CM5251

**ADVANCES IN METROLOGY AND INSPECTION**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To teach the students basic concepts in various methods of engineering measurement techniques and applications, understand the importance of measurement and inspection in manufacturing industries.
- To make the students capable of learning to operate and use advanced metrological devices with ease in industrial environments.

**UNIT I CONCEPTS OF METROLOGY: 8**  
Terminologies – Standards of measurement – Errors in measurement – Interchangeability and Selective assembly – Accuracy and Precision – Calibration of instruments – Basics of Dimensional metrology and Form metrology

**UNIT II MEASUREMENT OF SURFACE ROUGHNESS: 9**  
Definitions – Types of Surface Texture: Surface Roughness Measurement Methods- Comparison, Contact and Non Contact type roughness measuring devices, 3D Surface Roughness Measurement, Nano Level Surface Roughness Measurement – Instruments.

**UNIT III INTERFEROMETRY: 8**  
Introduction, Principles of light interference – Interferometers – Measurement and Calibration – Laser Interferometry.

**UNIT IV MEASURING MACHINES AND LASER METROLOGY: 10**  
Tool Makers Microscope – Microhite – Coordinate Measuring Machines – Applications – Laser Micrometer, Laser Scanning gauge, Computer Aided Inspection techniques - In-process inspection, Machine Vision system-Applications.

**UNIT V IMAGE PROCESSING FOR METROLOGY: 10**  
Overview, Computer imaging systems, Image Analysis, Preprocessing, Human vision system, Image model, Image enhancement, gray scale models, histogram models, Image Transforms - Examples.


**TOTAL: 45 PERIODS**

**OUTCOMES:**

- At the end of this course the students are expected to
1. Understand the advanced measurement principles with ease.
  2. Operate sophisticated measurement and inspection facilities.
  3. Design and develop new measuring methods.

**REFERENCES**

1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., 1992.
2. Bewoor, A.K. and Kulkarni, V.A., "Metrology and Measurement", Tata Mc Graw-Hill, 2009.
3. Galyer, F.W. and Shotbolt, C.R., "Metrology for engineers", ELBS, 1990.
4. Gupta, I.C., "A Text Book of engineering metrology", Dhanpat Rai and Sons, 1996.
5. Jain, R.K., "Engineering Metrology", Khanna Publishers, 2008.
6. Rajput, R.K., "Engineering Metrology and Instrumentations", Kataria & Sons Publishers, 2001.

  
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**OBJECTIVE:**

This course aims to impart knowledge on various techniques of material characterization.

**UNIT I MICRO AND CRYSTAL STRUCTURE ANALYSIS**

10

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

**UNIT II ELECTRON MICROSCOPY**

9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications .

**UNIT III CHEMICAL AND THERMAL ANALYSIS**

9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravimetric Analysis (TGA)

**UNIT IV MECHANICAL TESTING – STATIC TESTS**

8

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

**UNIT V MECHANICAL TESTING – DYNAMIC TESTS**

9


Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

**TOTAL: 45 PERIODS****OUTCOMES:**

At the end of this course the students are expected to be knowledgeable in microstructure evaluation, crystal structure analysis, electron microscopy, Chemical Thermal Analysis, static and dynamic mechanical testing methods.

**REFERENCES:**

1. ASM Hand book-Materials characterization, Vol – 10, 2004.
2. Cullity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3<sup>rd</sup> Edition). Prentice Hall, 2001.
3. Davis J. R., Tensile Testing, 2<sup>nd</sup> Edition, ASM International, 2004.
4. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4<sup>th</sup> Edition), McGraw Hill, College Divn., 1982.

  
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PX5101

**POWER SEMICONDUCTOR DEVICES**

L T P C  
3 0 0 3

**OBJECTIVES:**

- To improve power semiconductor device structures for adjustable speed motor control applications.
- To understand the static and dynamic characteristics of current controlled power semiconductor devices
- To understand the static and dynamic characteristics of voltage controlled power semiconductor devices
- To enable the students for the selection of devices for different power electronics applications
- To understand the control and firing circuit for different devices.

**UNIT I INTRODUCTION 9**

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

**UNIT II CURRENT CONTROLLED DEVICES 9**

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor- Basics of GTO, MCT, FCT, RCT

**UNIT III VOLTAGE CONTROLLED DEVICES 9**

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs -and IGCT. New semiconductor materials for devices – Intelligent power modules- Integrated gate commutated thyristor (IGCT) - omparison of all power devices.

**UNIT IV FIRING AND PROTECTING CIRCUITS 9**

Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.

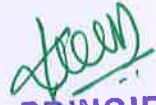
**UNIT V THERMAL PROTECTION 9**

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance –Electrical analogy of thermal components, heat sink types and design – Mounting types- switching loss calculation for power device.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Ability to determine the suitable device for the application.
- Ability to design of semiconductor device and its parameters.

  
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PS5092

**SOLAR AND ENERGY STORAGE SYSTEMS**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To Study about solar modules and PV system design and their applications
- To Deal with grid connected PV systems
- To Discuss about different energy storage systems

**UNIT I INTRODUCTION**

**9**

Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell properties – PV cell interconnection

**UNIT II STAND ALONE PV SYSTEM**

**9**

Solar modules – storage systems – power conditioning and regulation - MPPT- protection –stand alone PV systems design – sizing

**UNIT III GRID CONNECTED PV SYSTEMS**

**9**

PV systems in buildings – design issues for central power stations – safety – Economic aspect –Efficiency and performance - International PV programs

**UNIT IV ENERGY STORAGE SYSTEMS**

**9**

Impact of intermittent generation – Battery energy storage – solar thermal energy storage –pumped hydroelectric energy storage

**UNIT V APPLICATIONS**

**9**

Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Students will develop more understanding on solar energy storage systems
- Students will develop basic knowledge on standalone PV system
- Students will understand the issues in grid connected PV systems



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PX5071

**WIND ENERGY CONVERSION SYSTEMS**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed and variable speed, wind energy conversionsystems.
- To analyze the grid integration issues.

**UNIT I INTRODUCTION**

**9**

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory- Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine.

**UNIT II WIND TURBINES**

**9**

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control- stall control-Schemes for maximum power extraction.

**UNIT III FIXED SPEED SYSTEMS**

**9**

Generating Systems- Constant speed constant frequency systems -Choice of Generators- Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.

**UNIT IV VARIABLE SPEED SYSTEMS**

**9**

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling  
- Variable speed variable frequency schemes.

**UNIT V GRID CONNECTED SYSTEMS**


**9**

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Acquire knowledge on the basic concepts of Wind energy conversion system.
- Understand the mathematical modeling and control of the Wind turbine

  
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PX5202

**SOLID STATE DRIVES**

L T P C  
3 2 0 4

**OBJECTIVES:**

- To study and analyze the operation of the converter / chopper fed DC drives, both qualitatively and quantitatively.
- To familiarize the students on the operation of VSI and CSI fed induction motor drives.
- To understand the field oriented control of induction machines.
- To impart knowledge on the control of synchronous motor drives

**UNIT I RECTIFIER CONTROL OF DC DRIVES**

9

Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics. Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with freewheeling diode; Implementation of braking schemes; Drive employing dual converter.

**UNIT II CHOPPER CONTROL OF DC DRIVES**

9

Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motor – performance analysis, multi-quadrant control - Chopper based implementation of braking schemes; Multi-phase chopper; Related problems.

**UNIT III CONTROL OF INDUCTION MOTOR DRIVES- STATOR**

**SIDE AND ROTOR SIDE**

9

AC voltage controller circuit – six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed variable frequency drives – comparison Static rotor resistance control - injection of voltage in the rotor circuit – static Scherbius drives - power factor considerations – modified Kramer drives

**UNIT IV FIELD ORIENTED CONTROL OF INDUCTION MOTOR DRIVES**

9

Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy.

**UNIT V SYNCHRONOUS MOTOR DRIVES**

9


Wound field cylindrical rotor motor – Equivalent circuits – performance equations for operation from a voltage source – starting and braking - V curves - Self control-margin angle control-torque control-power factor control-Brushless excitation systems

**TOTAL : 45+30 = 75 PERIODS**

**OUTCOMES:**

Students,

- Will be able to formulate, design and analyze power supplies for generic loads and machine loads.
- Will acquire knowledge on the operation of VSI and CSI fed induction motor drives.

  
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**OBJECTIVES:**

- To provide knowledge about the stand alone and grid connected renewable energysystems.
- To equip with required skills to derive the criteria for the design of power converters forrenewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generatorsand solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to ACconverters for renewable energy systems.
- To develop maximum power point tracking algorithms

**UNIT I INTRODUCTION**

9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) -Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems : operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

**UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION**

9

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

**UNIT III POWER ELECTRONICS FOR SOLAR**

9

Block diagram of solar photo voltaic system : line commutated converters (inversion-mode) - Boost and buck-boost converters-selection of inverter, battery sizing, array sizing- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

**UNIT IV POWER ELECTRONICS FOR WIND**

9

Three phase AC voltage controllers-AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, matrix converters- Stand alone operation of fixed and variable speed wind energy conversion systems- Grid connection Issues -Grid integrated PMSG and SCIG Based WECS.

**UNIT V HYBRID RENEWABLE ENERGY SYSTEMS**

9


Need for Hybrid Systems -Range and type of Hybrid systems-Case studies of Wind-PV- Maximum Power Point Tracking (MPPT).

TOTAL : 45 PERIODS

**COURSE OUTCOMES**

After completion of this course, the student will be able to:

- Analyze the impacts of renewable energy generation on environment.
- Understand the importance and qualitative analysis of solar and wind energy sources.

  
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**OBJECTIVES:**

- To learn the fundamentals of data modeling and design in advanced databases.
- To study the working principles of distributed databases.
- To have an introductory knowledge about the query processing in object-based databases and its usage.
- To understand the basics of spatial,temporal and mobile databases and their applications.
- To learn emerging databases such as XML,Datawarehouse and NoSQL.

**UNIT I      DISTRIBUTED DATABASES      9**

Distributed Systems–Introduction–Architecture–Distributed Database Concepts–Distributed Data Storage–Distributed Transactions–Commit Protocols–Concurrency Control–Distributed Query Processing

**UNIT II      NOSQL DATABASES      9**

NoSQL– CAP Theorem – Sharding- Document based– MongoDB Operation: Insert,Update, Delete, Query, Indexing, Application, Replication, Sharding, Deployment – UsingMongoDB with PHP / JAVA – Advanced MongoDB Features – Cassandra: Data Model, KeySpace, Table Operations, CRUD Operations, CQL Types – HIVE: Data types, DatabaseOperations,Partitioning–HiveQL–OrientDBGraphdatabase–OrientDBFeatures

**UNITIII      ADVANCED DATABASE SYSTEMS      9**

Object Oriented Databases-Need for Complex DataTypes-The Object-Oriented DataModel-Object-Oriented Languages-Spatial Databases:Spatial DataTypes,Spatial Relationships, Spatial Data Structures, Spatial Access Methods– Temporal Databases:Overview – Active Databases – Deductive Databases – Recursive Queries in SQL – Mobile Databases: Location and Handoff Management, Mobile Transaction Models, Concurrency –Transaction Commit Protocols–Multimedia Databases.

**UNITIV      XMLANDDATAWAREHOUSE      9**

XML Database: XML – XML Schema – XML DOM and SAX Parsers – XSL – XSLT – XPath and XQuery – Data Warehouse: Introduction – Multidimensional Data Modeling – Star and Snowflake Schema–Architecture–OLAP Operations and Queries.

**UNITV      INFORMATIONRETRIEVALANDWEBSEARCH      9**

IR concepts – Retrieval Models – Queries in IR system – Text Preprocessing – Inverted Indexing – Evaluation Measures – Web Search and Analytics – Ontology based Search – Current trends.


## OUTCOMES:

On completion of the course, the student will be able to:

- Design a distributed database system and execute distributed queries.
- Use NoSQL database systems and manipulate the data associated with it.
- Design a data warehouse system and apply OLAP operations.
- Design XML database systems and validating with XML schema.
- Apply knowledge of information retrieval concepts on web databases.

## REFERENCES:

- Henry F. Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", 6<sup>th</sup> Edition, McGraw Hill, 2011.
- R. Elmasri, S. B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education/Addison Wesley, 2017.
- C. J. Date, A. Kannan, S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.
- Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", Third Edition, Morgan Kaufmann, 2012.
- Brad Dayley, "Teach Yourself NoSQL with MongoDB in 24 Hours", Sams Publishing, First Edition, 2014.
- Shashank Tiwari, "Professional NoSQL", O'Reilly Media, First Edition, 2011.
- Vijay Kumar, "Mobile Database Systems", John Wiley & Sons, First Edition, 2006

  
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**OBJECTIVES:**

- To understand the basic concepts of Distributed systems
- To learn about the current trend and basics of Cloud computing
- To be familiar with various Cloud concepts
- To expose with the Server, Network and storage virtualization
- To be aware of Micro services and DevOps

**UNIT I DISTRIBUTED SYSTEMS 9**

Introduction to Distributed Systems – Characterization of Distributed Systems – Distributed Architectural Models – Remote Invocation – Request-Reply Protocols – Remote Procedure Call – Remote Method Invocation – Group Communication – Coordination in Group Communication – Ordered Multicast – Time Ordering – Physical Clock Synchronization – Logical Time and Logical Clocks

**UNIT II INTRODUCTION TO CLOUD COMPUTING 9**

Cloud Computing Basics – Desired features of Cloud Computing – Elasticity in Cloud – On demand provisioning - Applications – Benefits – Cloud Components: Clients, Datacenters & Distributed Servers – Characterization of Distributed Systems – Distributed Architectural Models – Principles of Parallel and Distributed computing – Applications of Cloud computing – Benefits – Cloud services – Open source Cloud Software: Eucalyptus, Open Nebula, Openstack, Aneka, Cloudsim.

**UNIT III CLOUD INFRASTRUCTURE 9**

Cloud Architecture and Design – Architectural design challenges – Technologies for Network based system - NIST Cloud computing Reference Architecture – Public, Private and Hybrid clouds – Cloud Models: IaaS, PaaS and SaaS – Cloud storage providers - Enabling Technologies for the Internet of Things – Innovative Applications of the Internet of Things.

**UNIT IV CLOUD ENABLING TECHNOLOGIES 9**

Service Oriented Architecture – Web Services – Basics of Virtualization – Emulation – Types of Virtualization – Implementation levels of Virtualization – Virtualization structures – Tools & Mechanisms – Virtualization of CPU, Memory & I/O Devices – Desktop Virtualization – Server Virtualization – Google App Engine – Amazon AWS – Federation in the Cloud.

**UNIT V MICRO SERVICES AND DEVOPS 9**

Defining Micro services – Emergence of Micro service Architecture – Design patterns of Micro services – The Mini web service architecture – Micro service dependency tree – Challenges with Micro services - SOA vs Micro service – Micro service and API – Deploying and maintaining Micro services – Reason for having DevOps – Overview of DevOps – History of DevOps – Concepts and terminology in DevOps – Core elements of DevOps – Lifecycle of DevOps – Adoption of DevOps – DevOps Tools – Build, Promotion and Deployment in DevOps – DevOps in Business Enterprises.

**OUTCOMES:**

Upon completion of the course the students will be able to

- Use Distributed systems in Cloud Environment
- Articulate the main concepts, key technologies, strengths and limitations of Cloud computing
- Identify the Architecture, Infrastructure and delivery models of Cloud computing
- Install, choose and use the appropriate current technology for the implementation of Cloud
- Adopt Micro services and DevOps in Cloud environment

**REFERENCES:**

1. Kai Hwang, Geoffrey C. Fox & Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, First Edition, 2012
2. Andrew S. Tanenbaum & Maarten Van Steen, "Distributed Systems - Principles and Paradigms", Second Edition, Pearson Prentice Hall, 2006
3. Thomas Erl, Zaigham Mahood & Ricardo Puttini, "Cloud Computing, Concept, Technology & Architecture", Prentice Hall, Second Edition, 2013
4. Richard Rodger, "The Tao of Microservices", ISBN 9781617293146, Manning Publications, First Edition, December 2017.
5. Magnus Larsson, "Hands-On Micro services with Spring Boot and Spring Cloud: Build and deploy micro services using spring cloud, Istio and kubernetes", Packt Publishing Ltd, First Edition, September 2019.
6. Jim Lewis, "DEVOPS: A complete beginner's guide to DevOps best practices", ISBN-13: 978-1673259148, ISBN-10: 1673259146, First Edition, 2019.



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**COURSE OBJECTIVES:**

- To understand the fundamentals of web programming and client side scripting.
- To learn the server side development using servlets, websocket.
- To learn the Spring framework and build applications using Spring.
- To learn and implement the concept of Java Persistence API.
- To learn the advanced client side scripting and framework.

**UNIT I INTRODUCTION TO WEB&CLIENT SIDE PROGRAMMING 9**

Introduction to Web: Server - Client - Communication Protocol (HTTP), JavaScript: Data Types and Variables - Expressions - Operators and Statements - Objects and Arrays - Functions-Classes-Modules-DOM-Events-Storage :Local Storage, Cookies, Indexed DB,JSON,AJAX

**UNIT II SERVER SIDE PROGRAMMING 9**

Web Server: Web Containers - Web Components, Servlet: Lifecycle - Request – Servlet Context - Response - Filter - Session - Dispatching Requests, Web Socket, Logging - Log4j2,Buildtool-Gradle.Introduction to Spring:IoC Container and Dependency Injection(DI)

**UNIT III SPRING 9**

Spring Configuration and Spring Boot, Spring MVC: Dispatcher Servlet and Configuration - Interceptors - Controllers - Views - Input Validation - File Upload, Building RESTfull Web Services, Spring Security Architecture, Spring Cache.


**UNIT IV JAVA PERSISTENCE API AND HIBERNATE 9**

Entity : Basic,Embeddable and Collection Types-Identifiers-Entity Relationship-Inheritance, Persistence Context and Entity Manager, JPQL, Criteria API, Spring Data JPA –Specification and Projection.

**UNIT V ADVANCED CLIENT SIDE PROGRAMMING 9**

Asynchronous JavaScript: Callbacks - Promises - async and await, React JS: React DOM - JSX-Components-Properties-State and Life cycle-Events-Lifting State Up-Composition and Inheritance-Higher Order Components.

**TOTAL: 45 PERIODS**

  
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**Course Outcomes:**

Upon completion of the course the students should be able to:

- To write client side scripting.
- To implement the server side of the web application.
- To implement Web Application using Spring.
- To implement a Java application using Java Persistence API.
- To implement a full-stack Single Page Application using React, Spring and JPA.

**REFERENCE BOOKS:**

- David Flanagan, "Java Script: The Definitive Guide", O'Reilly Media, Inc, 7th Edition, 2020
- Matt Frisbie, "Professional JavaScript for Web Developers", Wiley Publishing, Inc, 4th Edition, ISBN: 978-1-119-36656-0, 2019
- Alex Banks, Eve Porcello, "Learning React", O'Reilly Media, Inc, 2nd Edition, 2020  
<https://reactjs.org/docs>
- David R. Heffelfinger, "Java EE 8 Application Development", Packt Publishing, First edition 2017
- Benjamin Muschko, "Gradle in Action", Manning Publications, First edition 2014
- Iuliana Cosmina, Rob Harrop, Chris Schaefer, Clarence Ho, "Pro Spring 5: An In-Depth Guide to the Spring Framework and Its Tools", Apress, Fifth edition 2017
- Christian Bauer, Gavin King, and Gary Gregory, "Java Persistence with Hibernate", Manning Publications, 2nd Edition, 2015

  
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**OBJECTIVES:**

- To familiarize with the principles of Artificial intelligence like problem solving, inference, perception, knowledge representation, and learning.
- To understand the various characteristics of Intelligent agents
- To design and implement the machine learning techniques for real world problems
- To gain experience in doing research using Artificial intelligence and Machine learning techniques.

**UNIT I ARTIFICIAL INTELLIGENCE**

9

Foundation of AI-History of AI-State of Art.-Intelligent Agents: Agents and Environments- Concepts of Rationality-Nature of Environments-Structure of Agents. Problem Solving: Problem Solving by Search: Problem Solving Agents-Searching for Solutions-Uniform Search Strategies-Heuristic Search Strategies- local Search Algorithms and Optimization Problems.

**UNIT II KNOWLEDGE AND REASONING**

9

Logical Agents: Knowledge Based Agents-Logic-Propositional Logic-Propositional Theorem Proving-Model Checking-Agent based on Propositional Logic. First-Order Logic: Syntax and Semantics- Using First-Order Logic-Knowledge Engineering. Inference in First-Order Logic:Prepositional Vs. First-Order Inference-Unification and Lifting-Forward Chaining-Backward Chaining -Resolution.

**UNIT III BAYESIAN LEARNING**

9

Basic Probability Notation- Inference – Independence - Bayes' Rule. Bayesian Learning: Maximum Likelihood and Least Squared error hypothesis-Maximum Likelihood hypotheses for predicting probabilities- Minimum description Length principle -Bayes optimal classifier - Naïve Bayes classifier - Bayesian Belief networks - EM algorithm.

**UNIT IV PARAMETRIC MACHINE LEARNING**

9

Logistic Regression: Classification and representation – Cost function – Gradient descent – Advanced optimization – Regularization - Solving the problems on over fitting. Perceptron – Neural Networks – Multi – class Classification – Back propagation – Non-linearity with activation functions (Tanh, Sigmoid, Relu, PRelu) - Dropout as regularization.

k- Nearest Neighbors- Decision Trees – Branching – Greedy Algorithm - Multiple Branches – Continuous attributes – Pruning. Random Forests:ensemble learning. Boosting – Adaboost algorithm. Support Vector Machines – Large Margin Intuition – Loss Function - Hinge Loss – SVM Kernels.


**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Apply the techniques of Problem Solving in Artificial Intelligence.
- Implement Knowledge and Reasoning for real world problems.
- Model the various Learning features of Artificial Intelligence
- Analyze the working model and features of Decision tree
- Apply k-nearest algorithm for appropriate research problem.

**REFERENCES:**

- Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach” , ThirdEdition Pearson Education Limited, 2015
- CalumChace , “Surviving AI: The Promise and Peril of Artificial Intelligence”, Three CSpublication, Second Edition, 2015.
- Christopher M Bishop, “Pattern Recognition and Machine Learning”, Spring 2011 Edition.
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, “The Elements of Statistical Learning: Data Mining, Inference and Prediction”, Springer 2<sup>nd</sup> Edition
- EthemAlpaydin, "Introduction to Machine Learning", Second Edition, MIT Press, 2010.
- Tom M. Mitchell, “Machine Learning”, India Edition, 1<sup>st</sup> Edition, McGraw-Hill EducationPrivate Limited, 2013
- Elaine Rich, Kevin Knight, Shivashankar B. Nair, “Artificial Intelligence”, Third Edition,Tata McGraw-Hill Education, 2012

  
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**OBJECTIVES:**

- To know the fundamental concepts of data science and analytics.
- To learn fundamental data analysis using R.
- To understand various data modeling techniques.
- To learn the basic and advanced features of open source big data tools and frameworks.
- To study various analytics on stream data.

**UNIT I INTRODUCTION TO DATA SCIENCE AND BIG DATA 9**

Introduction to Data Science – Data Science Process – Exploratory Data analysis – Big data: Definition, Risks of Big Data, Structure of Big Data – Web Data: The Original Big Data – Evolution Of Analytic Scalability – Analytic Processes and Tools – Analysis versus Reporting Core Analytics versus Advanced Analytics– Modern Data Analytic Tools – Statistical Concepts: Sampling Distributions – Re-Sampling – Statistical Inference – Introduction to Data Visualization.

**UNIT II DATA ANALYSIS USING R 9**

Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis – Bivariate Analysis: Correlation – Regression Modeling: Linear and Logistic Regression – Multivariate Analysis – Graphical representation of Univariate, Bivariate and Multivariate Analysis in R: Bar Plot, Histogram, Box Plot, Line Plot, ScatterPlot, Lattice Plot, Regression Line, Two-Way cross Tabulation.

**UNIT III DATA MODELING 9**

Bayesian Modeling – Support Vector and Kernel Methods – Neuro – Fuzzy Modeling – Principal Component Analysis – Introduction to NoSQL: CAP Theorem, MongoDB: RDBMS Vs MongoDB, Mongo DB Database Model, Data Types and Sharding – Data Modeling in HBase: Defining Schema – CRUD Operations

**UNIT IV DATA ANALYTICAL FRAMEWORKS 10**

Introduction to Hadoop: Hadoop Overview – RDBMS versus Hadoop – HDFS (Hadoop Distributed File System): Components and Block Replication – Introduction to MapReduce – Running Algorithms Using MapReduce – Introduction to HBase: HBase Architecture, HLog and HFile, Data Replication – Introduction to Hive, Spark and Apache Sqoop.

## UNIT V STREAM ANALYTICS

8

Introduction To Streams Concepts – Stream Data Model and Architecture – Stream Computing – Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window.

**TOTAL: 45 PERIODS**

### OUTCOMES:

- On completion of the course, the students will be able to:
- Convert real world problems to hypothesis and perform statistical testing.
- Perform data analysis using R.
- Design efficient modeling of very large data and work with big data platforms..
- Implement suitable data analysis for stream data.
- Write efficient Map Reduce programs for small problem solving methods.

### REFERENCES:

- Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons, First Edition, 2013.
- Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, First Edition, 2017.
- J. Leskovec, AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, Second Edition, 2014.
- NishantGarg, “HBase Essentials”, Packt, First Edition, 2014.
- Rachel Schutt, Cathy O'Neil, “Doing Data Science”, O'Reilly, First Edition, 2013
- Foster Provost, Tom Fawcet, “Data Science for Business”, O'Reilly, First Edition, 2013.
- Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley, First Edition, 2014.
- <https://www3.cs.stonybrook.edu/~skiena/519/>



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**COURSE OBJECTIVE:**

- To introduce the concepts of scarcity and efficiency; to explain principles of micro economics relevant to managing an organization; to describe principles of macroeconomics to have the understanding of economic environment of business.

**UNIT I INTRODUCTION**

9

The themes of economics – scarcity and efficiency – three fundamental economic problems – society's capability – Production possibility frontiers (PPF) – Productive efficiency Vs economic efficiency – economic growth & stability – Micro economies and Macro economies – the role of markets and government – Positive Vs negative externalities.

**UNIT II CONSUMER AND PRODUCER BEHAVIOUR**

9

Market – Demand and Supply – Determinants – Market equilibrium – elasticity of demand and supply – consumer behaviour – consumer equilibrium – Approaches to consumer behaviour – Production – Short-run and long-run Production Function – Returns to scale – economies Vs diseconomies of scale – Analysis of cost – Short-run and long-run cost function – Relation between Production and cost function.

**UNIT III PRODUCT AND FACTOR MARKET**

9

Product market – perfect and imperfect market – different market structures – Firm's equilibrium and supply – Market efficiency – Economic costs of imperfect competition – factor market – Land, Labour and capital – Demand and supply – determination of factor price – Interaction of product and factor market – General equilibrium and efficiency of competitive markets.

**UNIT IV PERFORMANCE OF AN ECONOMY – MACRO ECONOMICS**

9

Macro-economic aggregates – circular flow of macroeconomic activity – National income determination – Aggregate demand and supply – Macroeconomic equilibrium – Components of aggregate demand and national income – multiplier effect – Demand side management – Fiscal policy in theory.

**UNIT V AGGREGATE SUPPLY AND THE ROLE OF MONEY**

9

Short-run and Long-run supply curve – Unemployment and its impact – Okun's law – Inflation and the impact – reasons for inflation – Demand Vs Supply factors – Inflation Vs Unemployment tradeoff – Phillips curve – short- run and long-run – Supply side Policy and management- Money market- Demand and supply of money – money-market equilibrium and national income – the role of monetary policy.

**TOTAL: 45PERIODS****COURSE OUTCOMES:**

- To introduce the concepts of scarcity and efficiency;
- 2. To explain principles of microeconomics relevant to managing an organization
- 3. To describe principles of macroeconomics
- 4. To have the understanding of economic environment of business.
- 5. To study about the policies that regulate economic variables

**REFERENCES:**

1. Paul A. Samuelson, William D. Nordhaus, Sudip Chaudhuri and Anindya Sen, Economics, 19<sup>th</sup> edition, Tata McGraw Hill, New Delhi, 2011
2. William Boyes and Michael Melvin, Textbook of economics, Biztantra, 7<sup>th</sup> edition 2008.
3. N. Gregory Mankiw, Principles of Economics, 8<sup>th</sup> edition, Thomson learning, New Delhi, 2017.
4. Richard Lipsey and Alec Chrystal, Economics, 13<sup>th</sup> edition, Oxford, University Press, New Delhi, 2015.
5. Karl E. Case and Ray C. Fair, Principles of Economics, 12<sup>th</sup> edition, Pearson, Education Asia, New Delhi, 2017.
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**REFERENCES :**

1. N. D. Kapoor, Elements of Mercantile Law, Sultan Chand and Company, India, 2017.
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3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill,, 6th Edition 2018.
4. Ravinder Kumar, Legal Aspects of Business, New Delhi: Cengage Learning, 4 th edition, 2016.
5. Sinha P.K, Dr. Vinod Singhania, Text Book of Indirect Tax, Taxman Publication, New Delhi
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7. P. P. S. Gogna, Mercantile Law, S. Chand & Co. Ltd., India, Fourth Edition, 2015.
8. Dr. Vinod K. Singhania, Direct Taxes Planning and Management, 11 th, 2007.
9. Richard Stim, Intellectual Property- Copy Rights, Trade Marks, and Patents, Cengage Learning, 15 th edition 2017.
10. Daniel Albuquerque, Legal Aspect of Business, Oxford,2 nd edition, 2017
11. Ravinder Kumar– Legal Aspect of Business.– Cengage Learning, 4 th Edition-2016.
- 12.V.S. Datey, GST Ready Reckoner, 9 th edition, 2019

**BA4106**

**INFORMATION MANAGEMENT**

**L T P C**  
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the importance of information in business
- To know about the recent information systems and technologies.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Data, Information, Information System, evolution, types based on functions and hierarchy, Enterprise and functional information systems.		
<b>UNIT II</b>	<b>SYSTEM ANALYSIS AND DESIGN</b>	<b>10</b>
System development methodologies, Systems Analysis and Design, Data flow Diagram (DFD), Decision table, Entity Relationship (ER), Object Oriented Analysis and Design(OOAD), UML diagram.		
<b>UNIT III</b>	<b>DATABASE MANAGEMENT SYSTEMS</b>	<b>8</b>
DBMS – types and evolution, RDBMS, OODBMS, RODBMS, Data warehousing, Data Mart, Data mining.		
<b>UNIT IV</b>	<b>INTEGRATED SYSTEMS, SECURITY AND CONTROL</b>	<b>9</b>
Knowledge based decision support systems, Integrating social media and mobile technologies in Information system, Security, IS Vulnerability, Disaster Management, Computer Crimes, Securing the Web.		
<b>UNIT V</b>	<b>NEW IT INITIATIVES</b>	<b>9</b>
Introduction to Deep learning, Big data, Pervasive Computing, Cloud computing, Advancements in AI, IoT, Block chain, Crypto currency, Quantum computing		
<b>TOTAL : 45 PERIODS</b>		

**COURSE OUTCOMES:**

1. Learn the basics of data and information system.
2. Understand the system development methodologies.
3. Understand database management system and its types.
4. Learn the various technologies in information system and its security.
5. Gains knowledge on effective applications of information systems in Business.

  
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### COURSE OUTCOMES:

1. Identify the concepts of financial decision of an organisation
2. Recognize the time value of money
3. Learn the capital budgeting and cost of capital techniques
4. Understand how to decide the decision of capital structure and distribution of dividend
5. Assess the short-term and long-term sources of finance

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1. I M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd., 11th edition, 2018
2. M.Y. Khan and P.K.Jain Financial management, Text, Problems and cases Tata McGraw Hill, 8th edition, 2017.
1. AswathDamodaran, Corporate Finance Theory and practice, John Wiley & Sons, 2011.
2. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning, 13th Edition, 2014.
3. Brigham, Ehrhardt, Financial Management Theory and Practice, 14th edition, Cengage Learning 2015.
4. Prasanna Chandra, Financial Management, 9th edition, Tata McGraw Hill, 2017.
5. Srivatsava, Mishra, Financial Management, Oxford University Press, 2012.

BA4203

HUMAN RESOURCE MANAGEMENT

L T P C  
3 0 0 3

### COURSE OBJECTIVE:

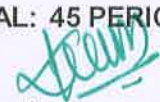
- To provide knowledge about management issues related to staffing, training, performance, compensation, human factors consideration and compliance with human resource requirements.

<b>UNIT I</b>	<b>PERSPECTIVES IN HUMAN RESOURCE MANAGEMENT</b>	<b>9</b>
Evolution of human resource management – The importance of the human capital – Role of human resource manager –Challenges for human resource managers - trends in Human resource policies – Computer applications in human resource management – Human resource accounting and audit.		
<b>UNIT II</b>	<b>HUMAN RESOURCE PLANNING AND RECRUITMENT</b>	<b>9</b>
Importance of Human Resource Planning – Forecasting human resource requirement –matching supply and demand - Internal and External sources- Organizational Attraction-. Recruitment, Selection, Induction and Socialization- Theories, Methods and Process.		
<b>UNIT III</b>	<b>TRAINING AND DEVELOPMENT</b>	<b>9</b>
Types of training methods –purpose- benefits- resistance. Executive development programme – Common practices - Benefits – Self development – Knowledge management.		
<b>UNIT IV</b>	<b>EMPLOYEE ENGAGEMENT</b>	<b>9</b>
Compensation plan – Reward – Motivation – Application of theories of motivation – Career management – Mentoring - Development of mentor – Protégé relationships- Job Satisfaction, Employee Engagement, Organizational Citizenship Behavior: Theories, Models.		
<b>UNIT V</b>	<b>PERFORMANCE EVALUATION AND CONTROL</b>	<b>9</b>
Method of performance evaluation – Feedback – Industry practices. Promotion, Demotion, Transfer and Separation – Implication of job change. The control process – Importance – Methods – Requirement of effective control systems grievances – Causes – Implications – Redressal methods.		

TOTAL: 45 PERIODS

### COURSE OUTCOMES:

1. Students would have gained knowledge on the various aspects of HRM
2. Students will gain knowledge needed for success as a human resources professional.
3. Students will develop the skills needed for a successful HR manager
4. Students would be prepared to implement the concepts learned in the workplace.
5. Students would be aware of the emerging concepts in the field of HRM

  
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**COURSE OBJECTIVES:**

- To understand the changing business environment and the fundamental premise underlying market driven strategies.
- To identify the indicators of management thoughts and practices.

**UNIT I INTRODUCTION**

9

Defining Marketing – Core concepts in Marketing – Evolution of Marketing – Marketing Planning Process – Scanning Business environment: Internal and External – Value chain – Core Competencies – PESTEL – SWOT Analysis – Marketing interface with other functional areas – Production, Finance, Human Relations Management, Information System – Marketing in global environment – International Marketing – Rural Marketing – Prospects and Challenges.

**UNIT II MARKETING STRATEGY**

9

Marketing strategy formulations – Key Drivers of Marketing Strategies – Strategies for Industrial Marketing – Consumer Marketing – Services marketing – Competition Analysis – Analysis of consumer and industrial markets – Influence of Economic and Behavioral Factors – Strategic Marketing Mix components.

**UNIT III MARKETING MIX DECISIONS**

9

Product planning and development – Product life cycle – New product Development and Management – Defining Market Segmentation – Targeting and Positioning – Brand Positioning and Differentiation – Channel Management – Managing Integrated Marketing Channels – Managing Retailing, Wholesaling and Logistics – Advertising and Sales Promotions – Pricing Objectives, Policies and Methods

**UNIT IV BUYER BEHAVIOUR**

9

Understanding Industrial and Consumer Buyer Behavior – Influencing factors – Buyer Behaviour Models – Online buyer behaviour – Building and measuring customer satisfaction – Customer relationships management – Customer acquisition, Retaining, Defection – Creating Long Term Loyalty Relationships.

**UNIT V MARKETING RESEARCH & TRENDS IN MARKETING**

9

Marketing Information System – Marketing Research Process – Concepts and applications: Product – Advertising – Promotion – Consumer Behaviour – Retail research – Customer driven organizations – Cause related marketing – Ethics in marketing – Online marketing trends - social media and digital marketing

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

1. Applied knowledge of contemporary marketing theories to the demands of business and management practice.
2. Enhanced knowledge of marketing strategies for consumer and industrial marketing
3. Deep understanding of choice of marketing mix elements and managing integrated marketing channels
4. Ability to analyze the nature of consumer buying behaviour
5. Understanding of the marketing research and new trends in the arena of marketing

**REFERENCES:**

1. Philip T. Kotler and Kevin Lane Keller, Marketing Management, Prentice Hall India, 15th Edition, 2017.
2. KS Chandrasekar, "Marketing management-Text and Cases", Tata McGraw Hill Education, 2012
3. Lamb, Hair, Sharma, Mc Daniel– Marketing – An Innovative approach to learning and teaching- A south Asian perspective, Cengage Learning, 2012.
4. Paul Baines, Chris Fill, Kelly Page, Marketing, Asian edition, Oxford University Press, 5th edition, 2019.
5. Ramasamy, V.S, Namakumari, S, Marketing Management: Global Perspective Indian Context, Macmillan Education, New Delhi, 6th edition, 2018.
6. A. NAG, Marketing successfully- A Professional Perspective, Macmillan 2008.
7. Micheal R. Czinkota, Masaaki Kotabe, Marketing Management, Vikas Thomson Learning, 2nd edition 2006.
8. Philip Kotler, Gay Armstrong, Prafulla Agnihotri, Principles of marketing, 7th edition, 2018.

**COURSE OBJECTIVE:**

- To understand the International Financial Environment, Management and Risks involved.

**UNIT I INTERNATIONAL TRANSACTIONS 9**

Overview and Evolution of International Finance –Institutions for International Finance – Internationalization process –International Monetary and Financial System – Balance of Payments – Exchange rate and money supply – International parity relations – Purchasing power parity – interest rate parity – Forward rate parity.

**UNIT II MULTINATIONAL FINANCIAL MANAGEMENT 9**

Process of overseas expansion – Reasons for cross-border investing – The theory of investment – techniques of project evaluation - Approaches for investment under uncertainty - FDI – Measuring and Managing Risk – International M&A – Financial Techniques in M&A – Regulations of M&A in major countries.

**UNIT III INTERNATIONAL MONETARY SYSTEM 9**

Introduction to Institutions of the Foreign Exchange Interbank Market - Foreign Exchange Spot Transactions – forward market — Hedging and Speculation – Hedging FX Transaction Exposure - The Eurocurrency market – international banking – structure and instruments

**UNIT IV BORROWING AND LENDING : INTERNATIONAL SOURCES OF FINANCE 9**

Bond Markets of various countries – Fixed and floating rate notes - Syndicate loans – Syndicated Eurocredits – ADR – GDR – Managing interest rate risk – Bond prices and yields – Bond Management – tools and techniques

**UNIT V INTERNATIONAL RISK ASSESSMENT AND OTHER INTERNATIONAL MARKETS 9**


Country and political risk analysis – benefits and risks of international portfolio investment – assessing country creditworthiness – futures markets and instruments – option markets and instruments – option pricing – option pricing theory in financial risk assessment

**TOTAL :45 PERIODS****COURSE OUTCOMES:**

1. Learn about evolution, process and system of International Finance
2. Identify the concepts of international merger and acquisitions, financial techniques and regulations
3. Understand about international monetary system
4. Knowing about ADR, GDR and bond management
5. Explore the learning in international risk assessment

**REFERENCES :**

1. Apte P.G., International Financial Management, Tata McGraw Hill, 2011.
2. Jeff Madura, International Corporate Finance, Cengage Learning, 9th Edition, 2011.
3. Alan C. Shapiro, Multinational Financial Management, PHI Learning, 5th Edition, 2010.
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**COURSE OBJECTIVE:**

- To study and understand the consumer' behavior in-order to effectively utilise the market' potential

**UNIT I INTRODUCTION**

9

Understanding Consumer behaviour - Consumption, Consumer orientation, Interpretive and Quantitative approaches - Effects of Technology, Demographics and Economy on Consumer behaviour.

**UNIT II INTERNAL INFLUENCES**

9

Influences on consumer behavior – motivation – perception – Attitudes and Beliefs - Learning and Experience - Personality & Self Image.

**UNIT III EXTERNAL INFLUENCES**

9

Socio-Cultural, Cross Culture - Family group – Reference group – Communication - Influences on Consumer behavior

**UNIT IV CONSUMER BEHAVIOR MODELS**

9

Traditional and Contemporary Consumer behaviour model for Individual and industrial buying behaviour and decision making.

**UNIT V PURCHASE DECISION PROCESS**

9

Consumer decision making process – Steps, Levels and decision rules - Evolving Indian consumers – Opinion Leadership - Diffusion and Adoption.

**TOTAL: 45 PERIODS****COURSE OUTCOMES:**

The student understands

1. Consumer orientation and consumption
2. Intrinsic influences
3. Effects of external influences
4. Models of consumer and industrial buying
5. The decision making process

**REFERENCES:**

1. RamanujMajumdar, Consumer Behaviour - Insights from Indian Market, PHI, 2010.
2. Leon G.Schiffman and Leslie LasarKanuk, Consumer Behavior, Pearson Education, India, ninth edition, 2010.
3. Barry J.B., Eric G.H., Ashutosh M., Consumer Behaviour - A South Asian Perspective, Cengage Learning, 2016.
4. Paul Peter et al., Consumer Behavior and Marketing Strategy, Tata McGraw Hill, Indian Edition, 7th Edition 2005.

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BA4011

SERVICES MARKETING

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COURSE OBJECTIVE:

- To appreciate the challenges involved in managing the services and analyse the strategies to deal with these challenges.
- To give insights about the foundations of services marketing, customer expectations of services and gap existing in the service delivery processes and service Quality.

UNIT I INTRODUCTION

9

Introduction– Definition– Service Economy – Evolution and growth of service sector – Nature and Scope of Services–Difference between services and tangible products– Unique characteristics of services– Challenges and issues in Services Marketing.

UNIT II SERVICE MARKETING OPPORTUNITIES

9

Assessing service market potential – Classification of services – Expanded marketing mix – Service marketing – Environment and trends – Service market segmentation, targeting and positioning.

UNIT III SERVICE DESIGN AND DEVELOPMENT

9

Service Life Cycle – New service development – Service Blue Printing – GAP model of service quality – Measuring service quality – SERVQUAL – Service Quality function development.

UNIT IV SERVICE DELIVERY AND PROMOTION

9

Positioning of services – Designing service delivery System, Service Channel – Pricing of services, methods – Service marketing triangle – Managing demand, Managing supply, managing Demand and Supply of Service–Integrated Service marketing communication.

UNIT V SERVICE STRATEGIES

9

Service Marketing Strategies for Health – Hospitality – Tourism – Financial – Logistics– Educational – Marketing of Online Services–Entertainment & public utility Information technique Services

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of the course students will be able to:

1. Demonstrate an extended understanding of the similarities and differences in service-based and physical product based marketing activities
2. Develop and justify marketing planning and control systems appropriate to service-based activities
3. Demonstrate integrative knowledge of marketing issues associated with service productivity, perceived quality, customer satisfaction and loyalty
4. Develop blueprint for the services sector and develop a better appreciation of the necessary strategies to create a service excellence.
5. Recognise the challenges faced in services delivery as outlined in the services gap model

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1. Chiristopher H. Lovelock and JochenWirtz, Services Marketing: People, Technology, strategy Pearson Education, New Delhi, 8<sup>th</sup> edition, 2016.
2. John.E.G.Bateson, K.Douglas Hoffman, Services Marketing, South Western Cengage learning, 4<sup>th</sup> Edition, 2011.
3. Kenneth E Clow, et al, Services Marketing Operation Management and Strategy, Biztantra, 2<sup>nd</sup> Edition, New Delhi, 2004.
4. Valarie Zeithaml et al, Services Marketing, 5<sup>th</sup> International Edition, Tata McGraw Hill, 2007.
5. Christian Gronroos, Services Management and Marketing a CRM in Service Competition, 3<sup>rd</sup>Edition,Wiley,2007.
6. R. Srinivasan, SERVICES MARKETING, Prentice Hall of India Private Limited,4<sup>th</sup> Edition 2014, New Delhi.
7. Vinnie Jauhari&kirti Dutta (2017), Services Marketing, Text and cases, 2<sup>nd</sup> edition.

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