

Research Methodology Syllabus

Research Methodology: An Introduction,. Defining the Research Problem, Research Design, Sampling Design,. Measurement and Scaling Techniques, Methods of Data Collection, literature survey and techniques introduction to performance evaluation; common mistakes in performance analysis and how to avoid them; measurement techniques and tools :

Introduction to experimental design, common mistakes in experimentation, types of experimental designs, verification and validation of simulation model and mathematical models The Art of Experimentation, planning an experiment

model building; Introduction to simulation and modeling verification of simulation models; mathematical modelling and statistical methods: probability theory and statistics, summarizing measured data,, basic probability and statistics concepts, selecting among the mean, median, and mode, common misuses of means, geometric mean, harmonic mean, comparing systems using sample data,

Processing and Analysis of Data, Sampling Fundamentals,

sample versus population, confidence interval for the mean, Testing of Hypotheses-I (Parametric or 184 Standard Tests of Hypotheses),

hypothesis testing versus confidence intervals, Monitors, How to write research papers, Technical writing, Testing of Hypotheses-I , Chi-square Test, Analysis of Variance and Covariance, Multivariate Analysis Techniques,

commonly used distributions:

: bernoulli distribution, beta distribution, binomial distribution, chi-square distribution, erlang distribution, exponential distribution, f distribution, gamma distribution, geometric distribution, lognormal distribution, negative binomial distribution, normal distribution, pareto distribution, pascal distribution, poisson distribution, student's t distribution, uniform distribution (continuous), uniform distribution (discrete), weibull distribution, relationships among distributions

Interpretation and Report Writing, Technical writing

Reference Books:

1. Raj Jain, "The Art of Systems Performance Analysis", Wiley- India, 1991.
2. Dean et al., Design and Analysis of Experiments, Springer Texts in Statistics, DOI 10.1007/978-3-319-52250-0_2
3. C.R. Kothari, "Research Methodology, Methods and Techniques" New Age publishers

Computer Science and Engineering

1. Database Management System

Components of DBMS and overall structure of DBMS, Data modeling, Entity, Attributes, Relationships, Constraints, Keys E-R diagrams, Components of E-R Model.

Relational Model: Basic concepts, Attributes and domains, Concept of integrity and referential constraints, Schema diagram. Relational query languages, Relational Algebra and Relational Calculus:

, DDL, DML and DCL Tables: creating, modifying, deleting, Views: creating, dropping, Updation, using views, DML, Operators, SQL DML queries, SELECT query and clauses, Set operations, Predicates and joins, Set membership, Tuple variables, Set comparison, Ordering of tuples, Aggregate functions, Nested queries,

Query Processing and Transaction Management: Measures of query cost, Selection operation, Sorting and join operation, Transaction concept, Components of transaction management, Concurrency and recovery system, Different concurrency control protocols such as timestamps and locking, Validation, Multiple granularity,

2. Operating Systems

Operating System Structures Definition, Types of operating system, Real time operating system, System components, System services, Systems calls,

Processes and CPU scheduling, process synchronization, Memory management Virtual memory, File management, File systems structure and allocation methods, disk scheduling.

Deadlocks : Systems model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock, Combined approach to deadlock handling.

3. Design and Analysis of Algorithms

Asymptotic Notations, Recursion, Recurrences Relation, Substitution Method, Iterative Method, Recursion Tree, Master Theorem, Changing Variable, Heap Sort.

Divide and Conquer: Binary Search, Merge Sort, Quick Sort, Strassen's Matrix Multiplication.

Greedy Algorithms: Introduction to Greedy Technique, Greedy Method, Optimal Merge Patterns, Huffman Coding, Knapsack Problem, Activity Selection Problem, Job Sequencing with Deadline, Minimum Spanning Tree, Single-Source Shortest Path Algorithm.

Dynamic Programming: Component of Dynamic Programming, Comparison of Divide-and-Conquer and Dynamic Programming Techniques, Longest Common Sub-sequence, matrix multiplication, shortest paths: Bellman Ford, Floyd Warshall, Application of Dynamic Programming.

Backtracking: N-Queens Problem, Four-Queens Problem, Eight-Queen Problem, Hamiltonian Cycle, Sum of Subsets Problem, Graph Coloring Problem. Branch and Bound: Introduction, Traveling Salesperson Problem, 15-Puzzle Problem, Comparisons between Backtracking and Branch and Bound.

Tree: Introduction, B-tree, Red-Black Tree (RBT):

NP Completeness: Introduction, The Complexity Class P, The Complexity Class NP, Polynomial-Time Reduction, The Complexity Class NP-Complete.

4. Data Structures

Need of data structures, Types of data structures, Recursion, ADT (Abstract Data Types), Basics of algorithm, Analysis of algorithm through time complexity and space complexity, Asymptotic notations, Pseudo code analysis, Recurrence relations and solving recurrences using substitution, Recursion tree and master method.

Stack and Queue Stack: Representation, Stack operation, Application. Queue: Representation, Queue operation, Circular and priority queue, Applications

Linked List Linked list: Operation on linked list, Linked stacks and Queues, Array implementation of linked list, Linked list using dynamic variable, Doubly linked list, Circular linked list.

Binary Tree Basic tree concept, Binary tree operations, Binary tree representation, Binary tree traversals, Binary search tree and operations on it, Balanced tree: AVL trees and operations, Applications of binary trees, Implementing priority queue using binary heap data structure.

Graphs Basics concepts of graphs, Representation of graphs, Graph traversals BFS and DFS, Minimum spanning tree algorithms: Kruskal's algorithm and Prim's algorithm, Applications of graphs.

Searching Techniques and Hashing Linear search and binary search, Hashing: Direct-address tables, Hash tables, Open addressing, Perfect Hashing. Sorting techniques Various sorting methods and their time complexity analysis: Insertion sort, Selection sort, Merge sort, Quick sort, Heap sort.

5. Computer Networks

[OSI and TCP/IP Protocol Stacks](#); [Basics of packet, circuit and virtual circuit-switching](#); Data link layer: [framing, error detection](#), Medium Access Control, Ethernet bridging; [Routing protocols: shortest path, flooding, distance vector and link state routing](#); [Fragmentation and IP addressing, IPv4](#), CIDR notation Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT) Transport layer: [flow control](#) and [congestion control](#), [UDP](#), [TCP](#), sockets; [Application layer protocols: DNS, SMTP, HTTP, FTP](#), Email.

6. Image Processing

Mathematical Preliminaries - 2D Linear Space Invariant Systems - 2D Convolution - Correlation 2D Random Sequence - 2D Spectrum.

Image transforms and enhancement Image Transforms: 2D Orthogonal and Unitary Transforms- Properties and Examples. 2D DFT- FFT – DCT - Hadamard Transform - Haar Transform - Slant Transform - KL Transform - Properties And Examples. Image Enhancement:- Histogram Equalization Technique- Point Processing-Spatial Filtering-In Space And Frequency - Nonlinear Filtering-Use Of Different Masks.

Image compression & segmentation Image Compression: Redundancy And Compression Models -Loss Less And Lossy. Loss Less- Variable-Length, Huffman, Arithmetic Coding - Bit-Plane Coding, Loss Less Predictive Coding, Lossy Transform (DCT) Based Coding, JPEG Standard - Sub Band Coding. Image Segmentation: Edge Detection - Line Detection - Curve Detection - Edge Linking And Boundary Extraction, Boundary Representation, Region Representation And Segmentation, Morphology-Dilation, Erosion, Opening And Closing. Hit And Miss Algorithms Feature Analysis

Color and multispectral image processing Color Image-Processing Fundamentals, RGB Models, HSI Models, Relationship Between Different Models. Multispectral Image Analysis - Color Image Processing Three Dimensional Image Processing-Computerized Axial Tomography-Stereometry-Stereoscopic Image Display-Shaded Surface Display.

Mechanical Engineering

Applied Mechanics and Design Engineering Mechanics: Free-body diagrams and equilibrium; friction and its applications including rolling friction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc. trusses and frames; virtual work; kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations; Lagrange's equation.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; concept of shear centre; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope. Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Fluid Mechanics: Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; control volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressible fluid flow.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of

turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations. Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles.

Refrigeration and air conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes.

Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton wheel, Francis and Kaplan turbines; steam and gas turbines. Section 4: Materials, Manufacturing and Industrial Engineering

Engineering Materials: Structure and properties of engineering materials, phase diagrams, heat treatment, stress strain diagrams for engineering materials. Casting, Forming and Joining Processes: Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design.

Casting: Types of casting processes and applications; Sand casting: patterns – types, materials and allowances; molds and cores–materials, making, and testing; design of gating system and riser; casting techniques of cast iron, steels, and nonferrous metals and alloys; analysis of solidification and microstructure development; Other casting techniques: Pressure die casting, Centrifugal casting, Investment casting, Shell mold casting; Casting defects and their inspection by non-destructive testing.

Metal Forming: Stress-strain relations in elastic and plastic deformation; von Mises and Tresca yield criteria, Concept of flow stress; Hot, warm and cold working; Bulk forming processes - forging, rolling, extrusion and wire drawing; Sheet metal working processes – blanking, punching,

bending, stretch forming, spinning and deep drawing; Ideal work and slab analysis; Defects in metal working and their causes.

Joining of Materials: Classification of joining processes; Principles of fusion welding processes using different heat sources (flame, arc, resistance, laser, electron beam), Heat transfer and associated losses; Arc welding processes - SMAW, GMAW, GTAW, plasma arc, submerged arc welding processes; Principles of solid state welding processes - friction welding, friction stir welding, ultrasonic welding; Welding defects - causes and inspection; Principles of adhesive joining, brazing and soldering processes

Machining: Orthogonal and oblique machining, Single point cutting tool and tool signature, Chip formation, cutting forces, Merchant's analysis, Specific cutting energy and power; Machining parameters and material removal rate; tool materials, Tool wear and tool life; Thermal aspects of machining, cutting fluids, machinability; Economics of machining;

Machining processes - turning, taper turning, thread cutting, drilling, boring, milling, gear cutting, thread production; Finishing processes – grinding, honing, lapping and super-finishing. Machine Tools: Lathe, milling, drilling and shaping machines – construction and kinematics; Jigs and fixtures – principles, applications, and design.

Advanced Manufacturing: Principles and applications of USM, AJM, WJM, AWJM, EDM and Wire EDM, LBM, EBM, PAM, CHM, ECM; Effect of process parameters on material removal rate, surface roughness and power consumption; Additive manufacturing techniques.

Computer Integrated Manufacturing: Basic concepts of CAD and CAM, Geometric modeling, CNC; Automation in Manufacturing; Industrial Robots – configurations, drives and controls; Cellular manufacturing and FMS - Group Technology, CAPP.

Metrology and Inspection: Accuracy and precision; Types of errors; Limits, fits and tolerances; Gauge design, Interchangeability, Selective assembly; Linear, angular, and form measurements (straightness, flatness, roundness, runout and cylindricity) by mechanical and optical methods; Inspection of screw threads and gears; Surface roughness measurement by contact and non-contact methods.

Quality Management: Quality – concept and costs; Statistical quality control – process capability analysis, control charts for variables and attributes and acceptance sampling; Six sigma; Total quality management; Quality assurance and certification - ISO 9000, ISO 14000.

Reliability and Maintenance: Reliability, availability and maintainability; Distribution of failure and repair times; Determination of MTBF and MTTR, Reliability models; Determination of system reliability; Preventive and predictive maintenance and replacement, Total productive maintenance. Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools; additive manufacturing.

Product Design and Development: Principles of product design, tolerance design; Quality and cost considerations; Product life cycle; Standardization, simplification, diversification; Value engineering and analysis; Concurrent engineering; Design for “X”. Work System Design: Taylor’s scientific management, Gilbreths’s contributions;

Productivity – concepts and measurements; Method study, Micro-motion study, Principles of motion economy; Work measurement – time study, Work sampling, Standard data, PMTS; Ergonomics; Job evaluation and merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning; lean manufacturing.

Inventory Control: Deterministic models; safety stock inventory control systems. Operations Research: Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Operation Research: Linear programming – problem formulation, simplex method, duality and sensitivity analysis; Transportation and assignment models; Integer programming; Constrained and unconstrained nonlinear optimization; Markovian queuing models; Simulation – manufacturing applications. Engineering Economy and Costing: Elementary cost accounting and methods of depreciation; Break-even analysis; Techniques for evaluation of capital investments; Financial statements; Activity based costing

Civil Engineering

Section 1: Structural Engineering

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Frictions and its applications; Centre of mass; Free Vibrations of undamped SDOF system.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses.

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

Construction Materials and Management: Construction Materials: Structural Steel - Composition, material properties and behavior; Concrete - Constituents, mix design, short-term and long-term properties. Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation.

Concrete Structures: Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete beams.

Steel Structures: Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Concept of plastic analysis - beams and frames.

Section 2: Geotechnical Engineering

Soil Mechanics: Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One- dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand; Stress paths.

Foundation Engineering: Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Stress distribution in soils – Boussinesq's theory; Pressure bulbs, Shallow foundations – Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations - dynamic and static formulae, Axial load capacity of piles in sands and clays, pile load test, pile under lateral loading, pile group efficiency, negative skin friction.

Section 3: Water Resources Engineering

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum and energy equations and their applications; Potential flow, Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift and drag.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles.

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's Law.

Irrigation: Types of irrigation systems and methods; Crop water requirements - Duty, delta, evapo-transpiration; Gravity Dams and Spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures.

Section 4: Environmental Engineering

Water and Waste Water Quality and Treatment: Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment. Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications.

Section 5: Transportation Engineering

Transportation Infrastructure: Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments. Geometric design of railway Track – Speed and Cant. Concept of airport runway length, calculations and corrections; taxiway and exit taxiway design. Highway Pavements:

Highway materials - desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes.

Section 6: Geomatics Engineering

Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves. Photogrammetry and Remote Sensing - Scale, flying height; Basics of remote sensing and GIS.

Electronics and Telecommunication engineering

Unit 1: Networks, Signals and Systems

Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton's, maximum power transfer; Wye- Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2- port network parameters: driving point and transfer functions; State equations for networks.

Signals and systems: Classification of signals, Operations on signals, classification of systems. Convolution integral and convolution sum.

Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem. Laplace transform.

Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete-time signals;

LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques, Basics of Multirate Filtering.

Unit 2: Analog Circuits and Digital Circuits

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET

Amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters;

Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation.

Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, Decoder;

Sequential circuits: latches and flip-flops, counters, shift-registers and finite state machines; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microprocessor (8085): architecture, programming, memory and I/O interfacing. Data converters: sample and hold circuits ADC and DAC

Unit 3: Communications

Random processes: Probability, Autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems;

Analog communications system: Amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, Circuits for analog communications;

Information theory: entropy, mutual information and channel capacity theorem, Fundamental of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference

Digital communication system: Pulse Modulation, Digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter

receiver, calculation of bandwidth, SNR and BER for digital modulation; Basics of TDMA, FDMA and CDMA.

Electromagnetics: Maxwell's equations: wave equation, Plane waves, reflection and refraction, polarization, phase and group velocity, Transmission lines, S-parameters, Smith chart; Waveguides, Antennas: types and parameters ; Basics of radar; Light propagation in optical fibers.

UNIT4: VLSI Design and Technology

Introduction to VHDL Behavioral – Different modeling styles in VHDL, Data types and objects, Sequential and concurrent statement, Packages, Subprograms, Attributes, Test bench, FSM, Hazards, PLD, CPLD, FPGA, ASIC. Synthesis and Simulation VHDL.

Clock skew, Clock distribution techniques, clock jitter, Supply and ground bounce, power distribution techniques. Power optimization, Interconnect routing techniques; wire parasitic, Signal integrity issues, I/O architecture, pad design, Architectures for low power.

CMOS Technologies: Layout design rules, MOS Transistor theory, C-V characteristics, Non ideal I-V effects, Technology Scaling. CMOS inverters, DC transfer characteristics, Power components, Power delay product, Transmission gate. CMOS combo logic design, Delays: RC delay model, Effective resistance, Gate and diffusion capacitance, Equivalent RC circuits; Linear delay model, Logical effort, Parasitic delay, Delay in a logic gate, Path logical efforts.

Design for Testability (DFT), Testability, Fault models

UNIT5: Electronic Devices and Control systems

Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photodiode and solar cell; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process.

Control systems :Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots;Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Reference Books:

- 1] Millman's Electronic Devices and Circuits,
- 2] Thomas L. Floyd, "Electronic devices" Conventional current version, Pearson prentice hall
- 3] R. A. Gayakwad, "Op-amps and Linear Integrated circuits", PHI New delhi
- 4] Anand Kumar - Fundamentals of Digital Circuits, PHI.
- 5] R.P.Jain:Modern Digital Electronics, Tata McGraw-Hill Education
- 6] Ramesh S. Gaonkar - Microprocessor Architecture, Programming, and Applications with the 8085.
- 7] A. Annand Kumar: Signals and Systems, PHI
- 8] Neil H. E. Weste, David Money Harris, CMOS VLSI Design A Circuits and Systems Perspective, Pearson India

9] Simon Haykin, Digital Communication Systems, John Wiley & Sons

10] Stephen Brown: Fundamentals of Digital logic with VHDL Design, Tata McGraw-Hill

Electrical Engineering

1. Electric circuits

Network elements: ideal voltage and current sources, dependent sources, R, L, C, M elements; Network solution methods: KCL, KVL, Node and Mesh analysis; Network Theorems: Thevenin's, Norton's, Superposition and Maximum Power Transfer theorem; Transient response of dc and ac networks, sinusoidal steady-state analysis, resonance, two port networks, balanced three phase circuits, star-delta transformation, complex power and power factor in ac circuits.

2. Electromagnetic Fields

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot- Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

3. Signals and Systems

Representation of continuous and discrete time signals, shifting and scaling properties, linear time invariant and causal systems, Fourier series representation of continuous and discrete time periodic signals, sampling theorem, Applications of Fourier Transform for continuous and discrete time signals, Laplace Transform and Z transform. R.M.S. value, average value calculation for any general periodic waveform

4. Electrical Machines

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency;

Three-phase transformers: connections, vector groups, parallel operation; Auto-transformer, Electromechanical energy conversion principles; DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, speed control of dc motors; Three-phase induction machines: principle of operation, types, performance, torque-speed characteristics, no-load and blocked-rotor tests, equivalent circuit, starting and speed control; Operating principle of single-phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance and characteristics, regulation and parallel operation of generators, starting of synchronous motors; Types of losses and efficiency calculations of electric machines

5. Power Systems

Basic concepts of electrical power generation, ac and dc transmission concepts, Models and performance of transmission lines and cables, Economic Load Dispatch (with and without considering transmission losses), Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per unit quantities, Bus admittance matrix, Gauss- Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over current, differential, directional and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

6. Control Systems

Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady state analysis of linear time invariant systems, Stability analysis using Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Lag, Lead and Lead- Lag compensators; P, PI and PID controllers; State space model, Solution of state equations of LTI systems

7. Electrical and Electronic Measurements

Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

8. Analog and Digital Electronics

Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers: characteristics and applications; single stage active filters, Active Filters: Sallen Key, Butterworth, VCOs and timers, combinatorial and sequential logic circuits, multiplexers, demultiplexers, Schmitt triggers, sample and hold circuits, A/D and D/A converters.

9. Power Electronics

Static V-I characteristics and firing/gating circuits for Thyristor, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of uncontrolled rectifiers; Voltage and Current commutated Thyristor based converters; Bidirectional ac to dc voltage source converters; Magnitude and Phase of line current harmonics for uncontrolled and thyristor based converters; Power factor and Distortion Factor of ac to dc converters; Single-phase and three-phase voltage and current source inverters, sinusoidal pulse width modulation.

Information Technology

Discrete Mathematics: Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Monoids, Graphs: connectivity, matching, coloring. Combinatorics: counting, recurrence relations, generating functions.

Probability and Statistics: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

Digital Logic

Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic

Computer Organization and Architecture

Machine instructions and addressing modes. ALU, data- path and control unit. Instruction pipelining, pipeline hazards. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

Programming and Data Structures

Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps

Algorithms

Searching, sorting, hashing. Asymptotic notations, worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide- and- conquer. Graph traversals, minimum spanning trees, shortest paths

Theory of Computation

Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.

Compiler Design

Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation. Local optimisation, Data flow analyses: constant propagation, liveness analysis, common subexpression elimination.

Operating System

System calls, processes, threads, inter- process communication, concurrency and synchronization.

Deadlock. CPU and I/O scheduling. Memory management and virtual memory. File systems.

Databases

ER- model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

Computer Networks

Concept of layering: OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit-switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; Fragmentation and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Email

Chemical Engineering

1. Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis.

First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

2: Fluid Mechanics and Mechanical Operations

Fluid statics, surface tension, Newtonian and non-Newtonian fluids, transport properties, shell-balances including differential form of Bernoulli equation and energy balance, equation of continuity, equation of motion, equation of mechanical energy, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, velocity profiles, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.

Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

3: Heat Transfer

Equation of energy, steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations; design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

4: Mass Transfer

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts; design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption, membrane separations(micro-filtration, ultra-filtration, nano-filtration and reverse osmosis).

5: Chemical Reaction Engineering

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, kinetics of enzyme reactions (Michaelis-Menten and Monod models), non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis; rate and performance equations for catalyst deactivation

6: Instrumentation and Process Control

Measurement of process variables; sensors and transducers; P&ID equipment symbols; process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; transducer dynamics; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

7: Plant Design and Economics

Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, optimization in process design and sizing of chemical engineering equipments such as heat exchangers and multistage contactors.

8: Chemical Technology

Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry), fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

Computer Applications

Data Communication and Computer Networks:

Data Communication: Components of a Data Communication System, Simplex, Half-Duplex and Duplex Modes of Communication; Analog and Digital Signals; Noiseless and Noisy Channels; Bandwidth, Throughput and Latency; Digital and Analog Transmission. Computer Networks: Network Topologies, Wireless Networks, Internet. Network Models: Layered Architecture, OSI Reference Model and its Protocols; TCP/IP Protocol Suite, Switching Techniques. World Wide Web (WWW): Electronic Mail Architecture, SMTP, POP and IMAP; TELNET and FTP.

Database Management Systems:

Database System Concepts and Architecture: Data Models, Schemas, and Instances; Three-Schema Architecture and Data Independence; Database Languages and Interfaces; Centralized and Client/Server Architectures for DBMS. Data Modeling: Entity-Relationship Diagram, Relational Model -Constraints, Languages, Design, and Programming, Relational Database Schemas, Update Operations and Dealing with Constraint Violations; Relational Algebra and Relational Calculus; Codd Rules. SQL Queries, Normalization for Relational Databases.

Programming Language:

Programming Language Concepts: Programming Language Syntax, Elementary Data Types: Properties of Types and Objects; Scalar and Composite Data Types. Programming in C: Arrays, Structures, Union, String, Pointers, Functions, File Handling, Command Line Arguments, Preprocessors. Object Oriented Programming, Programming in C++

Discrete Structures:

Mathematical Logic: Propositional and Predicate Logic, Propositional Equivalences, Normal Forms, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference. Sets and Relations: Set Operations, Counting, Mathematical Induction and Discrete Probability: Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion-Exclusion Principle, Mathematical Induction, Probability, Bayes' Theorem. Group Theory

Data Structure:

Basics: Arrays and their Applications; Sparse Matrix, Stacks, Queues, Priority Queues, Linked Lists, Trees, Forest, Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree, B Tree, B+ Tree, B* Tree, Data Structure for Sets, Graphs, Sorting and Searching Algorithms, Hashing. Performance Analysis of Algorithms and Recurrences: Time and Space Complexities; Asymptotic Notation, Recurrence Relations. Design Techniques: Divide and Conquer; Dynamic Programming, Greedy Algorithms, Backtracking, Branch and Bound. Graph Algorithms

Operating System:

System Software: Machine, Assembly and High-Level Languages; Compilers and Interpreters; Loading, Linking and Relocation; Macros, Debuggers. Basics of Operating Systems: Operating System Structure, Operations and Services; System Calls, Operating-System Design and Implementation; System Boot. Process Management and Threads: CPU Scheduling: Scheduling Criteria and Algorithms; Thread Scheduling, Multiple-Processor Scheduling, Real-Time CPU Scheduling. Deadlock, Memory and storage Management, File and Input/output Systems, Security

Compiler Design

Syntax Analysis: Associativity, Precedence, Grammar Transformations, Top Down Parsing, Recursive Descent Predictive Parsing, LL(1) Parsing, Bottom up Parsing, LR Parser, LALR(1)

Parser.Semantic Analysis: Attribute Grammar, Syntax Directed Definitions, Inherited and Synthesized Attributes; Dependency Graph, Evaluation Order, S-attributed and L-attributed Definitions; Type-Checking

Software Engineering:

Software Process Models: Software Process, Process Models, Formal Methods, Agile Process Models, Web Engineering. Software Requirements: Functional and Non-Functional Requirements; Eliciting Requirements, Developing Use Cases, SRS Software Testing: Unit and Integration testing; White-box and Black-box testing; Basis Path Testing, Control Structure Testing, Deriving Test Cases, Alpha and Beta testing; Software Re-engineering, Reverse Engineering.

Architecture

1. BASICS OF ARCHITECTURE

Architectural Theory and Aesthetics, Construction Technology & Materials– Structural design methods and techniques, long span structures, high rise construction, prefabricated construction, tensile construction, non-conventional materials, and techniques, Advanced building Technology.

Building services – Drainage and water supply at site level and city level, acoustics, firefighting, natural and mechanical ventilation, lighting, and illumination.

2. PLANNING

- a) **PLANNING PRINCIPLES AND TECHNIQUES**, Concepts, theories and principles of urban and regional planning; Rational Planning Approaches and Models.
- b) **URBAN PLANNING**: Urban Planning process; Land use Planning – Zonal/sub-city level; Urban Land Economics; Emerging concepts of cities – Eco-City, Smart City, Transit Oriented Development (TOD), SEZ, SRZ etc.; Law of demand and supply of land and its use in planning; Metropolitan Area Planning; Urban renewal and conservation; Site planning; Planning & Management of Informal Sector.
- c) **REGIONAL PLANNING**: Regions, city region; Regional Economics and related concepts
- d) **HOUSING**: Housing; Concepts, principles and examples of neighbourhood; Housing typologies; Slums; Affordable Housing. Standards for housing and community facilities; National Housing Policies, Programs and Schemes.
- e) **INFRASTRUCTURE AND TRANSPORTATION PLANNING**: Urban Infrastructure, Physical Infrastructure, Social Infrastructure, Urban Environmental Services, Urban, Transportation, theory of traffic flow, intersection design, integrated transportation planning and modal splits.
- f) **PLANNING LEGISLATION AND PUBLIC POLICY**: Major Policies, Mission and schemes of Government of India related to Housing, SMART cities, HRIDAY cities, Swachh Bharat Abhiyan, AMRUT, JNNURM, Slum Up-gradation, Development guidelines such as URDPFI etc.

3. **LANDSCAPE Architecture:** Principles of landscape design and site planning, landscape elements and materials, environmental considerations in landscape planning.

4. **Environmental Architecture and planning:** General Awareness about Environment, Ecology, Climate Change, Global Warming Sustainable Development Goals, Ecological zoning, Ecologically sensitive areas, Coastal Zone Regulations; Principles of Sustainable Development. Environmental Impact Assessment.

Sustainable architecture, Vernacular and traditional solar passive Design of buildings, Energy Efficiency, Energy management, Renewable resources, Green Building Materials, Carbon offset and Carbon Foot Printing, Life cycle of buildings. Green Building Rating systems global and Indian.

5. **Contemporary Architecture, Heritage conservation, architectural Conservation:** Architectural history of Indian sub-continent, regional architecture of India, modern movement, Contemporary architecture across the world. Conservation philosophy, Conservation principles and practices, Conservation science techniques and technology, Conservation management.

6. Concepts and theories related to Disaster Management, Re architecture, Futuristic Architecture, Digital Architecture, Biomimicry in Architecture, Adaptive Reuse.

7. **Professional Practice:** Nature of profession, difference between trade, business, and profession. Professional organizations like I.I.A., COA & their membership, Scope of comprehensive architectural services as framed under Architect's Act 1972. Code of Conduct, scale of professional fees as per rules and regulations framed by the Council of Architecture. Building byelaws, national building code, architects' act.

8. **Project Management:** Planning Project formulation; Projects and planning issues; Approaches of appraisal; Techniques of financial appraisal; Project management; Project implementation, monitoring and evaluation. PERT, CPM, Supply chain management, quality, control, safety issues on sites. Architectural supervision, quality control and monitoring of projects. Introduction to 'Arbitration'.