SCHEME AND SYLLABUS FOR RECRUITMENT TO THE POSTS OF MANAGER (ENGINEERING) IN HYDERABAD METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD

Scheme of Examination

	No. of Questions	Duration (Minutes)	Maximum Marks
Part: A: WRITTEN EXAMINATION (Objective Type) **Paper-I**: General Studies and General Abilities	150	150	150
Paper-II: Civil Engineering (Degree Level) **OR** Mechanical Engineering (Degree Level) **OR** Electrical Engineering (Degree Level) **OR** Electronics & Communication Engineering (Degree Level) **OR** Computer Science & Information Technology(Degree Level)	150	150	300
Part: B: Interview			50
		Total	**500**

Syllabus

PAPER-I: GENERAL STUDIES AND GENERAL ABILITIES

1. Current affairs – Regional, National and International.
2. International Relations and Events.
3. General Science; India's Achievements in Science and Technology.
4. Environmental issues; Disaster Management- Prevention and Mitigation Strategies.
5. Economic and Social Development of India and Telangana.
6. Physical, Social and Economic Geography of India.
7. Physical, Social and Economic Geography and Demography of Telangana.
8. Socio-economic, Political and Cultural History of Modern India with special emphasis on Indian National Movement.
9. Socio-economic, Political and Cultural History of Telangana with special emphasis on Telangana Statehood Movement and formation of Telangana state.
10. Indian Constitution; Indian Political System; Governance and Public Policy.
11. Social Exclusion; Rights issues such as Gender, Caste, Tribe, Disability etc. and inclusive policies.
12. Society, Culture, Heritage, Arts and Literature of Telangana.
13. Policies of Telangana State.
14. Logical Reasoning; Analytical Ability and Data Interpretation.
15. Basic English. (10^{th} class Standard)

Paper-II: CIVIL ENGINEERING (DEGREE LEVEL)

1. **Building Materials And Construction:**

Bricks– Types of Bricks, Indian standard classification, properties; Stones – Types of stones, classification, properties, dressing and polishing of stones; Methods of Quarrying; Cement – Different grades and types of cement, properties and IS specifications; Aggregates – coarse and fine aggregate, properties and IS specifications; Cement Mortar – Proportions of cement mortar for various applications; Concrete – Constituents of Concrete, Different grades of Concrete, mix proportioning using IS Code, Properties of fresh and hardened Concrete; Admixtures – Types of Admixtures

2. **Strength of Materials And Theory of Structures:**

Strength of Materials: Simple stresses and strains, elastic constants and relationship between them; Compound bars; Temperature stresses; Shear forces and bending moment diagrams for beams; Principal stresses and Mohr's circle of stress, Theory of bending and bending stresses ; Shear stress distribution; Theory of torsion; Springs; Deflections of beams; Thin and thick cylinders;; Analysis of trusses, Betti-Maxwell theorem; Shear centre and unsymmetrical bending.

Theory of Structures: Direct and bending stresses; Columns and struts; Strain energy method; Moving loads and influence lines; Arches and suspension bridges; Static and kinematic indeterminacy; Moment distribution, Slope deflection, and Kani's methods applied to continuous beams and portal frames; Column analogy and matrix methods of analysis.

3. **RCC and Steel Structures:**

Concrete Structures: Materials, permissible stresses and IS Specifications; Working stress methods; Limit State Method - Stress Blocks parameters, design of Beams, Slabs, Columns and Footing; Design for Shear and Torsion; Design of Retaining Walls, Water tanks, and T-Beam Slab bridges; Yield line theory.

Steel Structures: Properties of steel sections, permissible stresses, IS Specifications; Riveted and welded joints and connections; Design of simple and compound Beams and Columns, Column bases, Roof trusses, Plate and Gantry Girders; Plate Girder Lattice Girder Railway bridges, and Bearings. Plastic analysis.

Pre-Stressed Concrete: Basic concepts, material for pre-stressing, losses in Pre-stress, classification of pre-stressing system; Analysis of PSC Sections.

4. **Fluid Mechanics and Hydraulics:**

Fluid Properties; Measurement of Pressure - Manometers; Fluid Kinematics – Classification of Fluids, Stream function and Velocity potential, significance and use of Flownets, Fluid dynamics - Continuity equation, Bernoulli's equations and Impulse momentum equation; Laminar and Turbulent flow through pipes – significance of Reynolds number, Hagen – Poiseuille's equation, Darcy – Weisbach equation, Friction factor, Water hammer phenomenon; Compressible flow – Bernoulli's equation for Isothermal and Adiabatic conditions, Mach Number, Mach cone, stagnation properties; Steady uniform flow through open channels; Gradually varied flows – significance of Froude number, classification and computation of Flow profiles, Hydraulic jump, Surges; Boundary layer – Laminar and Turbulent Boundary layer, Boundary layer thickness, rough and smooth Boundaries, Boundary layer separation; Dimensional analysis and similarity laws; Hydraulic Turbines – classification, Velocity triangles, principles and design of reaction and impulse turbines; Centrifugal pumps – specific speed, work done and efficiency, characteristic curves.

5. **Hydrology and Water Resources Engineering:**

Hydrological cycle; Rainfall – types and measurement, network design; Infiltration - Φ-index; Runoff – process, factors and determination of runoff, dependable yield; Floods – flood hydrograph, computation of flood peak using rational formula, unit hydrograph method and Gumbel's extreme value methods; Groundwater – types of aquifer and properties, Darcy's law, specific yield, steady radial flow to wells in confined and unconfined aquifers; Irrigation – types and advantages, soil water plant relationship, consumptive use, duty, delta, base period, crops and their water requirements; Single and multipurpose projects; Dams – classification, forces and design of Gravity dam and Earth dam; Spillways – types, energy dissipation, stilling basin, Appurtenances; Canals – alignment, Kennedy's and Lacey's theories, lining of Canals; Weirs – components, design of vertical drop and sloping glacis weir; Seepage forces – Bligh's Theory, Khosla's theory; Canal falls – types and design principles; Cross drainage works – classification and design principles of aqueducts; Hydropower – classification and principle components of Hydroelectric power plants.

6. Environmental Engineering:

Water supply – objectives, rate of demand, population forecasts; Analysis of water – classification, design of coagulation, sedimentation, filtration, disinfection and softening processes; Methods of layout of distribution pipes – Hardy cross method; Waste water engineering – systems of sewerage, hydraulic formulae and design of sewers, BOD, COD, self purification of natural streams, methods of sewage disposal; Treatment of sewage – principles and design of grit chamber, sedimentation tanks, trickling filters, activated sludge process, sludge digestion tanks, septic tanks; Municipal solid waste – characteristics, collection and transportation of solid wastes; Air Pollution – types and sources of pollutants, air quality standards; Noise pollution – Impacts and permissible limits, measurement and control of noise pollution.

7. Transportation Engineering:

Highway Classification as per IRC; Highway alignment; Engineering Surveys; Geometric Design; Cross sectional elements of road; Gradient; Grade compensation; Traffic Surveys – speed, Volumes, origin and destination; Highway capacity and level of service as per HCM 2000; Intersection – at grade and grade separated; Channelization; Rotary intersection; signal design – webstar method, traffic signs, pavement marking; Parking studies, accidental studies, pavement types, Factors considered for pavement design, flexible and rigid pavements design concepts.

Railway Engineering: Permanent way, rails, sleepers, ballast; Creep, coning of wheel, rail fixtures and fastenings, super elevation, cant deficiency, curves, turnout; Points and crossings.

Airport Engineering: Selection of site of Airport, runway orientation and design, wind rose diagram, basic run way length, correction to basic runway length.

8. Soil Mechanics and Foundation Engineering:

Soil Mechanics: Physical properties of soils, Classification and identification, Permeability, Capillarity, Seepage, Compaction, Consolidation, Shear Strength, Earth pressure, Slope stability;

Foundation Engineering: Site investigations, stress distribution in soils, Bearing capacity, Settlement analysis, Types of Foundation, Pile foundations, Foundations on expansive soils; swelling and its preventions; Coffer dams, Caissons, Dewatering, Bracing for excavations, Newmark charts, machine foundations.

Engineering Geology: Mineralogy, Structural Geology, Groundwater Exploration methods; Engineering Geology applications for Tunnels, Dams and Reservoirs; Geological hazards and preventive measures.

9. **Estimation, Costing and Construction Management:**

   Abstract estimate: Detailed estimate – centerline, long & short wall method, various items of Civil Engineering works as per Indian Standard, General Specifications - Earth Work, Brick / Stone Masonry in Cement Mortar, RCC, Plastering in Cement Mortar, Floor finishes, white wash, colour wash; Standard schedule of rates, lead and lift, preparation of lead statement; Computation of earth work – Mid-ordinate, Mean Sectional area, Trepezoidal method, Prismoidal Rule; Approximate estimate – Plinth area and cubic rate estimate.

10. **Surveying:**

    Principle and classification of surveying, chain surveying; Compass surveying; Levelling and contouring; Theodolite surveying; curves; Introduction and Fundamental concepts of electronic measuring instruments – EDM, Total station, GIS & GPS.

PAPER-II: MECHANICAL ENGINEERING (DEGREE LEVEL)

Section I: Applied Mechanics and Design

1. **Engineering Mechanics:** Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

2. **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; 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.

3. **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.

4. **Vibrations:** Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

5. **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, keys, shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

Section II: Fluid Mechanics and Thermal Sciences

1. **Fluid Mechanics:** Fluid properties; fluid statics, manometry, buoyancy, 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.

2. **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, 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.

3. **Thermodynamics:** Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; availability and irreversibility; thermodynamic relations.

4. **Power Engineering**: Air compressors; vapour and gas power cycles, concepts of regeneration and reheat.

5. **I.C. Engines**: Air-standard Otto, Diesel and dual cycles.

6. **Refrigeration and air-conditioning:** Vapour and gas refrigeration and heat pump cycles; basic psychrometric processes.

7. **Turbomachinery:** Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

Section III: Materials, Manufacturing and Industrial Engineering

1. **Engineering Materials**: Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.

2. **Casting, Forming and Joining Processes:** Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk metal forming processes such as forging, rolling, extrusion, drawing; and sheet metal forming processes such as shearing, deep drawing, bending; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

3. **Machining and Machine Tool Operations:** Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, design of jigs and fixtures.

4. **Metrology and Inspection:** Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and surface finish measurement; machine tool; alignment and testing methods; tolerance analysis in manufacturing and assembly.

5. **Computer Integrated Manufacturing:** Basic concepts of CAD/CAM and their integration tools.

6. **Production Planning and Control:** Forecasting models, aggregate production planning, scheduling, materials requirement planning.

7. **Inventory Control:** Deterministic models; safety stock inventory control systems.

8. **Operations Research:** Linear programming, simplex method transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Paper-II: ELECTRICAL ENGINEERING (DEGREE LEVEL)

1. Electric Circuits and Fields: Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin's, Norton's, Superposition, Maximum Power Transfer and Reciprocity theorems; two-port networks, three phase circuits; Star, Delta connections, Measurement of power by two-wattmeter method; Fourier, Laplace and Z transforms; Gauss Theorem, electric field and potential due to point, line, plane and spherical charge distributions; Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.

2. Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto-transformer; energy conversion principles; DC machines - types, windings, generator and motor characteristics, losses and efficiency, armature reaction and commutation, starting and speed control of motors, tests; three phase induction motors - principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous machines - performance, regulation and parallel operation of alternators, motor starting, characteristics and applications; servo motors.

3. Power Systems: Basic power generation concepts, Economic aspects, Types of Tariffs; transmission line models and performance; cable performance, insulators, Sag and Tension; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow study; voltage control; power factor correction; economic operation; Load Frequency Control; symmetrical components; symmetrical & unsymmetrical fault analysis; principles of over-current, differential and distance protection; Generator protection, Transformer protection, Feeder protection, static relays; circuit breakers; Power system stability concepts, swing equation, power angle curve, solution of swing equation, equal area criterion.

4. Control Systems: Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Nyquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability.

5. Electrical and Electronic Measurements: DC, AC Bridges, potentiometers; PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; shunts, multipliers; instrument transformers; digital voltmeters, CRO; phase, time and frequency measurements using lissajous patterns; error analysis.

6. Analog and Digital Electronics: Characteristics of p-n junction diode, Zener diode, BJT, FET; amplifiers - biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers - characteristics and applications; simple active filters; VCOs and timers; Boolean Algebra, mizimizition of switching functions combinational and sequential logic circuits; schimitt trigger, multi vibrators Flip flops, counters and registers, sample and hold circuits; A/D and D/A converters; microprocessor basics.(8085 & 8086), architecture, programming and interfacing.

7. Power Electronics : Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits commutation circuits; phase control rectifiers; bridge converters - fully controlled and half controlled; dual converters, principles of choppers, inverters, cyclo-converters and ac voltage controllers.

8. Electric Drives: Four quadrant operation, Types of loads, Energy loss during starting and braking of dc and ac motors, Types of braking in dc & ac motors, Basis concepts of converter and chopper fed dc drives; V/f control, static rotor resistance control and slip power recovery scheme of 3-phase induction motor drives.

9. Utilization: High frequency eddy current heating, dielectric heating, Arc furnace, electric arc welding & electric resistance welding, Illumination: Laws of illumination, MSCP, SV & MV lamps, Factory, street & flood lighting, Electric traction and track electrification, Speed-time

curves, Tractive effort, Specific energy consumption, Mechanism of train movement, adhesive weight and coefficient of adhesion. DC motor series parallel control, energy saving.

Paper-II: ELECTRONICS & COMMUNICATION ENGINEERING (DEGREE LEVEL)

Section-I

Networks:

1. **Network graphs**: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis.
2. **Network theorems**: superposition, Thevenin's and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits,
3. **Solution of network equations using Laplace transform**: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.
4. **Electronic Devices:** Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers. p-n junction diode, zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, P- I -N and avalanche photo diode, Basics of LASERs.
5. **Device technology**: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.
6. **Analog Circuits:** Small Signal Equivalent circuits of diodes, BJTs, MOSFETs and analog CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers.
7. **Amplifiers**: single-and multi-stage, differential and operational, feedback, and power. Frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits, 555 Timers. Power supplies.

Section-II

1. **Digital circuits:** Boolean algebra, minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS).

2. **Combinatorial circuits**: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs.

3. **Sequential circuits**: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories.

4. **Microprocessor (8085):** architecture, programming, memory and I/O interfacing.

5. **Signals and Systems:** Definitions and properties of Laplace transform continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, and FFT, z-transform. Sampling theorem.

6. **Linear Time-Invariant (LTI) Systems**: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

7. **Control Systems:** Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability

analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response.

8. **Tools and techniques for LTI control system analysis**: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots.

9. **Control system compensators**: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

Section-III

1. **Communications:** Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

2. **Analog communication systems:** amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Fundamentals of information theory and channel capacity theorem.
3. **Digital communication systems**: pulse code modulation (PCM), differential pulse code modulation (DPCM),
4. **Digital modulation schemes:** amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA and CDMA and GSM.
5. **Electromagnetics:** Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems,
6. **Maxwell's equations**: differential and integral forms. Wave equation, Poynting vector.
7. **Plane waves**: propagation through various media; reflection and refraction; phase and group velocity; skin depth.

8. **Transmission lines**: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation.

9. **Waveguides**: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Basics of propagation in dielectric waveguide and optical fibers.

10. **Basics of Antennas:** Dipole antennas; radiation pattern; antenna gain.

Paper-II: COMPUTER SCIENCE & INFORMATION TECHNOLOGY (DEGREE LEVEL)

Engineering Mathematics

1. **Probability and Statistics**: Probability, Conditional Probability; Probability Density Function, Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

2. **Set Theory & Algebra:** Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

3. **Linear Algebra:** Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

4. **Numerical Methods:** LU decomposition for systems of linear equations; numerical solutions of non-linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

5. Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

Computer Science and Information Technology:

1. Combinatorics: Permutations; Combinations; Counting; Summation; Generating functions; Recurrence relations.

2. Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

3. Mathematical Logic: Propositional Logic; First Order Logic.

4. Digital Logic: Logic functions, Minimization, Design and synthesis of combinational and sequential circuits; Number representation and computer arithmetic (fixed and floating point).

5. Computer Organization and Architecture: Machine instructions and addressing modes, ALU, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Cache and main memory, Secondary storage.

6. Programming and Data Structures: Programming in C; Functions, Recursion, Parameter passing, Scope, Binding; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Binary heaps.

7. Algorithms: Analysis, Asymptotic notation, space and time complexity, Worst and average case analysis; Design: Greedy approach, Dynamic programming, Divide-and conquer; Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, Basic concepts of complexity classes P, NP, NP-hard, NP-complete.

8. Theory of Computation: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability.

9. Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.

10. Operating Systems: Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.

11. Databases: ER-model, Relational model (relational algebra, tuple relational calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B and B+ trees), Transactions and concurrency control.

12. Information Systems and Software Engineering: Information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

13. Computer Networks: ISO/OSI reference model, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IPv4, Application layer protocols (ICMP, DNS, SMTP, POP, FTP, HTTP); Basic concepts of hubs, switches, gateways, and routers. Network security: basic concepts of public key and private key cryptography, digital signature, firewalls.

14. Web technologies: HTML, XML, basic concepts of Client-Server computing.