SYLLABUS & WEIGHTAGE OF QUESTIONS FOR WRITTEN EXAMINATION

Advt. No. 02/2016

Junior Executive (Engineering - Civil)

Part-A

General Knowledge, General Intelligence, General Aptitude, English etc. — Weightage 30%

Part-B

Questions on subjects relating to educational qualifications. — Weightage 70%

1. **Engineering Mechanics, Strength of Materials and Structural Analysis:**

1.1 Engineering Mechanics:

Units and Dimensions, SI Units, Vectors, Concept of Force, Concept of particle and rigid body. Concurrent, Non Concurrent and parallel forces in a plane, moment of force, free body diagram, conditions of equilibrium, Principle of virtual work, equivalent force system.

1.2 Strength of Materials:

Simple Stress and Strain, Elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending, Shear Stress distribution across cross sections, Beams of uniform strength.

Deflection of beams: Macaulay's method, Mohr's Moment area method, Conjugate beam method, unit load method. Torsion of Shafts, Elastic stability of columns, Euler's Rankine's and Secant formulae.

1.3 Structural Analysis:

Castiglianio's theorems I and II, unit load method of consistent deformation applied to beams and pin jointed trusses. Slope-deflection, moment distribution,

Rolling loads and Influences lines: Influences lines for Shear Force and Bending moment at a section of beam. Criteria for maximum shear force and bending Moment in beams traversed by a system of moving loads. Influences lines for simply supported plane pin jointed trusses.

Arches: Three hinged, two hinged and fixed arches, rib shortening and temperature effects.

Matrix methods of analysis: Force method and displacement method of analysis of indeterminate beams and rigid frames.

Plastic Analysis of beams and frames: Theory of plastic bending, plastic analysis, statical method, Mechanism method.

Unsymmetrical bending: Moment of inertia, product of inertia, position of Neutral Axis and Principle axes, calculation of bending stresses.

2. **Design of Structures: Steel, Concrete and Masonry Structures:**

2.1 Structural Steel Design:

Structural Steel: Factors of safety and load factors. Riveted, bolted and welded joints and connections. Design of tension and compression member, beams of built up section, riveted and welded plate girders, gantry girders, stancheons with battens and lacings.

2.2 Design of Concrete and Masonry Structures:

Concept of mix design. Reinforced Concrete: Working Stress and Limit State method of design–Recommendations of I.S. codes Design of one way and two way slabs, stair-case slabs, simple and continuous beams of rectangular, T and L sections. Compression members under direct load with or without eccentricity,

Cantilever and Counter fort type retaining walls.

Water tanks: Design requirements for Rectangular and circular tanks resting on ground.

Prestressed concrete: Methods and systems of prestressing, anchorages, Analysis and design of sections for flexure based on working stress, loss of prestress.

Design of brick masonry as per I.S. Codes

3. Geotechnical Engineering:

Soil Type and structure – gradation and particle size distribution – consistency limits.

Water in soil – capillary and structural – effective stress and pore water pressure – permeability concept – field and laboratory determination of permeability – Seepage pressure – quick sand conditions – Shear strength determination – Mohr Coulomb concept.

Compaction of soil – Laboratory and field tests.

Compressibility and consolidation concept – consolidation theory – consolidation settlement analysis.

Earth pressure theory and analysis for retaining walls, Application for sheet piles and Braced excavation.

Bearing capacity of soil – approaches for analysis – Field tests – settlement analysis – stability of slope of earth walk.

Subsurface exploration of soils – methods

Foundation – Type and selection criteria for foundation of structures – Design criteria for foundation – Analysis of distribution of stress for footings and pile – pile group action-pile load test. Ground improvement techniques.

Soil Stabilization.

4. Construction Technology, Equipment, Planning and Management:

4.1 Construction Technology:

Engineering Materials:

Physical properties of construction materials with respect to their use in construction - Stones, Bricks and Tiles; Lime, Cement, different types of Mortars and Concrete.

Specific use of ferro cement, fibre reinforced C.C, High strength concrete and PPC.

4.2 Construction:

Masonry principles using Brick, stone, Blocks – construction detailing and strength characteristics.

Types of plastering, pointing, flooring, roofing and construction features.

Common repairs in buildings.

Principles of functional planning of building for residents and specific use - Building code provisions.

Basic principles of detailed and approximate estimating - specification writing and rate analysis – principles of valuation of real property.

Machinery for earthwork, concreting and their specific uses – Factors affecting selection of equipments – operating cost of Equipments.

4.3 Construction Planning and Management:

Construction activity – schedules- organization for construction industry – Quality assurance principles.

Use of Basic principles of network – analysis in form of CPM and PERT – their use in construction monitoring, Cost optimization and resource allocation.

5. Surveying and Transportation Engineering

5.1 Surveying:

Common methods and instruments for distance and angle measurement for CE work – their use in plane table, traverse survey, leveling work, triangulation, contouring and topographical map.

Basic principles of photogrammetry and remote sensing.

5.2 Highway Engineering:

Principles of Highway alignments – classification and geometrical design elements and standards for Roads.

Pavement structure for flexible and rigid pavements - Design principles and methodology of pavements.

Typical construction methods and standards of materials for stabilized soil, WBM, Bituminous works and CC roads.

Different types of joints in pavements.

Surface and sub-surface drainage arrangements for roads - culvert structures.

Pavement distresses and strengthening by overlays.

6. Environmental Engineering:

6.1 Water Supply:

Predicting demand for water, impurities, of water and their significance, physical, chemical and bacteriological analysis, waterborne diseases, standards for potable water.

6.2 Intake of water:

Water treatment: principles of coagulation, flocculation and sedimentation; slow-; rapid-, pressure-, filters; chlorination, softening, removal of taste, odour and salinity.

6.3 Sewerage systems:

Domestic and industrial wastes, storm sewage–separate and combined systems, flow through sewers, design of sewers.

6.4 Sewage characterization:

BOD, COD, solids, dissolved oxygen, nitrogen and TOC. Standards of disposal in normal watercourse and on land.

6.5 Sewage treatment:

Working principles, units, chambers, sedimentation tanks, trickling filters, oxidation ponds, activated sludge process, septic tank, disposal of sludge, recycling of wastewater.

6.6 Solid waste:

Collection and disposal in rural and urban contexts, management of long-term ill effects.

7. Environmental pollution: Sustainable development. Rawastes and disposal. Environmental impact assessment for thermal power plants, mines, river valley projects. Air pollution. Pollution control acts

8. Basic of computer software usage

Basic knowledge of MS Office (MS Word, MS Excel, MS PowerPoint)

Junior Executive (Engineering - Electrical)

Part-A

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Part-B

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1. **Circuit Theory:** Circuit components; network graphs; KCL, KVL; circuit analysis methods: nodal analysis, mesh analysis; basic network theorems and applications; transient analysis: RL, RC and RLC circuits; sinusoidal steady state analysis; resonant circuits; coupled circuits; balanced 3-phase circuits; Two-port networks.

2. **Signals and systems:** Representation of continuous and discrete time signals; shifting and scaling operation; liner time invariant and causal systems: Fourier, Laplace and Z transform.

3. **Instrumentation:** Insulation megger, earth megger, Kelvin's Double bridge, Quadrent electrometer, Rotating sub standard, TOD meter.

4. **Electrical Machines:-**
   a. **Transformers:** Constructional details – Principle of operation – vector diagrams on no load and load – regulation and efficiency – equivalent circuits and tests for the determination of parameters of equivalent circuits – types of three phase transformers and their applications – Scott connection of transformers.

   b. **3-Phase Induction Motors:** Principle of operation – Cage and Slip ring motors – torque slip characteristics – methods of speed control.

   c. **3-Phase Alternators:** Principle of operation and constructional details – types of Alternators –synchronous impedance – voltage regulation – short circuit ratio and its importance – phasor diagrams of round rotor and salient pole machines – synchronization – behavior of an alternator connected to infinite bus – effect of varying excitation current and mechanical torque – power angle curves – control of active and reactive powers.

   d. **3-Phase Synchronous Motors:** Principle of operation – torque developed and methods of starting – V and Inverted V curves – effects of variations of excitation – synchronous condensers.

   e. **Single phase induction Motors:** Types of single phase motors – Types of Single phase induction motors – characteristics and methods of starting – shaded pole induction motor.

5. **Transmission & Distribution:** Line constants – Inductance and Capacitance calculations – Representation of over head Lines – Short, Medium and Long lines – ABCD constants – Mechanical Design – Seg, Tension Calculations, Tuned Power Lines.
   a. **Over Head Line Insulators:** Types of Insulators – Potential distributions over a string of suspension insulators – string efficiency – Methods of improving string efficiency.

   b. **Underground Cables:** Insulation of cables – Grading of cables – Capacitance Measurement in cables – Testing of Cables – Power frequency withstand tests.

   c. **Fault Calculations:** Balanced Fault calculations on systems – Symmetrical components – Types of faults – Analysis of unbalanced faults.

   d. **Protection:** Characteristic of Relays – Over current, directional and distance protection of lines.
   Protection of Alternators against stator faults, rotor faults, loss of excitation, unbalanced loading, overloading, failure of prime-mover. Over speeding and over voltage. Protection of transformers against winding faults, overloads and external short circuits.

   e. **Circuit Breakers:** Air-blast, oil, minimum oil, vacuum – sulphur hexafluoride and d.c. circuit breakers –Relative merits and demerits.

6. **Power System Protection:** Principles of over current, differential and distance protection. Concept of solid state relays. Circuit breakers. Computer aided protection: Introduction; line bus, generator, transformer protection; numeric relays and application of DSP to protection.

7. **Microprocessors and Microcomputers:** PC organisation; CPU, instruction set, register set, timing diagram, programming, interrupts, memory interfacing, I/O interfacing, programmable peripheral devices.

8. **Analog and Digital Electronics:** Characteristics of diodes. BJT, MOSFET, amplifiers –biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers - characteristics and applications; simple active filters: VCOs and timers; combinational and sequential logic circuits; multiplexer; Schmitt trigger; multivibrators; sample and hold circuits; A/D and D/A converters; 8-bit microprocessor basics, architecture, programming and interfacing.

9. **Power Electronics and Drives:** Semiconductor power diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters - fully controlled and half controlled; principles of choppers and inverters; basis concepts of adjustable speed dc and ac drives.

10. **Fiber Optic Systems Multiplexing** – Time division multiplexing, frequency division multiplexing, optical properties of materials, refractive index absorption and emission of light, optical fibers lasers and optoelectronic materials, fiber optic links.

11. **Digital Communication:** Pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM), Digital modulation and demodulation schemes: amplitude, phase and frequency keying schemes (ASK, PSK, FSK). Error control coding: error detection and correction, linear block codes, convolution codes. Information measure and source coding. Data networks, 7-layer architecture.

12. **HVAC**
    a. **Fundamentals** - Air properties, psychometry, basic processes, for HVAC system.
13. **PUMPS**
    a. **PUMPS:** Water lifting devices, classification of pumps, centrifugal pump and its characteristics, specific speed, NPSH and cavitation, selection of pumps.
    b. **HYDRAULICS AND FLUID MECHANICS:** Definition and properties of fluids. Units of measurement, kinematics of fluid flow, Bernoulli's equation and Euler's equation of motion. Dimensional analysis and similitude. Laminar and turbulent flow. General equation for head loss in pipes. Flow through pipes; open channel flow, hydraulic jump; Measurement of discharge in pipes and open channels.

14. **Renewable energy sources.**

Junior Executive (Information Technology)

Part-A

General Knowledge, Weightage 50%
General Intelligence,
General Aptitude, English etc.

Part-B

Questions on subjects Weightage 50%
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educational qualifications.

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.
Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.
Combinatory: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotic.

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

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

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.

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

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

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

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.

Algorithms: Analysis, Asymptotic notation, Notions of 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.

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

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

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

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

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.

Computer Networks: ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP(v4), 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.

Web technologies: HTML, XML, basic concepts of client-server computing.

Junior Executive (Airport Operations)

Part-A

General Knowledge, Weightage 50%
General Intelligence,
General Aptitude, English etc.

Part-B

Questions on subjects Weightage 50%
relating to
educational qualifications.

[Physics 50%, Mathematics 50% (Class XII level)]