



భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్  
भारतीय प्रौद्योगिकी संस्थान हैदराबाद  
Indian Institute of Technology Hyderabad

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Post Number	Post Name
<b>15.8</b>	<b>Junior Technician – Civil Engineering</b>

### **Syllabus for Written and/ or Skill Test**

#### **1. Junior Technician – Civil Engineering -Geotechnical Engineering**

**Engineering Mechanics:** System of Forces, Free-Body Diagrams, Equilibrium Equations; Internal Forces in Structures; Friction and its Applications; Kinematics of Point Mass and Rigid Body; Centre of Mass; Euler's Equations of Motion; Impulse-Momentum; Energy Methods; Principles of Virtual Work.

**Solid Mechanics:** Bending Moment and Shear Force in Statically Determinate Beams. Simple Stress and Strain Relationship: Stress and Strain in Two Dimensions, Principal Stresses, Stress Transformation, Mohr's Circle. Simple Bending Theory, Flexural and Shear Stresses, Unsymmetrical Bending, Shear Centre. Thin-Walled Pressure Vessels, Uniform Torsion, Buckling of Column, Combined and Direct Bending Stresses.

**Structural Analysis:** Analysis of Statically Determinate Trusses, Arches, Beams, Cables and Frames, Displacements in Statically Determinate Structures and Analysis of Statically Indeterminate Structures by Force/ Energy Methods, Analysis by Displacement Methods (Slope Deflection and Moment Distribution Methods), Influence Lines for Determinate and Indeterminate Structures. Basic Concepts of Matrix Methods of Structural Analysis.

**Concrete Structures:** Concrete Technology- Properties of Concrete, Basics of Mix Design. Concrete Design Basic Working Stress and Limit State Design Concepts, Analysis of Ultimate Load Capacity and Design of Members Subjected to Flexure, Shear, Compression and Torsion by Limit State Methods. Basic Elements of Prestressed Concrete, Analysis of Beam Sections at Transfer and Service Loads. Concrete, Analysis of Beam Sections at Transfer and Service Loads.

**Steel Structures:** Analysis and Design of Tension and Compression Members, Beams and Beam-Columns, Column Bases. Connections-Simple and Eccentric, Beam-column Connections, Plate Girders and Trusses. Plastic Analysis of Beams and Frames.

#### **Fluid Mechanics, Hydrology, Water Resources, Irrigation**

**Water Resources & Environmental Engineering Fluid Mechanics and Hydraulics:** Properties of Fluids, Principle of Conservation of Mass, Momentum, Energy and Corresponding Equations, Potential Flow, Applications of Momentum and Bernoulli's Equation, Laminar and Turbulent Flow, Flow in Pipes, Pipe Networks. Concept of Boundary Layer and its Growth. Uniform Flow, Critical Flow and Gradually Varied Flow in Channels, Specific Energy Concept, Hydraulic Jump. Forces on Immersed Bodies, Flow

Measurements in Channels, Tanks and Pipes. Dimensional Analysis and Hydraulic Modeling. Kinematics of Flow, Velocity Triangles, and Specific Speed of Pumps and Turbines.

**Hydrology:** Hydrologic Cycle, Rainfall, Evaporation, Infiltration, Stage Discharge Relationships, Unit Hydrographs, Flood Estimation, Reservoir Capacity, Reservoir and Channel Routing. Well Hydraulics.

**Irrigation:** Duty, Delta, Estimation of Evapotranspiration. Crop Water Requirements. Design of: Lined and Unlined Canals, Waterways, Head Works, Gravity Dams, and Spillways. Design of Weirs on Permeable Foundation. Types of Irrigation System, Irrigation Methods. Water Logging and Drainage, Sodic Soils.

## **Geotechnical Engineering**

**Soil Mechanics:** Origin of Soils, Soil Classification, Three-Phase System, Fundamental Definitions, Relationship and Interrelationships, Permeability & Seepage, Effective Stress Principle, Consolidation, Compaction, Shear Strength.

**Foundation Engineering:** Sub-Surface Investigations- Scope, Drilling Bore Holes, Sampling, Penetration Tests, Plate Load Test. Earth Pressure Theories, Effect of Water Table, Layered Soils. Stability of Slopes Infinite Slopes, Finite Slopes. Foundation Types-Foundation Design Requirements. Shallow Foundations- Bearing Capacity, Effect of Shape, Water Table and Other Factors, Stress Distribution, Settlement Analysis in Sands & Clays. Deep Foundations Pile Types, Dynamic & Static Formulae, Load Capacity of Piles in Sands & Clays, Negative Skin Friction.

**Transportation & Geomatics Engineering Transportation Infrastructure:** Highway alignment and engineering surveys; Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments; Geometric design of railway track; Airport runway length, taxiway and exit taxiway design.

**Highway Planning:** Geometric Design of Highways, Testing and Specifications of Paving Materials, Design of Flexible and Rigid Pavements.

**Traffic Engineering:** Traffic Characteristics, Theory of Traffic Flow, Intersection Design, Traffic Signs and Signal Design, Highway Capacity.

**Surveying:** Importance of Surveying, Principles and Classifications, Mapping Concepts, Coordinate System, Map Projections, Measurements of Distance and Directions, Leveling, Theodolite Traversing, Plane Table Surveying, Errors and Adjustments, Curves.

**Photogrammetry:** scale, flying height; Remote sensing - basics, platform and sensors, visual image interpretation; Basics of Geographical information system (GIS) and Geographical Positioning system (GPS).

## **Wastewater/Environmental Engineering**

**Water & Waste Water Engineering:** Quality Standards, Basic Unit Processes and Operations for Water Treatment. Drinking Water Standards, Water Requirements, Basic Unit Operations and Unit Processes for Surface Water Treatment, Distribution of Water. Sewage and Sewerage Treatment, Quantity and Characteristics of Wastewater. Primary, Secondary, and Tertiary Treatment of Wastewater, Sludge Disposal, Effluent Discharge Standards. Domestic Wastewater Treatment, Quantity and Characteristics of Domestic Wastewater, Primary and Secondary Treatment Unit Operations and Unit Processes of Domestic Wastewater, Sludge Disposal.

**Air Pollution:** Types of Pollutants, their Sources and Impacts, Air Pollution Meteorology, Air Pollution Control, Air Quality Standards and Limits.

**Municipal Solid Wastes:** Characteristics, Generation, Collection and Transportation of Solid Wastes, Engineered Systems for Solid Waste Management (Reuse/ Recycle, Energy Recovery, Treatment and Disposal).

**Noise Pollution:** Impacts of Noise, Permissible Limits of Noise Pollution, Measurement of Noise and Control of Noise Pollution.

### **Engineering Mathematics**

**Linear Algebra:** Matrix algebra; Systems of linear equations; Eigen values and Eigen vectors.

**Calculus:** Functions of a single variable; Limit, continuity and differentiability; Mean value theorems, local maxima and minima; Taylor series; Evaluation of definite and indefinite integrals, application of definite integral to obtain area and volume; Partial derivatives; Total derivative; Gradient, Divergence and Curl, Vector identities; Directional derivatives; Line, Surface and Volume integrals.

**Ordinary Differential Equation (ODE):** First-order (linear and non-linear) equations; higher order linear equations with constant coefficients; Euler-Cauchy equations; initial and boundary value problems.

**Partial Differential Equation (PDE):** Fourier series; separation of variables; solutions of one-dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equation.

**Probability and Statistics: Sampling theorems;** Conditional probability; Descriptive statistics – Mean, median, mode, and standard deviation; Random Variables – Discrete and Continuous, Poisson and Normal Distribution; Linear regression.

**Numerical Methods:** Error analysis. Numerical solutions of linear and non-linear algebraic equations; Newton's and Lagrange polynomials; numerical differentiation; Integration by trapezoidal and Simpson's rule; Single and multi-step methods for first-order differential equation.

## 2. Junior Technician- Civil Engineering – Structural Engineering

### 1- Electrical Circuits and Machines:

- Voltage and current sources: independent, dependent, ideal, and practical; v-i relationships of resistor, inductor, mutual inductance, and capacitor; transient analysis of RLC circuits with DC excitation. Peak, average, and RMS values of ac quantities; apparent, active, and reactive powers; impedance and admittance; series and parallel resonance, basic filters with R, L, and C elements. Transient analysis of RLC circuits with ac excitation.
- Single phase transformer: principle of operation, equivalent circuit, open circuit and short circuit tests, regulation, and efficiency; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Types of losses and efficiency calculations of electric machines. Basics of Variable frequency drives (VFD); Basics of Uninterrupted power supply (UPS), Battery bank, Charging circuit, power & load calculation.

### 2- Sensors and Instrumentation:

Resistive-, capacitive-, inductive-, piezoelectric-, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (variable head, variable area, electromagnetic, ultrasonic, turbine, and open channel flow meters) temperature (thermocouple, bolometer, RTD (3/4 wire), thermistor, pyrometer and semiconductor); LVDT, Strain gauge, Pressure gauge, Differential flow transmitters, Mass flow meter, Orifice & venturi tube, liquid level, pH, conductivity and viscosity measurement. 4-20 mA two-wire transmitter. Proximity sensors, Optical transmitter & receiver, Ultrasonic transmitter & receiver, Capacitive & radar type level transmitters.

### 3- Control Systems:

Feedback principles, time-delay systems; mechanical, hydraulic, and pneumatic system components, synchro pair, servo, and stepper motors, servo valves; on-off, P, PI, PID, cascade, feedforward, and ratio controllers, tuning of PID controllers and sizing of control valves (Electrical, Pneumatic & Hydraulic).

### 4- Analog Electronics:

Characteristics, basic operations and applications of diode, Zener diode, BJT and MOSFET, IGBT, SCR, Thyristor; Characteristics of ideal and practical operational amplifiers; applications of opamps: adder, subtractor, integrator, differentiator, difference amplifier, instrumentation amplifier, precision rectifier, active filters, oscillators, signal generators, voltage-controlled oscillators and phase locked loop, sources and effects of noise and interference in electronic circuits.

### 5- Digital Electronics

Basics of number systems, logic gates, flipflops, timers, and counters; sample-and-hold circuit,

multiplexer, analog-to-digital converters (ADC) (successive approximation, integrating) and digital-to-analog converters (DAC) (R-2R ladder). Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion/settling time).

### **6- Embedded Systems:**

Microprocessor and microcontroller applications (Ref 8051, MSP430, LPC1768), Basic knowledge in Arduino development boards, Raspberry Pi Single board computer; GPIO, EEPROM, MicroSD card, Sensors, ADC, DAC interfacing; basics of data acquisition systems (Ref NI USB DAQ modules), basics of distributed control systems (DCS), programmable logic controllers (PLC) (Ref Siemens S7 1200), Thyristor modules.

### **7- Measurements**

SI units, standards (R, L, C, voltage, current, and frequency), systematic and random errors in measurement, expression of uncertainty - accuracy and precision, propagation of errors, linear and weighted regression. Bridges: Wheatstone, Kelvin, Megohm, Maxwell, Anderson, Schering, and Wien for measurement of R, L, C and frequency, Q-meter. Measurement of voltage, current, and power in single and three-phase circuits; AC and DC current probes; true rms meters, voltage and current scaling, instrument transformers, timer/counter, time, phase, and frequency measurements, digital voltmeter, digital multimeter; Digital Storage Oscilloscope, Function generator, Source meter, programmable power supply, shielding, and grounding.

### **8- Communication and Optical Instrumentation**

Amplitude- and frequency modulation and demodulation; Shannon's sampling theorem, pulse code modulation; frequency and time division multiplexing; IPV4, LAN, RJ45, UART, Profibus, CAN, USB, Ethernet protocols; Basics of Linux Operating system; Drivers & packages installations, configuring & troubleshooting basic communication issues in Linux-based system; optical sources and detectors: LED, laser, photodiode, light dependent resistor, square law detectors, and their characteristics; interferometer: applications in metrology; basics of fiber optic sensing. UV-VIS Spectro photometers, Mass spectrometer.

## **9. Analog Circuits:**

- Diode Circuits: clipping, clamping, and rectifiers.
- BJT and MOSFET Amplifiers: biasing, AC coupling, small signal analysis, frequency response.
- Current mirrors and differential amplifiers.
- Op-amp Circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers, and oscillators.
- Digital Circuits:
- Number Representations: binary, integer, and floating-point- numbers. 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, and decoders.

- Sequential Circuits: latches and flip-flops, counters, shift registers, finite state machines, propagation delay, setup and hold time, critical path delay.
- Data Converters: sample and hold circuits, ADCs, and DACs.
- Semiconductor Memories: ROM, SRAM, DRAM.
- Computer Organization: Machine instructions and addressing modes, ALU, data path and control unit, instruction pipelining.

## **10. Communications:**

- Random Processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems.
- Analog Communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers.
- Information Theory: entropy, mutual information, and channel capacity theorem.
- Digital Communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM),
- bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER.
- Fundamentals of error correction, Hamming codes, CRC.

Note: The syllabus topics mentioned above are for illustrative purposes only.

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