

# **RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER**

## **SYLLABUS FOR SCREENING TEST FOR THE POST OF VICE PRINCIPLE/ SUPERINTENDENT, I.T.I., TECHNICAL EDUCATION DEPARTMENT**

### **1 - CIVIL ENGINEERING**

#### **1 Engineering Materials & Construction Technology :**

Selection of site for construction of various types of buildings. Requirements and design criteria for foundations; construction details of walls, masonry, floors, staircases, arches, roofs, doors and windows. Requirements for Fire Protection, Ventilation and Air Conditioning and Acoustics. Water supply and drainage. Building materials : Stones, bricks, cement, lime, paints and timber.

#### **2 Surveying :**

Chain and compass surveying; leveling; Temporary & Permanent adjustments of level instrument & Theodolite. Use of Theodolite, Tacheometry, Triangulation and Traversing; contours and contouring; Simple, Circular, compound and Transition curves and their setting outs. Theory of Errors and Survey adjustment. EDM Surveys, Photogrammetry and Basics of Remote Sensing.

#### **3 Geotechnical Engineering :**

Classification of soil as per I.S. Code. Field identification tests for soils; water Content, specific Gravity, Void Ratio; Porosity, Degree of Saturation; Unit Weight, Density Index and their inter-relationship. Determination of various properties of soils, grain size distribution, Atterberg's/consistency limits, etc.

Soil permeability and its determination in the laboratory and field; Darcy's Law, Flow nets-its construction and uses. Compaction and consolidation of soil and quality control, soil stabilization methods; New mark's chart and its uses. Elements of shear strength parameters and their determination. Bearing capacity of shallow foundation, Earth pressures on retaining wall; Stability of slopes, Pile Foundations.

#### **4 Structural Mechanics :**

Stress and Strains, Elastic constants, Factor of Safety, Relation among elastic constants. Bending moment and shear force diagrams for cantilever, simply supported, overhanging, fixed & continuous beams subjected to static loads; concentrated, uniformly, distributed and uniformly varying loads. Theory of simple bending.

Deflection of cantilever, simple supported, fixed and continuous beams. Two and Three hinged arches.

## 5 **Steel Structures :**

Design of ordinary and plate girder beams, Design of members of Roof trusses, Rivetted and welded joints, Axially and Eccentrically loaded columns, Grillage, Gusseted & Slab base Foundation. Provisions of IS:800 and IS:875.

## 6 **Reinforced Concrete Structures :**

Provisions of latest IS:456, Design of beams singly and doubly reinforced, Design of shear reinforcement; Design of slabs simply supported, spanning in two directions and T-beam slabs, Flat Slabs. Design of columns axially and eccentrically loaded; Design of isolated and combined column footings; Design of simple RCC cantilevers and Retaining walls. Reinforcement in overhead & Underground water tanks. Limit state method for Design, Pre-stressed concrete.

## 7 **Fluid Mechanics and Water Resources Engineering :**

Hydraulic pressure at a point and its measurement, Buoyancy, conditions of equilibrium of floating bodies; fluid properties; Fluid Flow conditions; Bernoulli's Theorem; Navier-Stokes equation, Flow through orifices, Notches, and weirs; Laminar & Turbulent flow through pipes, flow through open channels, Hydraulic jump. Hydraulic turbines & pumps.

Hydrograph Analysis, Abstractions (Interception, infiltration, evaporation, and Transpiration), Floods/Drought, Frequency Analysis, Groundwater Hydrology.

Reservoirs and Dams; overflow structures, Irrigation canals, Groundwater and well Irrigation; water-logging.

## 8 **Environmental Engineering :**

Percapita requirement of water for urban and rural areas; Forecast of population. Sources, water quality standards for public water supplies; various methods of purification; Distribution network with all the ancillaries; systems of drainage; Layout of sewerage systems; Flushing of sewers; sewage treatment; Rural sanitation. Environmental Management aspects. Air Pollution

## 9 **Highway and Bridges :**

Principles of highway planning; classification of Roads, Alignment, Geometric Design, Traffic Engineering; pavement design for flexible & rigid pavements; paving materials and highway construction, maintenance of different types of roads. Highway drainage and Arboriculture; Types of bridges; choice of type of bridge, Economical considerations of fixing spans, causeways & Culverts.

## 10. **Construction Planning and Management**

Functions of construction management, Various aspects of construction project planning, project scheduling and controlling. CPM and PERT, Project cost control.

## 2 - ELECTRICAL ENGINEERING

Generation of emf and torque in rotating machines. D.C. motors and generators and their general characteristics, speed control methods of D.C. motors. Single-phase and three phase transformers & their equivalent circuits, phasor diagram, losses, regulation and efficiency. Three-phase and single-phase induction motor, equivalent circuits, starters, speed control methods of three phase induction motor. Synchronous motors & alternators.

Steady state analysis of d.c. and a.c. network, network theorems, Laplace transform, transient response, network functions, ABCD parameter, Z-parameter, Y-parameter & h-parameter, network synthesis. Three-phase networks.

Open & close loop systems, mathematical modeling of dynamic linear systems, transfer functions, block diagrams, signal flow graph, time response analysis, stability of control systems, compensating networks, state variable analysis.

Basic methods of measurement, indicating instruments, measurement of voltage, current power, energy, resistance, inductance, capacitance, frequency, time and flux, current and potential instrument transformers, transducers, cathode ray oscilloscope & digital instruments.

Semiconductor devices and analysis of electronic circuits, oscillators and feedback amplifiers, modulation and demodulation circuits, wave shaping circuits and time base generators, multi-vibrators. Binary system, logic gates, flip-flops, registers, counters, combinational and sequential circuits.

Power generating plants, transmission & distribution systems, load curves, tariffs, basic ideas of power system stability, swing equation, equal area criterion, grid substations, earthing, power system protection, relays, circuit breakers, symmetrical & non-symmetrical fault analysis, voltage & frequency control.

Conversion of a.c. to d.c. and d.c. to a.c. controlled rectifiers, speed control techniques for drives & traction systems. Electrical heating, welding & illumination.

Introduction to 8085/8086 microprocessor, computer architecture, C/C++, JAVA & MATLAB programming.

### 3 - MECHANICAL ENGINEERING

#### **Engineering Thermodynamics**

Laws of Thermodynamics, Gas Power Cycles: Diesel, Otto, Dual combustion, Brayton, Joule cycle, Sterling and Ericsson cycles; Vapour Power Cycle. Thermal efficiency and work ratio. Refrigeration Cycles/Processes: Brayton air refrigeration cycle, simple vapor compression cycle, Vapour absorption system. Compressors: Introduction & Application, Classification, construction of single stage and multi-stage compressors, work done in single stage and multi-stage,

#### **Manufacturing Technology**

Press working of sheet metal: Types of presses and operations. Die materials, Construction details of die set. Machine tools and operations, Cutting tools & materials : single point tool, cutting speed, feed and depth of cut. Metal Cutting: Orthogonal cutting, velocity relationships, force and power. Tool Life, Economics of machining. Capstan and Turret Lathes; boring and broaching machine. Indexing head; milling operations. Grinding machines and operations; Grinding Wheels. Cutting Fluids, Introduction to NC and CNC machines. FMS. Foundry technology, Welding technology .

Metrology: Dimensional and Geometrical accuracy, Standardization, Limits, fits and tolerances, Design of gauges.

#### **Fluid Mechanics & Machines**

Basics of fluid mechanics, Buoyant force, stability of floating and submerged bodies, kinematics of Fluid flow, Dynamics of fluid flow, Dimensional Analysis and Dynamic Similitude, Viscous flow, turbulent flow, Concept of boundary layers, Analysis of pipe flow.

Impact of Free Jet, Homologous units, specific speed, theory of Turbomachines, efficiencies. Methods of classifications, Reaction, impulse and mixed flow turbines, their efficiencies, characteristics, and principles of governing. Draft tube, cavitation, water hammer and surge tanks.

Centrifugal and Reciprocating pumps, air vessels, operating characteristics of these pumps. Miscellaneous machines: Hydraulic accumulator, hydraulic press, lift, ram, coupling and torque converter.

#### **Kinematics of Machines**

Links and pairs; kinematics chains; Mechanisms and machines; Inversion; Absolute and relative motions; Instantaneous centres: Acceleration analysis; Cam profiles & different types of followers; cams with specified contours; Fundamental laws of gearing; Types of gears, Gears trains, Belts, rope and chain drives. Efficiency of power transmission

#### **Dynamics of Machines**

Concept of free body and its equilibrium; Static & Dynamic force analysis; Fluctuation of energy and speed; Fly wheels & governors. Balancing of rotating masses, Power

Screw; Plate and Cone clutches; band and block brakes; Gyroscopic action and Gyroscopic torque. Friction.

### **Industrial Engineering**

Introduction to Industrial Engineering & productivity, Functions of Management, Organizational Structure, Financial Management, Marketing Management, Personnel Management, Wage, Incentives & Payment Systems, Labor relations & Legislations, Cost & Cost Control. Depreciation, budget and budgetary control.

Types of forecasting, Facilities Location & Layout Planning, Scheduling, routing, sequencing, Aggregate Production planning, Capacity planning, Inventory Control, Material requirement Planning, Manufacturing Resource Planning, Enterprise Resource Planning

Work Study: Methods study, time study, Work Measurement & Design. Ergonomic aspects in industrial design. Industrial Safety. Work & Job design, Job Evaluation & Merit Rating. CPM and PERT. JIT, Supply Chain, Group Technology, Computer aided process planning.

### **Mechanics of Solid**

Concepts and analysis of stresses and strains; mechanical properties; ductile and brittle materials; members in uni-axial state of stress; Transformation of stresses, members subjected to axi-symmetric, torsional and flexural loads; deflection in beams, members subjected to combined loads; elastic stability of columns. Eccentric loading.

### **Machine Design**

Design for strength, Stress concentration. Introduction of various design considerations like strength, stiffness, weight, cost, factor of safety, space etc; Fatigue consideration in Design, design of welded joints, riveted joint, screwed joints, helical and leaf springs, shafts, Couplings, brakes and clutches. Design of machine members subjected to combined steady & alternating stresses like Bolts and shafts, curved members like crane hooks, crankshafts, camshafts and connecting rod, gear tooth, sliding & journal bearings. Wear and dynamic load consideration. Design of fly-wheel and rotary devices.

### **Automobile Engineering**

Transmission system, steering system, suspension systems, tyres, springs and shock absorbers, brakes and their actuators, ignition systems, Automotive pollution and its control strategies. Legal aspects.

### **Turbo Machines**

Gas Turbines, Cycles, inter cooling, reheating and reheat, compounding. Impulse and reaction turbines. Performance of Practical Gas Turbine Cycles, Compressor and turbine efficiencies. Heat exchanger simple cycle and series and parallel flow cycles, Centrifugal and Axial Flow Compressors.

Steam Turbines, Steam nozzles, Velocity diagrams, main blade dimensions, thrust; theoretical power and torque, special constructional features of steam turbines, Condensers: performance of condenser; vacuum efficiency.

### **Heat Transfer**

Heat transfer processes; thermal conductivity of solids, liquids and gases; boundary conditions, one dimensional heat conduction, critical thickness of insulation; fins, Convection, appropriate nondimensional numbers; flow over flat plate; free and forced convection. Heat Exchangers: Different types of heat exchangers; arithmetic and logarithmic mean temperature differences; heat transfer coefficient for parallel, counter and cross flow type heat exchanger; effectiveness of heat exchanger. Thermal Radiation: Kirchoff's law; radiation intensity, heat exchange between two black bodies, between gray bodies.

### **Internal Combustion Engines**

Ideal and actual cycles of operation, fuels, Combustion SI and CI engines, carburetors and fuel injection systems for SI engines, fuel injection systems for diesel engines, lubrication systems, cooling systems, supercharging, scavenging, engine performance, testing and exhaust emission characteristics, exhaust pollution, special engines and computer simulation of two stroke and four-stroke engines. Abnormal combustions, knocking and pre-ignition.

### **Refrigeration & Air-conditioning**

Air Refrigeration & Heating System, air-craft air conditioning systems. Heat Pump cycle. COP, Vapor compression refrigeration: Simple cycle, factors affecting performance of vapor compression cycle, actual vapor compression cycle. Suitability of refrigerants for different applications. Vapor Absorption Refrigeration System. Psychrometry and Psychrometric properties, relations, charts and uses, evaporative cooling, air washers and air cleaners, human comfort, factors affecting comfort. Solar Radiation: Distribution of solar radiation, passive heating and cooling of buildings. Ducting System. Comfort air-conditioning.

### **Power Plant Engineering**

Steam Power Plants: Layout and site selections. Fuel storage and handling. Cooling towers. Diesel & Gas Turbine Power Plants: General layout, elements, fields of use, comparison with steam power plants. Comparison.

Nuclear Power Plants: Nuclear materials, waste disposal, fuels, coolants, moderating and reflecting materials, cladding materials, Disposal of nuclear waste, Nuclear reactors, location of nuclear power plants, comparison of nuclear plants with thermal plants. Enrichment, safety and control. Hydro-electric Power Plants, Power Plant Economics, performance and operating characteristics of power plants, Combined cycle plants, co-generation and tri-generation, peak load and base load power plants.

**Product Design**

Principles of modern design, Human factors in design and applied ergonomics. Product design methods. Legal issues in product design and design resources.

**Operations Research**

History of OR, General methodology of OR, Linear optimization models, simplex algorithms, duality; dual linear programming, Sensitivity; Integer programming, Assignment models, Transportation problems, Transshipment models, Theory of Games. Queuing Theory. Application to industrial problems. Sampling method.

**Vibrations**

Fundamentals of vibration: Free vibration, Forced vibration, single degree of freedom. Natural frequency, Principle of conservation of energy, Principles of virtual work. Damping. Forced vibrations: Harmonic excitation, Mechanical impedance, Critical speed, Vibration Isolation, whirling of shafts. Two degree of freedom systems.

## 4 - INFORMATION TECHNOLOGY (I.T.)

### **Computer Organization & Architecture**

Digital Logic Family: Logic Gates, Logic functions, Design of Sequential and Combinational Logic Circuits, Number System and data representation.

CPU Design: Design of ALU and Control Unit. Memory Organization, DMA, I/O organization.

### **Discrete Mathematics**

Fundamentals of Sets and Subsets, Propositional and Predicate Logic, Relation and Function, Permutation and Combinations, Trees and Graphs.

### **Programming and Data Structures**

Programming in C: Array, Function, Recursion, Union, Structure, File, Parameter Passing.

Data Structure: Stack, Queue, Linked List, Heap Sort, Binary Tree.

### **Operating System**

Processes, Threads, Inter Process Communication, Concurrency, Synchronization, Deadlock, CPU Scheduling, Memory Management and Virtual Memory, File System, I/O System, Protection and Security.

### **Computer Networks**

Data Communication Model, Networking Hardware, Data Transmission (analog and digital), modulation, multiplexing. ISO/OSI Network Model: Architecture and Function of each layer of OSI Model, Wired and Wireless Transmission Media, LAN, MAN, WAN, Routing Protocols, Network Technologies (ATM, Frame Relay, DSL, ISDN).

### **Database Management System**

Basic DBMS Terminology, Database System versus File System, Keys, Entity Relationship Model, Relational Model, SQL Query Processing and Optimization, Transaction Processing, Locking Techniques, Database Recovery and Security, Distributed Database System.

### **Network Management & Information Security**

Network Management: Standards, Functions, *SNMPv1* Protocol. Cryptography Techniques and Encryption Algorithms (DES & RSA), Network Attacks, IPsec, Network Scanning, Security of web Browsers and Servers, Firewalls and Intrusion Detection System.



**Software Engineering**

Software Development Paradigms and Models, Information Gathering, Software Requirement Specification, Software Process and Design, Modular Design, Process vs. Data Oriented Design, Software Testing: Functional and Structural, Testing Tools. Software Maintenance, Software Quality Assurance, Concept of Object Oriented Software Engineering.

**Data Warehousing & Mining**

Data Warehousing: Introduction, Architecture, Implementation, OLAP, Data Cleaning, Data Reduction, Data Integration and Transformation, Data Compression.

Data Mining: Data Mining Concepts, Data Mining Primitives, Architecture of Data Mining System, Data Mining Techniques, Mining Class Comparison, Mining Descriptive Statistical Measures, Associative Rule Mining, Apriori algorithm, Classification and Prediction, Mining of WWW.

**Web Design and Development**

Introduction to Internet, WWW, Scripting for Web Browser Portability, Client Vs Server Side Web Development, HTML, DHTML, XHTML, Java Script and Introduction to PHP.

**Emerging Technologies in the field of IT**

E-Commerce, Multimedia, Expert Systems, Machine Learning Techniques (Genetic Algorithm, BP algorithm & Fuzzy logic), Concept of Cyber Crimes and Cyber Laws.

## 5 - ELECTRONICS & COMMUNICATION ENGINEERING

### 1. Electronic Devices:

Semiconductor Devices: intrinsic and extrinsic semiconductors and their properties. p-n junction diode, Tunnel diode, BJT, JFET, MOS, MOSFET, LED, p-I-n and avalanche photo diode, Basics of LASER and MASER. VLSI technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, CMOS process. Power Switching Devices: SCR, GTO, Power MOSFET, Basics of Optoelectronics

### 2. Analog Circuits:

Small Signal Equivalent circuits of diodes, BJTs, MOSFETs and CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. 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 Timer. Power supplies.

### 3. Digital circuits:

Boolean algebra, minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

### 4. Electronic Measurement and Instrumentation:

Basic Concepts, Standards and error Analysis: Measurement of basic Electrical quantities and parameters; Electronic Measuring Instruments and their Principles of Working; analog and digital measurements, Comparison, Characteristics, Applications. Transducers, Electronic Measurements of Non Electrical Quantities like Temperature, Pressure, Humidity etc. Basics of Telemetry for Industrial use.

### 5. Networks:

Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin's and Norton's Theorem, Maximum power transfer Theorem, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, 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.

**6. Electromagnetics:**

Elements of vector calculus; Gauss' and Stokes' theorems, Maxwell's equations, Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies;. Basics of propagation in dielectric waveguide and optical fibers its dispersion and attenuation characteristics; Basics of Antennas: Dipole antennas; radiation pattern; antenna gain.

**7. Signals and Systems:**

Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

**8. Control Systems:**

Basic control system components; block diagram description, 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. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID), PD, PI Control Systems. State variable representation and solution of state equation of LTI control systems.

**9. Communications – I**

Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density. Analog communication systems: amplitude and angle modulation and demodulation systems, superheterodyne receivers; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions.

**10. Communications – II**

Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), 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. Fundamentals of information theory and Coding. Basics of TDMA, FDMA and CDMA and GSM. Basics of Satellite Communication.

## 6 - COMPUTER SCIENCE

1. **Digital Logic:** Number Systems, Representation and Computer arithmetic (fixed and floating point), Logic functions, Minimization, Combinational and Sequential circuits.
2. **Computer Organization and Architecture:** RAM and ROM, Microprocessor Architecture (8085, 8086), Machine instructions, Addressing modes, ALU, CPU, Control Unit, Memory interface, I/O interface (Interrupt and DMA mode), Microcontrollers, Interfacing, Instruction pipelining, Cache and main memory, Secondary storage.
3. **Programming:** Assemblers, Compilers and Interpreters, Programming in C - Functions, Recursion, Parameter passing, Scope; Object Oriented Programming (C++ and Java) – Objects, Classes, Inheritance, Polymorphism, Dynamic Binding, Access Modifiers.
4. **Data Structures and Algorithms:** Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Heaps, 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.
5. **Operating System:** Processes, Threads, Inter-process communication, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, I/O systems, Protection and security, Windows, Linux, Mobile OS, Android, RTOS.
6. **Databases:** ER-model, Relational model (relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), Transactions and concurrency control, Recovery and Failure.
7. **Information Systems and Software Engineering:** Process and Life cycle Models, information gathering, requirement and feasibility analysis, data flow diagrams, UML, process specifications, input/output design, planning and managing the project, design, coding, testing, implementation, maintenance, MIS and ERP.
8. **Computer Networks:** ISO/OSI 7 Layer Stack, LAN Topologies and Internetworking, Routing algorithms, Congestion control, TCP / UDP and sockets, IP (v4 and v6), Application layer protocols (ICMP, DNS, SMTP, POP, FTP, HTTP); Network and Web Security.
9. **Current Technologies:** Scripting Languages, HTML, XML, JavaScript, PHP; Mobile Computing, Cloud Computing, Wireless Communication, Data Mining and Information Retrieval.

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Pattern of Question Paper :

- 1 Objective type question paper.
- 2 Maximum Marks – 100
- 3 No. of question – 100
- 4 Duration of paper – 2 Hours
- 5 All questions carry equal marks.
- 6 There will be negative marking.
- 7 The candidates are required to opt only one subject.

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