

PUBLIC SERVICE COMMISSION, WEST BENGAL

Scheme and Syllabus for Preliminary Written Test for recruitment to the post of Assistant Engineer (Mechanical/Electrical) in the West Bengal Public Health Engineering Service (Mechanical/Electrical) under the Department of Public Health Engineering, Govt. of W.B. vide Advt. No. 3/2020

Scheme of Exam.

Full Marks: 200

No. of questions: 100 (each question carries 2 marks and the questions will be of objective type multiple choice) in each paper for Mechanical & Electrical Engineering.

Duration of examination: 2 hours

PUBLIC SERVICE COMMISSION, WEST BENGAL
Information to candidates for recruitment to post of Assistant Engineer (Mechanical)
under the different Departments of Govt. of West Bengal

Syllabus for the Preliminary Written Test for recruitment to the posts of Assistant Engineer (Mechanical/ Electrical) in the West Bengal Public Health Engineering Services (Mechanical/ Electrical).

i) **For Assistant Engineer (Mechanical) :**

The Preliminary Written Test will consist of one paper.

The question paper will be of the objective type (multiple choice) comprising 100 questions. Full marks will be 200 for 100 questions of 2 marks in each question.

The paper will be of 2 hours duration.

The course content of the syllabus for the paper will be of the DEGREE level.

SYLLABUS FOR THE WRITTEN TEST

ELECTRICAL TECHNOLOGY

Electrical Units, and dimensions. Electro magnetism, Magnetic circuits, D.C. generators and motors, speed control. Starters. Electrical measuring instruments – principles of operation and construction.

2. **MATHEMATICS**

Function of a single variable: Successive differentiation. Rolle's theorem. Mean value theorems. Taylor's theorem and Maclaurin's series. Maxima and minima. Indeterminate forms. Tangent, normal and curvature.

Functions of several variables; limit and continuity. Partial derivatives. Differentials. Partial derivatives of a composite function. Implicit function. Jacobian. Taylor's theorem. Maxima and minima. Lagrange's method.

Reimann integration: Definition, properties. Fundamental theorem of integral calculus. Improper integrals. Gamma and Beta functions.

Multiple integrals: Existence of integrals (statement only) Properties of double integral. Evaluation of double integral. Change of the order of integration and change of variables.

3. **ENGINEERING MECHANICS**

Laws of Coulomb's friction, equilibrium of rigid bodies, principle of virtual work, application of friction in machines, properties of surfaces, centre of mass, and centre of gravity, shear force and bending moment diagrams.

Introduction to elasticity, problems in uni-axial stress field.

Thin-walled beams, unsymmetrical bending, energy principles, Castigliano's theorems, curved beams, thick-walled cylinders under radial pressure. Lamé's equation, theories of failure.

Work-energy principle, momentum principle, central force motion.

4. PHYSICS

Angular momentum and torque. Moment of inertia. Parallel and perpendicular axes theorem. Calculation of moment of inertia of some common solids. Rotational dynamics of a rigid body.

Newton's law of Gravitation. Calculation of gravitational field and potential of a spherical distribution of mass. Motion under a central force.

Kepler's laws.

5. THERMODYNAMICS

Microscopic & macroscopic viewpoints in Thermodynamics; Fundamental concepts of system, control volume, state, properties, equilibrium, processes etc. Zeroeth law; Survey of units & Dimensions; Forms of energy and energy interactions, heat & work;

Ideal & Real Gases; Equations of state; Compressibility Factor; Generalised compressibility chart; First law of Thermodynamics for closed systems internal energy;

First law of Control Volumes; Steady flow & unsteady flow applications.

Definitions of Heat Engine, Heat Pump, Thermal Efficiency, COP; Carnot Cycle.

Second Law of Thermodynamics; Statements and Corollaries; Entropy; Concept of Reversibility and irreversibility.

Second law analysis of control Volumes; Concept of Entropy Generation. Reversible work, availability & Irreversibility.

T-ds relations; Maxwell equations; Clapeyron Equation; Clausius-Clapeyron equation, Joule-Thompson Coefficient; Compressibility & expansion co-efficient.

6. MATERIALS & METALLOGRAPHY

Unit cells, packing efficiency and co-ordination number, bonds and bond energy, plastic deformation and mechanical testing of metallic materials.

Strengthening mechanism, heat treatment of steels, cast iron and carbon steels, important alloy steels, important non-ferrous alloys.

7. STRENGTH OF MATERIALS

Thin pressure vessels, torsion of circular shafts, close-coiled helical springs, stresses in beams due to bending and shear.

Deflection of beams, combined bending and torsion, concept of elastic stability with particular reference to buckling of columns. Strain energy.

8. FLUID MECHANICS

Properties of fluid, Classification of fluid ideal and real fluids, Newtonian and Non-Newtonian Fluids. Compressible and Incompressible fluids.

Steady and Unsteady flow. Uniform and non-Uniform flow. Path line, Stream line and stream tube, One, two and three-dimensional flow. Continuity Equation-differential and integrated form. Rotational and Irrotational flow. Vortex motion. Laminar and Turbulent flow.

Darcy-Weisbach equation, Moody's diagram. Flow through non-circular ducts. Minor losses-heat losses at sudden expansions, sudden contractions and bends, Head losses in pipes in series and parallel, pipe line problems.

Dimensional Analysis, Similarity etc. to sink and Doublet.

Review of Irrotational flow, left around symmetrical bodies. Specific speed and classification of fluid machinery. Design methodology of axial and radial flow machines (pumps and fans).

9. DESIGN OF MACHINE ELEMENTS

Introduction to design. Factor of safety, calculation of allowable stress under various types of loading, stress-concentration, endurance diagram and design criteria.

Review of stress calculation in various situation-direct, bending and torsional loads and their combined effect.

Buckling

Design of pin-joint, cotter-joint etc.

Transmission screws.

Screw-joints, pre-loaded bolts, etc.

Rivets and riveted joints, etc.

Design of weldments

Key, Shaft and axle.

Belt drive: Flat & V-belt, pulleys.

Coupling: rigid and flexible.

Toothed gear drive: Spur, straight, and helical tooth.

Gears for non-intersecting shafts: Bevel & Hypoid gears. Brakes and clutches: Band & shoe brake, friction clutch, jaw clutch and centrifugal clutch.

Springs: Tension, compression, torsion and leaf springs.

10. DYNAMICS OF MACHINES

Gyroscopic motion, force analysis of machines-analysis of fly-wheels & governors.

Balancing of rotating and reciprocating masses.

Vibration of spring-mass systems, introduction to vibrations of elastic bodies-transverse vibration of beams and critical speed of shafts, Torsional vibration with multiple discs.

11. I.C. ENGINES & GAS TURBINE

Principle of working; basic engine types; comparison of air standard cycles; air cycle analysis with variable specific heats; introduction to fuel air cycle analysis; actual cycles, mep; thermal efficiency.

Combustion calculations related to I.C. Engine fuels. Desirable characteristics for fuels for I.C. engine.

Mixture requirement for S.I. Engine; Carburetion pressure drop-flow relation; fuel air-ratio; complete carburetor. Petrol injection. Ignition system in S.I. Engine- Battery, Magneto, and Electronic ignition system; ignition timing and spark advance.

Fuel oil injection in C.I. Engine-requirements; fuel injection systems: injection pumps and nozzles.

Supercharging I.C.Engine-requirements; supercharging limits; Turbocharging. Scavenging of I.C. Engines-two stroke S.I. and C.I. Engines; Scavenging parameters; ideal scavenging processes: actual scavenging; scavenging pumps.

12. MACHINE TOOLS

Machine tool design: Features of construction, function and principles involved in the design of machine tool elements: layout of speeds for various machine tool drives; hydraulic and electric drives; design of gear boxes for speed and feed changes; rigidity and vibration analysis of machine frames; columns, beds and spindles.

Economics of machine tool selection: economic tool life.

Completed by
EES
28.2.12

PUBLIC SERVICE COMMISSION, WEST BENGAL

Information to candidates for recruitment to post of Assistant Engineer (Electrical) under the different Departments of Govt. of West Bengal

Syllabus for the Preliminary Written Test for recruitment to the posts of Assistant Engineer (Mechanical/ Electrical) in the West Bengal Public Health Engineering Services (Mechanical/ Electrical).

i) **For Assistant Engineer (Electrical):**

The Preliminary Written Test will consist of one paper.

The question paper will be of the objective type (multiple choice) comprising 100 questions. Full marks will be 200 for 100 questions of 2 marks in each question.

The paper will be of 2 hours duration.

The course content of the syllabus for the paper will be of the DEGREE level.

SYLLABUS FOR THE WRITTEN TEST

1. **ENGINEERING MECHANICS :**

Elements of vector algebra, Basic dimension and units. Idealisation in Mechanics. Newton's Laws, equilibrium equations, frictional forces, properties of surfaces. Elements of vector calculus. Rectilinear and Curvilinear motion of a particle.

Alemberts principle, Methods of momentum, work, power and energy Mass moment of inertia, rotation of rigid bodies, Energy consideration.

2. **PHYSICS :**

Angular momentum and torque. Moment of inertia. Parallel and perpendicular axes theorem. Calculation of moment of inertia of some common solids. Rotational dynamics of a rigid body.

Newton's law of Gravitation. Calculation of gravitational field and potential of a spherical distribution of mass. Motion under a central force. Kepler's laws.

Relationships among different elastic constants. Bending moment. Cantilever problems. Elastic. Plastic and Visco-elastic behaviour of materials.

3. **MATHEMATICS :**

Review of limit, continuity and differentiability. Successive differentiation. Rolle's Theorem. Mean value Theorems.

Limit and continuity. Partial derivatives. Differentials.

Definition and dproperties. Fundamental Theorem of integral calculus.

4. **APPLIED MECHANICS :**

Belt, Pulley and Chain Bodies in rolling contact. Gear Wheels in trains, Epicyclic gear trains, Laws of machines etc. Four-bar linkages-velocity analysis (relative velocity method) acceleration analysis-simple problems.

Stress, Strain, Elasticity, Y.P., Stress-Strain diagram, factor of safety, working stress problems in direct tension, Compression-statically determinate cases, Thermal stresses.

Torsion of circular shafts, angle of twist, Torque, power transmission shearing force and bending moment in beams maximum moment and pt. of contraflexure.

5. ELECTRONICS :

Elementary physics of semiconductor materials, p-n junction semiconductor diode, zener diode, bipolar junction device-transistor, Field effect transistors JFET & MOSFET. Modelling of semiconductor devices-diode, junction transistors and field effect transistors-Hybrid, parameters.

Bipolar transistor biasing, common-emitter, common base and common collector configurations, low frequency response of RC coupled common emitter amplifiers FET biasing, MOSFET biasing. Transistor power amplifiers, class A, class B and class AB amplifier complimentary symmetry amplifiers.

Linear microcircuits : Operational amplifiers, offset voltage and currents, bias currents, common-mode rejection ratio, frequency response, slew rate, uses of operational amplifiers as inverting summing amplifier, integrator, non-inverting amplifier, differential input instrumentation amplifiers and oscillators.

IC voltage regulator : A typical industry standard (e.g. 723 or 3085) and its use as both dissipative and switching regulator, current limiting ordinary feedback.

6. CIRCUIT THEORY :

Review of Laplace Transform. Concept of complex frequency, Circuit elements in transient. Transform equivalent, Laplace transform of impulse and step waveforms.

Solutions of RL, RC, LC and RLC circuits in transient with or without stored energy, Concept of natural frequency and damping.

Applications of network theorems, in transient domain. Formulation of network equations. Source transformations. Loop variable analysis and mode variable analysis.

Two port networks, Short circuit Admittance parameters, Open circuit Impedance parameters, transmission parameters, hybrid parameters, series, cascade and parallel connections of two port networks.

7. ELECTRICAL ENGG. MATERIALS :

Atomic structure of materials energy levels and electronic states. Electronic distinction between metals. Insulators and intrinsic semiconductors. Interatomic distance, Cohesive forces and energies Gross electrical and thermal properties of materials in terms of cohesive energies.

States of insulating materials and their applications. Electrical conductivity of metals-Lorentz theory; free electron theory.

Alloys-High resistivity alloys. Thermocouple alloys, Shape memory alloys.

Semiconductor : Intrinsic and impurity semiconductor. Acceptors and donors, p-n diodes and transistors. Temperature dependence of p-n junction.

8. HYDRAULICS & WATER POWER :

Properties of Fluid and Units; Fluid Statics; Fluid Kinetics; Introduction; Ideal Fluid Flow; Viscous Fluid Flow; Flow through pipes; Flow Measurements; Momentum equation and Fluid dynamics.

Fluid Machinery; Reciprocating pumps & Gear Pumps; Centrifugal Pumps.

Elementary Hydrology.

9. ELECTRICAL MACHINES :

D.C. Generator : Function of commutator, Commutator and brush system. No load operation of d.c. generator; emf equation.

Excitation systems : Shunt, series and compound excitation, Building up of d.c. shunt generator D.C. Motor torque equation, Motoring and generating action, Elementary starters for motors.

A.C. Machines : Frequency of the induced emf. Mechanical and electrical angles. Elementary winding configuration of three phase machines. D.C. Excitation of alternators. Three phase balanced excitation. Development of rotating magnetic field.

Basic principle of operation of synchronous and Induction machines :

Slip speed and slip of an induction motor. Single phase a.c. excitation, oscillating field. emf induced in a rotating coil in an alternating field. Rotational and speed emf's. Double revolving field. Basic principle of operation of single phase a.c. motors.

Transformers – Constructional details :

Core materials, winding material and insulating materials. Core and, coil construction E.M.F. equation derivation of core losses and leakage reactance. No-load operation, equivalent circuit, phasor diagram under load, dependence of circuit parameters on v and f .

Transformer oil, inhibited oil, dry type transformer, Transformer accessories breather, conservator. Buchholz's relay, explosion vent, bushing etc. Different types of cooling methods. Regulation, efficiency, all-day efficiency, Parallel operation, O.C. and S.C. test-separation of eddy current and hysteresis loss.

Single-phase auto transformer : Phasor diagram, Comparison of weight, copper loss, equivalent reactance with 2-winding transformer.

10. Power Planning & Distribution :

Legal aspects of electricity supply. Electricity acts, rules and codes. Standards followed in power supply. Environmental and safety measures.

Technical aspects of electricity supply. Domestic, Commercial and Industrial wiring, estimation of main, submain and subcircuit wiring. Earthing practice. Testing of Installation. Special lighting connections. Fuse, Stranded conductors. Disconnecting devices. Lightning arrester. Lift, Pump, Air conditioning-Basic principle of operations safety & control.

PART-II : Power Distribution : Structure of power system, primary and secondary distribution. Types of conductors and insulators in distribution system.

11. FIELD THEORY :

Electrostatics :

Coulomb's Law, Field intensity and potential, Potential gradient, Electric displacement, Gauss Law (Integral form) and its applications, electric images and inversion, Electric dipoles, field and potential, Polarization, Divergence theorem (Gauss law in differential form), Poisson and Laplace's equations in Cartesian, cylindrical and spherical coordinates in 2 and 3 dimensional fields using circular and spherical symmetry, Boundary conditions. Electric stress and mechanical force on charges conductor surfaces, Electrostatic energy, capacitance calculations, energy transfer amongst connected capacitors in a system.

Electromagnetics

Magnetic field and intensity, Magnetic scalar and vector potentials, Lorentz force, Motoring and Generating principles, Faraday's Law Induced e.m.f. in conductor and coils, Ampere's Law. Magnetic polarisation, Poisson equations and solution.

12. NUMERICAL ANALYSIS & COMPUTER PROGRAMMING :

Numerical Analysis : Solution of linear equations, Gaussian elimination, Matrix inversion using Gauss-Jordan, Jordan elimination.

Interpolation : Lagrange, Newton's forward, backward and divided difference formulas and errors. Least square curve fitting, Numerical integration using trapezoidal, Simpson's rule.

Programming : Basic concepts and technology of computer system and system software. Concepts of flow-chart and algorithm, recursion. Overflow and underflow. Program in Fortran and Pascal. Introduction to data structures.

13. ELECTRIC POWER UTILISATION :

Illumination.

Fundamentals of Light-Radiation and vision, quantities, units, standards and measurement. General classification of lamps : Incandescent, TL and HID lamps, basic principle of their operation. Laws of illumination.

Elementary Lighting Design-Definitions of design parameters. Basic luminaries classification and their distribution characteristics. Lighting calculations for indoor applications.

Lighting circuits-Starters for fluorescent lamps and ignitors of HID lamps, multiple input of lamp.

Emergency lighting and Stand by power sources-Exterior, Interior, portable on site emergency lighting-storage batteries.

Electric Welding, resistance welding and equipment for such welding.

14. POWER SYSTEMS PROTECTION AND SWITCHGEAR :

Analysis asymmetrical faults in power system. Series unbalances in power system. Fundamental principles of protective relays, their properties and block diagrams. Single input relays, overcurrent, earth fault and over voltage relays.

Motor protection, Different types of pilot protection wire, carrier and wireless pilot.

Different forms of Switchgears and their functions. Contact wipe, contact travel and auto reclosing circuit breaker. Power system transients.

Different types of circuit breakers-their relative merits and demerits. Specific field of usage. Testing of circuit breakers

Checked by
27.2.12

27.2.12