

Public Service Commission, West Bengal

Syllabus for the Written Test for recruitment to the posts of **ASSISTANT ENGINEER (Agri - Mechanical)** in West Bengal Service of Agricultural Engineers

Mechanical Engineering

1. 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. Brakers 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.

**Syllabus for written test for recruitment to the post of Assistant Engineers
(Agri-Mechanical) in West Bengal Services of Agricultural Engineers**

Agricultural Engineering

1. Fluid Mechanics

Definition of properties of fluids; units of measurement; fluid statics; types of fluid flow – streamlines, pathlines, streaklines, stream functions and flow net; linear and angular momentum; continuity equation, Bernoulli's equation and Euler's equation of motion; dimensional analysis and similitude; laminar and turbulent flow; general equation of head loss in pipes; energy losses through pipe fittings; measurement of discharge through pipes and open channel.

2. Engineering Mechanics

Fundamentals of engineering mechanics; vector and scalar quantity; conditions of equilibrium; application of principle of moments and couples; Study of coplaner and non-coplaner force systems using analytical, vector and graphical approach

Internal forces in frames and trusses; Reactions of supports of frame; Free body diagram; Shear force and bending moment; analysis of frame using method of sections; application of laws of friction in wedge and block, screw jacks and brakes; law of machine, velocity ratio, mechanical advantage and efficiency of simple lifting machines; moment of inertia, centroid.

3. Thermodynamics and Heat Engines

First law of thermodynamics for open and closed system; kinetic energy and internal energy; Polytropic processes, control volume; steady flow process, variable flow process; pure substance and properties; P-V, P-T and T-S diagrams of pure substance; thermodynamic properties of steam, measurement of steam quality; second law of thermodynamics; difference between heat and work; cyclic heat engines, Kelvin-plank statement, Clausius statement, refrigeration and heat pumps; Carnot theorem and Carnot cycle, reversibility and irreversibility of process; boilers, thermodynamic cycles of I.C. engines, gas power cycles, Otto cycle, Diesel cycle, Dual cycle and their comparison.

4. Theory of Machines

Definition of mechanisms, kinematic link, Grubler's criterion and motion conversion; inversion of quadric cycle chain, slider-crank mechanism, analysis of displacement, velocity and acceleration; method of instantaneous centre, method of relative velocity and relative acceleration, Coriolis component, analysis of four bar mechanisms.

Inertia forces of piston, balancing of single and multi-cylinder engines, equivalent mass of connecting rod, balancing of rotating machinery, torque diagram and design of fly-wheels. Gear and gear trains; cams and cams with knife edge follower, roller follower and flat faced follower, governors.

5. **Machine Design**

Materials of constructions and their properties; manufacturing considerations in machine design, stresses in elementary machine parts, fits and tolerances; design of machine members subjected to different kinds of loads; machine vibrations, design of joints, design of shafts, power transmitting shafts; design of coupling, keys, pins and splines; threaded fastener, bolt loading; design of clutches and brakes, springs, gears, bearings, chain and belt drives, pulleys and fly wheels.

6. **Strength of Materials**

Elasticity, stress and strain, elastic limit, Hook's law, Young's modulus, bulk and shear modulus, volumetric strain; principal stresses, principal plane, Mohr's circle; Temperature stress, resilience; shear force and bending moment diagram, centroids of different cross-sectional lamina, moment of inertia, parallel and perpendicular axis theorem, bending stress in beams, shearing stresses.

Stresses in thin cylindrical and spherical shells; circumferential and longitudinal stresses in shells, combined bending and direct thrust, middle third rule, columns and struts, Euler's theory, buckling load, design of helical and laminated spring, analysis of beam subjected to different types of load.

7. **Electrical Technology**

Kirchhoff's laws, delta-star and star-delta transformation; Thevenin's and super position theorem, electrical circuits; A.C. fundamentals, transient and steady state response of circuits; Resonance of circuits, filters; Characteristics of magnetic and dielectric materials; magnetic circuits, hysteresis and eddy current losses; force acting on current carrying conductor in magnetic field, induced e.m.f., stored energy, force between parallel conductors; transformer and its efficiency; basic measuring instruments for current, voltage and power.

Principal and operation of rotating machines, D.C. machines, armature reaction; rotating magnetic field, single and three phase induction motors, starters for electric motors, speed control of motors, power factor; fractional horsepower motors; three phase power distribution, electrical wiring for farm houses and industries, earthing and electrical safety rules.

8. **Farm Machinery**

Status and scope of farm mechanization; Classification, constructional details and principles of operation of manually operated, animal drawn and power operated implements and machinery for primary and secondary tillage, puddling, seeding, planting, interculture, fertilizer application, crop harvesting and threshing; Chaff cutters and sugarcane crushers; Hitching of implements; Safety in farm machinery; Performance evaluation; Selection and cost analysis.

9. Farm Engines & Tractors

Power availability on the farms from animate and inanimate sources of energy- their capacities and efficiencies; Tractor engine components and their constructions; Valve and valve timing mechanism; Working principles of engine systems- fuel and air supply, cooling, lubrication, ignition, starting and electrical systems; Engine governing; Transmission system of wheel and track type tractors- clutch, brake, gearbox, differential, PTO, belt pulley, drawbar and final drive mechanism; Power tillers and small engines for farm operations; Performance and cost analysis of farm tractors and power tillers.

10. Renewable Energy

Solar energy, its appliances and their use on farm, house and village, solar radiation, liquid flat plate collectors and their performance, solar energy operated systems for heating, cooling, drying and water pumping, solar pond, thermal energy storage, photovoltaic conversion, solar cooker, solar lamps.

Wind energy, available wind power, analysis of wind regimes, types of wind mills; anaerobic fermentation of biomass, design of biogas system for heating and running IC engines; use of alcohol fuels in IC engines, producer gas; production of bio-diesel, ethanol and their use in IC engine.

11. Tubewells and Well Technology

Type of various tubewells; design and construction of wells; selection and placement of strainers; construction materials for wells and strainers; pipe joining methods; tubewell development by compressor and over pumping method; design of suitable pump of various types for deployment in the tubewell for lifting clear water; pump characteristic and selection of pump.