PUBLIC SERVICE COMMISSION, WEST BENGAL

161-A, S.P. Mukherjee Road, Kolkata – 700 026

IMPORTANT ANNOUNCEMENT

REF: ADVT. NO. 11(1)/2014

A *Preliminary Screening Test* for recruitment to the post of **Inspector of Factories** in the West Bengal Factories Service under the Labour Department, Govt. of West Bengal will be held on **the 8th April, 2015 (Wednesday)** at the Commission's Examination Hall.

Scheme of the P.S.T. is as follows:-

Type of Test – Multiple Choice Questions

Full Marks – 100

No of Questions – 100

Duration – 1 hr 30 minutes (From 12 Noon to 1.30 p.m.)

List of eligible candidates will be available from the **2nd April, 2015** at this Website.

The eligible candidates are requested to download their e-admission certificate from this website on and from the **4th April, 2015**. No admission certificate will be issued to eligible candidates from the office of the Commission. In case of any inconvenience the candidates may contact in person to the Commission's office on 06.04.2015 and 07.04.2015 between 11:30 a.m. and 3:30 p.m. with proof of submission of application form.

SCIENTIFIC CALCULATOR IS ALLOWED

SYLLABUS FOR PRELIMINARY SCREENING TEST FOR RECRUITMENT TO THE POST OF INSPECTOR OF FACTORIES IN WEST BENGAL FACTORIES SERVICE UNDER LABOUR DEPARTMENT, GOVT. OF WEST BENGAL.

SYLLABUS FOR MECHANICAL ENGINEERING

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

1. ELECTRICAL TECHNOLOGY

Electrical Units, and dimensions. Electromagnetism, 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.

Reumann integration : Definition, properties. Fundamental therorem 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. Lame'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 dynamic 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, process etc. Zeroeth Law; Survey of Units & Dimensions; Forms of energy and energy interactions, heat & work.

Ideal & Real Gases; Equations of state; Compressibility Factor, Generalized compressibility chart; First Law of Thermodynamics for closed systems internal energy.

First law for 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 Co-efficient; 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 can Doublet.

Review of Irrigational 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 and hypoid gears, breakers and clutches, band and shoe break, friction 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 AND 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 vibrations analysis of machine frames; columns, beds and spindles. Economics of machine tool selection; economic tool life.

Coupling : rigid and flexible, Toothed gear drive, Spur, straight and helical tooth. Gears for non-intersecting shafts; Level & Hypoid fears, Brakes and clutches; Bank & Shoe brake, friction clutch, jaw clutch and centrifugal clutch.

Springs; Tension, compression, torsion and leaf springs.

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SYLLABUS FOR ELECTRICAL ENGINEERING

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

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 dynamic 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 behavior 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 properties. 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 confraflexture.

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 responses, 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 semi-conductors. 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-Lorents theory, free electron theory.

Alloys-High resistivity alloys. Thermocouple alloys, Strainguage alloys.

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

8. HYDRAULICS AND WATER POWER:

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

Fluid Machineries; Reciprocating pumps & Gear Pump; 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.em f 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 accessoriesbreather, conservator. Buchlolz'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 : Phasordiagram, 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 :

Coilomb's Low 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 charged 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 polarization, Poisson equations and solution.

12. NUMERICAL ANALYSIS & COMPUTER PROGRAMMING

Numerical Analysis : Solution of liner equations, Gaussion 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 of asymmetrical faults in power system. Series unbalances in power system. Fundamental principles of protective relays, their properties and block diagrams. Single inpur 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.

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SYLLABUS FOR CIVIL ENGINEERING

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

I. THEORY AND DESIGN OF STRUCTURES

(a) **Theory of structures and strength of materials :-**

(i) Solid Mechanics – properties of material, Mohr's circle of stress-strain, plain stress & strain, combined stress, Elastic theories of failure, simple bending, shear, torsion of circular and rectangular sections, columns and struts, moving loads and influence lines for shear force and bending moment for-simple and continuous beams and frames.

(ii) Structural Analysis – Analysis of determinate structures. Different methods of analysis of indeterminate structures – moment distribution, slope-deflection, column analogy, strain energy method, three moment theorem, Muller Breslau Principle and application, etc. Analysis of determinate and indeterminate arches.

(b) **Steel Design – (Design of Steel Structures) :-**

Principle of working stress method, Design of all types of connection, Simple members, Built up sections and frames, Design of Industrial structures and Multistoried frames, Design of steel bridges and tanks of different types, Design of tubular structures, codal provisions for design of all those steel structures including foundation.

Principle of ultimate load design; Plastic design of continuous frames and portals.

(c) **Design of Reinforced Concrete and Masonry Structures :-**

Limit state method of design. Codal provisions for design. Working stress method of design. Concrete mix design & Quality control, Principles of prestressed concrete design, materials, methods of prestressing, losses in prestressing, anchorages. Design of Brick masonry as per I.S. codes.

II. FLUID MECHANICS AND HYDRAULICS

Fluid properties and definitions, Flow kinematics, continuity momentum and energy equations applicable to fluid flow, Bernoulli's theorem, flow through conduits, flow through open channels, Hydraulic jump, flow through pipes and losses in pipe flows, siphons, pipe network, forces in pipe ends, hydraulic energy grade line, water hammer. Viscosity, definition of ideal fluid.

III. SOIL MECHANICS AND FOUNDATION ENGINEERING

(1) Properties of soils, classifications and interrelationship; definitions of terms used; soil testing in laboratory and in-situ; compaction behaviour, methods of compaction and their choice; permeability and seepage, flow nets, flow under hydraulic structure, uplift and quicksand condition inverted filters, unconfined and direct shear stress, tri-axial test, shearing resistance, Earth pressure theories, stability of slopes; compressibility and consolidation. Theories of consolidation, pressure distribution in soils, soil stabilization, soil exploration and penetration tests, Pore water pressure.

(2) Types of foundation, selection criteria, bearing capacity, settlement, laboratory and field tests, codal provisions in all types of foundation including testing of piles etc. Types of piles and their design and layout; Foundations on expansive soils, swelling and its prevention, Design of retaining walls, wells, sheet piles and caissons, Reinforced earth technique and its use.

IV. SURVEYING

Classification of surveys, scales, accuracy; Measurement of distances-by direct and indirect methods, optical and electronic devices, Measurement of directions, Prismatic compass, local attractions; Theodolities-types, Measurement of elevations, trigonometric leveling, contours, Establishment of control by triangulations and traversing. Measurements and adjustment of observation, Computation of coordinates; Errors and their corrections of measurement of length, bearing horizontal and vertical angles and leveling operation, Correction due to refraction and curvatures, Map preparation by plane tabling and photogrammetry; Field astronomy, concept of global positioning system; Remote sensing concepts, map substitutes; Setting out directions and grades; types of curves, setting out of curves and excavation lines for building foundation.

V. CONSTRUCTION MATERIALS, PRACTICES, PLANNING AND MANAGEMENT

(1) Building Materials specifications, tests, uses and codal provisions.

(2) Concrete technology – Cement its properties, classification and specification – Provisions in I.S. code. Properties of coarse and fine aggregates – Provisions in I.S. code, concrete mix design, Laboratory concrete, Ready mixed concrete, field tests for quality control of concrete, concreting equipments.

(3) Earth moving machineries and pile driving equipments.

(4) Construction planning and management – Bar chart, linked bar chart, work break down structures, Activity-on-arrow diagrams, critical path, probabilistic activity durations, Event-based network, PERT Network, Time Cost study, crashing, Resource allocation, Rescheduling of construction programme.

(5) Quantity surveying; Methods of valuation, pricing and measurement of works; Rudiments of legal and technical aspects of engineering contracts.

VI. HIGHWAY ENGINEERING INCLUDING TRAFFIC ENGINEERING

Planning of Highway systems, its classification, objects and principles, Geometric design of highway alignment, gradients, super-elevation, camber, sight distances, etc. Horizontal and Vertical curves, Transition curves, grade separations, Segregation of traffic and intersection design. Materials of highway construction its properties and tests. Sub-grade and pavement components, Types of pavements & Road drainage. Principles of highway financing, Design of pavements, evaluation of pavement failure and strengthening. Construction methods and quality control measures for highway embankment, sub-grade, pavement courses and bituminous surfacings. Elements of Design and construction of highway – Bridges and culverts including their maintenance. Principles of transportation planning; forecasting techniques, origin and destination study; Highway capacity; Arterial routes; one-way roads and bye-pass roads; Ribbon development; Traffic control devices; Traffic study and parking surveys, speed, volume and delay studies; Accident characteristics; Traffic signal; Traffic projection factor.

VII. WATER RESOURCES ENGINEERING

(1) Hydrology – Hydrologic cycle, Measurements, Computations and statistics; Run off and stream flow, Measuring techniques and computations; Hydrographs, Computations and interpretation; ground water, Estimation, Measurements, Characteristics.

(2) Irrigation Engineering – Types of irrigation systems and their detail description, soil-water-crop relationship; Types of soils; water requirement of crops; Delta and duty.

Classification of rivers; River Regime Theory; Effects of dams on river regime; River training works.

Irrigation channels; Design principles of irrigation canals, Drainage channels and Navigation canals; canal linings; canal outlets.

Water logging and salt efflorescence, land reclamation.

(3) Hydraulic structures – Storage Reservoirs; Different types of dams and their design principles; Weirs, barrages and their design principles; spillways, Energy dissipation by hydraulic jump; different types of energy dissipation. Headworks; cross drainage works; Falls and Regulators.

VIII. ENVIRONMENTAL ENGINEERING

(1) Water Supply Engineering :-

Water uses, Quantity requirements, potable water quality, sources of water, ground water hydraulics, Development of surface source; Reservoir volume, Transmission of water.

Treatment of water; Typical flow-sheets for surface and ground sources; sedimentation, coagulation and flocculation, filtration, disinfection, hardness and chemical softening; Rudiments of Ion-exchange; Elements of rural water supply and removal of Iron, Arsenic and salinity from water.

Principles and methods of design of distribution systems, service reservoirs, and Intakes for urban and rural water supply.

(2) Waster Water Engineering :–

Sanitary Waster Water and Stormwater run off : Quantity estimation, Sewerage systems and their design principles; Sewer construction materials; structural design of sewers; Sewer appurtenances; Characteristics of domestic sewage; Typical flow-sheets for primary and secondary treatment; Design principles of screen, grit-removal, sedimentation, Bio-filter, Activated sludge process and Septic tank, Elements of industrial sewage and its treatment; Rural Sanitation its principles and practices.

(3) Environmental pollution and control :–

Atmospheric pollution : Types of pollutants, Natural and man-made sources, Effects of air pollution, unit systems; Rudiments of control methods; Elements of noise pollution.

Community solid wastes; Sources, Quantity and characteristics, Methods of disposal, Reuse and cycling.

Water quality management; Quality criteria for major uses of water; Applied stream sanitation.