

# **PUBLIC SERVICE COMMISSION, WEST BENGAL**

## **SUB-ASSISTANT ENGINEERS' (CIVIL/ MECHANICAL/ ELECTRICAL) RECRUITMENT EXAMINATION**

### **INFORMATION BROCHURE**

The Public Service Commission, West Bengal will hold a Combined Competitive Examination in the month of August, 2009 or thereabout for recruitment to the posts of Sub-Assistant Engineer (Civil/Mechanical/Electrical) in West Bengal Sub-ordinate Service of Engineers (Civil/Mechanical/Electrical) under the various Engineering Departments, Government of West Bengal. The actual date and time of holding the examination will be communicated to the candidates individually. The examination will be held in Kolkata.

#### 1. **SCHEME OF EXAMINATION :**

The examination will be held in the following branches of Engineering - i) Civil Engineering (ii) Mechanical Engineering (iii) Electrical Engineering .

There will be two parts of the examination as follows :

##### a) **Written Examination - Full Marks - 200, Time - 2 hours :**

The written examination will consist of one paper covering Engineering subjects (Multiple Choice Objective Type Questions) for each of the three branches. There will be 100 questions carrying 2 marks each. The standard and syllabus of the written examination are mentioned in the appendix (Appendix 'A', 'B' & 'C').

##### b) **Personality Test - Full Marks - 100 :**

A limited number of candidates, selected on the results of the written examination, will be called to Personality Test carrying 100 marks. Final merit list will be prepared on the basis of the total marks obtained in the Written Examination and the Personality Test.

**N. B. :** Candidates offering Mechanical Engineering or Electrical Engineering subject at the examination will be considered for appointment to the posts of Sub-Assistant Engineer in the respective branch as well as for the post of Sub-Assistant Engineer (Mechanical/Electrical).

2. All appointments will initially be made on a temporary basis. Some of the vacancies to be filled on the results of this examination may be reserved for SC, ST & BC candidates of West Bengal and Physically Handicapped persons.

3. **SCALE OF PAY :** Rs. 4800 -10925/- (unrevised). Allowances will also be admissible as per Government Order in force.

4. **VACANCIES :** The no. of vacancies in different services and posts to be filled on the results of the examination will be announced later.

**THE BENEFITS OF RESERVATION OF VACANCIES FOR SCHEDULED CASTE, SCHEDULED TRIBE & CANDIDATES BELONGING TO BACKWARD CLASSES OF WEST BENGAL AND PHYSICALLY HANDICAPPED PERSONS :-**

The benefits of reservation of vacancies for SC, ST & BC candidates are admissible only to SC, ST & BC candidates of West Bengal. Some vacancies may be reserved for Physically Handicapped persons provided they are otherwise suitable and possess the capacity to perform the duties attached to the post. Candidates claiming to be SC, ST, BC or PH must furnish either self-certified or attested photo copy of certificates in support of their claim from a competent authority as shown in item no. 8 along with their applications failing which their claim will not be entertained. SC, ST & BC candidates not belonging to the state of West Bengal shall be treated as General candidates.

5. **APPLICATION** : A candidate intending to apply for the examination shall submit his/her application before the closing date mentioned in the advertisement to the Deputy Secretary (Examination), Public Service Commission, West Bengal, 161A, S. P. Mukherjee Road, Kolkata – 700 026. A candidate is to submit one application. Application received after the closing date will not be accepted.

Submission of more than one application is strictly forbidden. The candidature of a candidate who submits more than one application for admission to the examination, will be cancelled even if he/she is admitted to the same.

6. **FEE** :

Candidates must enclose with their applications a fee of Rs.150/- (Rupees one hundred and fifty) only in the form of Indian Postal Order which must be purchased on a date after publication of this advertisement and crossed and endorsed to **THE SECRETARY, PUBLIC SERVICE COMMISSION, WEST BENGAL**, or in the form of a receipted challan from a Government Treasury in West Bengal or the Reserve Bank of India, Kolkata under the head “0051-00-105-State PSC Examination fees-001-Examination fees-16 other fees”. The Postal Orders should be made payable at G.P.O., Kolkata. **Money Orders, Cheques, Bank Drafts, Cash etc. will not be accepted.** No application will be considered unless accompanied with the requisite application fees.

Candidates belonging to SC/ST community of West Bengal and persons with disabilities specified under West Bengal persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Rules, 1999 only are not required to pay any fee. The application without fee of such candidates will not be accepted if the same is not accompanied with the self-certified or attested photocopy of SC/ST certificate issued by the competent authority of West Bengal in a prescribed format or P.H. certificate issued by the competent authority. BC candidates of West Bengal are, however, required to pay usual fee as aforesaid. NO EXEMPTION OF FEE IS AVAILABLE TO SC/ST/BC CANDIDATES OF OTHER STATES. No claim for refund of the fee will be entertained nor will it be held in reserve for any other examination.

7. **QUALIFICATIONS** :

i) Diploma in Civil/Mechanical/Electrical Engineering from State Council for Engineering and Technical Education, West Bengal or its equivalent. Departmental candidates will also be eligible to apply provided they possess the requisite educational qualifications.

Diploma in the following disciplines, interalia are not equivalent to the Diploma in Civil/ Mechanical/ Electrical Engineering :-

Architecture, Survey Engineering, Structural Fabrication, Drafting & Design, Automobile Engineering, Production Engineering, Leather Technology, Instrumentation Technology, Electronics, Tool & Die making, Technician, Engine Room Artificer, Construction Technology, Mechanical & Electrical Engineering (Combined).

ii) Ability to read, write and speak in Bengali (not required for recruitment in the case of Nepali speaking candidates from hill areas of District of Darjeeling).

iii) The candidates must be a citizen of India–

(iv) Good health and character suitability in all respects for appointment to Government Service.

8. **AGE** : Not more than 32 years on the 1st January, 2009 (i.e. born not earlier than the 2nd January, 1977) relaxable for candidates who have been in the employment of Central or State Government or Damodar Valley Corporation or Statutory Body recognized for the purpose by govt. and also for candidates who had been in such employment but are not out of such employment for more than one year on the 1st January, 2009 to the extent of actual period spent continuously in such employment. The Upper age limit is relaxable for SC/ST and BC candidates of West Bengal – by five years for SC & ST candidates and by three years for BC candidates of West Bengal. The upper age limit is also

relaxable up to 45 years for Physically Handicapped candidates having physical disability of 40% and above. Candidates claiming to be SC, ST, BC or Physically Handicapped must furnish either self-certified or attested photo copy of certificates in support of their claim from a competent authority as specified below :-

**FOR SC, ST & BC CANDIDATES :**

Vide the West Bengal SCs and STs (Identification) Act, 1994 at SCs and STs Welfare Department Order No. 261-TW/EC/MR-103/94 dated 06.04.1995.

- (a) In the district, the Sub-Divisional Officer of the Sub-Division concerned, and
- (b) In Kolkata, the District Magistrate, South 24-Parganas or such Additional District Magistrate, South 24-Parganas, as may be authorised by the District Magistrate, South 24-Parganas in this behalf.

**FOR PHYSICALLY HANDICAPPED CANDIDATES :**

Vide West Bengal persons with disabilities (equal opportunities, protection of rights and full participation) Rules, 1999 a certificate issued by a Medical Board constituted at Govt. Medical College Hospitals, District Hospitals, Sub-Divisional and Block Level Hospitals.

9. **RESULTS OF THE EXAMINATION :**

Candidates will be allowed to take the Personality Test and will be recommended to govt. for appointment provisionally subject to verification of their eligibility with reference to their original certificates in all respects.

10. **ALLOTMENT :**

Allotment of candidates in each branch will be made in order of merit and according to the order of preferences indicated by them.

11. **PARTICULARS AND CERTIFICATES REQUIRED :**

The Public Service Commission may require such further proof or particulars from the candidates as it may consider necessary.

A candidate in service of Central or State Government/Damodar Valley Corporation/Statutory Body must send his/her application to the Office within the closing date under intimation to his/her employer. His/her application shall be rejected / candidature cancelled if his/her employer withholds permission to him/her. Those who may be appointed after submission of their applications for admission to the examination must furnish forthwith evidence to show that their appointing authorities have no objection to their being selected for new appointments on the results of the examination. The candidates who hold substantive appointments including those are on probation under the Govt. of West Bengal are also required to submit an undertaking (as in the declaration printed in the application form) that they have informed in writing their department that they have applied for the examination.

Original certificates, where necessary will have to be submitted when the Commission asks for them. If any candidate fails to furnish any certificate or any other relevant document or information regarding his/her candidature within the time specified by the Commission, his/her claim for allotment may be passed over without further reference to him/her. Either self-certified or attested photo copies of the certificates in support of the statements made in the applications regarding educational qualifications, date of birth and citizenship as per provision **to item no.7 above** and to two self-addressed envelopes one with postage stamp of Rs.5/- affixed on it must be submitted with the applications.

12. **PHOTOGRAPH** :

The candidate must submit one copy of his/her recent passport size photograph duly signed and pasted on the first page of the application in the appropriate space provided therein.

13. The application form shall be filled in by the candidates own hand-writing and signed by him/her. If any of the statements made in the application be subsequently found to be false within the knowledge of the candidate, his/her candidature will be liable to be cancellation and even if appointed to a post on the results of this examination, his/her service will be liable to be terminated. Wilful suppression of any material fact will also be similarly dealt with.

Candidates should take particular note that entries in their applications submitted to the Commission must be made correctly against all the items which will be treated as final and no alteration or addition in this regard will be entertained after submission of the application.

Defective application in any respect shall be summarily rejected.

14. **ADMIT CARDS AND TIME-TABLE** :

The candidates who have fulfilled the advertised terms will receive an Admit Card and Time-table for the examination. The admission will be deemed provisional subject to determination of his/her eligibility in all respects. No candidate shall be admitted to the examination unless he/she holds an Admit Card. If at any stage after issue of the Admit Card a candidate is found ineligible for admission in terms of conditions of eligibility for this examination, his/her candidature will be cancelled without further reference to him/her.

15. The candidate must abide by such further instructions as may be given by Supervisor/Invigilator of the examination. If the candidate fails to do so or indulges in disorderly or improper conduct, he/she will render himself/herself liable to expulsion from the Examination Hall and/or such other punishment as the Commission may deem fit to impose.

A candidate who has been reported against by the Supervisor of the Examination Centre for violating any of the instructions will be punished with cancellation of candidature and also debarment from future examinations and selections as may be decided by the Commission according to the circumstances of the case.

16. **SUBMISSION OF MORE THAN ONE APPLICATION IS STRICTLY FORBIDDEN. THE CANDIDATURE OF A CANDIDATE WHO SUBMITS MORE THAN ONE APPLICATION FOR ADMISSION TO THE EXAMINATION WILL BE CANCELLED EVEN IF HE/SHE IS ADMITTED TO THE SAME.**

17. **CANVASSING** :

Any attempt on the part of a candidate to enlist support for his/her application through persons of influence or officials of government will disqualify him/her for appointment. Spontaneous recommendations from persons interested in the candidates or otherwise known to them will be disregarded and will render the candidates ineligible.

WEBSITE FOR GUIDANCE OF CANDIDATES ; The candidates may obtain the information of the examination in detail alongwith the Application Format through the Commission's Website at : <http://www.pscwb.org.in>. Application Forms downloaded from the Website will also be accepted.

## APPENDIX – “A”

### **SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT TO THE POST OF SUB-ASSISTANT ENGINEERS (CIVIL) IN WEST BENGAL SUBORDINATE SERVICE OF ENGINEERS**

#### **1. STRENGTH OF MATERIALS**

Centre of gravity of plane figures, composite rectilinear figures, simple structural sections, M.I. of lamina, composite areas & of simple structural sections, simple stresses & strains, Characteristics of stress-strain curve for Mild Steel, S.F. and B.M. diagrams of loaded beams (fixed beam excluded), Bending & Shear stresses of beams, slope and deflection of cantilever and simply supported beams (point load & UDL), direct & bending stress, Eccentric loading on masonry pillars.

#### **2. THEORY OF STRUCTURES**

Different types of frames-perfect, redundant & deficient, difference between statically determinate and statically indeterminate frames, Analysis of perfect frames, different methods (names only), Gravity structures – Dams & Retaining Walls (Rectangular & Trapezoidal sections), conditions of stability, Different types of failure of a Dam, Critical load on Columns – Euler's, Rankine's & B.I.S. Code formula.

##### **CONCRETE STRUCTURES**

Working stress method of design of simply supported R.C.C. rectangular beams (singly & doubly reinforced) and slabs (one way & two way), Cantilever slabs, singly reinforced T-Beams - Design of Reinforcements, Design of axially loaded R.C.C. short columns (square, rectangular & circular) by I.S. Code Formula, Isolated R.C.C. square footing of column, Basic Concept of pre-stressed concrete – Materials used.

##### **STEEL STRUCTURES**

Design of rivetted joints, Failure of rivetted joints, Eccentric rivetted connections (brackets), Design of rolled steel beams in flexure & shear for a given load, design of axially loaded columns using standard rolled I-sections with or without plates, Design of simple truss.

##### **TIMBER STRUCTURES**

Design of simple structures.

#### **3. CONSTRUCTION MATERIALS & PRACTICE**

##### **BUILDING MATERIALS**

Bricks – Traditional & Modular, Size & Weight, I.S. Classifications, Testing of Bricks, Mortar & Concrete – different types, Usual proportions, Specific uses, Slump of concrete, Recommended values of slump for various works, Water-Cement ratio – its effect on strength of concrete, Curing of concrete, Sources and uses of stone, Sand & lime, Mosaic Tiles & Roof Tiles, Period of curing timbers, Commonly used timber in engineering works & their specific uses, Uses of plywood, Laminated Board, Block Board, Particle Board, Expanded metal, Polymer, Plain & Frosted glass, Paints & Varnishes.

##### **CONSTRUCTION**

Foundation, Object, Shallow & Deep Foundation, Names of different types, their uses in specific locations, Brick Masonry works, General principles & precautions, reinforced brick work, its advantages, damp proofing – materials used, causes & effect of dampness, roofs and roof coverings – different types – uses at specific locations, flooring, doors & windows – different types – uses at specific locations, Stairs, different types (names only), their uses at specific locations, requirements of a good stair as per N.B.C., Scaffolding, Shoring, Underpinning, Formwork – materials used, characteristics of good formwork, rules for removal of formwork, Common construction equipments.

#### **4. FIELD SURVEYING**

Metric surveying chain, types – different types, uses, Triangulation and Traversing, Tie line, Check line & Base line offsets – different types, Field book entry, Right angle setting in field with instruments and with chain or tape.

Compass – different types, uses, bearing, W.C.B. & R.B., Fore & Back bearing, Local attraction, Declination, Dip, closing error of a compass traverse, causes, adjustment, permissible error in compass surveying.

Plane Table survey – suitability, advantages & disadvantages, methods of plane tabling, equipments necessary.

Levelling, types of level & leveling staff (names only), temporary adjustment of level, reduction of level, level book entry, reciprocal and profile levelling, correction for curvature & refraction, contouring, definition of contour, contour interval & horizontal equivalent, characteristics of contour lines, uses of contour map, methods of contouring (names only).

Theodolite Survey – different types of theodolite, important terms in connection with theodolite, uses of a theodolite, theodolite traversing, latitude & departure, closing error in a theodolite traverse, adjustments, permissible limits of error.

Curve setting – degree & radius of a curve, their inter-relation, elements of a simple curve, classification of curves.

#### **5. ESTIMATING, COSTING & CONTRACTS**

Specification of works and materials, Estimates, different Types, general items of works, Units of measurement for building works as per B.I.S. Code, method of measurement for different items of work and materials, present market rates of materials & unit rate of items of work, floor area, carpet area and plinth area, F.A.R., Rate analysis – factors governing it, schedule of rates, analysis of rates for different items of works of a building.

Contracts – different types, Contract documents, submission & opening of Tender, earnest money, security deposit, measurement book, work order book, imprest and temporary advance, material at site account, suspense account.

Valuation, functions of a Valuer, factors affecting the value of a property, value & cost, scrap value, salvage value, assessed value, speculative value, sinking fund, depreciation.

#### **6. PUBLIC HEALTH ENGINEERING**

## **WATER SUPPLY**

Sources of water, ground water (springs, infiltration galleries & wells), Aquifer, Tube-wells – methods of boring, development of Tube-well, determination of tube diameter, length and diameter of a strainer, Motor & Hand Pump. Water requirements per capita demand, domestic, industrial & fire demands, population forecast. Intake works & transportation of water, Purification of Water, Removal of Salinity, Arsenic & iron. Raw water and Treated Water Quality. Treatment of water – plain sedimentation, feeding and mixing of coagulants, flocculation devices & clariflocculators, filters – rapid & slow sand filters, removal of hardness, disinfections – methods & applications. Different Pipe materials, Distribution of Waters, different systems & their applications, different appurtenances of distribution systems, guiding regulations of service connections according to Bengal Municipal Act.

## **SANITARY ENGINEERING**

Elementary knowledge of Water & Air Pollution and Control. Classification of waste, necessity of waste disposal, different systems of Transportation of sewage, Sewers – Types, Sewerage, Sewer appurtenances, laying of sewers, quantity of sewage – domestic, industrial, storm water & ground water infiltration, estimation of run off, time of concentration, characteristics of sewage – Physical & Chemical (e.g. pH, colour, odour, turbidity, BOD, COD, nitrogen, chloride), sewage treatment processes - aerobic & anaerobic treatment, sewage treatment units, activated sludge process, trickling filter, septic tank, Rural Sanitation, Solid Waste disposal methods.

## **7. IRRIGATION**

### **PRINCIPLES OF IRRIGATION**

Necessity & benefits of irrigation – its ill effects, types of irrigation systems, methods of irrigation – surface irrigation, sprinkler irrigation and sub-surface irrigation.

### **HYDROLOGY**

Measurement of rainfall – Symon's rain gauge, average rainfall over an area by arithmetical mean method, Thiessen polygon method and Isohyetal method, Run off - factors affecting it.

### **WATER REQUIREMENT OF CROPS**

Duty, Delta and base period – their inter-relations, factors affecting duty, methods of improving duty, commanded area, capacity factor, time factor, outlet factor, crop ratio, overlap allowance.

### **CANALS**

Classification of canals, canal linings – Types and advantages, different parts of irrigation canals – their functions, designs of canal sections for a given discharge (using Kennedy & Kutter's formula), Design of canal sections by using Manning Formula, Canal structures.

### **WELL IRRIGATION**

Shallow and deep wells, yield from a well, advantages & disadvantages of well irrigation.

### **TUBEWELL IRRIGATION**

Piped Water Irrigation, Design of Pipelines and losses.

### **CROSS DRAINAGE WORKS**

Aqueduct, super passage, siphon aqueduct, level crossing.

### **HEAD WORKS**

Object, layout and functions of head works, classification of dams, different types of earthen dams, causes of failure of earthen dams and safety measures, difference between weir, barrage and dams.

### **FLOOD CONTROL**

Methods of flood control, reservoirs, flood walls, channel improvements, floodways. Cause & effect of flood.

### **RIVER TRAINING WORKS**

Objectives, different types, guide bank, spurs, groynes, pitching, revetment, rip-rap.

## **8. ROADS & HIGHWAYS**

### **INTRODUCTION**

Classification of rural (non-urban) & urban roads as per I.R.C., terrain classification as per I.R.C.

### **ROAD GEOMETRICS**

Road alignment, vertical and horizontal curves. Cross-sectional elements, recommended land width for different classes of roads, recommended speeds, Camber-objective-recommended values of camber for different types of roads, Gradients for roads in different terrains, Grade compensation at curves on hill roads, super-elevation-objects, transition curves objects, sight distance, different types, perception time, brake-reaction time, lag time, lag distance. Equipments used in road construction.

### **EARTH WORK**

Cutting, filling angle of repose, allowance for settlement, profile, benching, lead & lift, borrow pit & spoil bank.

### **CITY ROADS**

Kerb & channel, pedestrian crossing, guide island, refuge island, traffic lane.

### **HILL ROADS**

Retaining walls, breast walls, weep holes, catchwater drains, hair pin bend, cliff gallery.

### **ROAD AGGREGATES**

Different types, requirements of good road aggregates, testing of road aggregates (names of tests & their objectives).

### **HIGHWAY CONSTRUCTION**

Road structure, component parts, functions, soil stabilization methods, Road Drainage.

Water bound macadam roads – materials required – advantages & disadvantages.

Bitumen – sources – types, Asphalt, Tar.

Bituminous Road Types – Surface dressing (single & double coat), Grouting (semi grout & full grout), premix type (premix chipping carpet, premix macadam & premix concrete) – Functions, constructions, quantities of materials required for each type.

Cement concrete Roads : Pavement joints, necessity types, joint sealer, joint filler, dowel bar, tie bar, mud pumping,

Culverts & Bridges – differences – component parts – wing wall, Abutment and Piers.

Classification of Bridges, Span, Flood discharge, Waterway, Scouring, Depth of Foundation, Clearance and Free Board, Maintenance of Bridges.

## 9. SOIL MECHANICS & FOUNDATION ENGINEERING

Classification of soil – Particle size – MIT & IS Sieve Analysis.

Index, properties of soil.

Phase diagram for dry, moist and saturated soil, Definition – void ratio, porosity, water content, degree of saturation, Unit weight, Sp. Gr., Density, bulk density, dry density, submerged density, air content etc.

Consistency of soil – Moisture content & volume relationship, Definition – Atterberg Limit, plasticity index, density index shrinkage ratio.

Permeability of soil – Darcy's law, coeff of permeability, factors affecting permeability.

Compaction – Dry density by Proctor's compaction.

Consolidation – Difference between compaction & consolidation, compression index, coeff of compressibility, volume compressibility, coeff of consolidation, settlement of foundation.

Shear strength – Definition of shear strength and shear parameters.

Earth Pressure – Active and passive earth pressure, coeff of passive earth pressure – Rankine's earth pressure theory, Angle of repose, pressure intensity diagram, Resultant thrust.

Foundations – Shallow & deep foundations, types of shallow foundation (names & uses only) types of deep foundation (names & uses only), Bearing capacity, Terzaghi's bearing capacity formula, assumptions & problems, plate load test. Pile foundation – formula related to pile foundation, Dynamic Engineering News formula, Hiley's formula, static formula.

Soil Stabilization – Principles, types – Mechanical stabilization, cement stabilization, lime stabilization, bitumen, stabilization by grouting.

Soil exploration – Preliminary work – Site reconnaissance, trial pits, boring.

Types of soil samples – Procuring & handling of disturbed and undisturbed samples.

Presentation of soil investigation result.

## 10. CIVIL ENGINEERING DRAWING

Isometric view, Development of surface.

## APPENDIX – "B"

### SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT TO THE POST OF SUB-ASSISTANT ENGINEERS (MECHANICAL) IN WEST BENGAL SUBORDINATE SERVICE OF ENGINEERS

#### 1. STRENGTH OF MATERIALS

##### a) **Stress, Strain, Elasticity –**

Tensile, Compressive and Shear Stresses, Hooke's Law, Tensile test on M.S., Factor of Safety, Young's Modulus, Modulus of rigidity, Bulk Modulus, Poisson's Ratio, Temperature Stress, Hoop Stress, Longitudinal Stress, Strain energy. Ductility, Mobility & Plasticity.

##### b) **Riveted Joints –** Types of joints, failure of riveted joints, efficiency of joints, rivet joints in pressure vessel, structural joint.

##### c) **S.F. and B.M. –** Definition of beam, type of beam, types of loads, S.F. and B.M. diagrams for cantilever, simply supported and overhung beams with point loads and U.D.L., Point of Contraflexure.

##### d) **Bending Stress –** Assumptions in simple bending, Moment of resistance, Section modulus, Flitched beam, difference between neutral axis and neutral plane.

##### e) **Torsion of circular shafts (solid and hollow) –** Torque equation, power transmitted, Flange Couplings.

##### f) **Closed Coil helical spring –** Stress in spring, deflection, stiffness of springs, springs in series and parallel.

##### g) **Deflection of beam –** Cantilever, simply supported and overhung beams with point load and UDL, Superposition, Macaulay's Method.

##### h) **Columns and Struts –** Definition of Column and strut, types of columns, slenderness ratio, critical load, Euler's Formula, Rankine – Gordon's Formula (both ends fixed, one end fixed, other end hinged, both ends hinged, one end fixed, other end free – equivalent length).

#### 2. ENGINEERING MECHANICS

##### a) **Centre of gravity and moment of Inertia –**

C.G. of regular areas and volumes, M.I. of regular areas, Perpendicular Axis Theorem, Parallel Axis Theorem, Mass M.I. of thin cylinder.

- b) **Work, Power, Energy** – Definitions, Units, Conversion of Units, Kinetic energy, Potential energy, Power – M. K. S. and S. I. units.
- c) **Transmission of Motion and Power** –  
Belt drive – Velocity ratio, Simple and Compound drive, Initial Tension, Centrifugal Tension, Power transmitted, Speed for maximum power, Creep in Belt, belt length, Flat belt and V-belt drive – comparison.  
Gear Drive – Types of gears, gear trains, types of gear trains, elements of spur gear, power transmitted.
- d) **Lifting Machines** – Definitions, Mechanical advantage, velocity ratio, efficiency, condition for non-reversibility, velocity ratio for different types of lifting machines (simple and differential wheel and axle, differential pulley, screw jack, single purchase crab, worm and wheel).
- e) **Friction** – Definitions, Laws of friction, angle of friction, angle of repose, limiting frictions, coefficient of friction.

### 3. FLUID MECHANICS AND MACHINES

- a) Properties of fluid, units, measurement of pressure by manometers, Total pressure and centre of pressure of immersed flat surfaces, buoyancy and floatings, types of equilibrium of floating bodies.
- b) Types of fluid flow, Types of energy, Continuity equation, Bernoulli's Theorem.
- c) Measurement of fluid flow – Venturimeter, Orificemeter,  $C_d$ ,  $C_v$  and  $C_c$  of orifice, Notches (Rectangular and Vee), Pilot tube,
- d) Losses in flow through pipes, Reynold's number – its significance.
- e) Reciprocating Pumps – Types, Working Principle of a Reciprocating Pump, Pump Work, efficiency, Slip, Power, uses of Air Vessels, separation and cavitations, care and maintenance of reciprocating pumps.
- f) Centrifugal Pump – Types, parts, pump heads, working principle, priming, selection of pumps, specific speed, work done, power, efficiency, performance, starting, care and maintenance.
- g) Vert Turbine Pump.
- h) Submersible Pump.

### 4. HEAT POWER

- a) Units of pressure, Temperature, work, power, heat, first and second laws of thermodynamics, internal energy, enthalpy, entropy – unit of entropy.
- b) Difference between gas and vapour, characteristic equations of perfect gas, Universal gas constant, Specific heats at constant pressure and constant volume – their relationship, types of non-flow process for gases.
- c) I.C. Engines – Otto cycle and Diesel cycle – representation on P.V. and T-S diagram, thermal efficiency, comparison, Dual Combustion cycle – P-V and T-S diagram, use, parts of I.C. Engine.  
Working principle of petrol engine – 4-stroke and 2-stroke cycle engines, simple carburettor, preignition, Detonation, Supercharging, ignition systems.  
Working Principle of Diesel engine – 4-stroke and 2-stroke cycle engines, Air injection and solid injection, super charger & Torque convertor.  
Scavenging, valve timing, governing of I.C. Engines, Performance of I.C. Engine – indicator diagram, Indicated power, brake power, mechanical efficiency, thermal efficiencies, efficiency ratio, specific fuel consumption.  
Cooling systems of I.C. engines, components of cooling system.  
Care and maintenance – lubrication of I.C. engines.
- d) **Air Compressor** –  
Purpose of using compressors, field of application, classification, principle of working of reciprocating air compressor (single stage) and its performance, types of rotary compressors, comparison between reciprocating and rotary compressors, safety, care and maintenance.
- e) **Refrigerator and Air-conditioning** –  
Refrigerating effect, C.O.P., Properties of refrigerants, Refrigerants and pollution.  
Air Refrigeration – Reversed Carnof Cycle, Bell Coleman Cycle, uses.  
Vapour Compression Refrigeration – working principle, function of components, uses.  
Air-conditioning – Definition, types, factors of control.

### 5. MANUFACTURING PROCESS

- a) **Heat treatment of Steel** –  
Carbon Steel and alloy steel, structural steel and tool steel. Iron carbon diagram (Phrases and temperatures of transformation), Hypo and hyperentectoid steel.  
Concept of heat treatment of steel and its purpose.  
Different heat treatment processes - Annealing, normalizing, hardening, tempering, case hardening process – Carburising, Nitriding, Cyaniding (Principle, Purpose and uses).  
Surface Hardening – Flame Hardening, Induction Hardening.  
Heat treatment of H.S.S. cutting tools (Principle & purposes).  
Heat treatment furnaces. Composition of different alloy.
- b) **Pattern Making** –  
Definition of pattern, pattern materials, selection of pattern material, advantages and limitations of wooden and metal patterns, pattern allowances, reasons for pattern allowances, factors controlling the allowances, types of pattern – fields of application.
- c) **Moulding** –

Classification of moulding process, properties of moulding sand, preparation of moulding sand, moulding tools, Green sand moulding cope, drag, runner, riser, gatings, dry sand moulding, loam moulding, fit moulding, machine moulding.

d) **Casting –**

Melting of metals – furnaces required (Cupola, Tilting furnace).

Casting process – sand casting, die casting, centrifugal casting, malleable casting, investment casting (process in brief and field of application).

Fettling of casting, defects in castings, remedies, safety precautions in casting, testing of castings.

e) **Welding and allied processes –**

Definition of welding, classification, gas welding procedure, equipments, application, safety, types of flames – uses, function, use and types of fluxes.

Arc welding – principle, equipments, application safety.

Resistance welding – spot, butt, seam and projection.

Welding – principle, equipments, uses.

Thermit welding – principle of operations and applications.

Special welding techniques – TIG, MIG, Electron Beam welding.

Plasma Arc welding, Electroslag welding, laser welding – principle and application.

Defects in welding, remedies.

Soldering, brazing – principle, application.

f) **Fitting –**

Various operations and corresponding tools used, measuring tools, marking tools, specifications, care and maintenance of tools.

g) **Mechanical working of metal –**

Forging – types (Hand, Power, Drop and press forging – Principles of operation), tools used, forging operations, characteristics, advantages and defects of forged parts.

Extrusion – definition, types, principles of operation, advantages, field of application.

Rolling – principles of hot and cold rolling, field of application, types of rolling mills – uses, spinning, wire drawing – principle of operation, field of application.

## 6. MACHINE TOOLS

a) Introduction – definition, classification, basic elements and purpose of machine tools, safety in machine shop, machine tool drives – classification.

b) Metal cutting – purpose and classification of cutting tools, cutting tool materials – comparative study, orthogonal and oblique cutting, tool life, tool wears, machinability, cutting fluids – properties, purposes and types.

c) Lathe and Lathe work

Types, classification of Lathe Centre Lathe specification, parts, accessories, attachments, feed mechanism, feed reversing mechanism, operations – turning, facing, taper turning, thread cutting, boring, knurling etc. different types of lathe tools, tools elements, tool signature, cutting speed, feed, depth of cut.

d) Drilling Machine

Classification and specification of various types drilling machines, construction, uses and limitations of different types of drilling machines, different types of drills – specifications, nomenclature of twist drills, tap drill size, different operations in drilling machines, work holding devices, tool holding devices.

e) Shaper and Planer

Classification and specification of shaper, parts of shaper – their functions, work holding devices, driving mechanism, quick return mechanism, stroke length adjustment, stroke position adjustment, feed mechanism, shaper operations, clapper box.

Classification and specification of planer, different parts of planer, driving mechanism, quick return mechanism, operation, comparison of shaper and planer.

f) Milling Machine

Classification, specification of milling machines names and functions of different parts of plain, vertical and universal milling machines, attachments, milling process, milling operations, milling cutter – classification, negative rake milling, safety, care and maintenance of milling machine.

g) Gear Cutting

Gear cutting by formed milling cutter, indexing simple and differential, angular indexing.

Rack cutter, pinion cutter, gear hob – working principle, job tool movement.

h) Grinding and Grinders

Grinding wheel – composition, abrasives – types, properties, uses, bonds – types and uses, Grit, grade and structure of wheels, factors in selecting grinding wheel, mounting of wheels, glazing and loading, dressing, truing and balancing of grinding wheels, care and maintenance of grinding wheels, external, internal and surface grinding, centreless grinding, honing and lapping.

i) Jigs and Fixtures

Definition, comparison, purpose, location, clamping, guide bushes.

j) Non-traditional machining

Classification, advantages of non-traditional machining, EDM, ECM, USM, LBM – working principle, advantages, limitation, field of application.

- k) Numerical Control Machine Tools  
Meaning of NC and CNC, advantages of CNC, various components of NC and CNC machine tools and their functions.
- l) Different types of thread & their use.  
Maintenance of machinery & equipments. Limits & Fits. Air & Water pollution and control.

\*

## APPENDIX – “C”

### SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT TO THE POST OF SUB-ASSISTANT ENGINEERS (ELECTRICAL) IN WEST BENGAL SUBORDINATE SERVICE OF ENGINEERS

**Materials :** Conducting, Magnetic, Insulating, Contact, fuse materials, semi conductor.

#### **ELEMENTARY CIRCUIT ANALYSIS :**

**D.C. Circuit :** Star-delta conversion, Thevenin's theorem, Norton's theorem, Superposition theorem.

**A.C. Circuit :** Single Phase R, L & C Series, Parallel : resonance.

**Three Phase :** Star & delta connection, three phase 4 wire, neutral current measurement.

**Measuring Instruments :** D.C. & A.C. Ammeter & Voltmeter; A.C. Wattmeters, Energy meters, Frequency meters, Reactive power measurement, maximum demand indicator; testing & errors of energy meters, Megar Insulation Tester, Earth Megar Tester.

**Power Factor :** Effects of low power factor; methods of improving power factor.

**Motors :** Type of D.C. Motors – Speed Control; Induction motors; Different types of starters D.C. & A.C.; Applications of different motors – D.C. & A.C. (single phase, three phase); Selection of motors for various types of load.

**Transformers :** Single phase, Three phase connection, methods of cooling, oil testing, properties, Auto-transformers, Parallel operation.

**O.H. Line :** Conductors : Types of poles, stays & struts, type of insulators and their applications; Feeders, distributors, service mains, radial & ring main feeder; primary & Secondary distribution of single phase and poly phase system; line sag on level ground.

**Cable :** P.I.L.C. & P.V.C. cable, methods of cable laying; cable rating & deviating factor.

**Protective Devices :** Fuses – fuse elements, types; current limiting reactors; Thermal, electromagnetic, Induction type relays; Types of Circuit breakers to principle of operation, Isolators.

**Earthing :** Domestic installation & motors; pole earthing, Earth resistance measurement; Horn gap & thyrite type lightning arrestor.

**Design, Estimating :** Design of lighting Scheme in a hall, class room, workshop, electrical installation of machines in a small workshop, estimation of house service connection; design of small transformers upto 100 VA; Rate analysis factor governing it – specification & schedule of work.

**Battery :** Types of storage battery, different elements, charging methods, maintenance.

**Generation :** Various conventional & non-conventional sources of energy. Different tariff systems and bill calculation.

**Electronics :** Different types of transistors – their biasing & action; Amplifier – single stage transistor, multistage. Definition of gain, frequency response, bandwidth. Voltage & power amplifier difference; transformer coupled Class-B push-pull amplifier – advantages & disadvantages, uses, Feed back in amplifier.

**Oscillator :** Types; functions of filter circuits; different rectifier circuit. Indian Electricity Rules. Extra high voltage, High voltage Switchgears protections. Pumps, lifts, Air-conditioning–Basic principle of operation safety & control.

**Conservation of Energy –** G.L.S. Lamp – Energy Efficient Lamp. Illumination – Level of Illumination & Measuring.

**Secretary**  
Public Service Commission  
West Bengal.