

## APPENDIX – “B”

### **SYLLABUS FOR WRITTEN TEST FOR RECRUITMENT TO THE POST OF JUNIOR 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 Art 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 planner, 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, tracing 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.