DETAILED SYLLABUS FOR THE POST OF ASSISTANT ENGINEER IN GROUND WATER DEPARTMENT-

CATEGORY NO.466/2024

Total 100 Marks

I) Mechanical Engineering

1)Industrial Management and Industrial Engineering	**08 Marks**

Principles of Management: Meaning of management–Taylor's scientific management, Functions of management–Different types of ownership–organizational structure. Principles of a good Wage Payment System, minimum wages, Incentives. Quality Planning and its developments – Definitions, dimensions, and TQM concepts

Project Management Techniques: Commonly used terms in CPM and PERT, critical path, slack, or float, Comparison between CPM and PERT

Quantitative techniques in Management: Linear programming –formulation of LPP–transportation problem– Least cost method, North-West corner rule, Vogel's approximation method

Inventory management – definition and classification – EOQ and ABC analysis. Sales – sales forecasting.

Meaning of the terms production and productivity – types of production – Job production batch production, mass production, continuous production – Scheduling – Dispatching – Plant location and layout, Factors to be considered in locating industrial plants – Types of layouts

Method Study: Work study – Method study – Process chart symbols – operation process chart, flow process chart, man-machine chart, and SIMO chart, Principles of motion economy, Objectives of work measurement – Procedure of stop watch time study.

Concept of quality and quality control, Control Charts introduction, types of control charts – X-bar, R, P, 100P and C.

Fundamental Statistical Concepts: frequency, frequency distribution and frequency plot–Normal distribution curve – Explanation of the terms mean, mode, median and standard deviation

Project Analysis: Need and scope for project analysis–Explanation of the constituents elements of project analysis

2)Metallurgy and Machine Tools	**08 Marks**

Metals and alloys: Structure of materials – Crystal structure –BCC, FCC and HCP – Ferrous and non-ferrous– Cast iron, Manufacturing of Pig iron – Blast Furnace – Manufacturing of Cast iron – Cupola Furnace – Types of steel – Manufacturing of steel, Steel alloys – Non ferrous metals and alloys– Aluminium, Copper and its alloys–Crucible furnace.

Heat Treatment Processes: iron carbon equilibrium diagram – TTT diagram – Micro constituents of steel – Heat treatment process

Properties, testing and inspection of materials: Mechanical properties such as strength, hardness, toughness, brittleness, creep, fatigue, stiffness, ductility, malleability, elasticity and plasticity–Thermal properties such as specific heat, thermal conductivity, thermal resistance, and thermal diffusivity– Destructive tests and Non-destructive tests.

Classification of measuring instruments – precision and non precision instruments – Direct reading and indirect measuring instruments, classifications of gauges, comparators.

Principle of arc welding, selection of welding electrodes, Electrode coatings – Functions of electrode coating, Gas welding, submerged arc welding, tungsten inert gas (TIG) welding, metal inert gas (MIG) welding, Atomic hydrogen welding and thermit welding – Defects in welding – causes and remedies of the defects such as porosity, poor penetration, warping, under cut, distortion crack, poor appearances, soldering, brazing.

Metal Cutting: Orthogonal cutting and oblique cutting, Tool life, Machinability.

Type of lathes, Lathe accessories, Work holding and tool holding devices, Speed, feed and depth of cut – Operations – taper turning methods – Lathe specification.
Drilling Machines: Classification–Work holding devices–Types of drill bits–Tool holding devices–Operations. Shaping Machines: Parts and their functions. Milling Machines: General use of milling machines–Parts of milling machines and their functions–types of milling machines, Milling operations, Types of indexing.
Definition of jigs and fixtures.

Grinding: Abrasives, Bonding materials, kinds of abrasives, functions of the grinding wheels
Flexible Manufacturing System: Flexible automation–flexible manufacturing cell – components of FMS.
Computer Numerical Control (CNC)

3) Fluid Mechanics, Pneumatic and Hydraulic Machines	**08 Marks**

Properties of Fluids: Density–specific weight–specific volume–specific gravity – viscosity – Newton's law of viscosity –types of fluids– compressibility – surface tension –capillarity.

Fluid Pressure and its Measurement: Fluid pressure at a point– Pascal's law – absolute, gauge, atmospheric and vacuum pressures, measurement of fluid pressure – pressure measuring devices.
Types of fluid flow –steady and unsteady flow – uniform and non-uniform flow – laminar and turbulent flow – compressible and incompressible flow – rotational and irrotational flow - continuity of liquid flow – energy of a liquid in motion–Bernoulli's equation–practical applications of Bernoulli's equation.
Impact of Jets: Force exerted by the jet, Impulse turbines – classification – Pelton wheel components. Reaction Turbines: Components – difference between impulse and reaction turbines, classification of Reaction Turbines, specific speed.
Pumps: Types of pumps, centrifugal pumps – efficiencies – discharge – power required to drive – multi stagepumps– specific speedof CP –cavitation– priming. Reciprocating Pump – Types – comparison of CP & RP – discharge – slip – air vessels, Hydraulic ram.

4) Applied Mechanics, Strength of Materials and Design of Machine Elements	**08 Marks**

Direct Stresses and Strains: Types of Stresses and strains–tensile and compressive – longitudinal and lateral strain – Poisson's ratio – stress strain diagram – limit of proportionality – elastic limit –yield point – ultimate stress – working stress – factor of safety – comparison of stress strain diagrams, principle of superposition – stresses in varying section – stresses in composite section. Shear stress and strain – modulus of rigidity –volumetric strain, bulk modulus. Nature and magnitude of stresses due to change in temperature.
Introduction – type of friction – static friction, dynamic friction, sliding friction, rolling friction, pivot friction, limiting friction, angle of friction, coefficient of friction, cone of friction.
Moment of inertia–radius of gyration.

Joints: Riveted Joints – types–lap joint–single riveted, double riveted – failure of riveted joints, Welded Joints: Welding terms, strength of welded joints.
Torsion equation – strength equation for solid and hollow shaft, power equation – polar moment of inertia.
Springs: Types of spring–leaf spring–helical springs.

Types of beams – cantilever beam, simply supported beam, overhanging beam, built in beam or fixed beam and continuous beam, types of loading, shear force and bending moment diagrams –maximum bending moment on the section. – deflection of beams. Column, strut, buckling load, equivalent length, slenderness ratio –types of columns–short column, medium size column, long column.

Thread terminology – Forms of screw threads -Witworth thread, British Association thread, American

standard thread –Acme thread–ISO metric thread–square thread–single start and multi start threads right hand and left hand threads – conventional representation of threads. Bolted connection using standard proportions.

Limits, Fits and Tolerances: Definition of limits, fits and tolerances. Surface roughness terminology – surface roughness values.

General design procedure – Design stress and working stress – factor of safety – Kinematic link – pair – chain – four bar chain – examples and applications– mechanism– inversion.

Torsional stresses and strains – strength of solid and hollow shaft – design of shaft considering strength and rigidity – comparisons – power transmitted by shaft – solid and hollow shafts in terms of their weight, strength and stiffness. Shaft couplings–requirement–types.

Functions of bearings – classification of bearings – Radial bearings – thrust bearings – sliding contact bearings – rolling contact bearings.

Classification of followers and cams – motion of the followers – uniform velocity, simple harmonic motion – displacement diagrams.

Governors and Flywheels: Functions of the governors – types of governors – flywheels – coefficient of fluctuation of energy.

Gears and Gear Trains: Functions of gears – advantages and disadvantages of a gear drive – spur gear nomenclature – simple gear drive – velocity ratio – gear trains–simple gear train– compound gear train.

5) Thermal Engineering	**08 Marks**

Air Standard Cycles: Assumption, Air standard efficiency–explanation with diagrams and derivation of air standard efficiency of Carnot Cycle, Otto cycle, Diesel cycle, dual combustion cycle. Classification of fuels – solid, liquid and gaseous – requirements of a good fuel – Calorific Value –combustion of fuel.
Performance of I. C. Engines – testing, Total fuel consumption and Specific Fuel Consumption – Morse test of multi-cylinder engines.
Heat Transfer: Heat Transfer – conduction, convection and radiation – Fourier's law – Thermal conductivity – Conduction through plane wall and composite wall –Black body concept – Stefan-Boltzman law – free and forced convection**,** Heat exchangers – Classification – regenerative type, parallel flow, counter flow type and cross flow, LMTD.
Air Compressors: Construction and working of Air compressors – function of an air compressor – uses of compressed air – classification of the air compressors –working of reciprocating compressors (single stage and two stage), rotary compressors – fans and blowers, centrifugal compressors and axial flow compressors.
IC Engine sub-systems: Fuel systems, ignition system, cooling system, lubrication system – quantity governing – quality governing–hit and miss governing.
Definition of refrigeration, concept of C. O. P., unit of refrigeration–reversed Carnot cycle – COP, Application of refrigeration.
Principles and working of a vapour compression system with the help of flow diagram. C.O.P. of vapour compression systems. Compressors – Condensers – Evaporators–Expansion Devices–capillary tube, Thermostatic expansion valve. Definition of refrigerants, primary and secondary refrigerants, desirable properties of refrigerants.
Psychrometry - principles and uses, Sensible heating, sensible cooling–humidifying, dehumidifying. Definition of air conditioning, classification, factors affecting human comfort, effective temperature, working of summer air conditioning, winter and year round air-conditioning.

II) Agricultural Engineering

Module – I

Primary and secondary tillage operations -mould board plough, disc plough- functional component, accessories and attachments- chisel plough- subsoiler- horizontal and vertical suction of MB plough -forces acting on tillage implements- field efficiencies. Draft measurement of tillage implements and calculation of power requirement for tillage. Sowing, planting and weeding equipment. Seed drills and planters –types of seed metering mechanisms and furrow openers. Calibration and adjustments of seed drills and planters. Sprayers and dusters. types of nozzles.

Marks: 3

Module – II

Harvesting- methods and technologies: Reapers (VCR), mowers and chaff cutters. Threshers: types of threshing drums- factors affecting thresher performance. Winnowers. Grain and straw Combines– computation of combine losses. Tractors and power tillers - engines -power transmission systems: clutch, gearbox, differential and final drives. Tractor power outlets- p.t.o power and drawbar power. Determination of maximum draw bar pull. Tractor tyres. Traction aids. Centre of gravity and moment of inertia of tractors.

Marks: 3

Module - III

Hitching of implements – mounted, semi-mounted and trailed type implements. Traction mechanics: pull and draft, coefficient of traction, tractive efficiency and weight transfer. Calculation of field capacity and field efficiency- Economics of machinery usage, fixed cost, variable costs- estimating the cost of operation and break-even point.

Marks: 3

Module - IV

Testing of tractors and farm machines: type of tests, test codes and procedure. Ergonomic considerations in designing farm machines – anthropometry and assessment of energy expenditure. Vibration and noise levels and its physiological effects. Non-conventional energy sources- solar thermal energy conversion- flat plate and concentrating collectors - solar constant - photovoltaic electric production– PV systems.

Marks: 3

Module - V

Wind energy conversion- power coefficient- Betz limit -Bio energy: thermo chemical energy conversion of biomass- biomass gasification- gasifiers – biochemical energy conversion of biomass: anaerobic digestion process - fixed and floating type bio gas plants-bio mass characteristics. Gasifier technology- types of gasifiers.

Marks: 3

Module - VI

Soil properties influencing irrigation management- soil- water relations- infiltration characteristics of soil and equations -water requirement of crops. Mechanics and types of soil erosion- soil loss estimation -biological and engineering measures to control erosion- water harvesting structures. Estimation of mean rain fall. Measurement of run off – Cook's method. Linear, aerial and relief aspects of watersheds –stream order. Watershed management: factors and measures. Hydrograph- applications and limitations.

Marks: 3

Module - VII

Surveying: basic principles and classification. Levelling – rise and fall system, classification of levelling. Total station and GPS survey. Remote Sensing: basic components, advantages and limitations. Types of sensors and platforms. GIS: basic components, spatial data, map projections, data models and its integration. Properties of fluids- hydrostatic pressure and its measurement- Bernoulli's theorem- laminar flow in pipes- general equation for head loss-Darcy's equation- major and minor losses through pipes and fittings- open channel hydraulics-Chezy's and Bazin's formula- on farm structures for water conveyance- control and distribution-drop structures.

Marks: 3

Module - VIII

Surface and sub surface drainage – coefficient- design parameters - hydraulic conductivity- drainable porosity - Hooghoudt's spacing equations. Hydraulics of flow in wells- centrifugal pumps- total pumping head-NPSH- maximum suction lift- power requirement - performance curves. Sprinkler and drip irrigation systems- layout- hydraulic design of lateral sub-main and main pipe line- selection of pump.

Marks: 3

Module - IX

Rheological properties- force deformation- stress- strain- elastic –plastic- and viscous behavior- drying - theory of grain drying- moisture content and water activity- free, bound and equilibrium moisture content. Equipment for cleaning and grading. Size reduction: fineness modulus- principles of comminution: laws and procedures, crushing, impact, cutting and shearing.

Marks: 3

Module – X

Principles of processing and preservation: blanching and canning. Thermal processing of food – freezing, refrigeration and cold storage. Drying: hysteresis effect -EMC determination psychometric chart. Grain dryers - batch and continuous type -types of grain dryers: deep bed dryer- flat bed, continuous flow and LSU dryer. Storage of grains - improved storage structures: CAP, hermetic storage, pusabin, RCC ring bins.

Marks: 3

III) Mining Engineering

Module I: Mining Geology (2 Marks)

Geomorphology, Mineralogy, Petrology, Structural Geology, Economic Geology: Different Prospecting Techniques: Reconnaissance; Principles and methods of prospecting – by pit, shaft, trench, and boreholes; Methods of investigation ore bodies- rock sampling techniques ore reserve estimation methods and UN framework classification (UNFC).

Module II: Mine Development (3 Marks)

History of mining – contribution of mining in the human civilization and national economy, Indian mineral resources, and world status – role of mining engineers in industry - mode of entries – applicability and limitations comparison of opencast vs underground mining; Selection of site and size, sinking methods, support system, ventilation, lighting and drainage arrangements during sinking, material handling, and safety in sinking shafts.

Module III: Drilling and Blasting (4 Marks)

Drilling methods –selection of drilling methods and drilling techniques – Rotary, Percussive, Rotary-Percussive; Down the hole drilling vs Top hammer drilling, Explosives and Blasting Agents- ANFO, slurry, emulsion, permitted explosives, bulk explosives; Selection of explosives; Blasting accessories, Initiation systems; Drilling and blasting pattern for underground excavations; Advantages and limitations of blasting. Storage and transport of explosives; Dangers associated with blasting and preventive measures; Controlled blasting techniques; Alternatives to explosives.

Module IV: Surface Mining (3 Marks)

Bench parameters, haul roads, selection of equipment, different types of opencast equipment like excavators, transport (road, conveyors); Pit slope stability – mode of failures and stabilization; Overburden removal and disposal, design of waste dumps, mine closure plan; Introduction to hydraulicking, dredging, leaching, etc.

Module V: Underground Mining Methods and Mineral Processing (3 Marks)

Coal & Metalliferous Mines: Factors affecting choice of mining methods; Bord and Pillar Method-Development & Extraction; Longwall Mining; Special methods of working in coal deposit; Stoping methods in metalliferous deposits; Novel Innovative Techniques & Special Applications in metal mines; Introduction to comminution, Laboratory & Industrial Sizing and Sampling and Control; Separation/Concentration methods; Special methods of ore extraction.

Module VI: Mine Surveying (2 Marks)

Linear measurements, compass surveying, true meridian, magnetic meridian open & closed traverse, traversing with compass and chain, permissible errors, leveling — contouring; theodolite — temporary and permanent adjustments, permissible error for surface and underground and their distributions; correlation survey: tachometry, dip, strike, fault problems; EDM, GPS —DGPS, total station, introduction to remote sensing. Stope & Subsidence Surveys; Borehole surveying and calculations; Types of plans for the mine workings; Preparation, care, storage and preservation of Plans;

legislation concerning mine plans and sections; duties and responsibilities of surveyors. Application of computers in mine surveying and preparation of plans.

Module VII: Mine Planning and Design and Computer Applications in Mining (3 Marks)

Estimation of ore reserve based on bore hole data, design of mine openings, design of opencast mines, design of bench geometry, pillar design problems; Design of support system in underground mining; Production and Productivity in mines. Basic concepts of mine planning software such as SURPAC, DATAMINE, VULCAN etc. and other auxiliary software related to surveying, planning and design in mines.

Module VIII: Mining Machinery and Geo-mechanics (3 Marks)

Wire ropes - classification of wire ropes, applicability of different ropes - causes of deterioration, precautions, selection parameters; Transportation in Mines - Rope Haulages, Conveyors, Locomotives & Ariel Ropeways. Physical and Mechanical Properties of Rocks; Non-Destructive Testing Methods and Time Dependent Properties of Rocks. Theories of Failure of Rocks & Pillar Design and Rock Burst; Design of Underground Workings; Stowing/Filling.

Module IX: Mine Environment and Ventilation (3 Marks)

Air Pollution and Water Pollution – causes and types & effects. Different Sources of Water Pollution. Analysis of Air Pollutants. Air Pollution Control Measures & Equipment. Methods & Approach of Air Pollution Control. Soil Polluting Agencies & Effect of Pollution - Solid Waste Disposal; Noise Pollution & Control. Air & Water Pollution Control Acts & Rules (Salient Features only) – Functions of State / Central Pollution Control Boards. Mine Gases; Mine Climate and Control; Principal Laws of Air Movement in Underground; Natural Ventilation and Air Current Distribution in Mines; Mechanical Ventilation & Ventilation Planning.

Module X: Mine Management, Legislation and General Safety (4 Marks)

Mine organizational structure; Mines Act 1952, Mines Rules 1955, Metalliferous Mines Regulations 1961, Directorate General of Mines Safety (DGMS) issued technical Circulars, Vocational Training rules 1961, Granite Conservation and development rules 1999, Tamil Nadu Minor Mineral Concessional rules 1959 and Environmental Protection Act 1986, Environmental impact assessment (EIA) notifications – 1994 and 2006, Environmental clearance procedures for mining projects; Mine explosions and fires; Inundation; Safety Audit in mines, Accidents analysis and Compilations of investigation reports.

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.