DETAILED SYLLABUS FOR THE POST OF ASSISTANT ENGINEER (AGRICULTURE) IN AGRICULTURE DEVELOPMENT AND FARMERS WELFARE - DIRECT RECRUITMENT

(Cat.No: 665/2022)

Module - I Farm Machinery and Power Engineering (12 Marks)

Primary and secondary tillage operations -primary tillage implements-mould board plough, disc plough- functional components, accessories and attachments- chisel plough- subsoiler-secondary tillage implements-cultivators-harrows-rotary tillers-levelling and puddling implements. Forces acting on tillage implements- field capacity-field efficiencies. 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. Harvesting- methods and technologies: Reapers (VCR), mowers and chaff cutters. Threshers: types of threshing drums- factors acting thresher performance. Winnowers. Grain and straw Combines– computation of combine losses. Root crop diggers-principle of operation. Materials used in construction of farm machines - Heat treatment processes and their requirement in farm machines - Properties of materials used for critical and functional components of agricultural machines.

Tractors and power tillers - engines -power transmission systems: clutch, gearbox, differential and final drives. Tractor power outlets- PTO power and drawbar power. Tractor tyres. Traction aids. Centre of gravity and moment of inertia of tractors. Hitching of implements – mounted, semi mounted and trailed type implements. Traction mechanics: pull and draft, coefficient of traction, tractive efficiency and weight transfer. Ackerman steering; Hydraulic system - principle of operation; Types of hydraulic system, main functional components, functional requirements; Hydraulic system adjustments and ADDC.

Economics of machinery usage, fixed cost, variable cost - Methods for calculating depreciation - Estimation of cost of operation - Break even analysis – small, large and own, hired machine - Economic considerations in selection of farm implements and machinery. Testing of tractors and farm machines: Types, test procedure, national and international codes. Types of tests. Tractor performance criteria- Power measurement methods – types of dynamometers. Review and interpretation of test reports.

Ergonomic considerations in designing farm machines- Importance of ergonomics and its application in agriculture; Assessment of energy expenditure- direct calorimetry, Indirect calorimetry, Basal metabolism and work metabolism; Assessment of work load; Anthropometry; Anthropometric data and measurement techniques; Anthropometric dimensions and strength parameters.

Module II-Renewable Energy Engineering (5 marks)

Concept of Renewable Energy Sources (RES)-Clean Development Mechanism-Role of renewable energy for mitigation of Global warming, Classification of RES, Energy inputs for agricultural production. Solar Energy: Fundamentals and basic principles- Solar radiation measurement, Basic Principles of Solar thermal energy conversion, Flat plate and

Concentrating collectors, different solar thermal devices, Applications and gadgets- Solar drying, Solar still. Solar Photo voltaic electricity production: Principles of Photo voltaic energy production-p-n junctions, Solar cells, PV Systems- Cell characteristics.

Wind Energy: Energy available in wind, General formula, Lift and drag. Basics of Wind energy conversion, Power coefficient- Betz limit-Operational parameters of wind turbines-torque coefficient-tip speed ratio. Types of wind turbine rotors. Bio-energy: Thermo-chemical energy conversion of biomass – Biomass combustion- Combustion of Biomass and stoves -Biomass gasification, Types of gasifiers. Biochemical energy conversion of biomass: Anaerobic digestion process-types of biogas plants- Basic design aspects of Biogas plants-operational and environmental parameters affecting biogas generation. Liquid bio-fuels: Basic principles for production of alcohol and biodiesel.

Module – III: Soil and Water Conservation Engineering (9 marks)

Surveying – Instruments - Methods of surveying – Computation of area – Triangulation, intersection, traversing, cross staff survey – Plane table survey-Earth work computation – Simpson's and trapezoidal rule - Levelling – Definition - Types of benchmarks - Different types of levels – Reduction of levelling data by rise and fall method and height of collimation method -Contouring – Profile surveying - Cross section survey - Use of Minor instruments - Total station and GPS survey.

Hydrology – Hydrologic cycle-Measurement of rainfall-rain gauges- hyetograph and mass curves- evaporation and infiltration measurement – evapotranspiration measurement– Estimation of runoff-Factors affecting runoff – Computation of volume of runoff and peak flow-Rational method-Cook's method-SCS-Curve number method Hydrograph-components, applications and limitations-Unit hydrograph.

Soil erosion – Types – Factors affecting erosion by water and wind - Stages of water erosion -Biological control measures and their suitability - Contour farming, strip cropping, mixed cropping, intercropping and mulching - Mechanical control measures and their suitability –Design and construction of contour bunds, graded bunds, terraces, contour stone walls, contour trenches, staggered trenches and diversion drains - Gully erosion control structures- Drop spillway, chute spillway, drop inlet spill way and check dams - Wind erosion – Types and control - Dry farming techniques for improving crop production - Estimation of soil erosion - Universal Soil Loss Equation-RUSLE-MUSLE.

Watershed – Concept, types and delineation - Linear, aerial and relief aspects of water sheds –stream order. Land capability classification - Participatory rural appraisal technique – Watershed development plan – Estimation of cost and benefits -Gully and ravine reclamation – In-situ & Ex-situ water harvesting systems, micro catchments – Ground water recharge - Farm pond and percolation pond – Selection of suitable soil and water conservation practices – Afforestation – Holistic planning - Watershed based rural development- Use of aerial photography and remote sensing in watershed management- Applications of GIS in planning and development of watersheds including forest cover and water resources- on-farm structures for water conveyance- control and distribution-drop structures.

Underground pipe line system – Components and their functions – Structures for plant environment–Precision farming- Greenhouses, polyhouses and shade nets – Construction and utilization - Soilless cultivation.

Remote Sensing: basic components, advantages and limitations. Types of sensors and platforms. GIS: basic components, spatial data, map projections, data models and its integration.

Factors affecting quality of surface water and groundwater- domestic, industrial and agricultural activities- Drinking water quality standards, irrigation water quality classification as per USSL and All Indian Coordinated Research Project (AICRP) criteria- Point and non-point water pollution sources-water contamination due to inorganic and organic compounds- water contamination due to agricultural activities-Arsenic and fluoride contamination in groundwater and remedial measures- Water decontamination technologies.

Module – IV: Irrigation and Drainage Engineering (8 marks)

Occurrence of ground water- Verification of Darcy's Law-geological formations-aquifer, aquitard, aquiclude, aquifuge-Observation wells and piezometers-Hydraulics of flow in wells- types of wells and their construction - Well drilling – Techniques for different formations- Well logging - Types of well screen - Well design under confined and unconfined conditions- Design of well screens - Well d evelopment –Well Efficiency- Yield testing -Estimation of aquifer parameters by Theis method, Coopers-Jacob method, Chow's method-Theis Recovery method- Estimating ground water balance-Study of artificial ground water recharge structures.

Properties of fluids- Bernoulli's theorem-laminar flow in pipes-general equation for head loss-Darcy's equation major and minor losses through pipes and fittings.

Water conveyance and storage structures – Open channel hydraulics- Earthen channels and lined channels – Advantages of lining – materials of lining -Design of channel cross section- Measurement of flow in open channels-Chezy's and Manning's equation- Current meter- Kennedys theory- Lacey's theory–Hydraulic jump-types – Cross drainage works –Culvert, aqueduct, syphon aqueduct, super passage, level crossing- Design features of earthen dams and gravity dams.

Irrigation - Sources – Soil- water- Plant relationship - infiltration characteristics of soil and equation - Water requirement of crops– Measurement of irrigation water - Weirs and flumes - Methods of irrigation – Surface and sub-surface irrigation methods- sprinkler and drip irrigation - Drip irrigation – Components – Wetting pattern - Filters and Fertigation devices - Design of laterals – Sub main - Main lines -Pump capacity - Operation and maintenance- Sprinkler irrigation - Components - Sprinkler performance - Hydraulic design of sprinkler systems - Duty and delta relationship – Irrigation scheduling - Irrigation efficiencies and their estimation

Pumping systems- water lifting devices- different types of pumps, classification of pumps- Centrifugal pumps- parts of centrifugal pumps, priming, cavitation-pump selection, installation- affinity laws, total pumping head -NPSH- maximum suction lift- power requirement - performance curves- Maintenance and troubleshooting- hydraulic ram, propeller pumps, mixed flow pumps and their performance.

Drainage - Causes of water logging and salt problem - Methods of drainage – Surface drainage system –types and design, coefficient- design parameters - hydraulic conductivity

and its measurements- drainable porosity -Sub-surface drainage system-mole drains, tile drains-design of subsurface drainage system- Hooghout's drain spacing equations - Vertical drainage systems - Improvement and utilization of poor quality water - Reclamation of saline and alkali soils.

Module - V: Processing and Food Engineering (16 marks)

Engineering properties of biological materials – classification - physical properties – size – shape – roundness-sphericity- functional properties of agricultural materials: static and kinetic frictions- rolling resistance- angle of internal friction - angle of repose-aerodynamics of agricultural products: drag coefficient and terminal velocity. Rheological properties- force deformation- stress- strain- elastic – plastic- and viscous behaviour.

Equipment for cleaning and grading. Cleaning and grading, aspiration, scalping; size separators, screens, sieve analysis, capacity and effectiveness of screens. Various types of separators: specific gravity, magnetic, disc, spiral, pneumatic, inclined draper, velvet roll, colour sorters, cyclone, shape graders.

Heat transfer principles – Conduction, convection and radiation - Types of heat exchangers - Unit operations – Evaporators - Types - Mechanical separation – Filtration – Sedimentation – Settling – Centrifugal separation – Cyclone separation- Size reduction – Mixing – Blending – emulsification - Food processing operations- Pasteurization – Sterilization – Canning - Retort processing - Extrusion processing of foods - Methods of drying of foods-Preservation of food by irradiation - Microwave and dielectric heating - Fats and oil processing – Extraction methods and equipment - Food packaging – Materials and characteristics – Suitability - Processing of milk and milk products, packaging of milk - Principles of refrigeration and applications in food industries – Cold storage of fruits and vegetables - Design aspects.

Drying: moisture content and water activity; Free, bound and equilibrium moisture content, isotherm, hysteresis effect, EMC determination, Psychrometric chart and its use in drying, Drying principles and theory, Thin layer and deep bed drying analysis, Falling rate and constant rate drying periods, maximum and decreasing drying rate period, drying equations, Mass and energy balance, Shedd's equation, Dryer performance, Different methods of drying, batch-continuous; mixing-non-mixing, Sun-mechanical, conduction, convection, radiation, superheated steam, tempering during drying, Different types of grain dryers: bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray.

Size reduction: fineness modulus- Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), Size reduction machinery: Jaw crusher, Hammer mill, Plate mill, Ball mill. Material handling equipment.

Material handling equipment. Types of conveyors: Belt, roller, chain and screw. Elevators: bucket, Cranes& hoists. Trucks (refrigerated/ unrefrigerated), Pneumatic conveying.

Storage of grains, Causes of spoilage, Water activity for low and high moisture food and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa

bin, RCC ring bins), Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins, Storage of seeds. Principles of processing and preservation: blanching and canning. Thermal processing of food – freezing, refrigeration and cold storage.

Unit operation of various dairy and food processing systems. Principles and equipment related to receiving of milk-Pasteurization, sterilization, homogenization, centrifugation and cream separation. Preparation methods and equipment for manufacture of cheese, paneer, butter and ice cream, Filling and packaging of milk and milk products; Aseptic processing.

Planning and layout of farm stead. Scope, importance and need for environmental control, physiological reaction of livestock, environmental factors, climatic factors. BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc. Rural living and development, rural roads, their construction cost and repair and maintenance. Sources of water supply and water treatment suitable to rural community. Site and orientation of building in regard to sanitation, community sanitation system; sewage system-design, cost and maintenance, design of septic tank for small family- Estimation of domestic power requirement.

MECHANICAL ENGINEERING

MODULE 1. INDUSTRIAL MANAGEMENT & INDUSTRIAL ENGINEERING

(10 Marks)

Principles of management: Meaning of management -Taylor's scientific, management, Functions of management - Different types of ownership - Organizational structure. The principles of a good wage payment system: Types of wages - Nominal, real, living, fair, and minimum wages - Incentives Quality Planning and its developments: Definitions of quality-Dimensions of quality-TQM concept Project Management Techniques: Introduction to Network analysis - Commonly used terms in CPM and PERT - CPM - Operation, earliest finish time (EFT), latest finish time (LFT), critical path, event, slack or float, dummy activity - Construction and numbering of network diagram - Fulkerson's rule -Simple problems on CPM (by AOA method only) - PERT - Comparison between CPM and PERT -Calculation of expected time - Event, activity, successor event, predecessor event, earliest expected time, latest allowable time, slack. Quantitative techniques in management: Methods -Linear programming: - Formulation of LPP -Transportation problem - North West corner rule, Vogel's approximation method - Simple problems. -Game theory -Two-persons zero sum game - Maxi-min and mini-max principle - Saddle point -simple problems. Materials and sales management. Inventory management - definition and classification - purchase procedure - buying techniques - EOQ and ABC analysis. Stores management -introduction -store keeping functions -duties of store keeper -store layout -Centralized and decentralized store -store records indent forms -bincard -store ledger. Sales -importance -functions of sales department -sales forecasting.

Production planning and control: Concepts of industry - Meaning of the term production and productivity -Methods of increasing productivity - Types of production - Job production batch production, mass production, continuous production - Explanation of production planning control - Benefits and functions of PPC - Preplanning activities - Forecasting, plant location, product planning, design and development, material selection. Process planning, determination of men, machines, material and tool requirements — Process planning — Choice of machine in process planning - Break even analysis - Process sheet -Process planning procedure -Routing - Scheduling - Dispatching - Value Engineering - Plant location and layout - Factors to be considered in locating industrial plants - Plant layout - Types of layouts - Compare the advantages and disadvantages of each type - Plant maintenance - Types of maintenance. Method study: Work study - Advantages and application of work study to increase productivity -Method study - Therbligs and their symbols - Process chart symbols - Preparation of operation process chart, flow process chart, man-machine chart, right hand left hand chart, and simo chart - Flow diagram - Principles of motion economy - Rules concerning human body, work place layout and material handling, tools and equipment design - Objectives of work measurement - Procedure of stop watch time study - Standard time calculation -Production study - Work sampling - Steps in work sampling. Inspection and Quality control: Concept of quality and quality control - Product control - Concepts of inspection - Types of inspection - First piece inspection, working inspection, sample inspection, operation inspection, key operation inspection, floor or patrolling inspection , centralized inspection -Advantages and limitations Fundamental statistical concepts: Explain the term variability in measurements - Explain the terms variable, attribute, frequency, frequency distribution and frequency plot - Normal distribution curve - Tally sheet -

Explanation of the terms mean, mode, median and standard deviation - Calculation of mean, mode, median and standard deviation.

MODULE 2 METALLURGY AND MACHINE TOOLS (10 Marks)

Metals and alloys: Structure of materials - Structure of solids - Crystal structure - BCC , FCC and HCP — Ferrous and nonferrous - Cast iron- White, malleable, grey and nodular cast iron -Manufacturing of Pig iron-Blast Furnace - Manufacturing of Cast iron - Cupola Furnace - Types of steel - Manufacturing of steel - Bessemer process, LD process, Open hearth and Electric furnace -Steel alloys -Non ferrous metals and alloys - Aluminium, Copper and its alloys - Crucible furnace. Heat Treatment Processes: Cooling curve for pure iron- iron carbon equilibrium diagram -TTT diagram - Micro constituents of steel — Heat treatment process, annealing, normalizing, hardening, tempering, mar tempering, austempering, case hardening (cyaniding, nitriding and carburising), age hardening—induction hardening - flame hardening — residual stress due to heat treatment 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 testing --Tensile and compressive test - Hardness test: - Impact test - fatigue test - Creep test - Non-destructive testing - Radio graphic - Ultrasonic testing - Inspection -Spark test, magnetic particle, x-ray and dye penetration tests

Measuring instruments, gauges and comparators: Classification of measuring instruments- Precision and non-precision instruments - Direct reading and indirect measuring instruments — Vernier calliper, micrometer (inside, outside) - Classifications of gauges - Plug, ring, snap, screw pitch gauge, feeler gauge, standard wire gauge and indicating gauges -Comparators - Mechanical comparators, Electrical comparators, Optical comparators, Pneumatic comparators. Welding, soldering and brazing : Arc welding -Principle of arc welding - Welding positions — Flat, horizontal, vertical and overhead welding - Welded joints - Butt, lap ,corner, tee ,edge ,V- joints, U-joint — Selection of welding electrodes - Electrode coatings - Functions of Electrode coating - Gas welding --Type of flames - Functions and operation of oxy -acetylene cylinders, pressure regulators, welding torch, nozzle -Explanation of 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. Foundry: tools- rammer, trowel, slick, lifter, strike off bar, bellow, sprue pin, mallet, gate cutter, swab, vent rod, draw spike, moulding box - Composition of moulding sands - Types of moulding sand - Green sand, dry sand, parting sand, loom sand, lacing sand and core sand - Properties of molding sand such as porosity, plasticity, adhesiveness, cohesiveness. refractoriness. Types of patterns- single piece pattern, split pattern, match plate pattern, gated pattern, loose piece pattern, sweep pattern - Pattern allowances- shrinkage allowance, draft allowance, machining allowance, distortion or camber allowance, rapping allowance Bench work and fitting: Fitting operations like chipping. Filing, scraping, grinding, sawing, marking, drilling, reaming, tapping, dieing - Tools used in fining- vice (bench vice, pipe vice, hand vice), files- various types of files-specification of files-chisels, hammers, hack saw, scrapers, punches, surface plate, surface gauge. V-block, angle plate, try square, combination set, steel rule, callipers (outside and inside), divider, scriber, drills, reamer, tap and tap wrench, die and die stock, goggles.

Metal cutting: Orthogonal cutting and oblique cutting, chip formation, type of chips, cutting speed, feed and depth of cut —Tool life - Machinability Lathe and lathe work: Type of lathe -Lathe parts, function of each part - Lathe accessories - Work holing 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 : General use of a shaper - Parts and their functions. Slotting Machines: General use of a slotter - Slotter parts and their functions. Planing machines: General use of a planer - Planner parts and their functions. Milling machines: General use of milling machines - Parts of milling machines and their functions - Types of milling machines - Cutter holding devices (a) arbours (b) collets - Milling operations – plain milling, key and key ways, gang milling, T - slot milling - Milling methods (a) conventional milling (b) climb milling - Types of indexing. Broaching Machines: General use of a broaching machine - Parts and their functions. Gear manufacture: Method of making gears - Gear hobbling. Jigs and Fixtures: Definition of jigs and fixtures. Grinding: Abrasives-natural, artificial - Bonding materials -vitrified, silicate, shellac, rubber - Kind of abrasives, grain size, grade and structure, kind of bond material, functions of the grinding wheels - Grinding machines - Cylindrical grinders.-centre type and centre less type grinders. Capston and turret lathe: Construction and parts - tooling layout Automatic and copying machines: Automation - definition Flexible manufacturing system: Flexible automation - flexible manufacturing cell - components of FMS Robots and robotics: Basic elements of robots - types of joints - robotic arms - robotic hands Computer Numerical Control (CNC): Machine tools (brief description only)

MODULE 3- FLUID MECHANICS, PNEUMATICS AND HYDRAULIC MACHINES

(10 marks)

Properties of Fluids :Density - specific weight - specific volume - specific gravity - problems - viscosity -kinematics viscosity -Newton's law of viscosity - types of fluids - compressibility - surface tension - capillarity Fluid pressure and its measurement: Fluid pressure at a point — pressure head - problems - Pascal's law — absolute, gauge, atmospheric and vacuum pressures - simple problems - measurement of fluid pressure -Piezometer tube - simple manometer- differential manometer - inverted differential manometer - Bourdon's tube pressure gauge - total pressure. Kinematics and Dynamics of fluid flow: Introduction - 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 - rate of flow or discharge - equation of continuity of a liquid flow - simple problems -energy of a liquid in motion - potential energy - kinetic energy - pressure energy - total energy - total head of liquid in motion - Bernoulli's equation — practical applications of Bernoulli's equation - venturi meter - Orifice meter - Pitot tube. Flow through Orifices, Notches, Pipes and Nozzles: Orifices - types of orifices - Vena contracta - coefficient of contraction - coefficient of velocity - coefficient of discharge - Notches - types of notches - Flow through pipes - loss of head in pipes - major energy losses - minor energy losses - loss of energy due to friction - Darcy's formulae(No derivation) for loss of head in pipes - Chezy's formula (No derivation)for loss of head in pipes - simple problems - loss of head due to sudden enlargement - loss of head due to sudden contraction (No derivation) — water hammer — nozzles . Fluid Power: Introduction - Basic law -Applications of fluid power Hydraulic system: Basic elements of hydraulic system - Oil reservoir pump unit - Principles of working

of Positive displacement pump - Classifications - Gear pumps, Screw Pump, Vane pumps, Lobe pump, Simple piston pumps. Hydraulic control elements and components: Control valves - Functions - classifications - Describe the working of pressure control valves such as relief valves - poppet valve - Direction control valves- check valves. Flow control valves - types - gate, globe, butterfly valves, non return valve. Pneumatic System: Comparison of pneumatic system with hydraulic system - identification of standard pneumatic symbols - basic pneumatic system - air filter - pressure regulator - lubricator - mufflers Pneumatic control elements and components: Pneumatic control valves -Air cylinders.

Impact of jets: Force exerted by the jet - stationary - vertical - inclined - curved plate (symmetrical and unsymmetrical) - force exerted by the jet on moving plates - simple problems. Impulse turbines: Development of water Turbines-classification-impulse Turbine-Pelton wheel Components. Reaction turbines: Components—difference between impulse& Reaction—Classification of Reaction Turbines—Francis Turbine—Kaplan Turbine -Draft tubes - specific speed. Centrifugal pump: Types of casing—piping system of CP—work done, manometric head—efficiencies discharge—power required to drive —multistage pumps -specific speed of CP— cavitation—priming. Reciprocating pump: Types -comparison of CP & RP -discharge—slip -air vessels, Hydraulic ram.

MODULE 4 - APPLIED MECHANICS, STRENGTH OF MATERIALS AND DESIGN OF MACHINE ELEMENTS (10 marks)

Direct Stresses and strains: Types of stresses and strains - tensile and compressive - longitudinal and lateral strain -Poisson's ratio - behaviour of mild steel under tension - stress strain diagram - limit of proportionality - elastic limit - yield point - ultimate stress - working stress - factor of safety - comparison of stress strain diagram of a mild steel and a brittle material- Hooks law and Young*s modulus - principle of super position - stresses in varying section - stresses in composite section - simple problems. Shear stress and shear strain: Shear stress and strain - modulus of rigidity - volumetric strain, bulk modulus - simple problems Thermal Stress and strain: Nature and magnitude of stresses due to change in temperature - total or partial prevention of expansion and contraction - temperature stress on composite bar-simple problems. Truss analysis: Types of frames - formula for finding the redundancy—free body diagram - equilibrium - forces in various members of stress due to loading - method of joints and method of sections Friction: 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 – state laws of friction. - static friction and kinetic friction. Centre of gravity of sections: Centroids - centre of gravity - axis of symmetry and axis of reference - methods to find centre of gravity - simple geometric sections such as rectangle, triangle and circle. Moment of inertia of sections: Moment of inertia - radius of gyration. Riveted joints: Types - lap joint - single riveted, double riveted (chain and zigzag) - butt joint - single cover single riveted, double cover single riveted - failure of riveted joints - failure of rivets - shearing and crushing - failure of plates - tearing across a row of rivets - tearing off plate at an edge - strength of rivet, plate and riveted joint - efficiency of a riveted joint. - caulking and Fullering operations. Welded joints: welding terms - leg of the weld, size of the fillet weld, throat thickness, effective length of the weld, side fillet weld and end fillet weld - strength of welded joints. Thin Cylinders: Failures of thin cylinder - stresses in thin cylindrical shell - hoop stress - longitudinal stress. Torsion of circular shafts: Torsion equation - strength equation for solid and hollow shaft (no proof) - power equation - polar

moment of inertia. Springs: Types of spring - leaf spring - helical springs. Shear force and bending moment: Types of beams - cantilever beam, simply supported beam, over hanging beam, built in beam or fixed beam and continuous beam - types of loading — concentrated or point load, uniformly distributed load and uniformly varying load - shear force and bending moment diagrams - cantilever beams - point load, uniformly distributed load and combination of point load and uniformly distributed load - simply supported beam - point load, uniformly distributed load and combination of point load and uniformly distributed load - maximum bending moment on the section - - deflection of beams Columns and struts: Column, strut, buckling load, equivalent length, slenderness ratio - types of columns short column, medium size column, long column.

Screw Threads: Thread terminology- Forms of screw threads (Square thread. V thread) - Wit worth 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. Welded joints and piping layout: Classification of welds- Elementary welding symbols — Types of pipes -Methods of connecting pipes-pipe threads-Representation of pipe threads - Types of pipe joints – Single and double line orthographic symbols for pipe fittings and valves (flanged, screwed and welded joints). Limits, Fits and Tolerances: Definition of limits, fits and tolerances. Surface Roughness: Surface roughness terminology- surface roughness values, Grades and symbols. General design considerations: General procedure - Design stress and working stress - factor of safety - kinematic link - pair - chain - four bar chain - examples and applications - mechanism - inversion Bolts, Nuts and Key: Designation of screw threads - stresses in screwed fastenings due to static loading – initial stresses - stresses due to external forces - bolts of uniform strength - types of keys - forces acting on a sunk key - strength of a sunk key - calculation of key size using empirical proportions. Shafts: Torsional stresses and strains -strength of solid and hollow shaft - design of shaft considering strength and rigidity- comparisons - power transmitted by shaft - Compare solid and hollow shaft in terms of their weight, strength and stiffness. Couplings: Shaft couplings - requirement - types. Bearings: Functions of bearings - classification of bearings - Radial bearings - thrust bearings - sliding contact bearings - rolling contact bearings. Cams: Classification of followers and cams - motion of the followers - uniform velocity, simple harmonic motion - uniform acceleration and retardation - cam terminology - displacement diagrams. Governors and Flywheels: Functions of the governors - types of governors - simple watt governor - porter governor - flywheels - comparison with governors - coefficient of fluctuation of speed - fluctuation of energy – maximum fluctuation of energy - coefficient of fluctuation of energy. Belt Drives: Types of belts - flat belt, circular belt or rope, V-belt - types of flat belt drives - open and crossed belt drive - compound belt drive - stepped or cone pulley drive - velocity ratio - slip - creep. Gears and Gear Trains: Functions of gears - friction wheels - advantages and disadvantages of a gear drive - spur gear nomenclature - simple gear drive - velocity ratio - gear trains - simple gear train - compound gear train.

MODULE 5 THERMAL ENGINEERING (10 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 Fuels & Combustion: Classification of fuels-solid, liquid. & gaseous-

Merits & demerits of various types of fuels --Requirements of a good fuel.-- Calorific Value — combustion of fuel Testing of I.C. Engines: Performance of I.C. Engines - testing- Indicated power, Brake Power, Friction Power - Mechanical Efficiency - Indicated Thermal efficiency, Brake Thermal efficiency, Relative efficiency - Total fuel consumption & Specific Fuel Consumption - Morse test for Determination of I.P. of multi-cylinder engine- Heat balance sheet- problems 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 - Gray body concept - Newton Rikhman equation - free and forced convection Heat Exchangers: Heat exchangers-Classification- Recuperator type and regenerative type, parallel flow, counter flow type & cross flow - concept of overall heat transfer coefficient --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. Mechanical efficiency & volumetric efficiency Different systems of I C engines: Fuel systems, - components —carburetion - functions of carburetor - working fuel systems of diesel engine -fuel filter - injector and injection nozzle - ignition system — cooling system - classification of cooling system - radiators - I C engine lubrication system - forced system - governing systems- quantity governing - quality governing - hit and miss governing. Principles of Refrigeration: Definition of refrigeration, concept of C.O.P, unit of Refrigeration, reversed Carnot cycle- COP, Application of refrigeration, Vapour Compression Refrigeration systems: Principles and working of a vapour compression system with the help of flow diagram, C.O.P of vapour compression systems. Refrigeration Equipment: Compressors - Condensers - Evaporators - Expansion Devices: Capillary tube, Thermostatic expansion valve. Refrigerants: Definition: Primary and secondary refrigerants, desirable properties of refrigerants Psychrometry: Definition, Dry air, moist air. saturated, unsaturated and super saturated air, degree of saturation, dry bulb temperature, wet bulb temperature, dew point temperature. Psychrometric Processes: Sensible heating, sensible cooling -humidifying, dehumidifying Air Conditioning: Definition, factors affecting human comfort, effective temperature Air conditioning systems: Classification - industrial, comfort air conditioning, working of summer air conditioning, winter and year round air conditioning.

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