Recruitment of Technical Assistant (Group III) against CSIR-CMERI Advt. No. 04/2021

Scheme of Competitive Written Examination

Mode of Examination for Technical Posts in CSIR

Group III (Technical Assistant) [Erstwhile Group III(1) & III(2)]

For these posts, there will be three papers. The second and third paper will be evaluated only for those candidates who secure the minimum threshold marks (to be determined by the Selection Committee) in the first paper.

Mode of Examination	OMR Based or Computer Based Objective Type Multiple Choice Examination.
Medium of Questions	The questions will be set both in English and Hindi except the questions on English Language.
Standard of exam	Diploma / Graduation Level (based on the advertised qualification of the post).
Total No. of Questions	200
Total Time Allotted	3 hours

Paper-I (Time Allotted – 1 hour)

Subject	No. of questions	Maximum Marks	Negative Marks
Mental Ability Test*	50	100 (two marks for every correct answer)	There will be no negative marks in this paper.

**Mental Ability Test will be so devised so as to include General Intelligence, Quantitative Aptitude, Reasoning, Problem Solving, Situational Judgment, etc.*

Paper-II (Time Allotted – 30 minutes)

Subject	No. of questions	Maximum Marks	Negative Marks
General Awareness	25	75 (three marks for every correct answer)	One negative mark for every wrong answer
English Language	25	75 (three marks for every correct answer)	One negative mark for every wrong answer

Paper-III (Time Allotted – 90 minutes)

Subject	No. of questions	Maximum Marks	Negative Marks
Concerned Subject	100	300 (three marks for every correct answer)	One negative mark for every wrong answer

9 APR 2018
MANUEL THOMAS
Sr. Dy. Secretary

Syllabus of Competitive Written Examination:

I. Mechanical / Production Engineering

1. Engineering Materials

Properties of metals: Physical Properties – Structure, Density, Melting point; Mechanical Properties –hardness, hardenability, brittleness, fatigue, thermal conductivity, electrical conductivity, coefficient of linear thermal expansion;
Introduction to Corrosion, types of Corrosion, Corrosion resisting materials;
I.S. specification of materials like plain carbon steel, grey cast iron, low alloy steels & bearing Materials;
Phase equilibrium diagram for Iron and Iron Carbide;
Classification, composition and uses of cast iron;
Classification, composition and application of low carbon steel, medium carbon steel and high carbon steel with their chemical composition;
Composition and properties of common stainless steels, tool steels and high speed steel (HSS);
Special Cutting Tool Materials (Properties & Applications): Diamond, Stelites, Tungsten Carbide & Ceramics;
Principles and applications of Heat treatment of steel: TTT diagram, Annealing, Normalizing, Hardening, Tempering, Case hardening, Flame Hardening;
Non-destructive testing methods (basic principles and applications): Radiography (X-Ray & Gamma Ray), Ultrasonic crack detection, Dye penetrant test, Magnetic particle inspection.

2. Strength of Materials

Concept of stress-strain, Stress-strain diagram of mild steel;
Strain energy of axially loaded bars with uniform cross section due to gradually applied load, self-weight and sudden/impact load;
Definition of principal plane & principal stresses, Expression for normal and tangential stress, maximum shear stress, Stresses on inclined planes, Position of principal planes & planes of maximum shear, Graphical solution using Mohr's circle of Stresses;
Shearing and bending strain in beams, Theory of pure bending, equation of bending, Assumptions in the theory of bending, moment of resistance, section modulus & neutral axis (simple problems on bending stress having rectangular, circular & I section beam); Shear stresses in beam & its distribution diagram over various cross section of beam under point load/ uniformly distributed load;
Concept of Pure Torsion, Torsion equation for solid and hollow circular shafts, Assumptions in theory of pure Torsion, Comparison between Solid and Hollow Shafts subjected to pure torsion (composite and non-homogeneous shaft not included);
Types of spring, uses, Determination of shear stress & its distribution, deflection, stiffness,
solid length, concept of mean radius of coil & spring index (simple problem), Spring in series & parallel.

3. Engineering metrology

Tolerance, Selective Assembly, Interchangeability, Limits of Size, Allowances, Clearances, Interference, Fits, Selection of Fits, Numerical Problems on Limits of Size and Tolerances, Hole and shaft basis system;
Plain Plug Gauge IS: 3484 -1966, Plain Ring Gauge IS: 3485 -1972, Snap Gauge IS: 3477 -1973;
Description, working principle, method of reading, least count for Vernier Calipers, Micrometers (outside micrometer, Inside Micrometer, Stick Micrometers), Depth gauge & Height Gauge, Feeler gauge, Slip Gauges (category, use, Selection of Slip Gauges for setting particular dimension);
Concept, Instruments for Angular Measurements, construction, Working principle and Use of Universal Bevel Protractor, Sine Bar, Spirit Level, Principle of Working of Clinometers, Angle Gauges (With Numerical on Setting of Angle Gauges);
Working principle of Dial indicator;
Terminology of thread, Pitch errors, Measurement of different elements such as major diameter, minor diameter, effective diameter, pitch & thread angle, Screw Thread Micrometer, pitch measuring m/c, Two wire method, thread gauge (plug gauge, ring gauge & snap gauge);
Analytical and functional inspection, Rolling test, Measurement of tooth thickness (constant chord method), gear tooth Vernier, Errors in gears such as backlash, runout, composite;
Sources of lay and its significance, CLA, Ra, RMS, Rz values and their interpretation, Symbol for designating surface finish on drawing, Working principle of stylus probe type instruments;
Parallelism and flatness testing by dial indicator, Straightness testing by straight edge, spirit level.

4. Primary manufacturing: Casting, Forming, Welding, Powder metallurgy

Classification of manufacturing processes: Shaping process, joining process & Finishing process;

Briefing on different types of sheet metal, like Stainless Steel Sheet Metal, Copper Sheet Metal, Brass Sheet Metal, Corrugated Sheet Metal, Galvanized Sheet Metals etc., and their uses;
Different types of Tools & machines and their use in sheet metal work;
Different types sheet metal joints and their applications;
Different types of sheet metal working: cold working, hot working, warm working, bending, drawing, end curling, shearing, piercing, sheet metal presses, etc.;

Definition, Advantages and Limitations of Casting, Casting principle and operation;
Patterns: Types of Pattern, Material used, Patterns allowances, Cores, Core allowances, Core prints, Riser & Gate design;
Moulds: Mould materials, Types of sand, Mounding processes: Sand molding, Pit molding, machine molding, Shell molding;
Melting practice: Types of furnaces with specific application – Cupola furnace & Electric arc furnace;
Special casting processes: die casting, centrifugal casting, Investment casting;
Casting defects & Remedies;

Introduction of Hot Working & Cold Working;
Forging Processes: Drop forging, Upset forging, Die forging or press forging;
Types of dies: Open Die, Closed Die (Single Impression and Multiimpression);
Closed die Forging operations: Fullering, Edging, Bending, Blocking, Finishing;

Forgeable material and forgeability, Forging temperature, Grain flow in forged parts;
Types of Presses and hammers;
Principles of rolling and extrusion, Hot and cold rolling, Different rolled sections;
Methods of extrusion: Direct, Indirect, backward & impact Extrusion, Hot extrusion, Cold extrusion;

Definition of Welding, Classification of welding process as per AWS, Advantages of Welding over other fabrication process;
Different types of weld joints: Groove Weld, Fillet weld and their typical sketch with nomenclature, Edge preparation in Weld Joints, Basic Welding Symbols, Standard location of elements in Weld Symbols, Supplementary Weld Symbol;
Sheet metal joining operation like gas welding, brazing, soldering and riveting;
Shielded metal arc welding equipment: Electrodes – construction, types and specification, Power sources – AC, DC, DCEN & DCEP;
Welding positions, Welding parameters, Advantages, Disadvantages, Limitations;
Welding Parameters, advantages, disadvantages and application of Gas Metal Arc Welding and Gas Tungsten Arc Welding;
Different Types of Weld Defects & their causes/remedies;
Welding Inspection & Tests: Visual Inspection, Ultrasonic Test, Liquid Particle Test, Magnetic Particle Test, Radiographic Test, Tensile Test, Bend Test, Impact Test, Hardness Test;

Brief Description of Process of Powder Metallurgy: Powder making, blending, compacting, sintering, infiltration & impregnation.

5. Machining and machine tools

Definition and classification of machine tool, Idea of Directrix & Generatrix, Basic Elements of construction of a M/c Tool, Drive System, Power Transmission, Purpose & Accuracy of M/c Tools;

Classification of lathe, Centre Lathe – Working Principle, Specification & Function of Various Parts, Spindle Drive & Power Transmission in Lathe, Lathe accessories and attachments, Feed drive – apron mechanism, Different lathe operations – turning, facing, drilling, boring, reaming, grooving, knurling, parting off, Taper and taper turning – standard tapers, different methods of taper turning with calculation, Thread cutting in lathe – concept of right and left hand thread, odd and even thread, arrangement and calculation of change gears for metric thread, use of thread chasing dial, Different types of lathe tools, Cutting speed, feed and depth of cut – machining time estimation in lathe (turning and facing), Accuracy in lathe operations;

Classification and specification of shaper, Different parts of shaper and their functions – work holding devices, Quick-return mechanism – adjustment of stroke length and stroke position, feed mechanism, shaping machine operations and tool used for – flat surface machining, V-groove, keyway, dovetail grooves, T-slot, formed surface;

Different parts and function of a surface grinding machine, Grinding wheel – composition, Abrasive-types properties and uses, Bonds - types and uses, Grit size, grade, structure of wheels, Coding system for grinding wheel (nomenclature), Selection of grinding wheel and its mounting, Dressing – truing and balancing of grinding wheel;

Drilling Machine – classification and specification, Construction, uses of different types of drilling machine, Drilling spindle assembly, Geometry of twist drill-nomenclature, Principle of Boring Operation, Constructional features of a Horizontal Boring Machine, Operations and performance of Boring Machine, Reaming- different types of reamer, Different operation in drilling and tool used – Drilling, reaming, boring, counter boring, counter sinking, spot facing and tapping, Work holding devices in drilling machine, Comparison between accuracy obtained in drilling, boring and reaming;

Classification of Milling Machine, Different parts and their function of Plain, Horizontal and Vertical Milling Machine, Arbour assembly – Accessories and attachment (Name and function only), Specification of Milling Machine (Plain, Universal and Vertical), Milling Machine Operations: side and face milling, straddle milling, form milling, gang milling, end milling, face milling, T- slot milling, slitting; Milling cutter classification, Cutting speed, feed, depth of cut; Estimation of time for plain and face milling operations;

Type of Gears – Spur Gear, Helical Gear, Bevel Gear, Hypoid Gear, Harringbone Gear, Rack & Pinion, Worm & Worm Wheel, Internal Gear, Spur Gear – main elements, proportions, module, Gear Machining Methods – generating methods, form cutting method, Formed disc cutting method, Indexing & Dividing Head, Indexing Method, Spur Gear Milling Operation.

6. CAD/CAM - CNC

CAD/CAM hardware: Basic structure, CPU, Memory, Input/Output devices, Storage devices and system configuration;
Requirement of geometric modelling, Types of geometric models, Geometric construction method-sweep, solid modelling - Primitives & Boolean operations, free formed surfaces (Classification of surface only);

Types of automation and their application – fixed automation, programmable automation and flexible automation;
Concept of NC & CNC, CNC Turning Centre, Advantages & Disadvantages of CNC machine tools, Applications of NC/CNC Machine, Classification of CNC M/C Tools (Based on motion type, based on control loops, based on axis, based on power supply);
Automatic tool changer, Tool magazine;
Work holding methods for turning centre (name & relative advantage & disadvantage), work holding methods for machining centre (name & relative advantage & disadvantage), steps in CNC process;

Part Programming: concept of part programming, reference point (Machine Zero, Program Zero, Part Origin), Axis identification of Turning Centre & Machining Centre, CNC Codes for manual part programming G codes, M Codes, Spindle speed control, feed rate control, Tool selection;
Part programming for turning centre using different codes & fixed cycles (canned cycle, do-loop & Subroutine) to get step, taper, plain & circular turning, facing, external threading & parting off operation;
Part programming for machining centre considering Cutter radius compensation, ramp on/off motion, tool offset and using different codes, canned cycles & subroutine for generating different milled surfaces.

7. Non-conventional machining

Need for non-conventional machining, Classification and application of non-conventional machining processes;
Electrical discharge machining: Principle of working, Setup of EDM, Dielectric fluid, tools (electrodes), Process parameters, Applications e.g. micro-hole drilling, curve hole drilling;
Wire cut-Electrical Discharge Machining: Principle of working, Setup of WEDM, controlling Parameters, Applications;
Principle of working, Set-up, Controlling parameters and Applications of - Laser beam machining, Laser cutting and Laser welding;
Principle of working, Set-up, Controlling parameters and Applications of Abrasive jet machining;
Principle of working, Set-up, Controlling parameters and Applications of Ultrasonic machining;
Principle of working, Set-up, Controlling parameters and Applications of electrochemical machining;
Principle of working, Set-up, Controlling parameters and Applications of Chemical machining;
Principle of working, Set-up, Controlling parameters and Applications of Plasma arc machining.

Sample questions

1. The function of pattern allowance in casting process is

(a)	(b)	(c)	(d)
To compensate for the solid shrinkage	To compensate for the liquid shrinkage and solidification shrinkage	None of (a) and (b)	Both (a) and (b)

2. For which reason is Gas welding often preferred to Arc welding in case of joining sheet metals?

(a)	(b)	(c)	(d)
It minimizes burn-through	It gives more flexibility in filler metal deposition	None of (a) and (b)	Both (a) and (b)

3. Which of the following steps shall be suitable to cut 27 number of spur gear teeth on a blank of required diameter, through compound indexing in a universal milling machine?

(a)	(b)	(c)	(d)
First, rotate the crank by 26 holes on a 27-hole circle, and second, rotate both the index plate and the crank by another 14 holes on a 27-hole circle in the same direction.	First, rotate the crank by 17 holes on an 18-hole circle, and second, rotate both the index plate and the crank by another 23 holes on a 27-hole circle in the same direction.	First, rotate the crank by 23 holes on a 27-hole circle, and second, rotate both the index plate and the crank by another 15 holes on a 27-hole circle in the same direction.	First, rotate the crank by 18 holes on a 27-hole circle, and second, rotate both the index plate and the crank by another 26 holes on a 27-hole circle in the same direction.

4. For what reason is Quick return mechanism in a shaper machine used?

(a)	(b)	(c)	(d)
To reduce the idle time	To reduce the total machining time	To reduce the cutting stroke time	Both (a) and (b)

5. Which is the most commonly used tool material for electrical discharge machining?

(a)	(b)	(c)	(d)
Wrought aluminium	Stainless steel	Tungsten-copper	Tungsten carbide

6. G codes and M codes in programming a CNC machining centre is typically used for

(a) guiding tool motions and handling miscellaneous operations respectively.	(b) switching the coolant on and off respectively	(c) switching the spindle on and off respectively	(d) clamping and releasing the workpiece respectively

7. Which of the following oxides does protect stainless steel from rusting?

(a) Chromium oxide	(b) Ferrous oxide	(c) Aluminium oxide	(d) Titanium di-oxide

8. Which of the following symbol indicates "cylindricity"

(a) 	(b) 	(c) 	(d) None of these

9. In which of the following projection methods, projectors are orthogonal to the screen and the screen is in between the object and the observer

(a) First angle orthographic projection	(b) Third angle orthographic projection	(c) None of (a) and (b)	(d) Both (a) and (b)

10. How many redundant support does a simply supported beam have

(a) One	(b) Two	(c) depends upon the loading condition	(d) None of the options (a) – (c).

Answer (correct option) to the sample questions mentioned above

Question no.	1	2	3	4	5	6	7	8	9	10
Correct option	a	d	a	d	c	a	a	b	b	d

II. Civil Engineering

1. Surveying

a) Definition, objects of surveying, principles of surveying, uses of survey, classification of surveying -primary, plain, secondary, based on instruments, method, object, nature of field.

b) Methods of measuring horizontal distance – pacing, odometer reading, tacheometric surveying, chaining and taping

c) Principles of chain surveying and accessories for chaining and taping - chain, tape, ranging rod, arrows, pegs, cross staff, optical square, ranging rod, plumb bob, object rod.

d) Measurement by chain – on level ground and on sloping ground, reduction to measurement in slope, ranging – direct and indirect ranging

e) Systematic errors in linear measurement by chain or tape – incorrect length, tape or chain not horizontal, fluctuation in temperature, incorrect tension or pull, sag and incorrect alignments and chain or tape not straight, necessary corrections, Basic numerical problems

f) Chain and tape survey of a field - survey lines, check lines, tie lines, base line. taking offsets – perpendicular and oblique offset, long and short offset, degree of offset, error in offset, limiting length of offset, points to be considered in selecting station.

g) Brief introduction to different types of horizontal angles and directions, Principle of compass survey, bearing of lines – meridian – true, magnetic, and arbitrary bearing, fore bearing, back bearing, whole circle bearing, quadrantal bearing system and reduced bearing, conversion of bearings.

Compass surveying:

h) Prismatic compass, and trough compass – component, construction and use.

Local attraction, causes, precautions to be taken to avoid local attraction and correction of bearings affected due to local attraction, calculation of included angles.

Traversing – open traverse, closed traverse, check on open and closed traverse, Graphical adjustment for closing error. Numerical problems on calculation of bearings, angles and local attraction.

i) Error in compass surveying – instrumental error, personal error and natural error, permissible value of error.

Levelling:

j) Definitions – level surface, level line, horizontal line, vertical line, datum surface, mean sea level, reduced level, bench mark and its types.

k) Study and use of Engineers' level – dumpy level – components, construction, tilting level and automatic level or self levelling level, Terms used in levelling - line of sight, line of collimation, bubble tube axis, leveling staff –telescopic and folding type, foresight, back sight, intermediate sight, change point, height of collimation, fundamental axes and their relationship, recording in level book, temporary adjustments of dumpy level, procedure for permanent adjustment.

l) Method of reduction of levels – height of instrument method and rise and fall method- relative merit and demerits, arithmetical checks, numerical problems, computation of missing readings. Classifications of leveling - simple, differential, profile, cross sectional, fly and check levelling (basic numerical problems)

m) Sources of errors in levelling – instrumental error, personal error and natural error, precautions and reducing errors and eliminating mistakes in levelling, error adjustment, permissible error in levelling, difficulties faced in levelling.

n) Contouring – contour, contour interval, horizontal equivalent. Characteristics of contours (e.g. pond, cliff, overhanging cliff, etc) method of locating contours –indirect method of contouring (interpolation of contours), direct contouring methods, establishing grade contours. Uses of contour maps, interpretation of typical contour sheets.

Plane Table Survey:

o) Introduction – principle of plane table surveying, Equipment and accessories in plane table surveying, their use. Working with plane table – fixing, levelling, centering, orientation – by trough compass and by back sighting. Different methods of plane tabling work: a. radiation, b. intersection, c. traversing and d. resection – three point problem. Advantage and disadvantage of plane table survey, errors in plane table survey – instrumental, in plotting and due to manipulation and sighting.

2) Building materials and construction

a) Building components and types of structure

Building components & their function, Substructure – foundation, plinth, Superstructure – walls, sill, lintel, doors & windows, floor, roof, parapet, beams, columns; Types of structures – load bearing structures, framed Structures, composite structures.

b) Masonry materials:

Building stones- classification of rocks (physical, chemical), requirement of good building stone, dressing of stones, quarrying of stones, artificial or cast Stones

Bricks – conventional bricks, standard bricks, composition of clay brick, strength of bricks, proportions of burnt clay bricks, testing of bricks, special bricks (fire clay brick, refractory brick, fly ash bricks).

c) Mortars – classifications, lime mortar, cement mortar, composite mortar, functions of mortar, proportions, properties of mortar and tests for mortar.

d) Timber & Timber based material - Use of timber, characteristics of good timber, defects in timber, plywood, particle board, veneer.

e) Miscellaneous materials - Glass, plastic, fibers, aluminum, steel, galvanized iron, asphalt bitumen etc, micro silica, PVC, waterproofing and termite proofing materials, admixtures in concrete, bonding agents, epoxy resins, polishing materials.

f) Earthwork- Excavation for foundation, Shoring and strutting, earthwork for embankment, material for plinth filling, tools and plants used for earthwork.

g) Foundation: Types of foundation – open foundations, shallow foundation, stepped foundation, isolated and combined column footing, raft foundation and pile foundation.

h) Stone masonry - Terms used in stone masonry – facing, backing, hearting, through stone, Corner stone, uncoursed rubble masonry, coursed rubble masonry, point to be observed in construction of stone masonry, mortars for stone masonry.

i) Brick masonry - Common terms used in brick masonry, requirements of good brickwork, bonds in brick masonry (English, flemish, stretcher and header bonds, junction of wall – main wall to main wall and main wall to partition wall only), brick laying, line level and plumb of brickwork, striking and raking of Joints, lead and lift, precautions in brick masonry, pointing, comparison between brick and stone masonry.

j) Water proofing treatment, Termite proofing, Damp proofing, plastering, pointing, painting.

k) Building Maintenance- Cracks - causes and types of cracks, identification and repair of cracks, guniting and grouting, use of epoxy and crack fills, remedial measures.

3) Concrete Technology

a) Cement- Chemical composition, hydration of cement, heat of hydration, cement compounds. Physical properties, specifications of cement as per relevant IS codes. Testing of cement: (i) Fineness test (ii) Standard Consistency test (iii) Setting Time test (initial & final setting times) (iv) Compressive Strength test (v) Soundness test. Different grades of cement & their specifications of physical properties. Storing of cement at site, effect of storage of cement on properties of cement / concrete.

b) Properties of aggregates-Classification, Concept of size, shape, surface texture, strength, specific gravity, bulk density, water absorption, surface moisture, soundness, source, Bulking of sand, Fineness modulus of sand, determination of deleterious material (viz. silt content) in sand.

c) Properties of concrete- Introduction to concrete: Definition of concrete, necessity of supervision for concreting operation, different grades of concrete, minimum grade of concrete for different exposure conditions, minimum grade of concrete for R.C.C., water retaining structure. Definition of workability, factors affecting workability of concrete. Determination of workability of concrete by slump cone test, compaction factor test. Range values of workability requirement for different types of concrete works, segregation, bleeding. Shrinkage, factors affecting shrinkage.

d) Quality control of concrete- Selection of ingredients of concrete, Batching, Volume & weigh batching, volume batching for nominal mixes & weigh batching for design mix concrete, Different Types of Mixers (tilting & non tilting type). Different types of vibrators - needle vibrator, surface vibrator, table vibrator, principle & application of each type of vibrator.

4) Mechanics

a) Shear force and bending moment diagrams for simply supported beams, overhanging beams and cantilever subjected to couples and uniformly varying load.

b) Bending Stresses in Beams: Concept of pure bending, theory of simple bending, assumptions in theory of bending, neutral axis, neutral plane bending stresses and their nature, bending stress distribution diagram, moment of resistance.

c) Shear stresses in beams: shear stress distribution for rectangular, T-section and I-section.

5) Hydraulics

a) Basic principles of fluid flow (viz. water) – principle of conservation of mass, principles of conservation of energy and conservation of momentum, concept of control volume, discharge and its units, Continuity equation for fluid flow, Datum head, pressure head, Loss of head, Basic Numerical Problems based on the above principles.

b) Flow of Liquids (viz. water) through Pipes- Loss of head due to friction, Friction factor, relative roughness. Common range of friction factor for different types of pipe material. Minor loss of head in pipe flow- loss of head due to sudden contraction, sudden expansion, at entrance and exit of pipe, in various pipe fittings.

6) Civil Engineering Drawing

a) Principles of planning of Residential and Public building. Space requirements and norms for various units of Residential and Public building. Basic Rules and national building byelaws. Development of line plan – ground floor plan and roof plan with provision for drainage layout.

b) Two sectional elevation, Foundation details.

7) Geotechnical Engineering

a) Definition of soil, formation of soil, general types of soil. Introduction to soil structure – a) soil particle structure b) soil mass structure

b) Definition of Water/moisture content- Water content by oven drying method as per IS code, Definition of Void ratio, density index, porosity, degree of saturation, air content, Unit weight of soil mass – bulk unit weight, dry unit weight, unit weight of solids, saturated unit weight.

c) Determination of bulk unit weight and dry unit weight. Specific gravity of soil solid - determination of specific gravity. Atterberg's limits of consistency (Liquid limit, plastic limit and shrinkage limit.), Determination of liquid limit, plastic limit and shrinkage limit as per I.S code. Particle size distribution, mechanical sieve analysis as per IS code, particle size distribution curve, well graded and uniformly graded soils. Classification of soils – its requirement, field identification of soil.

8) Estimation, costing, contracts and accounts

a) Types of estimate - Approximate and Detailed. Approximate estimate Types- Plinth area rate method, Cubic Content method, Service Unit method, Typical bay method, Approximate Quantity method, Basic Problems on Plinth area rate method & application of Service unit method for selection of service unit for different types of civil Engineering Structures. Detailed estimate for new work, Revised estimate, Supplementary estimate.

b) Explanation of technical terms: Contingencies, work-charge establishment, overhead, tools and plants, schedule of rates and quantities, specification, administrative approval, technical sanction, plinth area, carpet area, floor area, horizontal and vertical circulation area, floor area ratio.

c) Centre line method and long & short wall method.

d) Items of work –earth work in excavation for foundation, brick flat soling(under foundation and floor subgrade, foundation concrete, brick in substructure, earth work in filling, DPC, plinth filling by silver sand, brickwork in superstructure, formwork, RCC excluding reinforcement, reinforcement (by percentage of component of structure, lime terracing or other similar roof treatment, finishing items – plastering, painting (on plastered surface wall, RCC surface, doors windows, grill etc), floor – (IPS, terrazzo, tiles, stone), rain water pipe, Preparation of bar bending schedule – lintel and chajja, column, slab (one way and two way), beam and their estimate.

Estimate of door and window. Units and methods of measurement as per IS code.

e) Preparing rate analysis of different items of work - (earthwork, brickwork, flooring, roofing, plastering and pointing, whitewash, colour wash, synthetic enamel, cement concrete, reinforcement, formwork, grill for window.

f) Definition of contract, objects of contract, requirements of valid 'Contract'. Types of engineering contract - lump sum contract, item rate contract, percentage rate contract, labour contract, demolition contract.,

g) Tendering-Definition of Tender, Necessity of Tender, Types-Local and Global.

Tender Notice, Points to be included while drafting tender notice. Meaning of Terms: Earnest Money, Security Deposit, Validity Period, Right to Reject One or All Tenders, Corrigendum To Tender Notice And Its Necessity. Tender Documents.

h) Terms Related to Tender Documents – Contract Conditions, Time Limit, Time Extension, Penalty, Defective Material And Workmanship, Termination of Contract, Suspension Of Work, Extra Items, Escalation, Arbitration.

i) Definition, necessity of valuation, Definitions – cost price, value, difference between them, characteristics of value, factors affecting value.

9) Construction of Roads, pavement and materials

a) Types of road materials and Tests – soil, aggregates, bitumen, Cement Concrete. Test on soil sub grade- C.B.R. test, Test on Aggregate – Los Angeles abrasion, impact, and shape test. Tests on bitumen- Penetration, Ductility and Softening point test.

b) Pavement – objective of pavement, structure of pavement, function of pavement components, types of pavement. Construction of earthen road – general terms used- borrows pits, spoil bank, lead and lift, balancing of earthwork. Construction procedure.

c) Water bound macadam roads – materials used, size and grading of aggregates and screening, construction procedure including precautions in rolling.

d) Construction of bituminous roads - Terms used– bitumen, asphalt, emulsion, cutback, tar, common grades adopted for construction. Types of bituminous surface – prime coat, tack coat, seal coat, Surface dressing – procedure of construction, bituminous penetration macadam, and Bitumen/Tar carpets – procedure of construction.

e) Cement concrete pavements- Construction procedure and equipments, Construction joints, joint filler, joint sealer.

10) Design of RCC Structures

a) Aim of design, Concept of R.C.C., Necessity of steel as reinforcement and its position in a Simply Supported and continuous member. Loads: Dead load, Imposed load, Wind loads & other loads as per IS code.

b) R.C. Sections, their behaviour, Grades of concrete & steel, permissible stresses, Equivalent bending stress distribution diagram & Moment of Resistance for singly reinforced rectangular section – balanced, under-reinforced & over-reinforced sections – basic numerical problems in working stress method.

c) Definition and types of limit states, partial safety factors for materials strength, characteristic strength, characteristic load, design load. Specification regarding spacing of reinforcement in slab, cover to reinforcement in slab, beam column & footing, reinforcement in slab, beam & column- basic numerical problems in Limit state method.

11) Environmental Engineering

a) Demands of water - Domestic, Industrial, Commercial & Institutional, Public use, Losses and wastes, Fire demand; Factors affecting rate of Demand, Variations of water demand, Estimation of quantity of water supply required for a town or city.

b) Building Sanitation and Plumbing- Definitions of the terms related to Building Sanitation-Water pipe, Rain water pipe, Soil pipe, Sullage pipe, Vent pipe, Building Sanitary fittings- Water closet – Indian and European type, flushing cistern, wash basin, sinks, Urinals, Traps- types, qualities of good trap, Systems of plumbing –one pipe, two pipe, single stack, choice of system Principles regarding design of building drainage, layout plan for building sanitary fittings (drainage plan) , inspection and junction chambers, their necessity, location , size and shape. Maintenance of sanitary units.

12) Building Services

a) Pipe joints & fittings-Introduction. Types of Pipe – G.I. Pipes, PVC Pipes, C.I. and D.I. Pipes, A.C. Pipes, prestressed concrete pipes, joints in pipes, method of fixing pipes such as G.I. fitting C.I. fitting.

b) Types of valves & its purpose, sluice valve, reflux valve, scour valve, Air relief valve, pressure relief valve, gate valves, stop valve, Flush valve.

Sample questions

1) The slump test is used to measure the:
A. Strength of concrete
B. Durability of concrete
C. Workability of concrete
D. Setting time of cement

2) A cantilever beam is fixed at:

A. One end only
B. Both ends
C. At the center
D. None of these

3) In surveying, a benchmark is used as a reference for:

A. Direction
B. Distance
C. Elevation
D. Magnetic declination

4) A first-class brick should not absorb water more than:

A. 15%
B. 20%
C. 25%
D. 30%

5) Which type of concrete is classified based on the design of concrete?

A) Plain
B) Reinforced
C) Prestressed
D) All of the above

6) What are the ingredients of concrete?

A) Binding material
B) Fine aggregate
C) Admixtures
D) All of the above

7) What is the importance of the Standard Consistency Test?

A) It is used to determine the quality of water
B) It is used to determine the quality of aggregates
C) It is used to determine the quality of cement
D) None of the above

8) In which of the following type of surveying only linear measurements are made?

A) Dumpy level
B) Theodolite surveying

C) Chain surveying

D) Contouring

9) Which of the following is not required for chain surveying?

A) Dumpy level

B) Pegs

C) Arrows

D) 20 m chain

10) Which of the following ratio is also known as water-cement ratio?

A) Weight of water to the weight of aggregates

B) Density of cement to the Density of water

C) Weight of water to the weight of cement

D) Volume of cement to the volume of water

Answer (correct option) to the sample questions mentioned above

Question no.	1	2	3	4	5	6	7	8	9	10
Correct option	C	A	C	B	D	D	C	C	A	C

III. Electrical / Electronic Engineering

1. **Basic Electrical Engineering**: Ohm's law and Kirchhoff's Law, Star/Delta Transformation, Network theorems, Power and Energy, Heating effects of Electric current, Magnetic effects, Electromagnetic Induction, Electrostatics, Batteries, Types of Electrical Engineering Materials –Conducting, Semi-conducting, Magnetic, Insulating, Di-electric – Properties and Uses.

2. **Electric Circuits & Networks:** Network Theorems (Thevenin's theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem), Power in three phase circuits, Star-Delta conversion, basic idea of Filter circuits.

3. **Electronic Devices and Circuits:** Semi-Conductor devices: N type & P type, Zener diode, PNP and NPN Transistors, Transistor configurations, characteristics, power supplies – half and full wave rectifiers, Filters, Zener diode regulation, Special devices – UJT, FET, LED, SCR, Opto Coupler, Photodiode, Photo Transistor, CRO and Timers. Amplifiers: Types, Principles of operation, Characteristics. Oscillators - Types, operation and application of each, JFET, MOSFET & UJT, Operational Amplifier (Op-Amp), Power Amplifier, Feedback Amplifier & Oscillator, Waveform Generator, Op-Amp using IC.

4. **Digital Electronics & Microcontroller**: Different numbering systems, inter Conversions Boolean Algebra, Logic families, performance of AND, OR, NOT, NOR, NAND gates, combinational Logic Circuits, sequential logic circuits, Resistors and Memories, A/D and D/A converters, Introduction to microprocessors - 8085 microprocessor - Architecture – Instruction set – Addressing mode – Instruction cycle. 8051 micro controllers – Architecture – Instruction set – Assembler - Addressing modes - Programmes – I/O programming – Timer programming- Serial communication – Interrupts- IC 8255 - Peripheral interfacing techniques with 8051 – Applications.

5. **Measurement and Instrumentation:** Methods of measurements, Classification of instruments, characteristics of Instruments Operating torques, Working and construction, damping systems, Range extension, Instruments for measurement of current, voltage, R, L, C, Power, Energy, Power factor, Frequency, Phase difference, waveform – Instruments types – operation – principles – construction – working – Rectifier type instruments – Instruments transformers – Testing, Errors and characteristics of CT and PT – Megger – Earth tester – Multimeters – Synchroscope – CRO – CRT – Digital storage oscilloscope – Transducers and sensors, PMMC & MI meters, Wattmeter, Power Factor meter, Energy meter (single & three phase), Transducers (RTD, LVDT, Piezoelectric etc.) and Potentiometers (DC & AC), Temperature measurement (Thermistor, Thermocouple), Level measurement, Pressure & Flow measurement, Function Generator, Microprocessor based instrumentation system.

6. **D.C. Machines & Batteries:** D.C. Generators, Construction, Operation, types, EMF Equation, Windings, Characteristics, Efficiency and Parallel operation. DC Motors: Principle of operation, Back EMF, Torque Equation, Types, armature reaction. Characteristics, Starters, Speed Control, Losses, Efficiency and Testing, Storage batteries, Types of Storage Batteries, Classification of cells – construction – chemical action – electrical specifications – efficiencies – defects and their remedies – capacity – methods of charging – series and parallel connections of batteries – maintenance – applications Batteries for EV charging.

7. **A.C. Machines and Special Machines:** Single phase transformer - construction - EMF equation - OC & SC Test – Regulation and efficiency- parallel operation. Three phase transformer – construction – Testing - Parallel operation – Maintenance Alternator - construction - EMF equation - methods of obtaining sine-wave - parallel operation – Testing–Determination of voltage regulation. Synchronous Motor - construction - starting methods - application. 3 phase induction motor - construction and working principle - phasor diagram - starters - speed control - maintenance. Single phase induction motors - working principle – types- applications - Special machines - PMSM, SRM, Stepper motor, PMBLDC motors.

8. **Electric power Generation:** Conventional methods of power generation – Hydel, Thermal, Nuclear power plants – Principles and types of co-generation – Diesel, Gas, pumped storage, schemes – Renewable Energy Sources – Solar PV system – Wind power Generation – Hybrid Solar PV system– Grid or Interconnected system – Load curves – Connected load – Average load – Maximum demand – Diversity factor – Tariff – Load sharing.

9. **Power Electronics & Industrial Automation:** Power Electronic Devices, Construction and working of SCR, GTOSCR, DIAC, TRIAC, Volt-ampere characteristics, Triggering of SCR using UJT, Protection. Converters, AC regulators, Choppers, Inverters and Cyclo converters: Types of Converters, working of AC regulators and Choppers. Types of inverters, Principles of working, Basic principle of working of Cyclo converters. Speed control of D.C. Motors by using converters and choppers, Speed control of induction motor by using AC Voltage regulators – V/F Control, Switched mode power supplies (SMPS), UPS, Introductory Process Control, Sensors & Actuators, Control circuit components –Switches, relays, timers, contactors – DC motor control circuits- Jogging, dynamic braking, plugging, reversing control circuit-speed control using UJT& SCR, Industrial control circuits - Programmable Logic Controller – Components of PLC - Input module – output module - programming.

Sample Questions & Answers

01. A power chopper converts
    (a) a.c. to .d.c
    (b) d.c. to d.c.
    (c) d.c. to a.c.
    (d) a.c. to a.c.

    Ans: (b)

02. In 8085 name the 16 bit registers
    (a) Stack pointer
    (b) Register B
    (c) Register A
    (d) PSW

    Ans: (a)

03. TRIACS can't be used in AC voltage regulator for a
    (a) resistive load
    (b) back emf load
    (c) inductive load
    (d) resistive inductive load

    Ans: (c)

04. A permanent magnet moving coil ammeter has a coil resistance of 99ohm and Full Scale Deflection FSD. current of 0.1mA. Shunt resistance is 1 ohm. Current through the meter at 0.5 F.S.D is
    (a) 0.007mA
    (b) 0.05mA
    (c) 0.023mA
    (d) 0.1mA

    Ans: (b)

05. One single phase wattmeter operating on 230V and 5A for 5 hours makes 1940 revolutions. Meter constant in revolutions is 400. What is the power factor of the load?

(a) 1
(b) 0.84
(c) 0.73
(d) 0.65

Ans: (b)

06. The form factor in AC is the ratio of
(a) peak value to average value
(b) peak value to rms value
(c) rms value to average value
(d) rms value to peak value

Ans: (c)

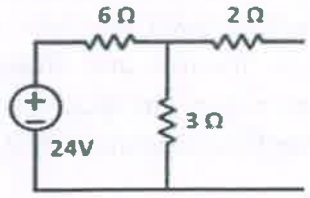
07. PMMC type instruments normally use
(a) Air friction damping
(b) Fluid friction damping
(c) Eddy current damping
(d) None of the above

Ans: (c)

08. It can be stated that
(a) CT operates at almost the same flux density as a PT
(b) CT operates with a higher flux density than PT
(c) CT operates with considerably lower flux density than a PT
(d) no generalisation can be made with regard to the flux densities in CT and PT

Ans: (c)

09. What is the Norton resistance across the open circuit terminal of the network shown below:



(a) 6 ohm
(b) 8 ohm
(c) 2 ohm
(d) 4 ohm

Ans: (d)

10. If the maximum power is being transferred to the load, then what is the power transfer efficiency?

(a) 75%
(b) 25%
(c) 50%
(d) 100%
Ans: c)

IV. Electrical Engineering

Electrical Engineering and Electrical Circuits

Overview of electrical components like R,L,C; voltage and current sources, waveforms, electrical and magnetic circuits, laws (Faraday law, Lenz law etc), AC circuits, sinusoidal signal and its characteristics (amplitude, rms, frequency etc), impedance, impedance triangle, power factor, active, reactive and apparent power, power triangle, voltage and current relationship in star and delta connections, network theorems (superposition and maximum power transfer theorem, mesh analysis, node analysis, source transformation), single-phase/ three-phase A.C circuits, transient analysis, two port network.

Electrical and Electronic Measurements

Fundamentals of Measurements - different parameters like range, sensitivity, true & indicated value, resolutions, accuracy, precision and instrument efficiency, measurement of voltage and current using PMMC, MI, dynamometer type instruments, CT, PT, clamp-on meter, measurement of electric power (active, reactive, apparent power) using 1/2/3 wattmeter method, measurement of electrical energy using single and three phase electronic energy meter, Measurement of circuit parameter and other meters like earth tester, megger and ohm meter, digital multi-meter; clamp-meter, L-C-R meter, single beam/single trace CRO, digital storage oscilloscope etc., measurements of parameters using different bridges.

Electrical Machines

Single and three phase transformers, characterization, voltage regulations, voltage-ratio, efficiency, power factor, testing of transformer like open circuit, short circuit, polarity test, phasing out test. Special transformers like isolation transformer, auto-transformer in step-up and down mode; Alternating current/ direct current/ synchronous/ induction (1-phase/3-phase) etc. type electric generators/alternators and motors - principle, construction, types, features and applications. Characteristics curves of electric machines like efficiency, power factor, voltage and speed regulations using open circuit/short circuit, torque-speed/slip characteristics, power flow diagram, testing like no load and block rotor test, brake test, heat run test.

Power System, Generation, Transmission & Distribution, Switch Gear & Protection

Economics of Power Generation and Interconnected Power Station, related terms like, Connected Load, Base Load Plant, various Load Curves, demand factor, plant use factor etc. Diesel Generator based plant, DG set; Classification of transmission lines, standard voltage levels; short, medium and large transmission line parameters and performances like regulation, Ferranti effect, skin effect; AC Distribution System- classification, distribution schemes: radial, ring etc., characteristics like voltage drops, end voltages, distribution sub-station types; types of fault, circuit interrupting devices like fuses, isolators, circuit breakers (MCB, ELCB), transformer and motor protection equipment, over voltage protection, protection against lighting.

Building electrification, Estimation & Costing, Testing & maintenance of electrical equipment

BIS symbols of electrical accessories, electrical conductors, and underground cables, cable sizing from standard data, different wiring method, BIS rule for domestic wiring; low pressure and high pressure discharge lamps, incandescent and halogen lamps, illumination control circuit (dimmer); standard norms and specifications, Indian Electricity Rules (1956), design electrical installation with costing for tendering, quotation for different electrical materials, design electrical installation scheme, estimation and costing of residential building, public lighting (street light), distribution line, LT substation based on the drawings; Testing & maintenance/ trouble shooting of rotating electrical machineries, transformers, insulation, earthing etc.

Power Electronics & Industrial Drives

Devices specifications like break down voltage, latching current and holding current, firing angle and characteristics V-I, for switches like SCR, BJT, GTO, MOSFET and IGBT, DIAC, TRIAC etc. Operation and waveforms of single phase half & full wave converter with R & RL load, power electronic converters like step down and step up MOSFET based choppers, operating principle and applications, IGBT based single, three phase PWM inverter, switched mode power supply (SMPS), uninterrupted power supply (UPS), power factor correction (PFC) and their types etc; Need of Electric Drives, Functional Block diagrams of an electric drives, DC drives - speed and direction control of dc motor (using chopper/rectifier); AC Drives - speed and direction control of induction motor (variable frequency PWM VSI, V/f control), different starters like DOL, star-delta, auto-transformer starters.

Sample Questions

1. **Ohm's law is not applicable to:**
   A. Carbon resistors
   B. High voltage circuits
   C. Vacuum tubes
   D. Circuits with low current densities
   Answer: C

2. **Potentiometer is basically a _____ instrument.**
   A. Digital
   B. Deflection type
   C. Null type
   D. Recording
   Answer: C

3. **The efficiency of a transformer is maximized when**
   A. Hysteresis losses = eddy current losses
   B. Copper losses = iron losses
   C. Copper losses = hysteresis losses
   D. Eddy current losses = copper losses
   Answer: B

4. Commutator segments are insulated from each other by which material?
   A. Mica
   B. Copper
   C. Carbon
   D. Steel

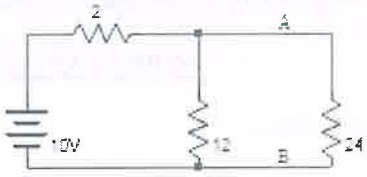
Answer: A

5. In the Nominal-T method of a medium transmission line, where is the shunt capacitance assumed to be lumped?
   A. At the sending end
   B. At the middle of the line
   C. At the receiving end
   D. Distributed between sending and receiving ends
   Answer: B

6. As per IE Rules, the permissible variation of voltage at the consumer's terminals for low and medium voltage supply should not exceed
   A. ±5%
   B. ±6%
   C. ±8%
   D. ±10%
   Answer: B

7. A thyristor is basically a _____ device.
   A. PN device
   B. NPN device
   C. PNP device
   D. PNPN device
   Answer: D

8. Consider the circuit shown below. Find the equivalent Thevenin's voltage between nodes A and B.



   A. 8.5
   B. 8.0
   C. 9.0
   D. 9.5
   Answer: A

9. Which type of distribution system is generally employed for residential areas?
   A. Radial system
   B. Ring main system
   C. Interconnected system
   D. None of the above
   Answer: A

10. According to standard norms, the number of total points (light, fan, and 5A socket) in a single sub-circuit should not exceed:
    A. 5 points
    B. 8 points
    C. 10 points
    D. 15 points
    Answer: C

V. Automobile Engineering

1. **Automobile Engines**:
   Principles of IC engines, constructional and functional details of IC engines. Combustion process of IC engines. IC engines wheelbase, overhangs, wheel track, ground clearance, kerb weight, gross weight, payload, indicated power, brake power, frictional power, types of engine, IC engine parts and its functions, firing order, SOHC, DOHC, valve clearance.

2. **IC Engine Fuels and Lubricants:**
   Petrol engines, carburettors, stoichiometric air fuel ratio, EFI system types SPFI, MPFI and GDI. Diesel engines: Conventional fuel injection, FIP- inline and distributer type, CRDI its advantages and parts, Fuel injectors, working and construction, emission control devices.
   Engine lubrication system & engine cooling system: Lubricating oil and its grades, multi grade oils, types of lubrication system; splash, pressure feed, mist lubrication, dry sump and wet sump lubrication, types of oil pumps; gear, vane and rotor pump.
   Types of cooling: air cooling, water cooling, coolant properties, water pump, radiator, pressure cap, expansion tank, thermostat valve. Intake and exhaust. Air filters, Variable valve timing, Turbocharger types, parts and working, catalytic converter, exhaust mufflers types, construction and working.

3. **Heat Power Engineering:**
   Thermodynamic terms, thermodynamic equilibrium, ideal gas equation, specific heats, internal energy, flow energy, enthalpy, entropy, thermodynamic process, laws of thermodynamics, Carnot cycle, Otto cycle, Diesel cycle, air standard cycle, efficiency of cycles, Indicated power, Brake power, friction power, heat balance sheet. Fundamentals of vehicle air conditioning.

4. **Automobile Chassis and Transmission**:
   Clutch: types, parts. Transmission gear box: types, parts. Torque converter: parts, planetary gear box; parts, automatic transmission. Propeller shaft, differential unit, transfers case. Tyres: designation of tyre types, tyre tread designs, parts, camber, castor, steering axis inclination, toe-in. Suspension parts, Mac-Pherson strut suspension, rigid axle suspension, independent suspension. Air suspension: parts and working, steering types, rack and pinion steering, re-circulating ball type, worm and roller type, power assisted steering, hydraulic brakes, parts, functions, metering valve, proportionating valve, drum brakes, disc brakes, vacuum boosters, air brakes.
   Bearings: types of bearings, bearing materials, designation of roller bearings: Gears: gear terminology, types. Gear trains; simple gear train, compound gear train, reverted gear train, gear ratios. Chain drive and types. Flywheel, Governor.

5. **Auto Electrical Systems:**
   Automobile battery: Lead acid Battery types, parts, specific gravity, battery ratings, Ah rating, cold rating, battery charging, battery troubles, Li-ion battery, jump starting.
   Alternators: components, stator, rotor, and rectifier unit. Starter motor: parts and operation, types; series, shunt and compound wound, gear reduction starters, bendix drive, axial drive. Ignition system: parts, CB points, distributer type ignition system, distributer less ignition system, ignition coil and construction, spark plug construction, ignition timing and its importance.
   Head lights: sealed beam head lights, HID lamps, LED lamps, Head light aiming, day time running lamps, rain-sensing wipers, keyless entry. PLC, Transducers, Sensors, Actuators and their applications in automobile.
   Automotive Power Train Controls: Engine control: open loop and closed loop, oxygen sensor, air flow sensor, pressure sensor, position sensors, knock sensor, temp. Sensor, EGR system, solenoid switches, relay.

Electric and Hybrid Vehicles: Series hybrid, parallel hybrid, series-parallel hybrid, regenerative braking, electric vehicle recharging, Li-ion batteries, fuel cells, types. Automotive Vehicle and Body Control Systems: Electronic power steering, four-wheel steering, cruise control, adaptive cruise control, ABS, traction control, Airbags, seatbelts. Vehicle safety: active and passive, seat belt pre-tensioners, airbags, tyre pressure monitoring system.

6. **Diagnosis, Vehicle Maintenance and Testing of Automobiles:**
Inspection & Servicing procedure of vehicle air-conditioning and Heating systems
Compression Test on Petrol/Diesel Engine
Assembly of Drive & Differential assembly
Layout and components of Steering Gear Box & Steering Linkage
Procedure of Wheel Balancing & Alignment of Caron Balancing Machine
Type of Tyres & designation, dimensions
Differential of a Tractor
Tractor & Farm Machinery terminologies
Components of Powertrain & transmission of a tractor.
Valve Clearance Adjustment and Valve Timing Procedure
Procedure for Testing of various elements of the automobile Systems: Battery, clutch, brakes etc. Performance test.

7. **Transport Management And Motor Industry:**
Transport authorities, Licensing, Regulations of motor vehicles, Motor vehicle insurance, Control of traffic, driving license & types, hand signals, road signals, vehicle classification based on GVW, vehicle documents, PUC certificate.

Sample Questions & Answers

1. The connecting rod connects the:
a) Piston to the crankshaft
b) Crankshaft to the camshaft
c) Piston to the valve
d) Cylinder to the piston
Answer: (a)

2. Detonation in an engine is caused by:
a) Slow burning of fuel
b) Premature ignition
c) Instantaneous combustion at multiple points
d) Rich fuel mixture
Answer: (c)

3. The firing order in a 4-cylinder inline petrol engine is generally:
a) 1-2-3-4
b) 1-3-4-2
c) 1-4-2-3
d) 1-2-4-3
Answer: (b)

4. In a SOHC engine, the number of camshafts per cylinder head is:
a) One

b) Two
c) Three
d) Four
Answer: (a)

5. Valve clearance is the:
a) Distance between valve head and piston
b) Gap between valve stem and rocker arm when valve is closed
c) Gap between cam lobe and tappet
d) Clearance between piston rings and cylinder wall
Answer: (b)

6. The ideal air-fuel ratio (stoichiometric ratio) for petrol engines is approximately:
a) 10:1
b) 12:1
c) 14.7:1
d) 16:1
Answer: (c)

7. In a conventional diesel engine, fuel is injected:
a) During compression stroke
b) During power stroke
c) Near the end of compression stroke
d) During suction stroke
Answer: (c)

8. CRDI stands for:
a) Common Rail Diesel Injection
b) Controlled Rotary Diesel Injection
c) Central Rotary Diesel Injector
d) Combined Rotary Direct Injection
Answer: (a)

9. A multi-grade oil marked as SAE 10W-40 means:
a) Works effectively in both cold and hot conditions
b) Used only in hot conditions
c) Used only in cold conditions
d) Synthetic oil only
Answer: (a)

10. Variable Valve Timing (VVT) is used to:
a) Reduce oil consumption
b) Improve engine efficiency and performance
c) Control spark timing
d) Cool engine faster

Answer: (b)

VI. Paper – I (Mental Ability)

This component may include questions on analogies, similarities and differences, space visualization spatial orientation problem solving, analysis, judgement, decision making, visual memory, discrimination, observation, relationship concepts, arithmetical reasoning and figural classification, arithmetic number series, non-verbal series, coding and decoding, statement conclusion, syllogistic reasoning etc.

Data interpretation: data graphs (bar graphs, pie charts, and other graphs representing data), 2-and 3-dimensional plots, maps and tables Numerical computation and estimation: rations, percentages, powers, exponents and logarithms, permutations and combinations, Mensuration and geometry, Elementary statistics and probability.

VII. Paper – II (General Awareness)

Questions in this component will be aimed at testing the candidates' general awareness of the environment around him, ecology and its application to society. Questions will also be designed to test knowledge of current events and of such matters of every day observations and experience in their scientific aspect as may be expected of any educated person. The test will also include questions relating to India and its neighbouring countries especially pertaining to Economic Scene, General Policy, Scientific Research and also Indian Constitution.

VIII. Paper – II (English Language)

Basic English grammar: Tenses, articles, adjectives, prepositions, conjunctions, verb-noun agreement and other parts of speech, basic vocabulary words, idioms and phrases in context, reading and comprehension, narrative sequencing, spot the error, fill in the blanks and cloze test.

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