

SSC JE Notification 2025



The Staff Selection Commission (SSC) will announce a recruitment drive for various Junior Engineer positions in 2025, offering a significant opportunity for engineering candidates. Interested applicants should review the key highlights of the SSC JE Recruitment 2025, including eligibility criteria, application procedures, application dates, and the selection process. It's important to understand all details before applying to ensure eligibility and a smooth recruitment process. Stay updated on SSC announcements for the latest information.

SSC JE Notification 2025	
Organization	Staff Selection Commission (SSC)
Name of Post	Junior Engineer
Name of Exam	SSC JE 2025
Number of Posts	To Be Notified
SSC JE Apply Online Starts	30 June 2025
SSC JE Last Date to Apply	21 July 2025
Exam Date	To Be Notified
Branches	• Civil • Mechanical • Electrical
Apply Mode	Online
Education Qualification	Diploma/Degree
Selection Process	• Paper 1 • Paper 2 • Document Verification • Medical Examination
Medium Of Paper	English/Hindi
SSC JE Official Website	www.ssc.gov.in

SSC JE Previous Year Cut Off:

The Staff Selection Commission conducts written tests for Junior Engineer positions. This section provides previous year cut-off marks to help aspirants understand exam trends. Check here for all the relevant information.

SSC JE Cut Off 2024		
Category	Civil	Mechanical/Electrical
Unreserved	122.92909	132.06654
OBC	116.82650	131.27256
EWS	109.20412	120.13213
SC	101.85006	112.97309
ST	97.83364	101.37117
PwBD	48.88704	58.92633

SSC JE Vacancy Trend:

These details provide a comprehensive and detailed overview of the current trends in job vacancies within the Staff Selection Commission (SSC). It offers insights into the various factors influencing these trends, including changes in recruitment policies, emerging job roles, and shifts in candidate expectations.

Year	Number of Vacancies
2025	To Be Notified
2024	1701
2023	1324
2022	2798
2021	887

SSC JE 2025 Eligibility Criteria:

To apply for SSC JE 2025, candidates need to meet specific eligibility conditions. The Staff Selection Commission will share all the details in the official notification, including required qualifications, age limit, and nationality rules. To make things easier, we have explained the full previous year eligibility criteria here, so that all interested candidates can understand it clearly.

SSC JE 2025 Age Limit:

The age limit for SSC JE 2025 depends on the department and post. Generally, candidates must be between 18 to 32 years old. However, age relaxations are given to reserved category candidates as per government rules. It is important to check the official notification for exact age details before applying for the SSC Junior Engineer exam.

SSC JE Age Relaxation:

Age relaxation criteria for different categories have been mentioned below:

Category	Age Relaxation
Scheduled Caste/ Scheduled Tribe (SC/ ST)	5 years
Other Backward Castes (OBC)	3 years
Persons with Disabilities (PwD)/ PH (OA/ HH) + OBC	13 years
Persons with Disabilities (PwD)/ Physically Handicapped (OH/ HH)	10 years
Defense Personnel disabled in operation during hostilities with any foreign country or in a disturbed area and released as a consequence thereof	3 years
Defense Personnel disabled in operation during hostilities with any foreign country or in a disturbed area and released as a consequence thereof (SC/ ST)	8 years
Ex-Servicemen (General)	3 years after the deduction of military service rendered in the Armed forces from the actual age

SSC JE 2025 Educational Qualification

To apply for SSC JE 2025, candidates must have the required educational qualification in engineering. A diploma or degree in Civil, Mechanical, or Electrical Engineering from a recognized university or institute is necessary. The qualification should match the post applied for. Only candidates who meet this requirement will be eligible to apply for the SSC JE exam.

SSC JE Salary 2025

The SSC JE Salary 2025 offers a good income for Junior Engineers in government departments. Selected candidates will receive a basic pay of Rs. 35,400 per month under Pay Level 6. Along with this, they also get allowances like HRA, DA, and TA. The total in-hand salary is attractive, making SSC JE a great career choice.

SSC JE 2025 Selection Process

According to the official notification, the SSC JE 2025 Selection process involves three phases:

- Paper 1
- Paper 2
- Document Verification
- Medical Examination



SSC JE 2025 Exam Pattern

The exam pattern outlines the question paper's structure, including the number of questions, marking scheme, exam duration, and negative marking. Candidates should understand the SSC JE Recruitment 2025 Exam Pattern to prepare effectively. Key points about the SSC JE Exam Pattern 2025 are highlighted below.

SSC JE Exam Pattern 2025			
Paper Name	Number Of Questions	Marks	Duration
SSC JE 2025 Paper 1			
General Intelligence & Reasoning	50	50	2 Hours.
General Awareness	50	50	
Part A: General Engineering (Civil & Structural) OR	100	100	
Part B: General Engineering (Electrical) OR			
Part C: General Engineering (Mechanical)			
Total	200	200	
SSC JE 2025 Paper 2			
Part A: General Engineering (Civil & Structural)	100	300	2 Hours.
OR			
Part B: General Engineering (Electrical)	100	300	2 Hours.
OR			
Part C: General Engineering (Mechanical)	100	300	2 Hours.

SSC JE 2025 Syllabus

Aspirants preparing for the SSC JE Exam 2025 must understand the SSC JE Syllabus, as it serves as a roadmap for study strategies. A solid grasp of the syllabus enhances your chances of success. The syllabus is organized by subject, covering essential topics for thorough preparation. Below is a subject-wise breakdown to help you effectively plan your study schedule and focus on key areas needed to excel in the exam.

SSC JE 2025 Paper 1 Syllabus

Candidates applying for various positions can refer to the syllabus based on their branch. A detailed syllabus for each post and branch has been provided. Please refer to the table below for the specific syllabus information.

Syllabus of General Intelligence & Reasoning

- Classification
- Analogy
- Coding-Decoding
- Paper Folding Method
- Matrix
- Word Formation
- Venn Diagram

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- Direction and Distance
 - Blood Relations
 - Series
 - Verbal Reasoning
 - Non-Verbal Reasoning
 - Seating arrangements
 - Space Visualization
 - Problem-Solving Analysis
 - Judgment
 - Decision Making
 - Visual Memory
 - Discrimination
 - Observation
 - Relationship Concept
 - Arithmetical Reasoning
 - Verbal and Figure Classification
 - Arithmetical Number Series
 - Arithmetical Computations

Syllabus of General Knowledge

- Static General Knowledge
- Science
- Current Affairs
- Sports
- Books and Authors
- Important Schemes
- Prominent Personalities in the News
- History
- Culture
- Geography
- Economic
- Awards and Honors

Syllabus of Civil Engineering

- Building Materials
- Estimating, Costing, and Valuation
- Surveying
- Soil Mechanics
- Hydraulics
- Irrigation Engineering
- Transportation Engineering
- Environmental Engineering
- Structural Engineering: Theory of Structures, Concrete Technology, RCC Design, Steel Design

Syllabus of Mechanical Engineering

- Theory of Machines and Machine Design
- Engineering Mechanics and Strength of Materials
- Properties of Pure Substances
- 1st Law of Thermodynamics, 2nd Law of Thermodynamics
- Air Standard cycles for IC Engines
- IC Engine Performance
- IC Engines Combustion
- IC Engine Cooling & Lubrication
- Rankine cycle of System
- Boilers, Classification, Specification
- Fitting & Accessories
- Air Compressors & their cycles
- Refrigeration cycles
- Principle of Refrigeration Plant
- Nozzles & Steam Turbines
- Properties & Classification of Fluids
- Fluid Statics
- Measurement of Fluid Pressure
- Fluid kinematics
- Dynamics of Ideal Fluids
- Measurement of Flow Rate
- basic principles
- Hydraulic Turbines
- Centrifugal Pumps
- Classification of steel.

Syllabus of Electrical Engineering

- Basic concepts
- Circuit law
- AC Fundamentals
- Magnetic Circuit
- Electrical Machines
- Utilization and Electrical Energy
- Transmission and Distribution
- Estimation and Costing
- Basic Electronics
- Generation
- Fractional Kilowatt Motors and Single-Phase Induction Motors
- Measurement and Measuring Instruments
- Synchronous Machines



LIVE BATCH

शंखनाद 3.0

RRB JE 2025

(Electrical)

Starts: 9 May, 25 | 10 am - 8 pm

SSC JE 2025 Paper 2 Syllabus

Candidates applying for different positions can refer to the syllabus based on their branch. We have provided a detailed syllabus for each post and branch. Please refer to the table below for the detailed syllabus.

Civil Engineering

The SSC JE Tier 2 exam for Civil Engineering includes several key topics, such as Building Materials, Estimating Costs, Surveying, Soil Mechanics, Hydraulics, Irrigation Engineering, Transportation Engineering, Environmental Engineering, Theory of Structures, Concrete Technology, RCC Design, and Steel Design. To excel in the Tier 2 exam, candidates must thoroughly understand these subjects.

Building Materials: Physical and Chemical properties, classification, standard tests, use, and manufacture/quarrying of materials e.g. building stones, silicate-based materials, cement (Portland), asbestos products, timber, and wood-based products, laminates, bituminous materials, paints, varnishes.

Estimating, Costing, and Valuation: estimate, glossary of technical terms, analysis of rates, methods, and unit of measurement, Items of work – earthwork, Brick work (Modular & Traditional bricks), RCC work, Shuttering, Timber work, Painting, Flooring, Plastering. Boundary wall, Brick building, Water Tank, Septic tank, Bar bending schedule, Centre line method, Mid-section formula, Trapezoidal formula, Simpson's rule. Cost estimate of Septic tank, flexible pavements, Tube well, isolates and combined footings, Steel Truss, Piles, and pile-caps. Valuation – Value and cost, scrap value, salvage value, assessed value, sinking fund, depreciation and obsolescence, methods of valuation.

Surveying: Principles of surveying, measurement of distance, chain surveying, working of the prismatic compass, compass traversing, bearings, local attraction, plane table surveying, theodolite traversing, adjustment of theodolite, Levelling, Definition of terms used in leveling, contouring, curvature, and refraction corrections, temporary and permanent adjustments of dumpy level, methods of contouring, use of a contour map, tech metric survey, curve setting, earthwork calculation, advanced surveying equipment.

Soil Mechanics: Origin of soil, phase diagram, Definitions-void ratio, porosity, degree of saturation, water content, the specific gravity of soil grains, unit weights, density index and interrelationship of different parameters, Grain size distribution curves, and their uses. Index properties of soils, Atterberg's limits, ISI soil classification, and plasticity chart. Permeability of soil, coefficient of permeability, determination of coefficient of permeability, Unconfined and confined aquifers, effective stress, quick sand, consolidation of soils, Principles of consolidation, degree of consolidation, pre-consolidation pressure, normally consolidated soil, e-log p curve, computation of ultimate settlement. Shear strength of soils, direct shear test, Vane shear test, Triaxial test. Soil compaction, Laboratory compaction test, Maximum dry density, optimum moisture content, earth pressure theories, active and passive earth pressures, Bearing capacity of soils, plate load test, and standard penetration test.

Hydraulics: Fluid properties, hydrostatics, measurements of flow, Bernoulli's theorem and its application, flow through pipes, flow in open channels, weirs, flumes, spillways, pumps, and turbines.

Irrigation Engineering: Definition, necessity, benefits, 2II effects of irrigation, types, and methods of irrigation, Hydrology – Measurement of rainfall, run off coefficient, rain gauge, losses from precipitation – evaporation, infiltration, etc. Water requirement of crops, duty, delta and base period, Kharif and Rabi Crops, Command area, Time factor, Crop ratio, Overlap allowance, Irrigation efficiencies. Different types of canals, types of canal irrigation, and loss of water in canals. Canal lining – types and advantages. Shallow and deep to wells, the yield from a well. Weir and barrage, Failure of weirs and permeable foundation, Slit, and Scour, Kennedy's theory of critical velocity. Lacey's theory of uniform flow. Definition of flood, causes, and effects, methods of flood control, water logging, preventive measures. Land reclamation, Characteristics affecting fertility of soils, purposes, methods, description of the land, and reclamation processes. Major irrigation projects in India.

Transportation Engineering: Highway Engineering – cross-sectional elements, geometric design, types of pavements, pavement materials – aggregates and bitumen, different tests, Design of flexible and rigid pavements – Water Bound Macadam (WBM) and Wet Mix Macadam (WMM), Gravel Road, Bituminous construction, Rigid pavement joint, pavement maintenance, Highway drainage, Railway Engineering- Components of the permanent way – sleepers, ballast, fixtures and fastening, track geometry, points and crossings, track junction, stations, and yards. Traffic Engineering – Different traffic survey, speed-flow-density, and their interrelationships, intersections, interchanges, traffic signals, traffic operation, traffic signs and markings, and road safety.

Environmental Engineering: Quality of water, source of water supply, purification of water, distribution of water, need of sanitation, sewerage systems, circular sewer, oval sewer, sewer appurtenances, sewage treatments. Surface water drainage. Solid waste management – types, effects, engineered management system. Air pollution – pollutants, causes, effects, control. Noise pollution – cause, health effects, control.

Theory of structures: Elasticity constants, types of beams – determinate and indeterminate, bending moment and shear force diagrams of simply supported, cantilever, and overhanging beams. Moment of area and moment of inertia for rectangular & circular sections, bending moment and shear stress for tee, channel, and compound sections, chimneys, dams and retaining walls, eccentric loads, slope deflection of simply supported and cantilever beams, critical load and columns, Torsion of circular section.

Concrete Technology: Properties, Advantages, and uses of concrete, cement aggregates, the importance of water quality, water-cement ratio, workability, mix design, storage, batching, mixing, placement, compaction, finishing, and curing of concrete, quality control of concrete, hot weather, and cold weather concreting, repair and maintenance of concrete structures.

RCC Design: RCC beams-flexural strength, shear strength, bond strength, design of singly reinforced and double reinforced beams, cantilever beams. T-beams, lintels. One-way and two-way slabs, isolated footings. Reinforced brickworks, columns, staircases, retaining walls, and water tanks (RCC design questions may be based on both Limit State and Working Stress methods).

Steel Design: Steel design and construction of steel columns, beams roof trusses plate girders.

Electrical Engineering

The SSC Junior Engineer Syllabus 2025 for Electrical Engineering is given below:

Basic concepts: Resistance, inductance, capacitance, and various factors affecting them. Concepts of current, voltage, power, energy, and their units.

Circuit law: Kirchhoff's law, Simple Circuit solution using network theorems.

Magnetic Circuit: Concepts of flux, MMF, reluctance, Different kinds of magnetic materials, Magnetic calculations for conductors of different configurations e.g. straight, circular, solenoidal, etc. Electromagnetic induction, self, and mutual induction.

AC Fundamentals: Instantaneous, peak, R.M.S. and average values of alternating waves, Representation of sinusoidal wave form, simple series and parallel AC Circuits consisting of R.L. and C, Resonance, Tank Circuit. Poly Phase system – star and delta connection, 3 phase power, DC, and sinusoidal response of R-Land R-C circuit.

Measurement and measuring instruments: Measurement of power (1 phase and 3 phase, both active and re-active) and energy, 2 wattmeter method of 3 phase power measurement. Measurement of frequency and phase angle. Ammeter and voltmeter (both moving oil and moving iron type), an extension of range wattmeter, Multimeters, Megger, Energy meter AC Bridges. Use of CRO, Signal Generator, CT, PT, and their uses. Earth Fault detection.

Electrical Machines: (a) D.C. Machine – Construction, Basic Principles of D.C. motors and generators, their characteristics, speed control, and starting of D.C. Motors. Method of braking motor, Losses, and efficiency of D.C. Machines. (b) 1-phase and 3-phase transformers – Construction, Principles of operation, equivalent circuit, voltage regulation, O.C., and S.C. Tests, Losses, and efficiency. Effect of voltage, frequency, and waveform on losses. Parallel operation of 1-phase/3 phase transformers. Auto transformers. (c) 3-phase induction motors, rotating magnetic field, the principle of operation, equivalent circuit, torque-speed characteristics, starting and speed control of 3-phase induction motors. Methods of braking, the effect of voltage and frequency variation on torque speed characteristics.

Fractional Kilowatt Motors and Single Phase Induction Motors: Characteristics and applications.

Synchronous Machines: Generation of 3-phase E.M.F. armature reaction, voltage regulation, parallel operation of two alternators, synchronizing, and control of active and reactive power. Starting and applications of synchronous motors.

Generation, Transmission, and Distribution: Different types of power stations, Load factor, diversity factor, demand factor, cost of generation, and interconnection of power stations. Power factor improvement, various types of tariffs, types of faults, and short circuit current for symmetrical faults. Switchgears – rating of circuit breakers, Principles of arc extinction by oil and air, H.R.C. Fuses, Protection against earth leakage / over current, etc. Buchholtz relay, Merz-Price system of protection of generators & transformers, protection of feeders and bus bars. Lightning arresters, various transmission and distribution systems, comparison of conductor materials, and the efficiency of a different system. Cable – Different types of cables, cable ratings, and derating factors.

Estimation and costing: Estimation of lighting scheme, electric installation of machines, and relevant IE rules. Earthing practices and IE Rules.

Utilization of Electrical Energy: Illumination, Electric heating, Electric welding, Electroplating, Electric drives, and motors.

Basic Electronics: Working of various electronic devices e.g. P N Junction diodes, Transistors (NPN and PNP type), BJT, and JFET. Simple circuits using these devices.

Mechanical Engineering

The SSC JE Syllabus 2025 for Mechanical Engineering is given below:

Theory of Machines and Machine Design: Concept of a simple machine, Four bar linkage and link motion, Flywheels and fluctuation of energy, Power transmission by belts – V-belts and Flat belts, Clutches – Plate and Conical clutch, Gears – Type of gears, gear profile and gear ratio calculation, Governors – Principles and classification, Riveted joint, Cams, Bearings, Friction in collars and pivots.

Engineering Mechanics and Strength of Materials: Equilibrium of Forces, Law of motion, Friction, Concepts of stress and strain, Elastic limit and elastic constants, Bending moments and shear force diagram, Stress in composite bars, Torsion of circular shafts, Buckling of columns – Euler's and Rankin's theories, Thin walled pressure vessels.

Properties of Pure Substances: p-v & P-T diagrams of pure substance like H_2O , Introduction of steam table for steam generation process; definition of saturation, wet & superheated status. Definition of dryness fraction of steam, degree of superheat of steam. H-s chart of steam (Mollier's Chart).

1st Law of Thermodynamics: Definition of stored energy & internal energy, 1st Law of Thermodynamics of cyclic process, Non-Flow Energy Equation, Flow Energy & Definition of Enthalpy, Conditions for Steady State Steady Flow; Steady State Steady Flow Energy Equation.

2nd Law of Thermodynamics: Definition of Sink, Source Reservoir of Heat, Heat Engine, Heat Pump & Refrigerator; Thermal Efficiency of Heat Engines & co-efficient of performance of Refrigerators, Kelvin – Planck & Clausius Statements of 2nd Law of Thermodynamics, Absolute or Thermodynamic Scale of temperature, Clausius Integral, Entropy, Entropy change calculation of ideal gas processes. Carnot Cycle & Carnot Efficiency, PMM-2; definition & its impossibility.

Air standard Cycles for IC engines: Otto cycle; plot on P-V, T-S Planes; Thermal Efficiency, Diesel Cycle; Plot on P-V, T-S planes; Thermal efficiency. IC Engine Performance, IC Engine Combustion, IC Engine Cooling & Lubrication.

Rankine cycle of steam: Simple Rankine cycle plot on P-V, T-S, h-s planes, Rankine cycle efficiency with & without pump work.

Boilers; Classification; Specification; Fittings & Accessories: Fire Tube & Water Tube Boilers.

Air Compressors & their cycles: Refrigeration cycles; Principle of a Refrigeration Plant; Nozzles & Steam Turbines

Properties & Classification of Fluid: ideal & real fluids, Newton's law of viscosity, Newtonian and Non-Newtonian fluids, compressible and incompressible fluids.

Fluid Statics: Pressure at a point.

Measurement of Fluid Pressure: Manometers, U-tube, Inclined tube.

Fluid Kinematics: Stream line, laminar & turbulent flow, external & internal flow, continuity equation.

Dynamics of ideal fluids: Bernoulli's equation, Total head; Velocity head; Pressure head; Application of Bernoulli's equation.

Measurement of Flow rate Basic Principles: Venturi Meter, Pilot tube, Orifice meter. Hydraulic Turbines: Classifications, Principles.

Centrifugal Pumps: Classifications, Principles, Performance. Production Engineering

Classification of Steels: mild steel & alloy steel, Heat treatment of steel, Welding – Arc Welding, Gas Welding, Resistance Welding, Special Welding Techniques i.e. TIG, MIG, etc. (Brazing & Soldering), Welding Defects & Testing; NDT, Foundry & Casting – methods, defects, different casting processes, Forging, Extrusion, etc, Metal cutting principles, cutting tools, Basic Principles of machining with (i) Lathe (ii) Milling (iii) Drilling (iv) Shaping (v) Grinding, Machines, tools & manufacturing processes.

SSC JE 2025 Document Verification

Candidates who qualify for the written examination will be called for document verification. They must bring both soft copies and hard copies of the documents listed below for SSC JE Document Verification. The required documents for SSC JE 2025 are as follows.

- 10th class mark sheet
- 12th Class Marksheet
- Graduation Marksheet
- Graduation certificate
- Domicile Certificate
- College Leaving Certificate
- PwD certificate, and
- No Objection Certificate

SSC JE 2025 Medical Examination

Ultimately, candidates who are chosen for the position will be required to undergo a comprehensive medical examination. This examination is crucial to assess their overall health and ensure that they meet the specific health standards necessary for the job. It may include a review of medical history, physical assessments, and various tests to evaluate fitness and the absence of any health conditions that could impact job performance.



1. Which of the following statements is/are true for a natural building material like bamboo during an earthquake?
 - (i) It will result in a flexible structure, however needs to be designed stiff enough to resist earthquake forces
 - (ii) Since it has a good specific strength (MPa/kg), the earthquake resistance is better
 - (iii) Being light in weight, it will experience lesser earthquake forces
 - (a) Only (i)
 - (b) (i) and (ii)
 - (c) (ii) and (iii)
 - (d) (i), (ii) and (iii)
2. Given below are the statements associated with concrete.

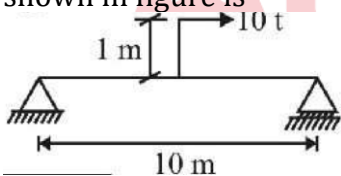
Statement 1 : As the compaction factor increases slump increases.

Statement 2 : Slump test helps in qualitatively understanding the strength of concrete.

 - (a) Statement 1 and statement 2 are false
 - (b) Statement 1 is true and statement 2 is false
 - (c) Statement 1 is false and statement 2 is true
 - (d) Statement 1 and statement 2 are true
3. A rectangular beam section of 300 mm width and 500 mm effective depth has tensile reinforcement of 1346 mm². The beam is constructed using M20 grade concrete and Fe 415 steel. Calculate the neutral axis.
 - (a) 225 mm
 - (b) 222 mm
 - (c) 135 mm
 - (d) 240 mm
4. The effective depth of a singly reinforced rectangular beam is 400 mm. The section is over reinforced and the neutral axis is 180 mm below the top. If the maximum stress attained by concrete is 5 N/mm² and the modular ratio is 18, then the stress developed in the steel will be
 - (a) 110 mm²
 - (b) 135 N/mm²
 - (c) 160 N/mm²
 - (d) 180 N/mm²
5. Consider the following statements for prediction of yield lines in a reinforced concrete slab :
 - (i) They represent the axis of rotation.
 - (ii) They will propagate outward from a point load.
 - (iii) They are straight lines between two intersection planes.
 - (iv) They end at the boundary of the slab or at another yield line.
 - (a) I, ii, iii and iv
 - (b) I, ii and iii only
 - (c) I, ii and iv only
 - (d) ii, iii and iv only

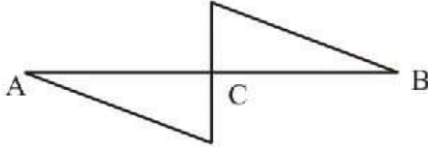
6. Read the following statements for RCC column/compression members?
- (i) A compression member may be considered as short when the maximum slenderness ratio is less than 12.
 - (ii) For a compressive member, the unsupported length between end restrains shall not exceed 60 times the least lateral dimensions.
- (a) Only (i) is correct
 - (b) Only (ii) is correct
 - (c) Both (i) and (ii) are correct
 - (d) Both (i) and (ii) are incorrect
7. According to IS 800, in case of structural steel design, the span length of a flexural member in a continuous frame system shall be taken as the distance between :
- (a) centre to centre of the support + twice the eccentricity
 - (b) diametrically opposite ends of the support
 - (c) centre to centre of the support
 - (d) edge to edge of the support
8. Which of the options given below are true about how the commonly used structural steels are made?
- 1. Very low carbon steels, $< 0.1\%$
 - 2. Low carbon steel 0.1 to 0.25%
 - 3. Medium carbon steel 0.25 to 0.6%
 - 4. High carbon steel 0.6 to 1.1%
- (a) 1 is true
 - (b) 1 and 2 are true
 - (c) 1, 2 and 3 are true
 - (d) All are true
9. In the simplified design of angle iron purlins, which one of the following assumption would not be valid -
- (a) Load component acting normal to the slope is considered
 - (b) Bending moment about the minor axis is considered
 - (c) Allowable bending stress is not reduced
 - (d) Slope of the roof should not exceed 30°
10. In the plasticity theory used for steel, which of the following assumptions are not applicable
- (a) Steel is ductile and can undergo plastic deformation without rupturing
 - (b) Elastic deforming is taken into account
 - (c) All connections provide satisfactory continuity so as to transmit the plastic moment
 - (d) Steel is assumed to be an ideal elastic – plastic material
11. The following statements (S1 to S4) pertain to a compression member.
- S1 : The effective length depends on the boundary conditions of member at ends.
- S2 : The elastic critical stress in compression decreases with decrease in slenderness ratio.
- S3 : The ratio of the effective length to the radius of gyration of the member is termed as slenderness ratio of member.
- S4 : The elastic critical stress in compression is independent of the slenderness ratio.
- Identify the correct statements.
- (a) S1 and S3
 - (b) S2 and S4
 - (c) S1, S2, S4
 - (d) S1, S3, S4

12. Choose the wrong statement:
- Column is a vertical member of a structure which carries an axial compressive force.
 - The ratio of length of a column to its minimum radius of gyration is called slenderness ratio.
 - A column tends to buckle in the direction of the minimum moment of inertia.
 - The equivalent length of a column with one end fixed and other end free, is half of its actual length.
13. Effective length of groove welds in case of butt joint is equal to-
- Length of continuous full size weld
 - Overall length of weld minus twice the size of weld
 - Overall length of weld minus four times the size of weld
 - Overall length of weld plus twice the size of weld
14. According to IS 3414, the recommended spacing of expansion joints for thin unprotected slabs is
- 30 m
 - 45 m
 - 6 m
 - 12 m
15. A Ready - mix concrete supplier supplied 101 cum of concrete for a slab. As per the minimum sampling frequency, the number of cube samples required are
- 5
 - 4
 - 7
 - 6
16. In a simple bending theory, one of the assumption is that the plane sections before bending remain plain after bending. This assumption means that :
- Stress is uniform throughout the beam
 - Strain is uniform throughout the beam
 - Stress is proportional to the distance from the neutral axis.
 - Strain is proportional to the distance from the neutral axis
17. The shear force diagram (SFD) for the beam shown in figure is



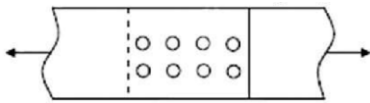
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18. If the BMD for a simply supported beam is as shown below. the load on the beam will be



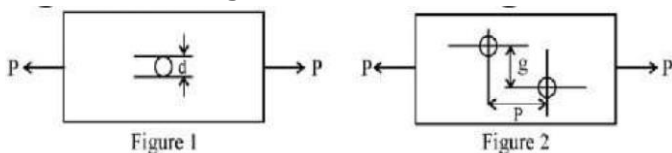
- (a) a concentrated load at C
 (b) equal and opposite couples at the ends A and B
 (c) a uniformly distributed load acting on the entire span
 (d) concentrated couple at C
19. Fixed end moments for a beam fixed at both ends and centrally loaded with a concentrated load P are.
- (a) $\frac{-Pl}{8}, \frac{Pl}{8}$
 (b) $\frac{-Pl^2}{30}, \frac{Pl^2}{30}$
 (c) $\frac{-Pl}{4}, \frac{Pl}{4}$
 (d) $0, \frac{Pl}{4}$
20. A circular ring of radius 42cm is cut and bent into the form of a rectangle whose sides are in the ratio of 6:5. The small side of the rectangle is:
- (a) 80 cm
 (b) 30 cm
 (c) 120 cm
 (d) 60 cm
21. In which of the following cases, there exists the situation of Pure Bending in some part of the beam or along the entire beam?
- (i) A simply supported beam subjected to two equally spaced downward concentrated loads
 (ii) A simply supported beam subjected to two equally spaced opposite moments
 (iii) A cantilever beam subjected to clockwise moment at free end
 (iv) An overhanging beam with both side equal overhangs subjected to different concentrated loads at both the free ends
- (a) (i) and (iv)
 (b) (i), (ii) and (iv)
 (c) (i), (ii) and (iii)
 (d) (i) and (iii)
22. Consider the following statements :
- The theory of simple bending assumes that :
1. The material of the beam is homogeneous, isotropic and obeys Hooke's law.
 2. The plane section remains plane after bending.
 3. Each cross-section of the beam is symmetric about the loading plane.
 4. Young's moduli are the same in tension and compression.
- Of the above statements which are correct?
- (a) 1 and 2 only
 (b) 1, 3 and 4 only
 (c) 2, 3 and 4 only
 (d) 1, 2, 3 and 4

23. Two steel plate each 300mm wide and 10mm thick are connected by single bolt. If the plates are in tension and diameter of bolt hole in 20 mm, the net section area of the plate will be
- 2686 mm²
 - 2780 mm²
 - 2800 mm²
 - 3000 mm²
24. If T is the tensile force and μ is the coefficient of friction, then in a steel bolt the horizontal frictional force (F) induced is given by :
- $F = \mu + T$
 - $F = \mu / T$
 - $F = \mu - T$
 - $F = \mu T$
25. A plate of size 100 mm × 10 mm having yield strength of 250 MPa, the design strength of plate in yielding of the cross-section is
- 167 kN
 - 200 kN
 - 217 kN
 - 227 kN
26. Statement (I): In a bolted joint, all similarly placed bolts share the load equally.



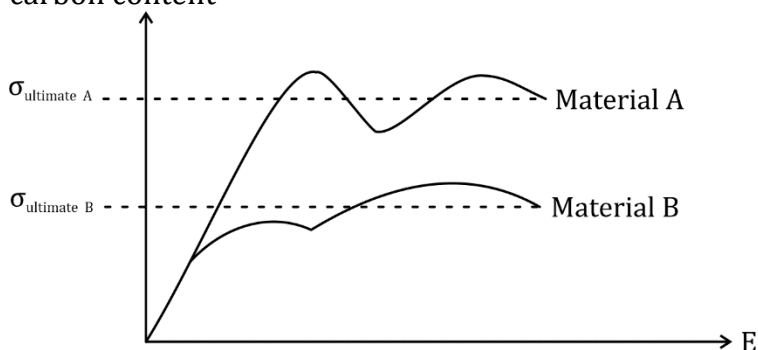
Statement (II): Bolts are placed in holes having slightly larger diameters.

- Both Statements-I and Statement-II are individually true and Statement-II is the correct explanation of Statement-I.
 - Both Statements—I and Statement-II are individually true but Statement-II is NOT the correct explanation of Statement-I
 - Statement-I is true but Statement-II is false.
 - Statement-I is false but Statement-II is true.
27. Two bolted plates under tension with alternative arrangement of bolt holes are shown in figures 1 and 2. The hole diameter, pitch, and gauge length are d, p and g, respectively. Which one of the following conditions must be ensured to have higher net tensile capacity of configuration shown in Figure 2 than that shown in Figure 1?



- $p^2 > 2gd$
- $p^2 < \sqrt{4dg}$
- $p^2 > 4gd$
- $p > 4gd$

28. The creep coefficient as per IS 456 : 2000, when the age of concrete at loading is 50 days will be
 (a) 2.200
 (b) 1.678
 (c) 1.487
 (d) 1.895
29. A base plate is resting on a concrete pedestal of M30 grade of concrete. The bearing strength of concrete in working stress method of design as per IS 456 : 2000 is _____ (in MPa, correct upto two decimal places)
 (a) 5
 (b) 7.5
 (c) 3.4
 (d) 9
30. The maximum factored compressive force developed in a RCC beam of width 250mm and effective depth of 500mm will be
 Take: M25 grade of concrete and Fe415 grade of steel
 (a) 500KN
 (b) 540 KN
 (c) 560 KN
 (d) 580 KN
31. Maximum depth of neutral axis for Fe500 grade of steel on effective depth of beam 450mm will be.
 (a) 205.21mm
 (b) 175.35mm
 (c) 225.45mm
 (d) 250.15mm
32. In a 2-dimensional stress body, the radius of the mohr's circle represents
 (a) maximum shear stress
 (b) minimum shear stress
 (c) maximum normal stress
 (d) minimum normal stress
33. The stress-strain diagram for two materials A and B is shown below of steel specimens of varying carbon content



Which of the material will undergo cup-cone fracture when an actual tensile load is applied?

- (a) Material A
 (b) Both Material A and B
 (c) Material B
 (d) None of these

34. Which one of the following related to domestic potable water quality is correct?
- (a) Turbidity (on silica scale) is 15 to 20 mg/l
 - (b) The permissible limit of colour for drinking water is 5 TCU and cause for rejection is 15 TCU
 - (c) Hardness (expressed as CaCO_3 equivalent) is 150 to 200 ppm
 - (d) BOD is 20 ppm or mg/l.
35. The reason to provide proportional flow weir in a grit chamber is ____?
- (a) To allow sewage fresh into grit chamber
 - (b) To maintain constant flow velocity in the grit chamber over a certain depth
 - (c) For continuous flow in the grit chamber
 - (d) All of the above
36. The addition of a small portion of granite polishing waste in the design mix results in:
- (a) Decreased strength
 - (b) Higher void ratio
 - (c) Improved packing density
 - (d) Lighter concrete
37. As per IS 383 (1970), the passing percentage of fine aggregates under the Zone IV from an IS 600 microns sieve is ____.
- (a) 60-79%
 - (b) 80-100%
 - (c) 8-30%
 - (d) 15-34%
38. According to IS 2180:1988, what is the minimum bulk density of heavy duty burnt clay bricks?
- (a) 4.5 g/cm^3
 - (b) 2.5 g/cm^3
 - (c) 7.5 g/cm^3
 - (d) 8.5 g/cm^3
39. What is the percentage of alumina in good brick earth?
- (a) 45 to 55%
 - (b) 5 to 10%
 - (c) 20 to 30%
 - (d) 1 to 5%
40. Select the correct option with regard to the following statements (S1 and S2) pertaining to two types of paints.
- S1: In plastic paint, the thinner used is oil.
S2: Varnish is a homogeneous solution of resin in alcohol.
- (a) Both S1 and S2 are true
 - (b) S1 is false and S2 is true
 - (c) S1 is true and S2 is false
 - (d) Both S1 and S2 are false

41. Which of the following is a sedimentary rock?
- (a) Limestone
 - (b) Gneiss
 - (c) Granite
 - (d) Dolerite
42. Two statements associated with concrete are given. Select the correct option with regard to these statements.
- 1: As the compaction factor increases, slump decreases.
2: Slump test helps in qualitatively understand the setting time of concrete.
- (a) Statement 1 is false and statement 2 is true
 - (b) Statement 1 and statement 2 are false
 - (c) Statement 1 is true and statement 2 is false
 - (d) Statement 1 and statement 2 are true
43. A newly built house is let out for a rent of Rs. 1,000 per month inclusive of all taxes. If outgoings are at 20% of the gross rent and expected rate of return is 10%, what is the capital value by the rental method of valuation?
- (a) Rs. 99,600
 - (b) Rs. 87,600
 - (c) Rs. 1,12,300
 - (d) Rs. 96,000
44. In a horizontal highway curve, if the width of the highway is 10 m and the outer edge is 40 cm higher with respect to the inner edge, then the super elevation is
- (a) 1 in 50
 - (b) 1 in 25
 - (c) 1 in 20
 - (d) 1 in 40
45. Indian Roads Congress (IRC) was founded in the year:
- (a) 1934
 - (b) 1948
 - (c) 1945
 - (d) 1950
46. An 8 m wide bituminous concrete pavement of a state highway is to be constructed in a heavy rainfall region. What should be the height of the crown with respect to the edges if cross fall of 1 in 50 is used?
- (a) 0.062 m
 - (b) 0.07 m
 - (c) 0.058 m
 - (d) 0.08 m
47. An oil which has kinematic viscosity 0.2 stokes flows through a circular pipe of 1cm radius. The velocity at which the flow will be critical is about
- (a) 2.0 m/s
 - (b) 1.5 m/s
 - (c) 0.5 m/s
 - (d) 4.0 m/s

48. An open tank contains 80 cm of water with 20 cm of oil specific gravity 0.8. The pressure intensity at the bottom of the tank is about ____ N/m^2 .
- (a) 15696
 - (b) 11,220
 - (c) 9417.6
 - (d) 8800
49. The term $\frac{\rho L v}{\mu}$ is called as ____.
- (a) Euler number
 - (b) Froude number
 - (c) Prandtl number
 - (d) Reynolds number
50. If the speed of a pump is 1200 rpm, head is 16 m and discharge is 16 m^3/s . Then the specific speed will be:
- (a) 150
 - (b) 800
 - (c) 60
 - (d) 600
51. What does CPM stand for in Civil Engineering?
- (a) Critical Path Method
 - (b) Concrete Production Management
 - (c) Construction Project Management
 - (d) Civil Planning Model
52. Which of the following is a key feature of PERT in Civil Engineering?
- (a) Resource leveling
 - (b) Time-cost trade-off
 - (c) Probabilistic time estimates
 - (d) Linear scheduling
53. In CPM, what does the critical path represent?
- (a) Shortest path to project completion
 - (b) Longest path to project completion
 - (c) Least resource-intensive activities
 - (d) Activities with the lowest duration
54. What is the primary purpose of using CPM and PERT in Civil Engineering projects?
- (a) To increase project complexity
 - (b) To minimize project risks
 - (c) To optimize project performance
 - (d) To accelerate project completion

55. In CPM, what is the Float or Slack of an activity?
- (a) Duration of the activity
 - (b) Total project duration
 - (c) Maximum delay without delaying project completion
 - (d) Resource availability for the activity
56. Which of the following is a limitation of using PERT and CPM in Civil Engineering projects?
- (a) Complexity in implementation
 - (b) Inability to handle large projects
 - (c) Dependency on accurate activity duration estimates
 - (d) Lack of project control
57. The coefficient earth pressure at rest is _____
- (a) less than coefficient of active pressure
 - (b) greater than coefficient of active pressure
 - (c) equal to coefficient of active pressure
 - (d) one
58. The lateral strain in the horizontal direction is _____
- (a) $\epsilon_h = \frac{1}{E}[\sigma_h - \mu(\sigma_v)]$
 - (b) $\epsilon_h = \frac{1}{E}[\sigma_h - \mu(\sigma_h - \sigma_v)]$
 - (c) $\epsilon_h = \frac{1}{E}[\sigma_h - \mu(\sigma_h + \sigma_v)]$
 - (d) $\epsilon_h = \frac{1}{E}[\sigma_h - (\sigma_h - \sigma_v)]$
59. A backfill of a retaining wall consists of $\gamma=19 \text{ kN/m}^3$ which is 6 m high. Find the lateral earth pressure per meter length. Given coefficient of earth pressure at rest is 0.5.
- (a) 43 kN/m²
 - (b) 57 kN/m²
 - (c) 48 kN/m²
 - (d) 76 kN/m²
60. Large movement of retaining structure is required to produce
- (a) Active earth pressure
 - (b) Passive earth pressure
 - (c) Both active and passive earth pressure
 - (d) At rest pressure
61. To determine the liquid limit, in the flow curve the water content is plotted on:
- (a) X-axis
 - (b) Y-axis
 - (c) on any axis
 - (d) one of the above

62. The appropriate triaxial test to assess the immediate stability of an unloading problem, such as excavation of a clay slope, would be the
- (a) Unconsolidated – undrained test
 - (b) Consolidated – undrained test
 - (c) Consolidated – drained test
 - (d) Unconsolidated – drained test
63. Reciprocating pumps are suitable for
- (a) Low discharge and high head
 - (b) High discharge and low head
 - (c) Low discharge and low head
 - (d) High discharge and high head
64. The range of specific speed of a Kaplan or propeller turbine in SI units, is:
- (a) 30 -51
 - (b) 51 -225
 - (c) 8.5 - 30
 - (d) 250 - 850
65. Which of the following efficiencies for Francis Turbine is defined as the ratio between the power available at the shaft of the turbine to the power produced by the runner?
- (a) Hydraulic efficiency
 - (b) Volumetric efficiency
 - (c) Mechanical efficiency
 - (d) Overall efficiency
66. Highway lighting serves which of the following purposes?
- i. Prevent accidents
 - ii. Increase in traffic capacity
 - iii. Increase in safety against crime
 - iv. Increase green cycle time
- (a) Both iii and iv
 - (b) Both i and iii
 - (c) Only i, ii and iii
 - (d) Both ii and iv
67. Which of the following statements are correct, with reference to the Road Formation width?
- i. It is the bottom width of the embankment.
 - ii. It is the bottom width of the cutting.
 - iii. It is inclusive of the width of the shoulders.
 - iv. It is inclusive of the width of side drains.
- (a) Both (ii) and (iv)
 - (b) Only (ii), (iii) and (iv)
 - (c) Both (ii) and (iii)
 - (d) Both (i) and (iv)

68. As described by Indian Road Congress, which of the following methods is used for the design and analysis of flexible pavements?
- (a) Theoretical method
 - (b) California bearing ratio method
 - (c) Benkelman beam deflection method
 - (d) Semi empirical method
69. Signs having red border, white background and black symbols are:
- (a) Warning signs
 - (b) Can be both warning and prohibitory signs
 - (c) Prohibitory signs
 - (d) Mandatory signs
70. The test commonly adopted to determine the grade of bitumen in terms of its hardness is:
- (a) The softening point test
 - (b) The flash and fire point test
 - (c) The ductility test
 - (d) The penetration test
71. Which of the following can be considered as a taking off point in road planning in India?
- (a) Bombay plan
 - (b) Nagpur plan
 - (c) Lucknow plan
 - (d) Delhi plan
72. The sight distance is defined as the:
- (a) Length of the roadway a driver can see ahead at any particular time.
 - (b) Nautical distance for which ships can continue signaling
 - (c) Length of the runway
 - (d) Total length of road to be traversed
73. For concrete to be used for making airport runway. the aggregate impact value should not be more than:
- (a) 10% by weight
 - (b) 30% by weight
 - (c) 25% by weight
 - (d) 45% by weight
74. There are 40 vehicles on a 1 km length of lane of a roadway at a given instant. It is
- (a) Practical traffic capacity
 - (b) Traffic density
 - (c) Traffic volume
 - (d) Basic traffic capacity
75. In an area of 200 hectares, water table drops by 4 m. If the porosity is 0.35 and the specific retention is 0.15, change in volume of storage in the aquifer is _____.
- (a) 160 m^3
 - (b) $1.6 \times 10^6 \text{ m}^3$
 - (c) $8 \times 10^6 \text{ m}^3$
 - (d) $1.6 \times 10^3 \text{ m}^3$

76. The transplantation of rice requires 10 days and total depth of water required during transplantation is 48 cm. During transplantation, there is an effective rainfall (useful for irrigation) of 8 cm. The duty of irrigation water (in hectare/cumec) is ____.
- (a) 612
(b) 216
(c) 300
(d) 108
77. Wheat crop requires 55 cm of water during 120 days of base period. The total rainfall during this period is 100 mm. Assume, the irrigation efficiency to be 60%. The area (in ha) of the land, which can be irrigated with a canal flow of $0.01 \text{ m}^3/\text{s}$ is ____.
- (a) 13.82
(b) 18.85
(c) 23.04
(d) 230.40
78. On which of the canal systems, R.G. Kennedy, executive engineer in the Punjab Irrigation Department made his observations for proposing his theory on stable channels?
- (a) Krishna Western Delta canals
(b) Lower Bari Doab canals
(c) Lower Chenab canals
(d) Upper Bari Doab canals
79. Which one of the following equations represents the downstream profile of Ogee spillway with vertical upstream face? [(x, y) are the coordinates of the point on the downstream profile with origin at the crest of the spillway and H_d is the design head]
- (a) $\frac{y}{H_d} = -0.5 \left(\frac{x}{H_d} \right)^{1.85}$
(b) $\frac{y}{H_d} = -0.5 \left(\frac{x}{H_d} \right)^{1/1.85}$
(c) $\frac{y}{H_d} = -2.0 \left(\frac{x}{H_d} \right)^{1.85}$
(d) $\frac{y}{H_d} = -2.0 \left(\frac{x}{H_d} \right)^{1/1.85}$
80. In connection with the design of a barrage, identify the correct matching of the criteria of design (A), (B), (C), (D) for the items of design (I), (II), (III), (IV), respectively.

Item of Design	Criteria of Design
i. Width of waterway	A. Hydraulic jump considerations
II. Level and length of downstream floor	B. Lacey's wetted perimeter and discharge capacity of the barrage as determined by appropriate weir formulae
III. Depth of downstream sheet piles and total length of floor	C. Uplift pressure distribution as determined by Khosla's theory
IV. Barrage floor thickness at different locations	D. Lacey's scour depth and exit hydraulic gradient as given by Khosla's theory

- (a) A, B, C, D
(b) A, B, D, C
(c) B, A, D, C
(d) B, A, C, D

81. If the critical shear stress of a channel from bed slope is $\gamma_w RS$, then the average value of shear stress required to move the grain on the side bank is
- (a) $0.5 \gamma_w RS$
 - (b) $0.75 \gamma_w RS$
 - (c) $\gamma_w RS$
 - (d) None of the above
82. A launching apron is to be designed at downstream of a weir for discharge intensity of $6.5 \text{ m}^3/\text{s}/\text{m}$. For the design of launching aprons the scour depth is taken two times of Lacey scour depth. The silt factor of the bed material is unity. What will be the design scour depth:
- (a) 9.4 m
 - (b) 4.7 m
 - (c) 5 m
 - (d) $5\sqrt{5}$ m
83. The exit gradient determined by Khosla's theory in case of design of weir working under head (H) with impervious floor length 'b' and depth of downstream sheet pile as d is
- (a) $\frac{d}{H} \frac{1}{\pi\sqrt{\lambda}}$
 - (b) $\frac{H}{d} \frac{a}{\sqrt{\lambda}}$
 - (c) $\frac{H}{d} \frac{1}{\pi\sqrt{\lambda}}$
 - (d) None of these
84. Which of the following is an objective of aeration of water?
- (a) To increase the carbon dioxide content of water
 - (b) To preserve hydrogen sulphide
 - (c) To remove tastes and odours from the gases produced due to organic decomposition
 - (d) to decrease the dissolved oxygen content of the water
85. The length of sedimentation tank should be at least _____ the breadth of the tank.
- (a) one time
 - (b) four times
 - (c) two times
 - (d) three times
86. Two primary settling basins are 25m in diameter and 2.1 m in depth. If the discharge is 26000 m^3 per day, and the detention time is 2.40h, calculate the volume of the tank.
- (a) 1300 m^3
 - (b) 1200 m^3
 - (c) 1350 m^3
 - (d) 1250 m^3

87. In the cross-section method of indirect contouring, the spacing of cross-sections depends upon (i) Contour interval
(ii) Scale of plan
(iii) Characteristics of ground
The correct answer is
(a) Only (i)
(b) (i) and (ii)
(c) (ii) and (iii)
(d) (i), (ii) and (iii)
88. In levelling operation,
(a) The first sight on any change point is a back sight
(b) The second sight on any change point is a fore sight
(c) The line commences with a fore sight and closes with a back sight
(d) The line commences with a back sight and closes with a foresight
89. The sensitivity of a bubble tube can be increased by
(a) Decreasing the viscosity of liquid used in bubble tube
(b) Decreasing the length of bubble
(c) Increasing the viscosity of liquid
(d) Decreasing the radius of curvature of tube
90. The length of a curve connecting two uniform gradients of +0.8% and -0.6%, the rate of change of grade being 0.1% per 30 m, will be
(a) 220 m
(b) 320 m
(c) 420 m
(d) 520 m
91. In a tacheometry, if intercept taken on a vertically held staff is inclined at θ to horizontal, the horizontal distance is:
(a) $kS + c$
(b) $kS \cos \theta + C \cos \theta$
(c) $kS \cos^2 \theta + C \cos \theta$
(d) $kS \sin^2 \theta + C \sin \theta$
92. The vehicle which holds the constituents of paints in suspension and make it possible to spread the paint evenly and uniform on the surface is called:
(a) Pigments
(b) Base
(c) Drier
(d) Binder
93. The paint which has high reflective property is
(a) Enamel paint
(b) Casein paint
(c) Cellulose paint
(d) Bronze paint

94. When the final coat of paint has not sufficient the background is clearly seen. This is known
- (a) Grinning
 - (b) Bloom
 - (c) Wrinkling
 - (d) Flaking
95. The function of a solvent in the paint is
- (a) To dilute the base of paint
 - (b) To produce desired colour of the paint
 - (c) To dissolve and hold in suspension the base and pigment
 - (d) To dilute the vehicle prior to the application of paint of the surface
96. Which of the following tests are used for testing of tiles?
- 1. breaking strength test
 - 2. impact test
 - 3. transverse strength test
 - 4. water absorption test
- (a) 1 and 3 only
 - (b) 1, 2 and 3 only
 - (c) 1, 2 and 4 only
 - (d) 1, 2, 3 and 4
97. Which of the following are types of gauges present in Indian railways?
- (a) Broad gauge, standard gauge and metre gauge
 - (b) Standard gauge, metre gauge and narrow gauge
 - (c) Metre gauge, narrow gauge and 2 broad gauges
 - (d) Broad gauge, metre gauge and 2 narrow gauges
98. Which of the following is not a component of the rail?
- (a) Ballast
 - (b) Foot
 - (c) Web
 - (d) Head
99. A procedure of actual costing and valuing an item of work on the basis of labourers and materials required is:
- (a) day work
 - (b) provisional sum
 - (c) lump sum amount
 - (d) prime cost
100. A property fetches 79000/- deducting all outgoings. If the rate of interest is 8% per annum the capitalized value of the property is_____
- (a) Rs. 1,22,500
 - (b) Rs. 1,32,500
 - (c) Rs. 1,34,500
 - (d) Rs. 1,12,500

Solutions

1. (d)

Sol. For a natural building material like bamboo during an earthquake —

It will result in a flexible structure. however needs to be designed stiff enough to resist earthquake forces.

Since it has a good specific strength (MPa/kg), the earthquake resistance is better.

Being light in weight, it will experience lesser earthquake forces.

2. (b)

Sol. In the 'compaction factor test' the degree of workability of concrete is measured in terms of internal energy required to compact the concrete thoroughly.

(CF) compaction factor

$$= \frac{\text{Mass of partially compacted concrete}}{\text{Mass of fully compacted concrete}}$$

In general

CF	< 0.85	low workability
CF	0.86– 0.92	medium workability
CF	0.93 – 0.95	high workability

as increasing the value of compaction factor, workability of concrete is increases. hence the value of slump is also increase.

There is no relationship b/w the workability and the strength of the concrete.

3. (a)

Sol. Equalizing tensile and compressive forces $0.36 f_{ck} b x_u = 0.87 f_y A_{st}$

$$x_u = \frac{0.87 \times 415 \times 1346}{0.36 \times 20 \times 300} = 225 \text{ mm}$$

4. (a)

Sol. Given,

$$M = 18$$

$$d = 400 \text{ mm}$$

$$n = 180 \text{ mm}$$

$$c = 5 \text{ N/mm}^2$$

$$\text{By using formula } \frac{M \times c}{t} = \frac{n}{d-n}$$

$$\frac{18 \times}{t} = \frac{180}{400-180}$$

$$\frac{90}{t} = \frac{180}{220}$$

$$t = \frac{90 \times 220}{180} = 110 \text{ N / mm}^2$$

5. (a)

Sol. yield lines in a reinforced concrete slab represent–

(i) They represent the axis of rotation.

(ii) They will propagate outward from a point load.

(iii) They are straight lines between two intersection planes

(iv) They end at the boundary of the slab or at another yield line.

6. (c)

Sol. for RCC column/compression member

- (1) A compression members may be considered as short when the maximum slenderness ratio < 12 .
(2) For a compression member, the unsupported length between end restrain shall not exceed 60 times the least lateral dimension.

7. (c)

Sol. According to [S 800. in case of structural steel design, the span length of a flexural member in a continuous frame system shall be taken as the distance between centre to centre of the support.

8. (c)

Sol.

Types of carbon steel	Carbon content
1. Very low carbon steel	$< 0.1\%$
2. Low carbon steel	0.1 to 0.25%
3. Medium carbon steel	0.25 to 0.6%
4. High carbon steel	0.6 to 0.95%

9. (b)

Sol. An angle iron purlin is unsymmetrical about the both axes. IS : 800 - 1984 permits the use of the angle section as a purlin provided the slope of the roof truss is less than 30° . The bending moment about the minor axis is neglected.

10. (b)

Sol. Elastic deformation is not considered in steel structure in plastic theory.

11. (a)

Sol. For compression member:

The effective length depends on the boundary conditions of member at ends.

The ratio of the effective length to the radius of gyration of the member is turned as slenderness ratio of member.

12. (d)

Sol. The equivalent length of a column with one end fixed and other end free, is twice of its actual length

$$l_{eff} = 2l$$

13. (a)

Sol. $\Rightarrow$ Effective length of groove welds in case of butt joint is equal to length of continuous full size weld.

$\Rightarrow$ Effective length of welds in case of fillet joint is equal to overall length of weld minus two times the size of weld.

14. (a)

Sol. According to IS 456-2000, structure exceeding 45 m in length are designed with one or more expansion joint.

As per IS 3414, which is a specific code for joints, it is mentioned as 30 m.

15. (a)

Sol. As per IS 456: 2000

Frequency of sampling

Minimum sample of cube per 3^3 concrete quantity.

for 1 – 5 m^3 concrete – 1 sample – 3 cube

for 6 – 15 m^3 concrete – 2 sample – 6 cube

for 16 – 30 m^3 concrete – 3 sample – 9 cube

for 31 – 50 m^3 concrete – 4 sample – 12 cube

for greater than 51 m^3 concrete – (4 + 1) sample

i.e. for every 50 m^3 -1 sample additional.

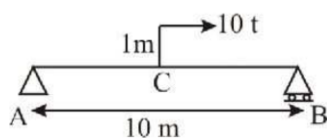
16. (d)

Sol. In Bending theory, one of the Assumption is that, the plane section before bending remain plane
After Bending this Assumption means that –

→ Strain at any point on the x-section is directly proportional to its distance from its neutral Axis, it mean strain diagram is linear.

17. (a)

Sol.



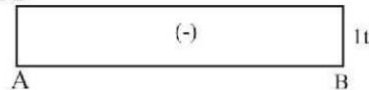
$$R_A + R_B = 0$$

$$\Sigma M_B = 0$$

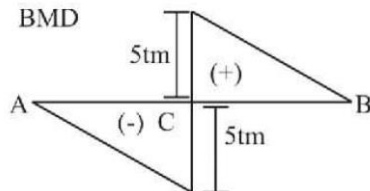
$$\therefore R_A \times 10 + 10t \times 1 = 0$$

$$R_A = -1t; R_B = 1t$$

SFD

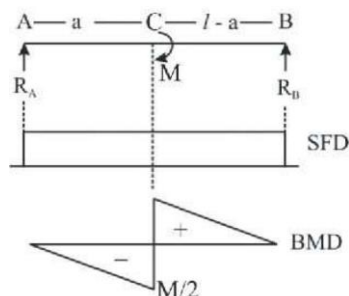


BMD



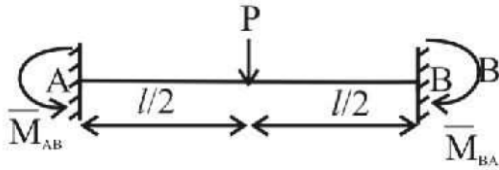
18. (d)

Sol. In bending moment diagram-sudden jump indicates couple and straight line means-constant shear force-no load.



19. (a)

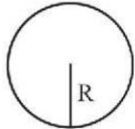
Sol.



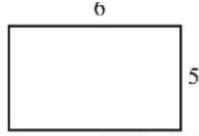
$$\bar{M}_{AB} = \frac{-Pl}{8}, \bar{M}_{BA} = \frac{Pl}{8}$$

20. (d)

Sol. Circumference of circle = $2\pi R$ Perimeter of rectangle = $2(l+b)$



Perimeter = $2\pi R$



Perimeter = $2(6x+5x)$

$$2\pi R = 2 \times (6x + 5x)$$

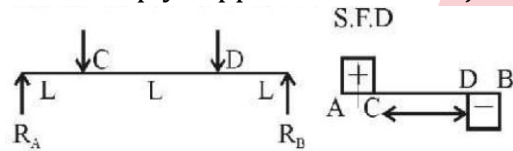
$$2 \times \frac{22}{7} \times 42 = 2 \times 11x$$

$$x = 12 \text{ cm}$$

The small side of rectangle is $5x = 12 = 60 \text{ cm}$

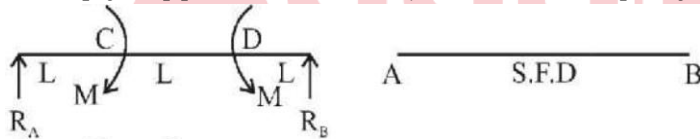
21. (c)

Sol. A simply supported beam subjected to two equally spaced downward concentrated loads.



Part CD of beam AB is in pure bending condition.

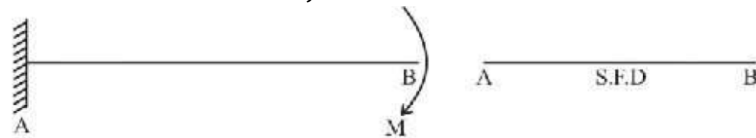
A simply supported beam subjected to two equally spaced opposite moment.



$$\text{As } R_A = R_B = 0$$

Beam AB is in pure bending condition.

A cantilever beam subjected to clockwise moment at free end.



Beam AB is in pure bending condition.

22. (d)

Sol. In case of the theory of simple bending there are the following assumptions

23. (b)

Sol. Given, $B = 300 \text{ mm}$

$t = 10 \text{ mm}$

Nominal diameter $d = 20 \text{ mm}$

Gross diameter of hole $(D) = 20 + 2 = 22 \text{ mm}$

Net sectional area $= (B - nD) \times t$

$$= (300 - 22) \times 10$$

$$= 2780 \text{ mm}^2$$

24. (d)

Sol. $F = \mu T$

F = frictional force

μ = coefficient of friction

T = Tensile force

25. (d)

Sol. given plate size $100 \text{ mm} \times 10 \text{ mm}$ yield strength $(f_y) = 250 \text{ MPa}$

Area of cross -section of plate $= 100 \times 10 \text{ mm}^2 = 1000 \text{ mm}^2$

partial safety factor of yield $= 1.1$

Design strength of plate $=$

$$\frac{\text{Area} \times \text{yield strength}}{\text{partial safety factor}} = \frac{A_g \times f_y}{\gamma_{mo}}$$

$$= \frac{1000 \text{ mm}^2 \times 250 \text{ N/mm}^2}{1.1} = 227.27 \text{ KN}$$

26. (b)

Sol. The diameter of the hole is about 1.5 to 2.0 mm larger than the bolt diameter for ease in fitting. in a bolted joint, all similarly placed bolts share the load equally.

27. (c)

$$\text{Sol. } T_{dn} = \frac{0.9F_u}{\gamma_m} A_{net}$$

$$T_{dn} \propto A_{net}$$

$$(T_{dn})_{max} \propto (A_{net})_{max}$$

$$(A_{net})_{max} = \frac{p^2}{4g}$$

$$p^2 > 4g \text{ for max. } A_{net}.$$

28. (c)

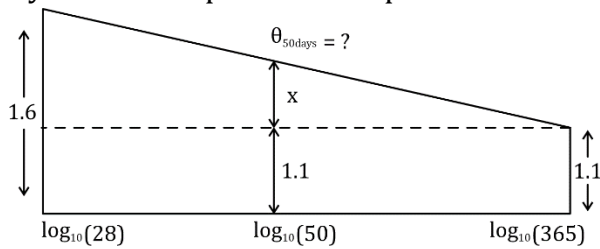
Sol. given that:

Age of concrete at loading $(t) = 50 \text{ days}$

From table of code IS 456 : 2000

Age of concrete (t)	Creep co-efficient (θ)	$\log_{10}(t)$
7 days	2.2	$\log_{10}(7)$
28 days	1.6	$\log_{10}(28)$
1 year = 365 days	1.1	$\log_{10}(365)$

By linear interpolation creep coefficient at loading after 50days



From above diagram

$$\begin{aligned}
 (\theta)_{at\ 50day} &= 1.1 + x \\
 &= 1.1 + \frac{(1.6-1.1)}{(\log_{10} 365 - \log_{10} 28)} \times (\log_{10}(365) - \log_{10}(50)) \\
 &= 1.1 + 0.387 \\
 &= 1.487
 \end{aligned}$$

29. (b)

Sol. Given that:

Grade of concrete M30

The bearing strength of concrete in WSM as per IS 456:2000 is given by.

$$\text{Bearing strength} = 0.25 f_{ck}$$

$$= 0.25 \times 30$$

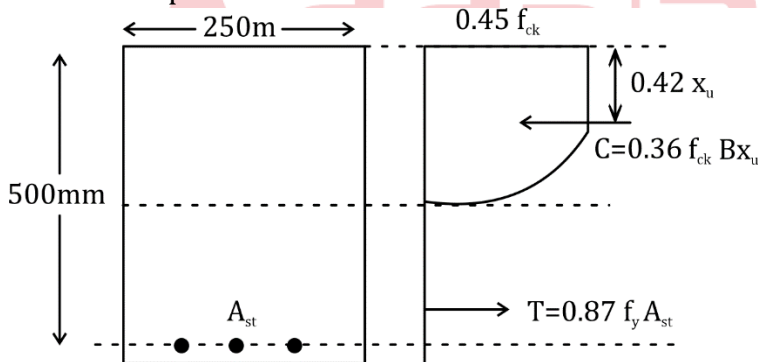
$$= 7.5 \text{ N/mm}^2 = 7.5 \text{ MPa}$$

30. (b)

Sol. Given that:

Width of beam $B = 250 \text{ mm}$

Effective depth $d = 500 \text{ mm}$



Compressive force in beam section is given by

$$C = 0.36 f_{ck} B x_u$$

For maximum value of compressive force

$$x_u = x_{ulim} = k \times d$$

$$\therefore C_{max} = 0.36 f_{ck} B x_{ulim}$$

$$= 0.36 \times 25 \times 250 \times (0.48 \times 500)$$

$$= 540 \times 10^3 \text{ N}$$

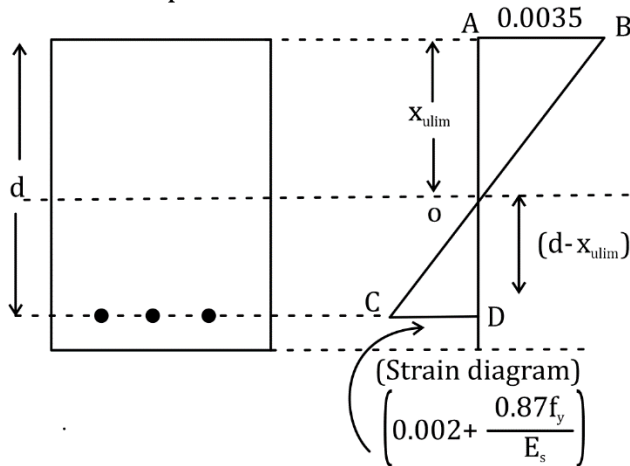
$$C_{max} = 540 \text{ kN}$$

31. (a)

Sol. Given that:

Grade of steel Fe500

Effective depth of Beam $d = 450\text{mm}$



$\therefore \Delta OAB$ and ΔOCD are similar triangle

$$\therefore \frac{x_{ulim}}{0.0035} = \frac{d - x_{ulim}}{\left(0.002 + \frac{0.87f_y}{E_s}\right)}$$

$$\frac{x_{ulim}}{0.0035} = \frac{d - x_{ulim}}{\left(0.002 + \frac{0.87 \times 500}{2 \times 10^5}\right)}$$

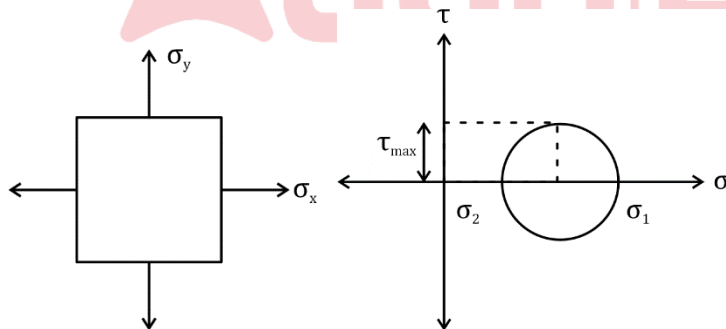
$$1.19285 x_{ulim} = 450 - x_{ulim}$$

$$2.19285 x_{ulim} = 450$$

$$x_{ulim} = 205.21\text{mm}$$

32. (a)

Sol.



Radius of Mohr's circle $= \tau_{\max}$

$$\Rightarrow \tau_{\max} = \left(\frac{\sigma_1 - \sigma_2}{2}\right) = \text{max shear stress}$$

Option A is correct.

33. (b)

Sol. From the stress strain diagram we can see that slope is constant means, $E = \text{constant}$

For material A, $\sigma_{ultimate}$ is greater than material B. As we know as carbon content in steel increases ultimate stress goes on increases

Increase in carbon content makes the steel specimen brittle therefore material A is brittle material.

Material B is ductile material Ductile materials are weak in shear material B will undergo cup-cone failure.

34. (b)

Sol. The permissible limit of colour for drinking water is 5 TCU and cause for rejection is 15 TCU .

35. (b)

Sol. The grit chamber is a settling tank with a provision to control flow velocity. A velocity control device known as proportional weir flow and parshall flume is provided at the outlet of the grit chamber to maintain constant flow velocity irrespective of the flow rate.

36. (c)

Sol.

Granite polishing waste :

- It is the waste of granite stone generated during the cutting and polishing of granite stone in the production of stoneware.
- When granite polishing waste is added as sand replacement, it increases the strength and durability.
- When granite polishing waste is added as cement replacement, it increases flowability but decreased strength and durability.
- It also improve packing density in the design mix.

37. (b)

Sol.

- According to IS 2386:1963 fine aggregate is divided into four zone :

Zone-I, Zone-II, Zone-III, Zone-IV

- As per IS 383:1970 (Table-4)

IS Sieve	Percentage passing for			
Designation	Grading Zone-I	Grading Zone-II	Grading Zone-III	Grading Zone-IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

38. (b)

Sol. Explanation

As per IS 2180 = 1988 the density of bricks shall not be less than 2.5 g/cm^3

As per IS 2180 : 1988 Classification of heavy duty bricks

Class	Ang. Compressive strength	
	Not less than	Less than N/mm^2
40	40 N/mm^2	45 N/mm^2
50	45 N/mm^2	

39. (c)

Sol. Explanation

Constitute	Function
i. Silica (50 to 60%)	Provide strength, hardness, and durability
ii. Alumina (20 to 30%)	Gives plasticity of brick for easy moulding
iii. Lime (< 5%)	Couses silica to fuse during burning and binding particles together
iv. Iron oxide (5 to 6%)	Provide colour
v. Magnesia (< 1%)	Provide yellow tint colour

40. (b)

Sol. Explanation

Plastic paint: Plastic paint is also known as emulsions.

It is used for painting the walls.

Water is used as thinner in plastic paint

It provide a better appearance

Varnish: - it is a transparent film provided on the woods.

Varnish is the mixture of resin and thinner solvent

41. (a)

Sol. Explanation

Types of rock on the basis of georgical classification

Igneous rock

Sedimentary rock

Metamorphic rock

I. Igneous rock: Formed by colling and solidification of magma and lava

Eg:- Granite, Basalt, Trap, Pegmatite, Dolerite, Rhyolite

II. Sedimentary rock: - formed by weathering action of existing rock.

Eg: - Lime stone, Gypsum, Shales, Gravel, lignite, sand stone.

III. metamorphic rock: - Igneous and sedimentary rocks are changed in character when they are subjected to high heat and pressure this process known as meta morphism and rock formed is known as metamorphic rock

Eg:- Marble, Gneiss, Quartzite, Slate.

42. (b)

Sol. Explanation

Slump test : - Slump test is to be done for the determination of workability of concrete.

Workability : - Workability is defined as the ease with which concrete can be transported, placed compacted and finished without excessive segregation and bleeding.

Slump value for different concrete work	
Work	Slump value
Mass concreting	25 – 50 mm
Road works	20 – 40 mm
Canal lining	70 – 80 mm
Concrete to be vibrated	10 – 25 mm

Slab, beam, piers	50 – 100 mm
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Compaction factor test: -

Compaction factor test is to be done for the determination of low and medium workability

As the compaction factor increases workability of concrete increases.

Workability	Compaction factor
Low workability	0.85
Medium workability	0.92
High workability	0.95

Note: Other test for workability

Test	Condition
Slump test	Low and Medium workability
Compaction factor test	Low and medium workability
Vee – Bee consistometer test	Very low workability
Flow table test	High workability

43. (d)

Sol.

Valuation : It is a method of determining the value of the property such as building, land, factory etc.

Rental Method of Valuation

Net rent = Gross rent – outgoing

Capitalized value = Net rent $\times$ year's purchase (y_p)

Year's purchase (y_p) = $\left(\frac{1}{i}\right)$

Where,

i = rate of interest

Given

Gross rent = 1000 per month

Gross rent = 1000×12 per year

Outgoing = 20% of gross rent

Outgoing = $\frac{20}{100} \times 12 \times 1000 = 2400$

Net rent = $12000 - 2400$

Net rent = 9600

Year's Purchase (y_p) = $\left(\frac{1}{i}\right) = \frac{1}{0.10}$ [$i = 10\%$]

$y_p = 10$

Capitalized Value = Net rent $\times y_p$

Capitalized Value = 9600×10

Capitalized Value = 96000

44. (b)

Sol. Given

Width of highway = 10 m = 1000 cm

Rise of outer edge with respect to inner edge = 40 cm

Super elevation(e) = ?

Rise of outer edge = $e \times w$ (Pavement rotated about inner side)

$$40 = e \times 1000$$

$$e = \frac{40}{1000}$$

$$e = \frac{1}{25}$$

Note: -

$$\text{Rise of outer edge} = \frac{e \times w}{2} \quad [\text{pavement is rotated about the centre line}]$$

45. (a)

Sol.

IRC (Indian road congress)

→ It was established in 1934

→ The main aim of establishing IRC was to promote the development and maintenance of roads and road transportation in the country

→ IRC provide guidance and technical expertise on all aspect of road infrastructure, including planning, design, construction and maintenance

46. (d)

Sol. Given,

Width of pavement = 8 m

Cross fall = 1 in 50

$$\text{Height of crown} = \left(\text{Cross fall} \times \frac{\text{width}}{2} \right)$$

$$\text{Height of crown} = \frac{1}{50} \times \frac{8}{2}$$

$$\text{Height of crown} = 0.08 \text{ m}$$

47. (a)

Sol.

Critical Reynold number,

$$Re = 2000$$

Given that radius of circular pipe $R = 1 \text{ cm}$

$$\text{So, Diameter } D = 2R = 2 \text{ cm} = 0.02 \text{ m}$$

Also given that Kinematic viscosity, $\nu = 0.2 \text{ stokes} = 0.2 \times 10^{-4} \text{ m}^2/\text{sec}$

$$Re = \frac{V \times D}{\nu}$$

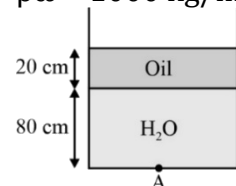
$$2000 = \frac{V \times 0.02}{0.2 \times 10^{-4}}$$

$$V = 2 \text{ m/sec}$$

48. (c)

Sol. Given: $h_o = 80 \text{ cm} = 0.8 \text{ m}$, $h_{oi} = 20 \text{ cm} = 0.2 \text{ m}$

$$\rho_o = 1000 \text{ kg/m}^3$$



$$\rho_{oil} = s \rho_o \Rightarrow \rho_{oil} = 0.8 \times 1000 = 800 \text{ kg/m}^3$$

$$P_A = P_w + P_{oil}$$

$$\begin{aligned}
 &= \rho_w g h_w + \rho_{oil} g h_{oil} \\
 &= 9.81 (1000 \times 0.8 + 800 \times 0.2) \\
 &= 9.81 (800 + 160) \\
 &= 9.81 \times 960 \\
 &= 9417.6 \text{ N/m}^2
 \end{aligned}$$

49. (d)

Sol. Reynolds number (Re) = $\frac{\text{Inertia force}}{\text{Viscous force}}$

$$F_{\text{inertia}} = m \times a = \rho L^3 \left(\frac{L}{T^2} \right) = \rho L^2 v^2$$

$$F_{\text{viscous}} = \frac{\mu A v}{h} = \mu L v$$

{ $\therefore$ Using dimensions for volume and area}

$$Re = \frac{\rho L^2 v^2}{\mu L v} = \frac{\rho L v}{\mu}$$

$$R_e = \frac{\rho L v}{\mu}$$

50. (d)

Sol. Given: N = 1200 rpm, Q = 16 m³/s, H = 16 m

We know:

$$N_s = \frac{N \sqrt{Q}}{H^{3/4}}$$

Now on putting values:

$$N_s = \frac{1200 \sqrt{16}}{(16)^{3/4}} = \frac{1200 \times 4}{8}$$

$$N_s = 600$$

51. (a)

Explanation: The Critical Path Method (CPM) is a project management technique used to determine the longest sequence of dependent activities and the shortest time needed to complete a project. It helps in identifying critical activities that cannot be delayed without delaying the entire project timeline.

52. (c)

Explanation: Program Evaluation and Review Technique (PERT) in Civil Engineering involves using probabilistic time estimates for various project activities. It considers the uncertainty associated with activity durations, which helps in better project planning and risk management.

53. (b)

Explanation: The critical path in CPM represents the longest path of dependent activities from the project's start to its end. Any delay in activities along this path directly impacts the project's overall timeline.

54. (c)

Explanation: The primary goal of using CPM and PERT in Civil Engineering projects is to optimize project performance by efficiently managing project schedules, resources, and activities, leading to timely and successful project completion.

55. (c)

Explanation: The Float or Slack of an activity in CPM represents the maximum delay that can be tolerated for that activity without delaying the project's overall completion. Activities on the critical path have zero float, indicating any delay will directly impact the project duration.

56. (c)

Explanation: A limitation of PERT and CPM in Civil Engineering projects is their dependency on accurate estimates of activity durations. Inaccurate estimates can lead to unreliable project schedules and ineffective project management.

57. (b)

Sol. The coefficient earth pressure at rest is greater than that of the coefficient of active earth pressure. But, The coefficient earth pressure at rest is less than the coefficient of passive earth pressure.

58. (b)

Sol. The lateral strain ϵ_h in the horizontal direction is given by,

$$\epsilon_h = \frac{1}{E}[\sigma_h - \mu(\sigma_h - \sigma_v)]$$

where, σ_h = horizontal stress

σ_v = vertical stress

E = elastic modulus

μ = Poisson's ratio.

59. (b)

Sol.

Given,

$$\gamma = 19 \text{ kN/m}^2$$

$$z = 6 \text{ m}$$

$$K_0 = 0.5$$

$$P_0 = K_0 \gamma z = 0.5 \times 19 \times 6$$

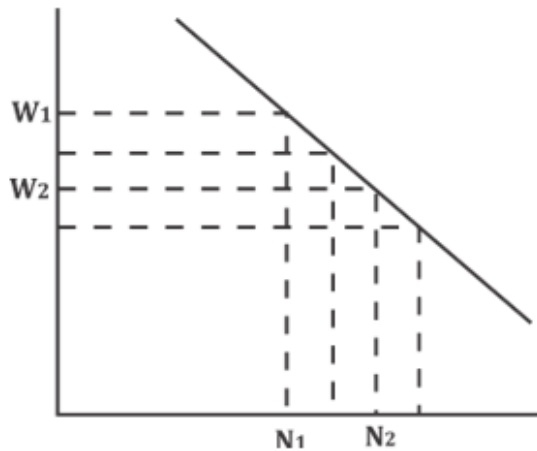
$$P_0 = 57 \text{ kN/m}^2.$$

60. (b)

Sol. The passive earth pressure occurs when a wall or plane moves toward earth, this will create additional pressure so it requires large movement of retaining structure.

61. (b)

Sol.



$\text{Log}_{10}(N) \rightarrow$

(Flow Curve)

$N \rightarrow$ Number of blows

$$\text{Flow index} = \tan \theta = \frac{dy}{dx} = I_f$$

$$I_f = \frac{W_1 - W_2}{\log \frac{N_2}{N_1}}$$

$\rightarrow$ Flow index of soil indicates shear strength variation with water content.

62. (a)

Sol. in saturated clay for short term analysis, unconsolidated – undrained test is used. This test takes only 5 to 7 minutes.

63. (a)

Sol. Reciprocating pumps are suitable when high head is required. It generally gives low but constant discharge under variable heads.

S64.

(d)

Sol. The specific speed of a turbine is in the range of

Turbine	Ns
Pelton wheel	10 - 60
Francis	60 - 300
Kaplan	> 300

65. (c)

Sol. Mechanical efficiency = $\frac{\text{Shaft power}}{\text{Runner power}}$

66. (c)

Sol.

Benefits of road lighting are as follows :

- Lighting on the road reduces the chance of accident
- By lighting crime on the roads and highway is minimized.
- By lighting on road traffic capacity of road will be increased
- By lighting glare from other vehicles head lamp will reduces

67. (c)

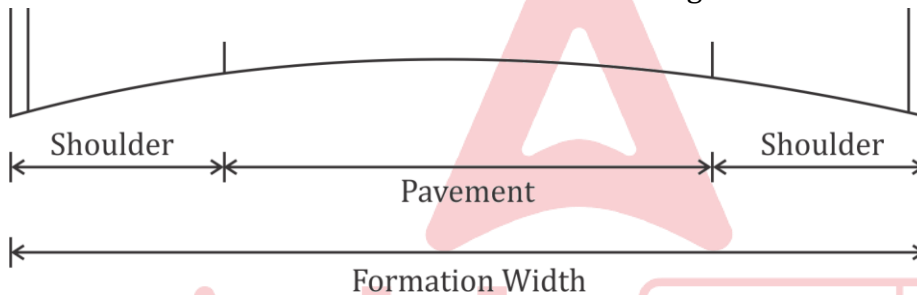
Sol.

Formation width of pavement = Width of the pavement

+

Width of shoulder

Formation width is the bottom width of the cutting



68. (b)

Sol.

Following are the methods used for designing the flexible pavement

- i) Group Index Method
- ii) CBR Method
- iii) Mcleod Method

Note : Westergaard theory is considered in design of rigid pavement.

69. (b)

Sol. Speed limit signs are circular in shape with the red border and black symbols on white background.

Cautionary/ warning signs: Cautionary/ warning signs are triangular in shape with the red border and black symbols on white background. For example, hairpin bend, narrow bridge, school ahead, etc.

70. (d)

Sol.

Following are the test done on the bitumen.

Property of bitumen	Type of test	Remark
i) Viscosity	Viscometer test	RC-2, MC-2, SC-2 having same viscosity but RC-3 is more viscous than RC-2

ii)	Grade of bitumen	Penetration test	The unit of penetration is 1/10 mm Industrial bitumen are specified as IS:73-1961
iii)	Softening	Ring and ball test	It is the temperature at which bitumen attains a particular degree of softness under standard test condition
iv)	Point of ductility	Standard briquette of bitumen	Bitumen should be capable of being stretched without breaking
v)	Flash and Fire point test	Pensky Martin test	Flash and fire point indicate the lowest temperature at which the material can ignite and sustain a fire

71. (b)

Sol.

→ Taking off in road planning in India refers to the rapid expansion and improvement of the road infrastructure in the Country.

→ For the rapid expansion and improvement of the road 20 year plan was established in 1943 known as Nagpur road plan.

→ The aim of first 20 year plan, also known as first highway development plan was to develop a network of high quality roads and highway in India to support economic growth and regional development.

• Following Key Objective of the 1st 20 year plan (Nagpur Road Plan)

→ Develop National Highway

→ Improve road connectivity in rural areas

→ Upgrade existing road

→ Enhance road safety

• Important points for 20 year plan

1st 20 year plan	2nd 20 year plan	3rd 20 year plan
Nagpur road plan	Bombay road plan	Lucknow road plan
1943-1963	1961-1981	1981-2001
Road density = 16 km/100 km ²	Road density = 32 km/100 km ²	Road Density = 82 km/100 km ²
Road divided into 5 category NH, SH, MDR, ODR & VR		Road divided into three category • Primary road • Secondary road • Tertiary road

72. (a)

Sol.

Sight Distance : It refers to the length of roadway visible to a driver at any given point along a road or highway.

It is the length of the roadway a driver can see ahead at any particular time.

Types of sight distance :

- i) Stopping sight distance (SSD) : It is the distance required for a driver to bring their vehicle to a stop before reaching an object on the road.
- ii) Intermediate sight distance (ISD) = $2 \times SSD$
- iii) Overtaking sight distance (OSD) : It is the safe distance for overtaking.

73. (b)

Sol.

Aggregate Impact Test : This test is done for determining the dynamic load carrying capacity of aggregate.

For test aggregate passing through 12.5 mm sieve and retained on 10 mm sieve is taken.

Aggregate impact value for different requirement.

Type of Pavement Material	Maximum Aggregate Impact Value (%)
i) WBM sub base course	50
ii) Airport runway	30
iii) Bituminous wearing surface	30
iv) Cement concrete base course	45

74. (b)

Sol.

i) Traffic Density : It is defined as the number of vehicle per unit length of road.

Eg:- 40 vehicles per km length

ii) Traffic Volume : It is defined as the number of vehicle per unit time.

Eg:- 40 vehicle per hour

iii) Basic Traffic Capacity : The maximum no. of vehicle that can be passed through a particular section of road during a given period of time under the most ideal condition is known as basic traffic capacity

$$Q_B = \left(\frac{1000}{S} \right) \times V$$

Where,

Q_B = Basic traffic capacity

S = Space head in m

V = Traffic speed in km/hr

iv) Practical Traffic Capacity : It is the maximum possible number of vehicle that can be passed through a particular section of road during a given period of time during the prevalent condition of road.

Note :

- Practical capacity $\leq$ Basic traffic capacity

- $Q = K \times V$

Where

Q = Traffic volume

K = Traffic density

V = Traffic speed

75. (b)

Sol.

Area of aquifer: $A = 200$ hectares

Drawdown of water table = 4 m

Porosity of soil: $n = 0.35$

Specific retention: $S_r = 0.15$

Volume of aquifer = $200 \times 10^4 \times 4 = 8 \times 10^6 \text{ m}^3$

Specific yield: $S_y = n - S_r$

$$= 0.35 - 0.15 = 0.2$$

$$S_y = \frac{\text{Change in volume } (\Delta V)}{\text{Original volume } (V)}$$

$$\Delta V = 0.2 \times 8 \times 10^6 = 1.6 \times 10^6 \text{ m}^3$$

76. (b)

Sol.

Transplantation period of rice: $B = 10$ days

Total depth of water required during transplantation = 48 cm

Effective rainfall useful for irrigation = 8 cm

Depth of water required through irrigation: $\Delta = 48 - 8 = 40$ cm

Duty of irrigation water: $D = 8.64 \frac{B}{\Delta}$

$$D = 8.64 \times \frac{10}{0.4} = 216 \text{ hectares/cumec}$$

77. (a)

Sol.

Delta: $\Delta = 55$ cm

Base period: $B = 120$ days

Total rainfall = 100 mm

Irrigation efficiency: $\eta = 60\%$

Area of land: $A = ?$

Canal flow: $Q = 0.01 \text{ m}^3/\text{sec}$

Quantity of water flow through canal during the base period:

$$V = 0.01 \times 120 \times 24 \times 60 \times 60 = 1,03,680 \text{ m}^3$$

Net depth of water required: $d = 55 - 10 = 45$ cm

$$\text{Area of land irrigated} = \frac{V}{d} = \frac{1,03,680}{0.45} = 2,30,400 \text{ m}^2$$

$$\text{Actual area irrigated} = 23.04 \times 0.6 = 13.82 \text{ hectares.}$$

78. (d)

Sol.

On Upper Bari Doab canal system, Kennedy selected a number of sites for carrying out investigations about velocity and depth of the channel. The sites selected by him did not require any silt clearance for more than 30 years and were thus, supposed to be flowing with non-silting non-scouring velocity.

79. (a)

Sol.

The downstream profile of Ogee spillway with vertical upstream face is given by

$$x^{1.85} = -2H_d^{0.85}y$$

$$\left(\frac{x}{H_d}\right)^{1.85} = -2\frac{H_d^{0.85}}{H_d^{1.85}}y = -2\frac{y}{H_d}$$

$$\frac{y}{H_d} = -0.5\left(\frac{x}{H_d}\right)^{1.85}$$

80. (c)

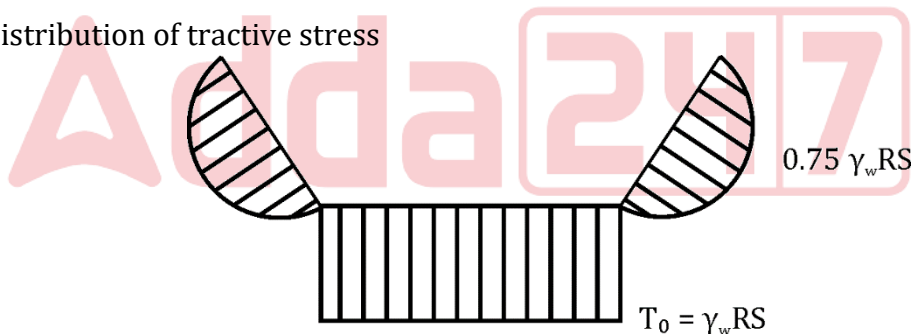
Sol.

Item of design	Criteria of design
Width of waterway	Lacey's wetted perimeter and discharge capacity of the barrage as determined by appropriate weir formulae.
Level and length of downstream floor	Hydraulic jump consideration
Depth of downstream sheet piles and total length of floor	Lacey's scour depth and exit hydraulic gradient as given by Khosla's theory
Barrage floor thickness at different location	Uplift pressure distribution as determined by Khosla's theory.

81. (b)

Sol.

Actual distribution of tractive stress



Where, T_0 = Tractive force at the channel

S = Channel Longitudinal Slope

R = Hydraulic Mean Depth

82. (a)

Sol.

Discharge intensity, $q = 6.5 \text{ m}^3/\text{s}/\text{m}$

Design scour depth = $2 \times$ Lacey's scour depth

Silt factor, $f = 1.0$

Lacey's scour depth, $R = 1.35 \left(\frac{q^2}{f}\right)^{1/3}$

$$R = 1.35 \left(\frac{6.5}{1} \right)^{1/3} = 4.7 \text{ m}$$

$$\begin{aligned} \text{Design scour depth} &= 2R \\ &= 2 \times 4.7 = 9.4 \text{ m} \end{aligned}$$

83. (c)

Sol. By Khosla's theory

$$\text{Exit gradient} = \frac{H}{d} \frac{1}{\pi\sqrt{\lambda}}$$

H = weir head

d = depth of downstream

$$\text{where, } \lambda = \frac{1 + \sqrt{1 + \alpha^2}}{2}$$

$$\text{where } \alpha = \frac{b}{d}$$

b = Impervious floor length.

84. (c)

Sol. in aeration method, the water is brought in intimate contact with air which removes undesirable gases (like CO_2 , H_2S), tastes, odours, volatile liquid and dissolved mineral (like iron and magnese) from water.

85. (b)

Sol. the length of sedimentation tank should be at least four times the breadth of the tank. The breadth of sedimentation tank should be 10 to 12 m and depth should be 3 to 4.5 m.

86. (a)

Sol. Given, Discharge (Q) = 26000 m³/day

$$\text{Detention time } (t_d) = 2.4 \text{ h or } \frac{2.4}{24} = 0.1 \text{ day}$$

$$\text{Detention time } (t_d) = \frac{\text{Volume of tank}}{\text{Rate of flow or discharge}(Q)}$$

$$\text{Volume of both tank} = t_d \times Q$$

$$= 0.1 \times 26000$$

$$= 2600 \text{ m}^3$$

$$\text{Volume of each tank} = \frac{2600}{2}$$

$$= 1300 \text{ m}^3$$

87. (d)

Cross Section Method:

This method is most suitable for the surveys of long narrow strips such as road, railways or canal alignment etc.

In this method cross sections perpendicular to the centre line of the area are set out.

The spacing of the cross-section depends upon the contour interval, scale of plan and the characteristic of ground.

The common value is 10 to 20m in hilly country and 20-30m in flat country.

The centre line and cross sections are plotted along with important features on the desired scale and their R.Ls are entered.

The contours are then interpolated with respect to these R.Ls.

The levels of the points along the section lines are plotted on the plan and the contours are then interpolated as usual.

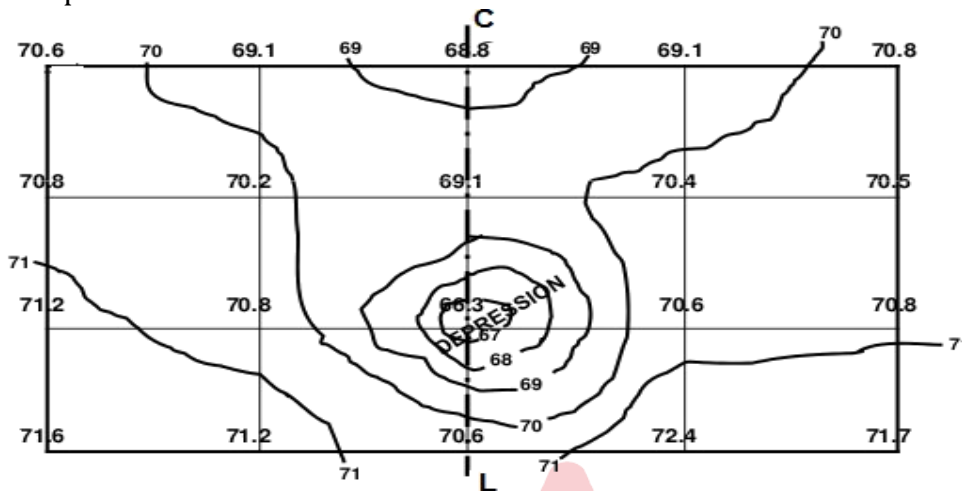


Fig. Depression under Cross-section method

88. (d)

Sol.

Back sight(BS):

It is the first sight taken on the level staff, of a known elevation with the intention to obtain the elevation of plane of collimation.

Intermediate sights(IS):

These are the sight taken after back sight and before sighting the final point.

Fore sight(FS):

The last reading taken from the instrument.

89. (a)

Sol.

Sensitivity of Bubble Tube:

It is defined as the angular value of one division of the bubble tube.

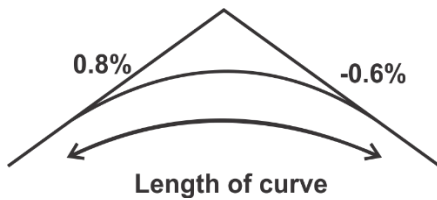
Generally, the linear value of one division is kept as 2mm. How much the bubble moves due to a given amount of inclination is sensitivity of bubble tube. The more the bubble moves, the more sensitive the bubble tube is.

The sensitivity of bubble tube can be increased by

1. Increasing the internal radius of the tube
2. Increasing diameter of the tube
3. Increasing length of the bubble
4. Decreasing roughness of the wall
5. Decreasing viscosity of the liquid

90. (c)

Sol.

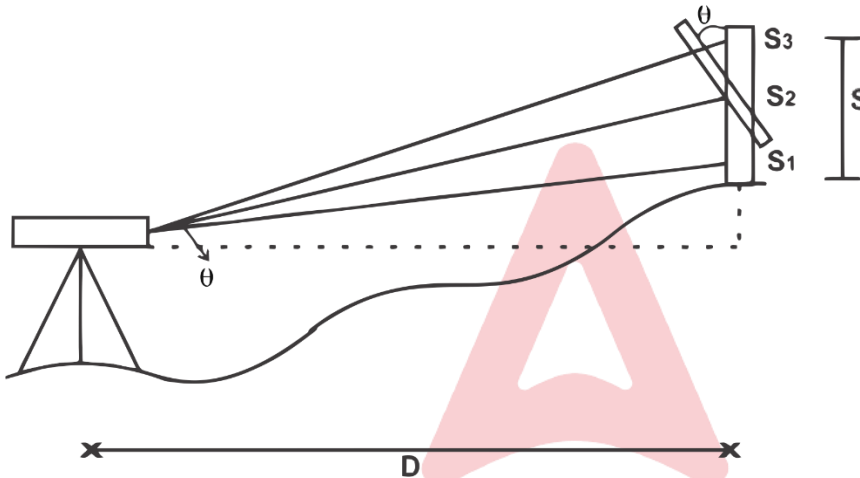


$$\text{Length of curve} = \frac{0.8 - (-0.6)}{0.1} \times 30$$

$$L = 420\text{m.}$$

91. (c)

Sol.



$$\text{Staff intercept (s)} = S_3 - S_1$$

$$\text{Staff perpendicular to line of sight} = s \cos \theta$$

$$L = k(s \cos \theta) + c$$

$$D = L \cos \theta$$

$$D = kS \cos^2 \theta + C \cos \theta$$

92. (d)

Sol.

Vehicle: It is the liquid substance which holds the ingredients of paint in suspension.

Use of vehicle in paint :

- To make it possible to spread the paint evenly and uniformly on the surface.
- To provide a binder for the ingredients of paint so that they may stick or adhere to the surface.

Some vehicle used in paint are given as follows :

- Linseed oil
- Nut oil
- Poppy oil
- Tung oil

93. (d)

Sol. Bronze paint: - they produce a very reflective type surface and are hence very useful for being applied to radiators.

These paints are equally effective for painting interior or exterior metallic surfaces.

94. (a)

Sol.

1. Grinning : is due to the imperfect opacity of the paint film after the final coat. The background and defect can clearly visible in such case.
2. Blooming : is defect caused due to improper ventilation weathering defective paint.
3. Wrinkling : are occur when a thicker layer of paint is to be coated on the surface.
4. Flaking : The detachment of paint film from the surface is called Flaking.

95. (d)

Sol.

The function of solvent in the paint is to dilute the vehicle prior to the application of paint of the surface.

96. (d)

Sol. Various tests performed on tiles are:

- (a) Breaking Strength Test
- (b) Impact test (Toughness)
- (c) Transvers Strength Test
- (d) Water Absorption Test (To test vitrification)
- (e) Hardness Test
- (f) Thermal Shocks Test
- (g) Chemical Resistance Test

97. (d)

Sol. There are 4 different types of gauges in Indian railways namely: broad gauge, meter gauge and 2 narrow gauges. The sizes of these gauges are: Broad gauge – 1676 mm, Metre gauge – 1000 mm, Narrow gauge – 762 mm and Narrow gauge – 610 mm.

98. (a)

Sol. The rail consists of three parts, a head, a web and a foot. Ballast is a separate component which is not a part of the rail section.

99. (a)

Sol.

Day work : - it is a procedure of actual costing and valuating on item of work on the basis of labourers and material.

Lump sum amount: - A lump sum investment means investing the entire amount at once, for example if one wants to invest the entire amount available with him in a mutual fund. It will be termed as lumpsum mutual fund investment.

Prime cost = Direct material cost + Direct labour cost

Provisional sum :- A provisional sum is an allowance or estimate made for a specific part of the project that is yet to be described in detail for contractors.

100. (d)

Sol. Calculations

Given,

Given annual rent = 9000

rate of interest (i) = 8% = 0.08

Capitalized value (C) = ?

Capitalized value (C) = Annual rent year purchase

Year purchase (YP) = $\frac{1}{i}$

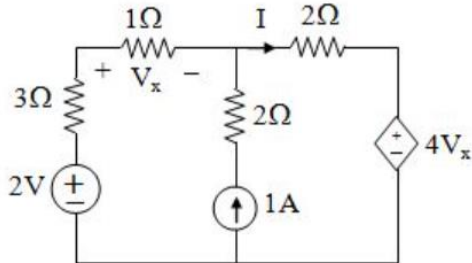
Capitalized value (c) = 9000×10.08

C = 112500 Rs.

1. Which of the following statement is correct regarding an auto – transformer?
I. A part of the winding is common to both the primary and secondary circuits
II. The two windings are not electrically isolated
(a) Only I
(b) Neither I nor II
(c) Only II
(d) Both I and II
2. If the open circuit and short circuit impedances of a transmission line are $200\ \Omega$ each, what is the characteristic impedance of the line?
(a) $100\sqrt{2}\ \Omega$
(b) $\frac{200}{\sqrt{2}}\ \Omega$
(c) $100\ \Omega$
(d) $200\ \Omega$
3. In a three-wire dc distribution system, what is the area of cross section of the neutral wire compared to the either outer wire?
(a) Double that of outer wire
(b) Same as that of outer wire.
(c) Half of that of outer wire
(d) One third of that of outer wire
4. In an alternator how the current from the stator is taken out to the external load circuit?
(a) Through direct connection
(b) Through commutator segments
(c) Through carbon brushes
(d) Through slip rings
5. Which of the following effects are associated with transmission line?
1. Skin effect
2. Corona effect
3. Proximity effect
(a) 1 and 3 only
(b) 1 and 2 only
(c) 1, 2 and 3
(d) 2 only
6. A power transformer steps up the voltage by a factor of 100. Then, what is the ratio of primary to secondary current?
(a) 0.01
(b) 100
(c) 1
(d) 0.1

7. A 100 kVA, 1100/220 V, 50Hz single phase transformer gave the following results on open circuit test conducted on LV side. 220 V, 100 A, 6.6 kW. What is the core loss component of current?
- 60 A
 - 50 A
 - 100 A
 - 30 A

8. Consider the following network. The value of the current 'I' is

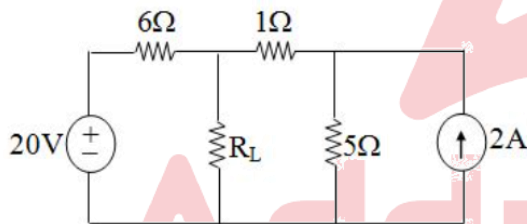


- 0.5 A
 - 1 A
 - 2 A
 - 1.5 A
9. During the open circuit test of a transformer
- Primary is supplied rated voltage
 - Primary is supplied current at reduce the voltage
 - Primary is supplied rated KVA
 - Primary is supplied full load current
10. Five identical capacitors, each of value of 4 F are connected between the pair of nodes (m, o) (o, p), (m, p), (n, p) and (o, n). If all capacitors are initially uncharged, then equivalent capacitance between the node m and n will be
- 1 F
 - 2 F
 - 3 F
 - 4 F
11. The iron loss in a 100 KVA transformer is 1 kW and full load copper losses are 2 kW. The maximum efficiency occurs at a load of
- 100 KVA
 - 70.7 KVA
 - 141.4 KVA
 - 50 KVA
12. Which of the following is true regarding Kirchhoff's voltage law (KVL)?
- The sum of the rises of potential around any closed circuit equals the sum of the drops of potential in that circuit
 - General expression of KVL is $\sum_{j=1}^k V_j = 0$ (where, V_j represent the voltage drop of the element in any given closed circuit which is assumed to have 'k' element)
- Only I
 - Neither I nor II
 - Both I and II
 - Only II

13. Which of following statement is correct regarding working of nuclear power stations?
I. A nuclear power station is just like a thermal power station in which the nuclear reactor replaces the steam boiler
II. The fundamental process in a nuclear reactor is the chain reaction of fissile material
(a) Both I and II
(b) Only II
(c) Only I
(d) Neither I nor II
14. Which of following statement is correct regarding working of hydroelectric power stations?
I. Plant is simpler and maintenance is minimum
II. The running charges of stations are very small
(a) Only II
(b) Neither I nor II
(c) Both I and II
(d) Only I
15. The maximum torque of a 3-phase induction motor under running conditions is
(a) Inversely proportional to supply voltage
(b) Inversely proportional to rotor reactance at standstill
(c) Directly proportional to rotor resistance
(d) None of the above
16. If N_s and N are the speeds of rotating field and rotor respectively, then ratio rotor input/rotor output is equal to
(a) N/N_s
(b) N_s/N
(c) $N_s - N$
(d) $N - N_s$
17. For higher efficiency of 3-phase induction motor, the slip should be
(a) Large
(b) Very large
(c) As small as possible
(d) 1
18. A 3-phase induction motor is running at 2% slip. If the input to rotor is 1000 W, then mechanical power developed by the motor is.....
(a) 20 W
(b) 980 W
(c) 500 W
(d) 200 W
19. Which of the following provides support to the insulators used in overhead lines?
(a) Cross-Arm
(b) Support/base
(c) Phase Plate
(d) Conductor

- 20.** Assertion A: Fractional pitch winding is used in DC machines
Reason B: Fractional Pitch winding reduces sparking in DC machines
Which of the following is correct?
(a) B is true, but A is false
(b) A and B are true, but B is not the correct explanation of A
(c) A and B are true, and B is the correct explanation of A
(d) A is true but B is false
- 21.** The essential requirement of good heating elements is
(a) High Specific resistance
(b) Free from oxidation
(c) Low-temperature coefficient of resistance
(d) All of the above
- 22.** In order to switch-off and EHV circuit for maintenance, the following sequence is adopted:
(a) Open the circuit breaker, open the isolator, operate the earth switch
(b) Operate the earth switch, open the isolator, open the circuit breaker
(c) Open the isolator, operate the earth switch, open the circuit breaker
(d) Open the isolator, open the circuit breaker, operate the earth switch
- 23.** Electrical fault between two windings of same phase of a generator having double star winding can be detected by the following protection in a generator:
(a) Short circuit protection
(b) Earth fault protection
(c) Inter turn Fault protection
(d) Over voltage protection
- 24.** An uncharged 50 μF capacitor is connected to 40 mA constant source. The voltage across it after 10 ms is
(a) 6 V
(b) 8 V
(c) 10 V
(d) 12 V
- 25.** The speed of a DC motor can be varied by varying
(a) Field current
(b) Applied voltage
(c) Resistance in series with armature
(d) Any of the above
- 26.** If conditions for maximum power for a DC motor are established, the efficiency of the motor will be
(a) 100%
(b) 90 to 95%
(c) 81%
(d) Less than 50%
- 27.** The speed of DC motor is
(a) Always constant
(b) Directly proportional to back e.m.f
(c) Directly proportional to flux
(d) Inversely proportional to the product of back e.m.f and flux

28. In a DC motor the inter-pole winding is connected in_____?
- Series with field winding
 - Series with armature winding
 - Parallel with field winding
 - Parallel with armature winding
29. A separately excited DC motor has an armature resistance of 0.5 Ohm. The supply voltage is 210V. Armature current is 20A and the speed of rotation is 1500 rpm. Find the torque developed?
- 25.48 Nm
 15. 28 Nm
 - 160 Nm
 - Zero
30. Bundled conductors are used in Extra High Voltage (EHV) transmission lines primarily to
- Reduce cost of transmission lines
 - Improve voltage regulation of transmission lines
 - Reduce copper losses
 - Reduce corona losses
31. Consider the following circuit. The maximum power transfer to ' R_L ' is



- 18.75 W
 - 18 W
 - 19.75 W
 - 16.75 W
32. The function of the interpole flux is to
- Neutralize the armature reaction flux
 - Neutralize the commutating self-induced e.m.f
 - Neutralize both the armature reaction flux as well as commutating e.m.f induced in the coil
 - None
33. In dc machines, the space distribution of air gap flux density wave at no-load is
- Sinusoidal
 - Co-sinusoidal
 - Flat-topped
 - Rectangular

34. Match the following

List -I	List-II
A. Maxwell bridge	1. Low Q-coil($Q < 1$)
B. Hay's bridge	2. High Q-coil($Q > 10$)
C. Anderson	3. Medium Q-coil($1 < Q < 10$)

- | A | B | C |
|-------|---|---|
| (a) 3 | 1 | 2 |
| (b) 1 | 2 | 3 |
| (c) 3 | 2 | 1 |
| (d) 2 | 3 | 1 |

35. Which of the following theorems can be applied to any network linear or non-linear, active or passive, time-variant or time-invariant?

- (a) Norton theorem
- (b) Thevenin theorem
- (c) Superposition theorem
- (d) Tellegen theorem

36. The bandwidth of an AC series circuit consisting of R, L & C is

- (a) L/RC
- (b) RC/L
- (c) R/L
- (d) L/R

37. A three-phase circuit breaker is rated at 2000 MVA, 33 KV. The symmetrical breaking current and making current respectively will be:

- (a) 20 kA, 35 kA
- (b) 60 kA, 70 kA
- (c) 80 kA, 160 kA
- (d) 35 kA, 89 kA

38. A circuit has an impedance of $(1 - j 2) \Omega$. The susceptance of the circuit is

- (a) 0.1 S
- (b) 0.2 S
- (c) 0.4 S
- (d) None of these

39. A single-phase transformer has rating of 15 kVA, 600/ 120 V. It is reconnected as an autotransformer to supply at 720 V from a 600 V primary source. Maximum load it can supply is

- (a) 90 kVA
- (b) 18 kVA
- (c) 15 kVA
- (d) 12 kVA

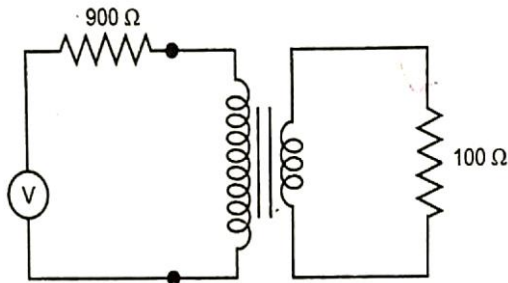
40. D.C. shunt motors are used in those applications where is required.
- (a) High starting torque
 - (b) Constant speed
 - (c) Low no-load speed
 - (d) None of the above
41. A balanced 3 – phase system consists of
- (a) Zero sequence current only
 - (b) Positive sequence current only
 - (c) Negative sequence current only
 - (d) Zero, positive and negative sequence currents
42. A γ -connected alternator has $X_1 = X_2 = 0.3$ and $X_0 = 0.1$ per unit. Find the magnitude of fault current for LG faults. (Alternate solidly grounded)
- (a) 4.28 Pu
 - (b) 10 Pu
 - (c) 3.33 Pu
 - (d) 1.66 Pu
43. A generator delivers 210 V on no-load and 200 V on full load. The voltage regulation of the dc generator is:
- (a) 4.76 %
 - (b) 5 %
 - (c) 10 %
 - (d) 95 %
44. Negative voltage regulation of a transformer is possible with
- (a) Inductive load
 - (b) Capacitive load
 - (c) Resistive load
 - (d) Resistive-inductive load
45. Which of the following materials has susceptibility independent of temperature?
- (a) Ferromagnetic
 - (b) Ferrimagnetic
 - (c) Paramagnetic
 - (d) Diamagnetic
46. Determine the capacitive susceptance (in siemens) of a circuit if the capacitor of the circuit is 0.08 mF and supplied with a 50 Hz frequency.
- (a) 0.025
 - (b) 0.064
 - (c) 0.046
 - (d) 0.034
47. Which of the following is an effect of non-uniform current distribution in a conductor?
- (a) Skin effect
 - (b) Ferranti effect
 - (c) Proximity effect
 - (d) Skin effect or proximity effect

48. A transformer has iron loss of 900 W and copper loss of 1600 W at full load. At what percentage of load will the efficiency be maximum?
- (a) 133
 - (b) 125
 - (c) 75
 - (d) 66.66
49. A transformer is working at full load with maximum efficiency. Its iron loss is 1000 W. What will be its copper loss at half full load?
- (a) 2000 W
 - (b) 1000 W
 - (c) 500 W
 - (d) 250 W
50. A R-L-C circuit has a resistance of 6 ohms, inductive reactance of 8 ohms and capacitive reactance of 16 ohms. The impedance of the circuit will be:
- (a) 10 ohms
 - (b) 16 ohms
 - (c) 8 ohms
 - (d) 6 ohms
51. The interchange of energy between the source and the inductive and capacitive elements in an A.C. power system is taking place at:
- (a) The supply frequency
 - (b) At twice the supply frequency
 - (c) At half the supply frequency
 - (d) No energy exchange takes place
52. The maximum torque of a 3-phase induction motor under running conditions is
- (a) Inversely proportional to supply voltage
 - (b) Inversely proportional to rotor reactance at standstill
 - (c) Directly proportional to rotor resistance
 - (d) None of the above
53. Which type of duty is used for centrifugal pumps?
- (a) Short duty
 - (b) Continuous duty
 - (c) Intermittent duty
 - (d) None of the above
54. The radiator of engine of a DG set is filled with:
- (a) Normal water
 - (b) Coolant only
 - (c) Both a and b
 - (d) None of the above
55. The efficiency of a DG set ranges between:
- (a) 0-20 %
 - (b) 20-25 %
 - (c) 40-45 %
 - (d) 60-70 %

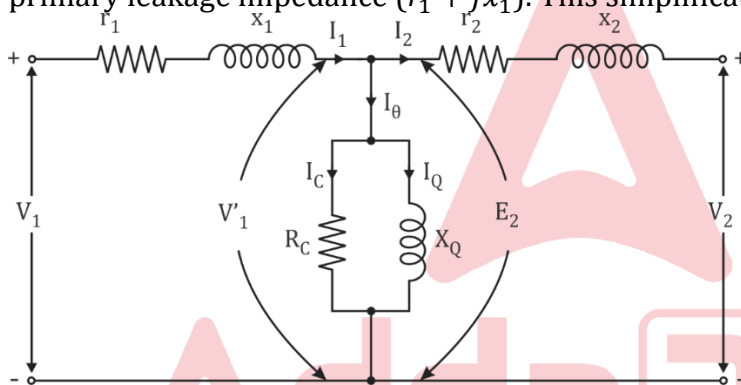
56. If A is cross-sectional area of a conductor, the bus-bar temperature rise in DG set is proportional to:
- (a) A
 - (b) A^2
 - (c) A^3
 - (d) $\frac{1}{A^2}$
57. Maximum permissible earth resistance for building is
- (a) 0.5Ω
 - (b) 1Ω
 - (c) 2Ω
 - (d) 5Ω
58. Pelton wheels are most efficient under the conditions of.....
- (a) High pressure and high flow
 - (b) Low pressure and low flow
 - (c) High pressure and low flow
 - (d) Low pressure and high flow
59. Calculate the current (in (Amperes) flowing in the conductor when 5×10^{19} electrons are flowing per seconds through it.
- (a) 5
 - (b) 3
 - (c) 8
 - (d) 1
60. Based on which law, economical area of the conductor is decided so that the cost of transmission line is minimized?
- (a) Kelvin's law
 - (b) Lez's law
 - (c) Gauss's law
 - (d) Maxwell's law
61. When voltage is transformed from primary to secondary then it is _____.
- (a) Multiplied by K^2
 - (b) Multiplied by K
 - (c) Divided by K^2
 - (d) Divided by K
62. Which of the following method is the method of measurement of high resistance?
- I. Direct deflection method
 - II. Megohm bridge
- (a) Only II
 - (b) Neither I nor II
 - (c) Only I
 - (d) Both I and II

63. Which of the following pair is correct?
I. Squirrel cage induction motor_____ maintenance is very low
II. Slipring induction motor____ maintenance is high because there are brushes, brush gears etc.
(a) Both I and II
(b) Only II
(c) Neither I nor II
(d) Only II
64. Which of the following is correct statement?
I. Star connection also be termed as 'T' connection
II. Delta connection can be termed as ' π '(pie) connection
(a) Neither I nor II
(b) Only II
(c) Only I
(d) Both I and II
65. According to Coulomb's law which of the following statement is correct?
I. The direction of force is along the line joining the charges
II. The force depends upon the medium in which the charges are placed.
(a) Both I and II
(b) Only I
(c) Neither I nor II
(d) Only II
66. Which of the following is known as Spool insulators?
(a) Pin Type insulators
(b) Post insulators
(c) Strain insulators
(d) Shackle insulators
67. In a transformer core, third and fifth harmonic components of fluxes are respectively 10% and 4% of the fundamental flux. The third and fifth harmonic induced emfs in the winding, in terms of the fundamental induced emfs are respectively
(a) 30%, 20%
(b) 10%, 12%
(c) 50%, 20%
(d) 50%, 12%
68. A 2,00/200V, 50 Hz single – phase transformer has an exciting current of 0.5 A and a core loss of 600 W. When H. V. side is energized by the rated voltage and frequency, the magnetizing current is
(a) 0.1 A
(b) 0.2 A
(c) 0.3 A
(d) 0.4 A

69. Consider the circuit shown in the given figure. For maximum power transfer to the load, the primary to secondary turn – ratio must be



- (a) 9 : 1
(b) 3 : 1
(c) 1 : 3
(d) 1 : 9
70. The exact equivalent circuit of a two – winding transformer is give in the figure. For affecting simplification, the parallel magnetizing branch, consisting of R_C and X_Q is shifted to the left of the primary leakage impedance ($r_1 + jx_1$). This simplification introduces the inaccuracy, in the neglect of



- (a) Voltage drop in the primary impedance due to the secondary current.
(b) Voltage drop in the primary impedance due to the exciting current.
(c) Voltage drop in the secondary impedance due to the exciting current.
(d) Reduction in values of R_C and X_Q of the exciting current.
71. Which of the following acts as a depolarizer in a dry cell?
(a) Carbon powder
(b) Manganese dioxide
(c) Ammonium chloride
(d) Zinc chloride
72. Lead-acid cells are
(a) Rechargeable cells
(b) Use and throw cells
(c) Forbidden cells
(d) Non-rechargeable cells
73. Batteries operate by converting chemical energy into electrical energy through- _ reactions.
(a) Electromechanical discharge
(b) Electron discharge
(c) Chemically neutral
(d) Electrochemical discharge

74. Usually, --- is used as an electrolyte in an Ni-Cd battery.
- (a) Cadmium peroxide
 - (b) Nickel hydroxide
 - (c) Sodium chloride
 - (d) Potassium hydroxide
75. Lead, in case of lead-acid cell, is known as
- (a) Negative passive material
 - (b) Positive active material
 - (c) Positive passive material
 - (d) Negative active material
76. Which of the following is not true about fuel cells
- (a) Cost is higher than batteries
 - (b) No recharging is needed
 - (c) More efficient
 - (d) Need more than two electrode
77. In a lead-acid battery the energy is stored in the form of
- (a) Charged ions
 - (b) Chemical energy
 - (c) Electrostatic energy
 - (d) Electromagnetic energy
78. In dry cells, free electrons are released at:
- (a) Cathode and anode both
 - (b) Outside the electrolyte chamber
 - (c) Anode
 - (d) Cathode
79. Which of the following is NOT one of the tips/methods while using washing machine to save energy?
- (a) Use the correct amount of detergent.
 - (b) Never wash with full loads.
 - (c) Use hot water only for very dirty clothes.
 - (d) Use optimal quantity of water.
80. Power factor in an industry can be improved by:
- (a) Transformers
 - (b) Capacitors
 - (c) Inductors
 - (d) Stabilizers
81. The most preferred motor used in traction is;
- (a) DC series motor
 - (b) Squirrel cage induction motor
 - (c) Synchronous motor
 - (d) Universal motor

82. Long distance railways operate on
(a) 600 Vdc
(b) 25kV three phase ac.
(c) 25kV single phase ac.
(d) 600 V three phase ac.
83. An electric motor may give noise due to
(a) Magnetic effect
(b) Defective bearing
(c) Cooling air
(d) All the above
84. What is the advantage of electric braking?
(a) Motor continues to remain loaded during braking
(b) It is instantaneous
(c) It avoids wear and tear of track
(d) More heat can be generated
85. The least expensive drive is
(a) Belt drive
(b) Rope drive
(c) Chain drive
(d) Gear drive
86. A motor has to be selected for following load cycle. Load uniformly rising from zero to 100 hp in 10 minutes after which it is constant at 100hp for the next 10 minutes, followed by no load period of 30 minutes. Suitable size of continuous rated motor is:
(a) 100hp
(b) 25hp
(c) 50hp
(d) 200hp
87. In AC locomotives, squirrel cage induction motors are used, the method of speed control is:
(a) Pole changing method of speed control
(b) Frequency control method of speed control
(c) Cascade control method of speed control
(d) Slip control method of speed control
88. For auto off an electric iron the switch is used
(a) Thermostat
(b) Overload
(c) Time delay
(d) Any of the above
89. Load frequency control is achieved by properly matching the individual machine's
(a) Reactive powers
(b) Generated voltages
(c) Turbine inputs
(d) Turbine and generator ratings

90. The window type air conditioner is an example of..... type air conditioner.
- (a) Axial type
 - (b) Unitary type
 - (c) Central type
 - (d) Unitary central type
91. Which of the following lightning arresters, can discharge currents, between 65,000 to 1,00,000 A
- (a) Station type
 - (b) Line type
 - (c) Distribution type
 - (d) Rod gaps
92. Reverse Power flow relays are used for the protection of
- (a) Generating stations
 - (b) Transmission stations
 - (c) Transformers
 - (d) Domestic power supplies
93. Which of the following properties must be used for the fuse material used in the wire?
- (a) Low conductivity
 - (b) Low melting point
 - (c) High melting point
 - (d) High resistivity
94. A good fuse wire must have:
- (a) High Melting point
 - (b) High Ohmic losses
 - (c) High Conductivity
 - (d) High Deterioration
95. To limit current chopping in vacuum circuit breakers, the contact material employed should have the properties of
- (a) Low conductivity and high vapour pressure
 - (b) Low conductivity and low vapour pressure
 - (c) High conductivity and high vapour pressure
 - (d) Low conductivity and low vapour pressure
96. Molded case circuit breaker is used for
- (a) Over load and short circuit protection
 - (b) Over load protection
 - (c) Short circuit protection
 - (d) Open circuit protection
97. With respect to stability point of view, which of the following statements are correct?
- (a) The impedance grounding is better than solid grounding during ground faults
 - (b) In a two-machine system, it is advisable to have resistance grounding at the sending end and reactance grounding at the receiving end during L-G faults
 - (c) During 3-phase fault, reactance grounding is used at the both ends
- (a) A and B only
 - (b) B and C only
 - (c) A, B and C
 - (d) A and C only

98. Which of the following is the advantage of a joint box system?

- (a) No chance of short circuit
- (b) The cost of wiring is saved
- (c) It require least skilled labour
- (d) The fault location is easy to detect

99. Inside the earth pit, the earthing electrode should be placed

- (a) Vertical
- (b) Horizontal
- (c) Inclined at 45°
- (d) Inclined at any angle other than 45°

100. Earthing conductivity is affected by:

- (a) Moisture content in the soil
- (b) Chemical composition
- (c) Concentration of salts in the soil
- (d) All of these

SOLUTIONS

1. (d)

Sol. Both I and II

Statement I: A part of the winding is common to both the primary and secondary circuits

- This statement is correct. In an auto-transformer, part of the winding is shared by both the primary and secondary circuits, unlike in a two-winding transformer where the windings are separate.

Statement II: The two windings are not electrically isolated.

- This statement is also correct. Because a portion of the winding is common to both primary and secondary circuits, there is no electrical isolation between the two circuits. They share a common electrical path.

Therefore, both statements I and II are correct.

So, the correct answer is Both I and II.

2. (d)

Sol. $Z = \sqrt{Z_{oc} \times Z_{sc}} = \sqrt{200 \times 200} = 200 \Omega$.

3. (c)

Sol. **Three-wire dc distribution system:**

- Consists of two outers and a neutral wire
- X-section of neutral is taken half as compared to either of the outers.

4. (d)

Sol. The current from the stator of an alternator is taken out to the external load circuit **through solid connections**. Whenever there is a need of connecting the rotating part of the machine to the stationary external circuit, then slip rings and brush assembly is used.

5. (c)

Sol. These all effects are associated with transmission line.

- Under no load conditions or light load conditions of a transmission line, receiving end voltage is greater than sending end voltage will occur in case of medium and transmission lines. This is called Ferranti effect.
- Accumulation of current on the surface of the conductor is called skin effect. Due to skin effect the effective area of current flowing path is reduced.
- Corona is the electrical discharge of atmospheric air.

6. (b)

Sol. ACQ: $\frac{V_2}{V_1} = 100$

$$\therefore \frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2} = 100$$

7. (d)

Sol. The core loss component of current = $I \cos \phi$

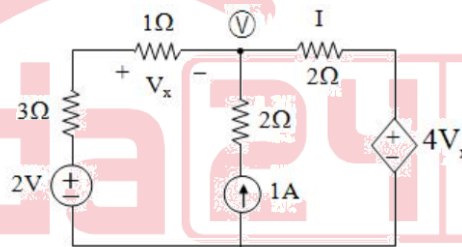
ACQ: $P = 6.6 \text{ KW} = 6600 \text{ W}$

$$\therefore P = VI \cos \phi = 6600$$

$$\Rightarrow I \cos \phi = \frac{P}{V} = \frac{6600}{220} = 30 \text{ A.}$$

8. (b)

Sol. Apply KCL at Node (V)



$$\Rightarrow \frac{V-2}{4} - 1 + \frac{V-4V_x}{2} = 0 \dots \dots (1)$$

$$\Rightarrow \frac{2-V}{4} = V_x \dots \dots (2)$$

Solving equations (1) & (2), we get

$$\Rightarrow V = 2 \text{ V}$$

$$\Rightarrow V_x = 0 \text{ V}$$

$$\Rightarrow I = \frac{V-4V_x}{2} = \frac{2-0}{2} = 1 \text{ A}$$

9. (a)

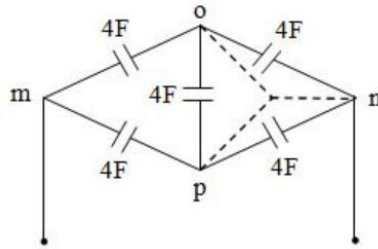
Sol.

- An open circuit test is performed to determine the iron loss in the transformer.
- Rated voltage is applied at primary.

- If the applied voltage is normal voltage, then normal flux will be set up. Since iron loss is a function of applied voltage, the normal iron loss will occur. Hence the iron loss is maximum at rated voltage. This maximum iron loss is measured using the wattmeter.

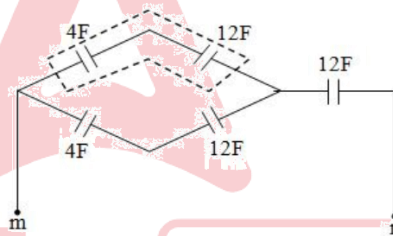
10. (d)

Sol.

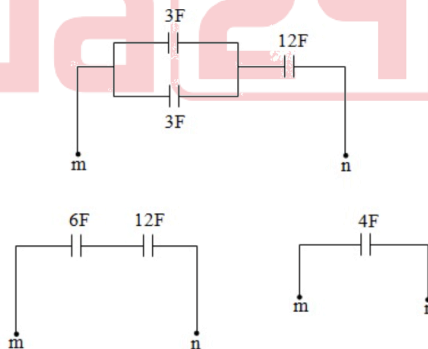


On delta-star transformation

$$\frac{1}{C_Y} = \frac{\frac{1}{4} \times \frac{1}{4}}{\frac{1}{4} + \frac{1}{4} + \frac{1}{4}} \Rightarrow C_Y = 12$$



$$\frac{12 \times 4}{16} F = 3 F$$



$$C_{eq} = C_{mn} = 4 F$$

11. (b)

Sol. Load for maximum efficiency.

$$(S_\eta)_{\max} = S_{full\ load} \sqrt{\frac{P_i}{P_{cuf t}}}$$

$$= 100 \text{ kVA} \sqrt{\frac{1}{2}} = 70.7 \text{ kVA}$$

12. (c)

Sol. Both I and II

1. Statement I: The sum of the rises of potential around any closed circuit equals the sum of the drops of potential in that circuit.

○ This statement is correct. Kirchhoff's Voltage Law (KVL) states that the total sum of all voltage rises (increases) in a closed loop is equal to the total sum of all voltage drops (decreases) in that same loop. Mathematically, it can be expressed as:

$\Sigma \text{ Voltage rises} = \Sigma \text{ Voltages drops}$

2. Statement II: General expression of KVL is $\sum_{j=1}^k V_j = 0$ (where, V_j represents the voltage drop of the element in any given closed circuit which is assumed to have 'k' elements).

○ This statement is also correct. The general mathematical expression of Kirchhoff's Voltage Law is that the algebraic sum of all voltages around any closed loop in a circuit is zero. This can be written as:

$$\sum_{j=1}^k V_j = 0$$

Here, V_j is the voltage drop (or rise) across the j th element, and k is the total number of elements in the closed loop.

Thus, both statements are correct, making the correct answer Both I and II.

13. (a)

Sol. Both I and II

Statement I:

• **Correct:** A nuclear power station operates similarly to a thermal power station. The key difference is the source of heat used to produce steam. In a thermal power station, the steam is generated by burning fossil fuels like coal, oil, or natural gas. In contrast, a nuclear power station uses a nuclear reactor to produce the heat required to generate steam. The steam then drives the turbines, which in turn generate electricity.

Statement II:

• **Correct:** The fundamental process in a nuclear reactor is the chain reaction of fissile material. This chain reaction involves the splitting (fission) of heavy atomic nuclei (such as Uranium-235 or Plutonium-239), releasing a significant amount of energy in the form of heat. This heat is used to produce steam, which drives the turbines to generate electricity. The chain reaction is carefully controlled to ensure a steady and safe production of heat.

14. (c)

Sol. Both I and II

Statement I:

• **Correct:** Hydroelectric power plants are generally simpler in construction compared to thermal or nuclear power plants. The primary components include a dam, a reservoir, a penstock (pipeline), turbines, and generators. These components work together to convert the potential energy of stored water into mechanical energy and then into electrical energy. Maintenance is relatively minimal because there are fewer moving parts compared to other types of power plants, and the equipment tends to be more robust and long-lasting.

Statement II:

- **Correct:** The running charges (operational costs) of hydroelectric power stations are very small. Once the plant is constructed, the primary fuel source—water—is free. Unlike fossil fuel or nuclear plants, hydroelectric plants do not require the continuous purchase of fuel. Operational costs mainly include maintenance and personnel costs, which are relatively low. Additionally, hydroelectric power plants have a long lifespan, which further reduces the costs over time

15. (b)

Sol. The maximum torque (T_{max}) of a 3-phase induction motor is given by;

$$T_{max} = \frac{3}{2\pi N_s} \times \frac{E_2^2}{2X_2}$$

where N_s is synchronous speed, E_2 is rotor e.m.f./phase at standstill and X_2 is rotor reactance/phase at standstill.

It is clear that $T_{max} \propto 1/X_2$

16. (b)

$$\text{Sol. } \frac{\text{Rotor output}}{\text{Rotor input}} = 1 - s = 1 - \left(1 - \frac{N}{N_s}\right) = \frac{N}{N_s} \therefore \frac{\text{Rotor input}}{\text{Rotor output}} = \frac{N_s}{N}$$

17. (c)

Sol. Approximate efficiency = $1 - s$ where s = decimal slip.

It is clear that for higher efficiency of 3-phase induction motor, the slip should be as small as possible

18. (b)

Sol. Mechanical power developed in 3-phase motor

$$= (1 - s) \times \text{power input to rotor} = (1 - 0.02) \times 1000 = 980 \text{ W}$$

19. (a)

Sol. Cross arms are installed at the top of the pole for holding for holding the insulator on which the conductors are fastened. Cross arms are either made up of wood or steel angle sections.

20. (c)

Sol. Some advantages of short pitch winding are:

- (a) Due to shortening span, the copper required is less.
- (b) Low copper losses
- (c) Improve waveform due to reduction in harmonic
- (d) Fractional Pitch winding reduces sparking in DC machines

21. (d)

Sol. The required properties in material used for heating elements-

- (a) High melting point.
- (b) Free from oxidation in open atmosphere.
- (c) High tensile strength.
- (d) Sufficient ductility to draw the metal or alloy in the form of wire.
- (e) High resistivity.
- (f) Low temperature coefficient of resistance.

22. (a)

Sol. In order to switch-off and EHV circuit for maintenance, the following sequence is adopted:

S1: Open the circuit breaker: CB is a device which can make and break the circuit under normal as well as under faulty condition by manually or automatically.

S2: Open the isolator: Isolator is a device which always operates under no load condition.

S3: Operate the Earth switch: Its function is to discharge any remnant charge due to residual magnetism which might be lethal to human and expensive testing equipment.

23. (c)

Sol. Inter turn stator winding fault can easily be detected by stator differential protection or stator earth fault protection. Hence, it is not very essential to provide special protection scheme for inter turn faults occurred in stator winding. This type of faults is generated if the insulation between conductor (with distinct potentials) in the same slot is punctured. This type of fault rapidly changes to earth fault.

24. (b)

Sol.

$$\Rightarrow Q = \int i \cdot dt; Q = i \cdot t = CV$$

$$\Rightarrow V = \frac{1}{C} \cdot t = \frac{40 \times 10^{-3}}{50 \times 10^{-6}} \times 10 \times 10^{-3} = 8 \text{ V}$$

25. (d)

Sol. Speed of the motor is directly proportional to supply voltage, inversely proportional to armature voltage drop and to the flux due to the field findings.

Thus, the speed of a DC motor can be controlled in three ways:

- By varying the supply voltage
- By varying the flux, and by varying the current through field winding
- By varying the armature voltage, and by varying the armature resistance

26. (d)

Sol. The gross mechanical power developed by a motor is maximum when back EMF is equal to half the applied voltage. Moreover, half the input would be wasted in the form of heat and taking other losses (mechanical and magnetic) into consideration, the motor efficiency will be well below 50 percent.

27. (b)

Sol. The emf equation of DC motor is given by

$$E = \frac{NP\phi Z}{60A}$$

Here,

N = Speed of rotation in rpm.

P = Number of poles.

A = Number of parallel paths.

Z = Total no. conductors in armature.

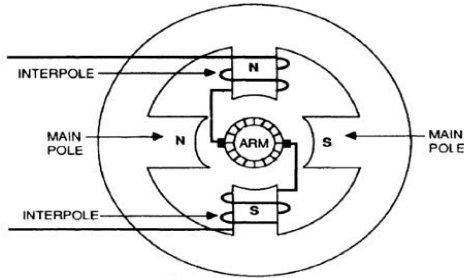
$$\text{Thus, speed of rotation } N = \frac{60A}{PZ} \times \frac{E}{\phi}$$

$$\Rightarrow N = \frac{E}{k\phi} \text{ Where } k = \frac{PZ}{60A} \text{ is a constant}$$

Hence, speed of a DC motor is directly proportional to emf of rotation (E) and inversely proportional to flux per pole (ϕ).

28. (b)

Sol. interpole winding is connected in series with armature winding through brushes to neutralize the armature flux in the interpolar region.



29. (a)

$$T = \frac{E_b I_a}{\omega}$$

Sol. We know torque developed in separately excited DC motor is given as:

$$\therefore T = \frac{(210 - 0.5 \times 20) \times 20}{2 \times \pi \times 1500 / 60} = 25.48 \text{ Nm}$$

30. (d)

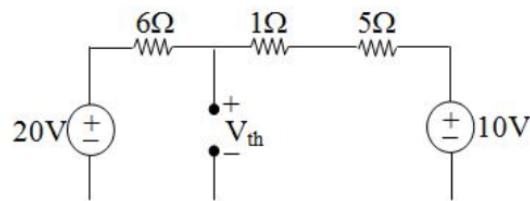
Sol. Bundle conductor is a conductor made up of two or more sub-conductors and is used as one phase conductor.

With the help of bundle conductor: -

- (i) Corona loss decreases
- (ii) Due to minimization of corona loss, electrical losses minimize.
- (iii) Inductance decreases & line capacitance increases.

31. (a)

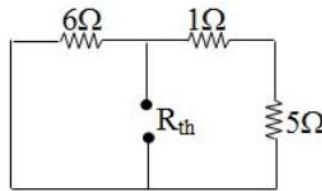
Sol. Calculation for V_{th}



$$\Rightarrow \therefore \frac{V_{th} - 20}{6} + \frac{V_{th} - 10}{6} = 0$$

$$\Rightarrow V_{th} = 15 \text{ Volts}$$

Calculation for R_{th}



$$\Rightarrow \therefore R_{th} = 6 // 6 = \frac{6}{2} = 3\Omega$$

$$\therefore P_{max} = \frac{V_{th}}{4R_{th}} = \frac{15^2}{4 \times 3} = \frac{15 \times 15}{4 \times 3}$$

$$\Rightarrow \frac{15 \times 5}{4} = \frac{75}{4} = 18.75 \text{ W}$$

32. (c)

Sol.

The inter poles produces the flux in opposite direction to cross magnetizing flux, there by the effect of CME will be neutralized. Which will be in phase opposition to reactance voltage, there by the effect of reactance voltage is also neutralized. So the commutation will be improved.

Interpoles, also known as commutating poles, are small poles placed between the main poles of a DC machine. They serve two primary functions:

- **Neutralizing Armature Reaction Flux:** The armature reaction flux distorts the main flux and can cause issues with the commutation process. Interpoles generate a flux that counteracts the armature reaction flux, helping to maintain a uniform magnetic field in the air gap.
- **Neutralizing Commutating Self-induced e.m.f:** During commutation, the coils undergoing commutation experience a change in current direction, which induces an electromotive force (e.m.f). This self-induced e.m.f can cause sparking at the brushes. Interpoles provide a flux that induces an e.m.f in the opposite direction, thereby neutralizing the commutating e.m.f and ensuring smooth commutation.

33. (c)

Sol.

- In DC machines, the air gap flux density wave at no-load tends to be flat-topped rather than sinusoidal.
- This is due to the design of the main poles, which are usually shaped to provide a uniform magnetic flux distribution across the pole arc.
- This flat-topped distribution helps in reducing the peak flux density, thereby minimizing core losses and improving the efficiency of the machine.
- At no-load, there is minimal armature reaction, and the flux distribution is primarily determined by the shape and design of the pole faces.
- The flat-topped waveform is a result of the efforts to achieve a more uniform flux distribution across the air gap.
- The air gap flux distribution under the pole shoe is constant. It's minimum at the quadrature axis. (In between the poles)

34. (c)

Sol. Bridges used for measurement of inductance:

- (a) Anderson bridge ($Q < 1$).
- (b) **Maxwell bridge** ($1 < Q < 10$).
- (c) Hay bridge ($Q > 10$).

35. (d)

Sol. Tellegen theorem can be applied to any network linear or non-linear, active or passive, time-variant or time-invariant.

36. (c)

Sol. The bandwidth of an AC series circuit consisting of R, L & C: $\mathbf{BW} = \frac{R}{L}$

37. (d)

Sol. Breaking capacity = $\sqrt{3} \times V_L \times I_{FL}$

$$\therefore 2000 = \sqrt{3} \times 33 \times I_{FL}$$

$$\therefore I_{FL} = 34.99 = 35 \text{ KA} = \text{Symm. breaking current}$$

$$\text{And, making current} = 2.55 \times \text{Symm. breaking current} = 2.55 \times 35 = 89 \text{ kA}$$

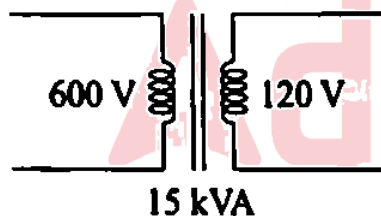
38. (c)

Sol.

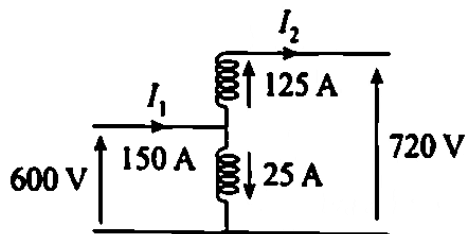
$$B = \frac{X_C}{Z^2} = \frac{2}{(1)^2 + (2)^2} = \frac{2}{5} = 0.4 \text{ S}$$

39. (a)

Sol. The given transformer can be represented as



When reconnected as an autotransformer the configuration is,



The current rating of 600 V winding,

$$= \frac{15000}{600} = 25 \text{ A}$$

And that of the 720 V side is 125 A.

The maximum load supplied,

$$= 125 \times 720 = 90 \text{ kVA}$$

$$\text{Or, } 150 \times 600 = 90 \text{ kVA}$$

40. (a)

Sol. In a d.c. motor, $T_a \propto \phi I_a$. At first (i.e., at starting), $\phi \propto I_a$ in a series d.c. motor so that $T_a \propto I_a^2$. Consequently, starting torque is very high

41. (b)

Sol. A balance three phase system consists of positive sequence current only.

42. (a)

Sol. → Given that

$$X_1 = j0.3$$

$$X_2 = j0.3$$

$$X_0 = j0.1$$

$$\text{For LG fault; } I_f = \frac{3E_a}{j(X_1 + X_2 + X_0)}$$

$$= \frac{3 \times 1}{j0.7}$$

$$= -j4.28 \text{ pu}$$

43. (b)

$$\text{Sol. Voltage regulation} = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100 = \frac{210 - 200}{200} \times 100 = 5 \%$$

44. (b)

Sol. Negative voltage regulation of a transformer is possible with capacitive load or leading pf load.

$$VR = (\%R)\cos\phi \pm (\%X)\sin\phi$$

+ → for lagging

- → for leading

- Maximum regulation at lagging pf
- Minimum or zero or negative regulation at leading pf

45. (d)

Sol. **Diamagnetic material:** Magnetic materials which align against the magnetic field are known as diamagnetic materials. Magnetic susceptibility is $\chi < 0$ which means it is always a negative value for diamagnetic material.

These materials are independent of temperature. As these materials magnetize in the opposite direction, they do have a small amount of magnetization intensity. Gold, tin, mercury, water, etc are examples of diamagnetic materials.

For a diamagnetic material, the relative permeability lies between $0 \leq \mu_r < 1$ and its susceptibility lies between $-1 < \chi < 0$. $x = \mu_r - 1$

Where x is a dimensionless quantity defines as the magnetic susceptibility of the medium.

46. (a)

$$\text{Sol. capacitive susceptance(B)} = \frac{1}{X_C} = \frac{1}{\left(\frac{1}{2\pi fC}\right)}$$

$$\therefore B = 2\pi fC = 2 \times 3.14 \times 50 \times 0.08 \times 10^{-3} = 0.025 \text{ siemens}$$

47. (d)

Sol. Skin effect: When an Alternating Current flow through a conductor, it is not distributed uniformly throughout the conductor cross-section. AC current has a tendency to concentrate near the surface of the conductor. This phenomenon in alternating currents is called as the **skin effect**.

Proximity effect:

When two or more conductors carrying alternating current are close to each other, then distribution of current in each conductor is affected due to the varying magnetic field of each other. when the nearby conductors carrying current in the same direction, the current is concentrated at the farthest side of the conductors. When the nearby conductors are carrying current in opposite direction to each other, the current is concentrated at the nearest parts of the conductors. This effect is called as **Proximity effect**.

48. (c)

$$\text{Sol. maximum efficiency in \%} = \sqrt{\frac{\text{iron loss}(P_i)}{\text{full load cu-loss}(P_{cu})}} \times 100 = \sqrt{\frac{900}{1600}} \times 100 = 75 \% \text{ of full-load}$$

49. (d)

Sol. For maximum efficiency, Copper loss (P_c) = Iron losses (P_i) = 1000 W

And $P_{cu}(x) = x^2 \times P_{cu}(\text{full} - \text{load})$

$$\therefore P_{cu}(\text{half-load}) = \left(\frac{1}{2}\right)^2 P_{cu}(\text{full-load}) = \frac{1}{4} \times 1000 = 250 \text{ W}$$

50. (a)

Sol. Given: $R = 6\Omega$, $X_L = 8\Omega$, $X_C = 16\Omega$

$$Z = R + j(X_L - X_C)$$

$$Z = 6 + j(8 - 16)$$

$$Z = 6 + j(-8)$$

$$|Z| = \sqrt{6^2 + (-8)^2} = 10 \text{ ohms}$$

51. (b)

Sol. instantaneous power $P(t) = V(t) I(t)$

$$V(t) = V_m \sin \omega t, i(t) = I_m \sin \omega t$$

$$P(t) = V_m \sin \omega t \times I_m \sin \omega t$$

$$P(t) = V_m I_m (\sin^2 \omega t) = V_m I_m \left(\frac{1 - \cos 2\omega t}{2} \right)$$

$$P(t) = \frac{V_m I_m}{\sqrt{2} \sqrt{2}} - \frac{V_m I_m}{\sqrt{2} \sqrt{2}} \cos 2\omega t$$

This term showing the power is of twice frequency of the supply frequency so, the interchange of energy between the source and the inductive and capacitive elements in an A.C. power system is taking place at twice the supply frequency.

52. (b)

Sol. The maximum torque ($T_{\max}$) of a 3-phase induction motor is given by;

$$T_{\max} = \frac{3}{2\pi N_s} \times \frac{E_2^2}{2X_2}$$

where N_s is synchronous speed, E_2 is rotor e.m.f./phase at standstill and X_2 is rotor reactance/phase at standstill.

It is clear that $T_{max} \propto 1/X_2$

53. (b)

Sol. Continuous duty is used for centrifugal pumps where the flows are large and used in lifting situations.

54. (c)

Sol. The radiator of engine of a DG set is filled with coolant and normal water.

55. (c)

Sol. The efficiency of a DG set ranges between 40-45%.

56. (d)

Sol. If A is cross-sectional area of a conductor, the bus-bar temperature rise in DG set is proportional to $\frac{1}{A^2}$.

57. (d)

Sol. Maximum permissible earth resistance for building is 5Ω .

58. (c)

Sol. Pelton wheels are most efficient under the conditions of high pressure and low flow.

59. (c)

Sol. $I = \frac{q}{t} = \frac{ne}{t}$

Where e = charge on e^- :

$$I = \frac{5 \times 10^{19} \times 1.6 \times 10^{-19}}{1}$$

$$= 8A$$

60. (a)

Sol. "The Kelvin's law states that the most economical size of a conductor is that for which annual interest and depreciation on the capital cost of the conductor is equal to the annual cost of energy loss."

S61. : (b)

Sol: From emf equation of transformer, it is clear that volts per turn is exactly the same for both primary and secondary windings i.e., in any related to each other by the ratio of secondary and primary turns. Thus

$$\frac{V_2}{V_1} = \frac{E_2}{E_1} = \frac{N_2}{N_1} = K$$

$$\text{or } V_2 = V_1 \times K$$

62. (d)

Sol. Both I and II

For the measurement of high resistance, two commonly used methods are:

1. Direct Deflection Method:

- This method involves using a sensitive galvanometer to detect the small current that flows through the high resistance. The deflection of the galvanometer is directly proportional to the current, and hence the resistance can be calculated. This method is simple but requires a highly sensitive galvanometer and is usually used for resistances in the range of megaohms ($M\Omega$).

2 Megohm Bridge:

- A megohm bridge is a specialized bridge circuit designed for measuring very high principle similar to a Wheatstone bridge but is adapted to measure very high resistances with greater accuracy.

63. (a)

Sol. Both I and II

1 Squirrel Cage Induction Motor:

- Maintenance is very low: This statement is correct. Squirrel cage induction motors are known for their simple and rugged construction. They have no brushes, slip rings, or commutators, which means fewer parts that can wear out or require regular maintenance. This results in low maintenance costs and high reliability.

2 Slip Ring Induction Motor:

- Maintenance is high because there are brushes, brush gears, etc.: This statement is also correct. Slip ring induction motors have additional components like slip rings and brushes that are not present in squirrel cage motors. These components require regular maintenance due to wear and tear. The presence of these additional parts increases the complexity and maintenance needs of the motor.

64. (d)

Sol. Both I and II

Correct Statements about Electrical Connections:

1 Statement I:

- "Star connection also be termed as 'T' connection."
- This is correct because in a star (or Y) connection, the three-phase windings are connected in such a way that one end of each winding is connected to a common neutral point, forming a 'T' shape when visualized. The other ends of the windings are connected to the three-phase supply lines.

2 Statement II:

- "Delta connection can be termed as ' π ' (pie) connection."
- This is also correct because in a delta (Δ) connection, the three-phase windings are connected end-to-end, forming a closed loop that resembles the shape of the Greek letter π (pi). This type of connection does not have a common neutral point, and each winding is connected between two phase lines.

Therefore, both statements I and II correctly describe alternative terminologies for star and delta connections.

65. (a)

Sol. Both I and II

Coulomb's Law:

Coulomb's law states that the force F between two point charges q_1 and q_2 is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance r between them. Mathematically, it is expressed as:

$$F = k_e \frac{|q_1 q_2|}{r^2}$$

where k_e is Coulomb's constant.

Analysis of Statements:

1 Statement I:

- "The direction of force is along the line joining the charges."
- This is correct. According to Coulomb's law, the electrostatic force between two charges acts along the straight line connecting the centers of the two charges. If the charges are of like signs, the force is repulsive, and if the charges are of opposite signs, the force is attractive.

2 Statement II:

- "The force depends upon the medium in which the charges are placed."
- This is also correct. The electrostatic force between two charges is affected by the medium in which the charges are situated. This effect is quantified by the relative permittivity (dielectric constant) of the medium. The force in a medium with relative permittivity ϵ_r is given by:
Therefore, both statements I and II correctly describe aspects of Coulomb's law.

66. (d)

Sol. Shackle insulators

Explanation:

- Shackle insulators are also known as spool insulators. They are typically used in low voltage distribution networks and can be either mounted horizontally or vertically. These insulators are used to support the overhead line conductors in a straight run or at the angle of a distribution line. They are often used in short line spans, distribution poles, or at the end of a distribution line.

67. (a)

Sol: For 3rd harmonic

Flux component, $\Phi_3 = 10\%$ of Φ_1

Supply frequency, $\omega_3 = 3\omega_1$

Since induced emf, $E \propto \Phi f \propto \Phi \omega$

3rd harmonic induced emf = $10\% \times 3 = 30\%$ $\because \omega_3 = 3\omega_1$

Similarly for 5th harmonic,

Induced emf = $4\% \times 5 = 20\%$

68. (d)

Sol: Exciting current, $I_0 = 0.5$ A

Energy component of exciting current,

$$I_e = \frac{\text{Core loss}}{\text{Supply voltage}} = \frac{600}{2,000} = 0.3 \text{ A}$$

Magnetizing component of exciting current,

$$I_m = \sqrt{I_0^2 - I_e^2} = \sqrt{0.5^2 - 0.3^2} = 0.4 \text{ A}$$

69. (b)

Sol: Load impedance reflected on primary side is transformed in the direct ratio of the square of turns so

$$Z'_L = \left(\frac{N_1}{N_2}\right)^2 \times Z_L$$

For transformation of maximum power Z_L must be equal to Z_1

$$\therefore \left(\frac{N_1}{N_2}\right)^2 \times Z_L = Z_1$$

$$\text{or } \frac{N_1}{N_2} = \sqrt{\frac{Z_1}{Z_L}} = \sqrt{\frac{900}{100}} = 3$$

So $N_1:N_2::3:1$

70. (b)

Sol: The exact equivalent circuit of two winding transformer is given in the figure of Q.63. For affecting simplification, the parallel magnetizing branch consisting of R_C and X_Q is shifted to the left of the primary leakage impedance ($r_1 + jx_1$). This simplification leads to following deviations.

1. In approximate equivalent circuit, in-phase, active or energy component I_e is used to meet the iron loss in addition to small amount of copper loss occurring in the primary winding. So this accounts for somewhat lesser primary winding copper loss and more core loss.

2. In approximate equivalent circuit, the parallel magnetizing branch is shifted to the left of the primary leakage impedance with the assumption that voltage drop in the primary impedance due to the exciting current can be neglected.

Since no-load current I_0 is very small (hardly 5 to 8% of full-load current). Hence deviations are very less.

71. (b)

Sol. Manganese- dioxide acts as a depolarizer in a dry cell.

The term "depolarizer" has been used to denote a substance used in a primary cell to prevent a buildup of hydrogen gas bubbles. A battery depolarizer takes up electrons during discharge of the cell, therefore it is always an oxidizing agent.

72. (a)

Sol: Lead-acid cell is also known as secondary cell. It can be charged and discharged about 1200 times. In this, electrical energy is collected as chemical energy. They are commonly used at power centers, sub-centres and telephone centres etc.

73. (d)

Sol: In the state of discharging, the battery converts the stored electrochemical energy into electrical energy and supplies to the external circuit. In the state of charging, the battery converts electrical energy into chemical energy and stored it inside.

74. (d)

Sol: Nickel cadmium and nickel iron are alkaline cells. To prepare its electrolyte, 20% potassium hydroxide (KOH) and 1% lithium hydrate (LiOH) are added to distilled water.

The addition of LiOH increases the battery life. The number of positive plates in nickel cadmium batteries or plates is one more than the number of negative cells.

75. (d)

Sol: Lead is called negative active substance in lead acid cell. The positive plate of lead acid cell is made of lead peroxide (PbO_2) whose colour is thick chocolate brown. While the negative plate made of pure lead (Pb). The colour of negative plate is light gray.

76. (d)

Sol: Fuel cell works like batteries, but they do not run down or need recharging.

- A fuel cell consists two electrodes -

1 Anode & cathode

2 The electrode anode and cathode they are sandwiched around an electrolyte.

- Cost is higher than batteries
- No need run down or recharging
- More efficient

77. (b)

Sol: The lead-acid battery (secondary battery) is such a battery where electrical energy can be stored as chemical energy and this chemical energy can be converted into electrical energy as required.

The main active materials required to construct a lead acid battery are.

- Lead peroxide (PbO_2)
- Sponge lead (Pb)
- Dilute sulfuric acid (H_2SO_4)

78. (a)

Sol: In dry cells, free electrons are released at cathode and anode both. The anode is always where oxidation happens and cathode is always where reduction happens. Oxidation is where an element gives up one or more electrons to become more positively charged (higher oxidation state). Reduction is where an element picks up an electron to become more negatively charged (less positive, lower oxidation state).

79. (b)

Sol: There are following methods for tips to save energy while operating washing machine.

- Use correct amount of detergent it reduces the surface tension of water which removes dust particles easily and consume less energy.
- Use hot water only for very dirty clothes.
- Use optimal quantity of water

80. (b)

Sol: Power factor in an industry can be improved by capacitors-

Power factor plays an important role in ac circuit.

Since power consumed depend upon the power factor-

$$P = \sqrt{3} V_L I_L \cos \phi$$

$$I_L = \frac{P}{\sqrt{3} V_L \cos \phi}$$

$$I_L \propto \frac{1}{\cos \phi} \cos \phi \downarrow \rightarrow I_L \uparrow$$

If power factor is less than one, they have to supply more current to the user for a given amount of power use. In industry a lot of induction motors winding of motor act as inductor which lag the power factor but capacitor have the opposite effect and can compensate for the inductive motor winding.

81. (a)

Sol: The most preferred motor in the traction is dc series motor.

The following features of DC series motor used for traction-

- 1 DC series motor robust in construction and capable of withstand against continuous vibration.
- 2 DC series motor has high starting torque.
- 3 DC series motor has high rate of acceleration and retardation.
- 4 DC series motor has develops high torque at low speed, low torque at high speed,
- 5 When DC series motor are running in parallel the all motors share almost equal load.

82. (c)

Sol: 25kV single phase AC is used in railway i.e. 25kVAC is more economical than 1.5kV DC voltage system. Since 25kV voltage system has higher voltage, the higher voltage reduces the current flow through conductor, this reflects to reduce the conductor size, and the cost of conductor.

83. (d)

Sol: Noise in electric motor-

The most likely mechanical cause of noise are → warm bearing

- Moving parts rubbing together or colliding
- A bend shaft
- A loose or missing screw
- Magnetic effect
- The noise may well indicate the problem & the relevant part of motor can be inspected & repaired if necessary.

84. (c)

Sol: Advantages of electric braking are -

- By using electric braking the capacity of the system (like higher speeds, heavy loads) can be increased.
- Electric braking is fast and cheap.
- In electric braking there is no maintenance cost like replaced brake shoes periodically.
- A part of energy is return to the supply consequently the running cost is reduced.

- In electric braking negligible amount of heat is generated where as in mechanical braking enormous heat is produced at brake shoes which leads to failure of brakes.

85. (a)

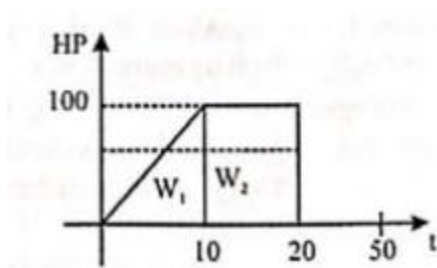
Sol: Belt drive- One of the most common drive belt drive are use to transmit motion from one shaft to another.

Advantage of belt drive-

- They are simple in use
- New belt drive efficiency can be up to 95 – 98%
- They have low maintenance cost
- Different speed can be obtained by means of step or tapered pulley.

86. (c)

Sol:



Total work (W) = $W_1 + W_2$

or,

$$W = \frac{1}{2} \times 10 \times 100 + 10 \times 100$$

$$= 500 + 1000$$

$$W = 1500 \text{ joule}$$

Here, motor is continuous running-

$$1500 = \text{HP} \times 30$$

$$\text{HP} = \frac{1500}{30} = 50\text{HP}$$

87. (b)

Sol. $\left(\frac{V}{f}\right)$ Speed control method in squirrel cage induction motor is one of the great advantages over d.c. motor.

In squirrel cage induction motor both V and f are reduced in such a manner that

$$\frac{V}{f} = \phi_m = \text{constant}$$

Air gap flux (ϕ) of squirrel cage induction motor is directly proportional to the magnitude of supply voltage (V) and inversely proportional to the frequency (f).

$$\phi \propto \frac{V}{f}$$

The speed an AC IM can be controlled by adjusting the frequency and the magnitude of the stator voltage motor speed is proportional to frequency, but the voltage must be simultaneously adjust to avoid over fluxing the motor.

It produces a wide range of speed control below the base speed (rated speed).

88. (a)

Sol: An electric iron gets cut off if output temperature goes beyond the setting point of temperature. The device that control this temperature is called thermostat.

The thermostat is an important component of electric iron (or several home appliance) that regulate its temperature and get cut off it temperature limit goes to desired value of temperature.

89. (c)

Sol: When the load on generator or group of generators increases, the speed of the rotor decreases, resulting in reduction in frequency. To bring this frequency to the normal level, governor increases the turbine input.

When the load on the generator decreases, the speed of the rotor increases, which leads to increase in frequency. To bring this frequency to normal level, the governor reduces the turbine input.

90. (b)

Sol: The window type air-conditioner is an example of unitary type air conditioner. It is the simplest form of an air conditioning system and is mounted on windows or walls. It is a single unit that is assembled in a casing where all the components are located.

- Indoor parts of a window air condition is cooling coils, fan blower, capillary tube, operating panel, filter driver, drain pan.
- Outdoor side component is compressor, condenser coil, propeller fan, fan motor.

91. (b)

Sol: Lightning arrester type on the basis of application -

Station type- The voltage rating of such arresters vary from 3kV to 312kV and are designed to discharge currents not less than 100000 amps. They are used for the protection of substation and power transformers.

Line type- The voltage rating vary from 20kV to 73 kV and can discharge currents between 65000amps and 100000 apms they are used for the protection of distribution transformers, small power transformers and sometimes small substations.

Distribution type- The voltage rating vary from 8kV to 15kV and can discharge currents upto 65000 amperes. They are used mainly for pole mounted substation for the protection of distribution transformers upto and including the 15kV classification.

Hence, line type lightning arrester can discharge currents between 65000 to 100000 A.

92. (a)

Sol: Reverse Power flow relays are used for the protection of generating stations. Reverse power supply is a directional protective relay that protect the generator from motoring effect (going to reverse direction). It is used where generator runs is parallel with other utility or generator.

93. (b)

Sol: Properties of fuse material-

- (1) High conductivity
- (2) Low melting point

(3) Low resistivity

It is generally made of alloy of tin and lead (63%Sn + 37% Pb). Which are placed in series order in the circuit

line for protection from over current.

94. (c)

Sol: A fuse is a safety device consisting of strip of wire that melts itself and breaks an electrical circuit if the current exceeds the safe value.

Characteristics of fuse wire-

(i) It should have low melting point.

(ii) It should have low ohmic losses.

(iii) It should have high conductivity (or low resistivity)

(iv) It should be economical.

(v) It should be free from detraction.

95. (a)

Sol: In vacuum CB, the current chopping depends upon the vapour pressure and the electrons emission property of the contact material- Therefore, to reduce the current level for chopping to occur, a high vapour pressure and low conductivity metal is desirable. Since gas pressure is low in a vacuum switch. A low conductive material will maintain contact surface temperature and vaporization for a longer time to maintain the arc stability which is necessary for current chopping.

96. (a)

Sol. Molded case circuit breaker is used for over load and short circuit protection. Rating of circuit breaker is generally in MVA. It is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit. It has two type-

1 Automatic

2 Manually

97. (a)

Sol:

(A) Impedance grounding reduce the ground fault current level to safe value.

(B) In alternator we use resistance earthing for reducing the losses as well as for activating earth fault relay. But in case of receiving end capacitance are generated so faulty charging current flow in receiving end. So, reactance earthing use in motor.

98. (b)

Sol. In the joint box method of wire placement, the various wiring of the circuit is connected to the circuit by a connector on the circuit wires and wooden box attached to each joint. In this method, cables are connected but cables are also saved. Thereby reducing wiring cost.

99. (a)

Sol. The earth wire and earth electrode will be the same material. The earthing electrode should always be placed at a vertical position inside the earth or pit, so that it may be in contact with all the different earth layer.

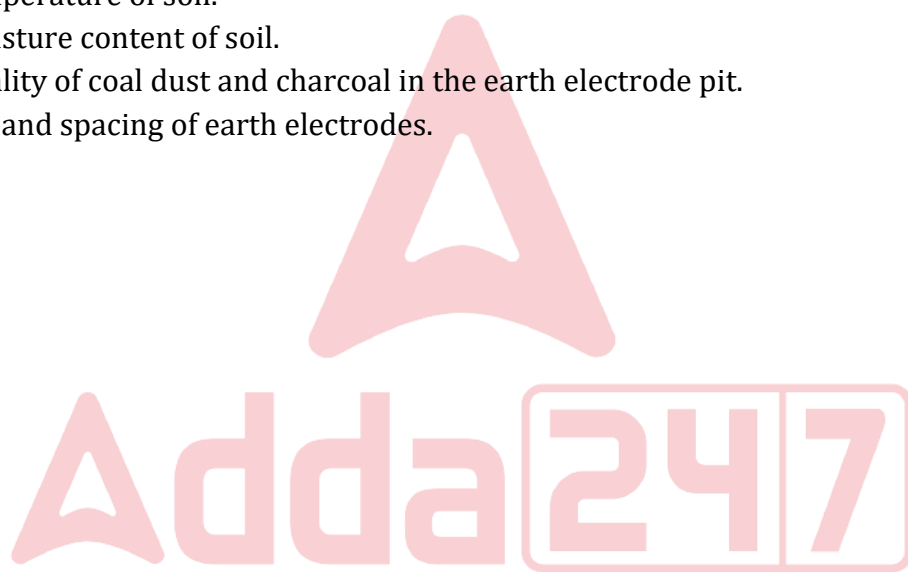
Properties of earth electrodes are-

- (1) Low resistance
- (2) Smooth structure
- (3) Depth of soil
- (4) Soil condition (pH value of soil)

100. (d)

Sol: The resistance of earth system depends upon

- (i) condition of soil.
- (ii) Temperature of soil.
- (iii) Moisture content of soil.
- (iv) Quality of coal dust and charcoal in the earth electrode pit.
- (v) Size and spacing of earth electrodes.



1. For a helical spring, spring index is:
 - (a) the ratio of the mean coil diameter to the pitch of helix
 - (b) the ratio of the wire diameter to the pitch of helix
 - (c) the difference between the mean coil diameter and the wire diameter
 - (d) the ratio of mean coil diameter to wire diameter
2. In a closed helical spring subjected to an axial load, other quantities remaining the same, if the wire diameter is doubled and mean radius of the wire diameter is doubled and mean radius of the coil is also doubled, then stiffness of spring when compared to original one will become _____.
 - (a) Twice
 - (b) Four times
 - (c) Eight times
 - (d) Sixteen times
3. A body weighing 1000 kg falls 8 cm and strikes a 500 kg/cm spring. The deformation of spring will be _____ cm.
 - (a) 8
 - (b) 4
 - (c) 16
 - (d) 2
4. The term $\omega^3 d^3 y / d\theta^3$ in cam follower motion represents which of the following parameters?
 - (a) acceleration of follower
 - (b) velocity of follower
 - (c) jerk
 - (d) displacement
5. Back gear mechanism of lathe is an application of.....
 - (a) Simple gear train
 - (b) compounded gear train
 - (c) Reverted gear train
 - (d) Epicyclic gear train
6. A fixed gear having 200 teeth is in mesh with another gear having 50 teeth. The two gears are connected by an arm. The number of turns made by the smaller gear for one revolution of arm about the center of bigger gear would be?
 - (a) 2
 - (b) 3
 - (c) 4
 - (d) 5
7. Which one of the following options is correct to describe the speed ratio of a simple gear train?
 - (a) $\frac{N_1}{N_2} = \frac{T_1}{T_2}$
 - (b) $\frac{N_1}{N_2} = \frac{T_2}{T_1}$
 - (c) $\frac{N_1}{N_2} = \sqrt{\frac{T_2}{T_1}}$
 - (d) $\frac{N_1}{N_2} = \sqrt{\frac{T_1}{T_2}}$

8. A body is vibrating at 10 vibrations/ second in Simple harmonic Motion with 10 cm amplitude. The maximum velocity in cm/sec can be_____.
- (a) 100π
 - (b) 50π
 - (c) 200π
 - (d) 100
9. In a Vernier caliper, the main scale reads in millimeters with a least count of 0.1 mm. Ten divisions on the Vernier correspond to nine division on the main scale. Determine the least count of the caliper.
- (a) 0.01 mm
 - (b) 0.001 mm
 - (c) 0.1 mm
 - (d) 1 mm
10. An optical gauge works on the principle of
- (a) reflection of light rays
 - (b) polarization of light rays
 - (c) interference of light rays
 - (d) refraction of light rays
11. A single riveted lap joint is used to join the two 16 mm plates. If the tensile load acting on the plate is 60 kN, determine the diameter of rivet.
- (a) 17 mm
 - (b) 24 mm
 - (c) 16 mm
 - (d) 20 mm
12. NC machine tools used system of instructions.
- (a) Binary coded decimals
 - (b) Binary numbers
 - (c) Alphanumeric
 - (d) Numeric
13. In part programming of CNC machines, M06 stands for
- (a) Spindle start clockwise
 - (b) Spindle start anti-clockwise
 - (c) Tool change
 - (d) Spindle stop
14. CNC machine operator can set the zero point at any position on the machine table. This feature is called
- (a) Fixed origin
 - (b) Floating zero
 - (c) Fixed zero
 - (d) None of these

15. The type of coupling used for high torque and low speed is -
(a) Oldham's coupling
(b) Muff coupling
(c) Bushed pin flexible coupling
(d) Disc coupling
16. In a reversible isothermal expansion process, fluid expands from 10 bar and 2m^3 to 2bar and 10m^3 . During the process the heat supplied is at a rate of 200 kW. What is the rate of work done during the process
(a) 180 kW
(b) 35 kW
(c) 200 kW
(d) 120 kW
17. The instrument which measures the temperature of the source without direct contact is
(a) Pyrometer
(b) Bi-metallic cut-out
(c) Vapour pressure thermometer
(d) Thin film thermometer.
18. During a certain compression process, 2 KJ of mechanical work input is supplied to 2 kg of the gas enclosed in a cylinder piston assembly and 1400 J of heat rejected to the cooling water being circulated in the jacket encasing the cylinder, this brings about a change in the specific internal energy by:
(a) -700 J kg^{-1}
(b) 600 J kg^{-1}
(c) 300 J kg^{-1}
(d) -600 J kg^{-1}
19. According to Chvorinov, following is the correct formula for solidification time (T_s), where K = mould casting constant, V = volume of casting, SA = Surface area.
(a) $T_s = V \left(\frac{SA}{K} \right)^2$
(b) $T_s = K \left(\frac{SA}{V} \right)^2$
(c) $T_s = K \left(\frac{V}{SA} \right)^2$
(d) $T_s = V \left(\frac{K}{SA} \right)^2$
20. Which one of the following moulding processes does not require use of core?
(a) Sand moulding
(b) Shell moulding
(c) Centrifugal casting
(d) Continuous casting

21. The device that produces network in a complete cycle by exchanging heat only with single thermal energy reservoir is known as:
- (a) PMM1
 - (b) PMM2
 - (c) PMM3
 - (d) Heat Pump
22. Which of the following is a casting defect?
- (a) Blow hole
 - (b) Slag inclusion
 - (c) Pour shot
 - (d) All the above
23. The Strouhal number S is defined as $s =$
- (a) $\frac{f \cdot D}{V}$
 - (b) $\frac{f D^2}{V^2}$
 - (c) $\frac{f^2 D}{V^2}$
 - (d) $\frac{f D}{2V}$
- Where,
- V = free stream velocity
 D = diameter of cylinder
 F = Vortex shedding frequency
24. The separation of boundary layer takes place when the pressure gradient is
- (a) Constant
 - (b) Negative
 - (c) Positive
 - (d) Zero
25. The flow profile of a fluid depends upon
- (a) Velocity of the fluid only
 - (b) Reynold number
 - (c) The diameter of the tube only
 - (d) The surface roughness
26. If angle of contact of a drop of liquid is acute than
- (a) Adhesion is more than cohesion
 - (b) Cohesion is more than adhesion
 - (c) Cohesion is equal to adhesion
 - (d) None of these
27. The materials which exhibit the same elastic properties in all directions are called –
- (a) Homogeneous
 - (b) Inelastic
 - (c) Isotropic
 - (d) Isentropic

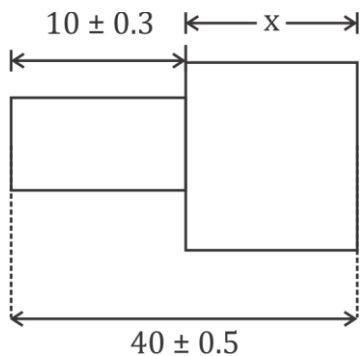
28. The crystal structure of alpha-iron is –

- (a) Body centered cubic
- (b) Face centered cubic
- (c) Hexagonal closed pack
- (d) Simple cubic

29. The fundamental tolerance unit 'i' in terms of mean diameter D is

- (a) $i = 0.45\sqrt{D} + 0.1D$
- (b) $i = 0.45\sqrt{D} + 0.01D$
- (c) $i = 0.45(D)^{1/3} + 0.001D$
- (d) $i = 0.45\sqrt{D} + 0.001D$

30. The tolerance of 'x' in the given figure.



- (a) 30 ± 0.8
- (b) 30 ± 0.2
- (c) 30 ± 0.3
- (d) 30 ± 0.5

31. The percentage of carbon in low carbon steel is –

- (a) 0.05%
- (b) 0.75%
- (c) 0.3%
- (d) 0.5%

32. The elastic stress strain behavior of rubber is

- (a) Linear
- (b) Non-linear
- (c) Plastic
- (d) No fixed relationship

33. Foundry crucible is made of

- (a) Mild steel
- (b) German silver
- (c) Lead
- (d) Graphite

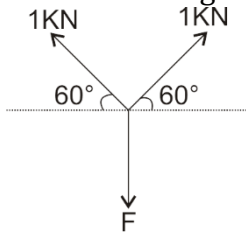
34. The maximum interference in mm after assembly between a bush of size $30^{+0.07}_{+0.02}$ mm and shaft $30^{+0.05}_{-0.01}$ mm is
(a) 0.01 mm
(b) 0.02 mm
(c) 0.03 mm
(d) 0.003 mm
35. Milling machine is classified as horizontal or vertical type, depending on the position of:
(a) Spindle
(b) Work piece
(c) Milling cutter
(d) Work table or bed
36. Size of shaper is specified by:
(a) Length of stroke
(b) Size of table
(c) Maximum size of tool
(d) Ratio of forward to return stroke
37. Orthogonal cutting system is also called
(a) One-dimensional cutting system
(b) Two-dimensional cutting system
(c) Three-dimensional cutting system
(d) None of these
38. In a drill operation:
(a) Torque is equal to the axial force
(b) Torque is more than the axial force
(c) Torque is less than the axial force
(d) Torque is half the axial force
39. Which of the following is NOT the part of 6 M's of six sigma?
(a) Motion
(b) Materials
(c) Machine
(d) Man
40. Simplex problem is considered as infeasible when
(a) All the variable in entering column are negative
(b) Variables in the basis are negative
(c) Artificial variable is present in basis.
(d) Pivotal value is negative
41. A PERT network has 4 activities on its critical path. The standard deviation of each activity on the critical path is 2. The standard deviation of the critical path is –
(a) 2
(b) 3
(c) 8
(d) 4

42. In wire – drawing operation, the maximum reduction per pass for perfectly plastic material in ideal condition is
- (a) 68 %
 - (b) 63 %
 - (c) 58 %
 - (d) 50 %
43. Extrusion process can effectively reduce the cost of product through
- (a) Material saving
 - (b) Process time saving
 - (c) Saving in tooling cost
 - (d) Saving administrative cost
44. Which of the following is an inversion of double slider crank chain?
- (a) Whitworth quick return mechanism
 - (b) Reciprocating compressor
 - (c) Scotch yoke mechanism
 - (d) Rotary engine
45. Quick return mechanism is used in
- (a) Milling machine
 - (b) Slotter
 - (c) Universal lathe machine
 - (d) Hook's coupling
46. Break even point (BEP) indicates
- (a) Recovery of variable cost
 - (b) Recovery of fixed cost
 - (c) Recovery of both of the above costs
 - (d) Recovery of fixed, variable costs, and margin of profit
47. Out of the following which type of coding system is used in NC programming?
- (a) Indian coding system
 - (b) Binary coding system
 - (c) Discrete coding system
 - (d) None of the above
48. GO-NO GO gauges are used for inspection of
- (a) Variables
 - (b) Attributes
 - (c) Both variables and attributes
 - (d) None of these
49. A comparator for its working depends on
- (a) Accurately calibrated scale
 - (b) Comparison with standard such as slip gauges
 - (c) Accurate micrometer gauge
 - (d) Optical devices

50. When ordering cost is increased to 16 times the EOQ will be increased to -
(a) 2 times
(b) 4 times
(c) 8 times
(d) None of the above
51. A Carnot engine operates between reservoirs at 20°C and 200°C. If 20 kW of power is produced, the rejected heat rate is nearest
(a) 26.3 kJ/s
(b) 32.5 kJ/s
(c) 16.3 kJ/s
(d) 12 kJ/s
52. An inventor invents a thermal engine that operates between ocean layers at 27°C and 10°C. It produces 15 kW and discharges 7200 kJ/min of heat. Such an engine is
(a) Impossible
(b) Reversible
(c) Possible
(d) Probable
53. In a taper turning operation, maximum and minimum diameters of the job are 'D' and 'd' respectively. What is the taper angle, if the job length is L?
(a) $2 \tan^{-1} \left(\frac{D-d}{2L} \right)$
(b) $\tan^{-1} \left(\frac{D-d}{L} \right)$
(c) $\tan^{-1} (D - d)$
(d) $2 \tan^{-1} \left(\frac{D-d}{L} \right)$
54. When a system is in equilibrium, any conceivable change in entropy would be
(a) Maximum
(b) Zero
(c) Positive
(d) Negative
55. The slope of constant pressure line on a T-s diagram is given by
(a) $\frac{C_p}{T}$
(b) $\frac{T}{C_p}$
(c) $\frac{s}{T}$
(d) $\frac{T}{s}$
56. Pseudo-plastic substance are non-Newtonian fluids for which:
(a) Dynamic viscosity increases as the rate of shear increases
(b) Dynamic viscosity decreases with the time for which shearing forces applied
(c) Dynamic viscosity increases with time for which shearing force applied.
(d) Dynamic viscosity decreases as the rate of shear increases

57. Redwood viscometer _____.
(a) Absolute value of viscosity is determined
(b) Part of the head of fluid is utilized in overcoming friction
(c) Fluid discharges through orifice with negligible velocity
(d) Comparison of viscosity is done
58. The chip thickness during slab milling operation is directly proportional to
(a) Cutter's rotation speed
(b) Angle of contact of tooth
(c) Number of teeth of the cutter
(d) Feed rate of the workpiece
59. The angle of contact in case of a liquid depends upon;
The nature of the liquid and the solid
The material which exists above the free surface of the liquid.
(a) Only A
(b) Only B
(c) Both A and B
(d) Neither A nor B
60. Maximum shear stress theory was postulated by ____.
(a) St. Venant
(b) Mohr
(c) Rankine
(d) Tresca
61. A body is subjected to principle stresses at a point having value as 200 MPa, 150 MPa and 100 MPa respectively. what is the value of maximum shear stress in (MPa)
(a) 25
(b) 50
(c) 75
(d) 100
62. The spindle of a machine tool is subjected to the following type of load-
(a) Torsional load
(b) Bending load
(c) Axial compressive load
(d) Axial tensile load
63. Two shafts A and B are made of the same material. The diameter of shaft B is twice that of shaft A. the ratio of power which can be transmitted by shaft A to that of shaft B is _____.
(a) $1/2$
(b) $1/4$
(c) $1/8$
(d) $1/16$

64. Force F in the given figure equals to



- (a) $\sqrt{3}$ kN
 - (b) 2 kN
 - (c) $-\sqrt{3}$ kN
 - (d) $3\sqrt{3}$ kN
65. At what efficiency a machine can be called as an ideal machine?
- (a) Between 60 and 70%
 - (b) Between 70 and 80%
 - (c) Between 80 and 90%
 - (d) 100%
66. A machine part is designed as a strut, when it is subjected to
- (a) An axial tensile stress
 - (b) An axial compressive stress
 - (c) A tangential force
 - (d) Any one of the above
67. A rubber ball is dropped from a height of 2m. If there is no loss of velocity after rebounding the ball will rise to a height of
- (a) 1 m
 - (b) 2 m
 - (c) 3 m
 - (d) 4 m
68. A spherical drop of molten metal of radius 2 mm was found to solidify in 10 seconds. A similar drop of radius 4 mm would solidify in
- (a) 14-14 sec.
 - (b) 20 sec.
 - (c) 28.30 sec.
 - (d) 40 sec.
69. The number of instantaneous centers for the mechanism having 5 links is.....
- (a) 6
 - (b) 4
 - (c) 12
 - (d) 10
70. The primary function of the flywheel is:
- (a) To limit the fluctuations of speed during each cycle
 - (b) To absorb energy during these periods of crank rotation when turning moment is less than the resisting points
 - (c) To maintain the constant speed of rotation of the crankshaft when the load on the engine increases
 - (d) To maintain constant speed of rotation of the crank shaft when the load on the engine decreases

71. The power of a governor is equal to:

- (a) $\frac{c^3}{1+2c} (m + M)gh$
- (b) $\frac{2c^2}{1+2c} (m + M)gh$
- (c) $\frac{3c^2}{1+2c} (m + M)gh$
- (d) $\frac{4c^2}{1+2c} (m + M)gh$

Where, c = Percentage increase in speed

h = Height of governor

M = mass of each ball

M = Mass of central load

72. In gramophones for adjusting the speed of the turntable, the following type of governor is commonly employed

- (a) Hartung governor
- (b) Wilson Hartnell governor
- (c) Pickering governor
- (d) Inertia governor

73. High pressure steam is expanded adiabatically and reversible through a well-insulated turbine which produces some shaft work. If the enthalpy change and entropy change across the turbine are represented by ΔH and ΔS , respectively, for this process:

- (a) $\Delta H = 0$ and $\Delta S = 0$
- (b) $\Delta H \neq 0$ and $\Delta S = 0$
- (c) $\Delta H \neq 0$ and $\Delta S \neq 0$
- (d) $\Delta H = 0$ and $\Delta S \neq 0$

74. The process of sublimation is found to occur in case of

- (a) Liquid nitrogen
- (b) Solid carbon di-oxide
- (c) Solid oxygen
- (d) Air

75. Consider the following statements:

1. Thermodynamics properties are the macroscopic coordinates significant only for systems existing in states of thermodynamic equilibrium.
2. Engineering thermodynamics studies about transfer and transformation energy.
3. Engineering thermodynamics studies about storage, transfer and transformation of energy.

Which of the above statements is/are true?

- (a) 3 only
- (b) 1 and 3
- (c) 2 only
- (d) None of these

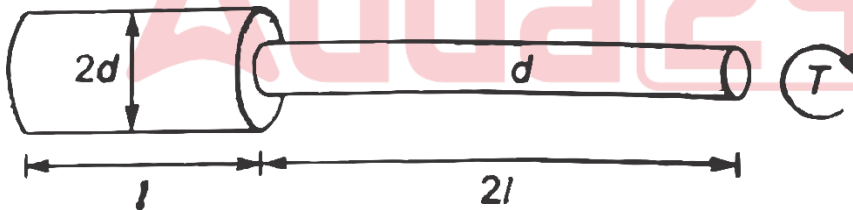
76. Which one of the following is correct relation between $(COP)_{HP}$ and $(COP)_R$
- (a) $(COP)_{HP} - (COP)_R = 1$
 - (b) $(COP)_R - (COP)_{HP} = 1$
 - (c) $(COP)_{HP} + (COP)_R = 1$
 - (d) $(COP)_{HP} + (COP)_R = 0$
77. Horse power and kW required per ton of refrigeration is expressed as
- (a) $\frac{4.75}{COP}$ and $\frac{3.5}{COP}$
 - (b) $\frac{3.75}{COP}$ and $\frac{4.75}{COP}$
 - (c) $4.75 \times COP$ and $3.5 \times COP$
 - (d) $\frac{4.5}{COP}$ and $\frac{3.75}{COP}$
78. In most of water coolers, the atmospheric air is made to pass through a wet khas-khas or bamboo mat to render a surface cool in summer. Thermodynamically, this process may be called
- (a) Sensible cooling
 - (b) Cooling and dehumidification
 - (c) Cooling and humidification
 - (d) Adiabatic saturation
79. When atmospheric air is heated at constant pressure its
1. Humidity ratio does not change.
 2. Relative humidity increases
 3. Dew point temperature does not change
 4. Wet bulb temperature increases
- Which one of the following is correct?
- (a) 1 and 3
 - (b) 1 and 2
 - (c) 2 and 3
 - (d) 3 and 4
80. Which is not a boiler accessory?
- (a) Economizer
 - (b) Fusible plug
 - (c) Superheater
 - (d) Air preheater
81. Consider the following statements in respect of regenerative Rankine cycle:
- Regeneration increases the efficiency of the cycle.
- The boiler capacity is increased for a given output.
- The capacity of the condenser is reduced.
- Which of the above statements are correct?
- (a) 1, 2 and 3
 - (b) 1 and 2 only
 - (c) 1 and 3 only
 - (d) 2 and 3 only

82. In an experiment, the following shear stress-time rate of shear strain values are obtained for a fluid:

Time rate of shear strain (1/S)	0	2	3	4
Shear stress (kPa)	0	1.4	2.6	4

How can the fluid be classified?

- (a) Newtonian fluid
 - (b) Bingham plastic
 - (c) Pseudo plastic
 - (d) Dilatant
83. A rectangular tank of square cross-section (2 m × 2m) and height 4 m is completely filled up with a liquid. The ratio of total hydrostatic force on any vertical wall to its bottom is-
- (a) 2.0
 - (b) 1.5
 - (c) 1.0
 - (d) 0.5
84. At a point on a streamline, the velocity is 3 m/s and the radius of curvature is 9 m. if the rate of increase of velocity along the streamline at this point is 1/3 m/s/m, then the total acceleration at this point would be _____.
- (a) 1 m/s²
 - (b) 3 m/s²
 - (c) 1/3 m/s²
 - (d) $\sqrt{2}$ m/s²
85. Calculate the total angle of twist for a stepped shaft which is subjected to the torque (T) as shown in the figure below



- (a) $\frac{Tl}{\pi G d^4}$
 - (b) $\frac{66Tl}{\pi G d^4}$
 - (c) $\frac{Tl}{66G d^4}$
 - (d) $\frac{36Tl}{\pi G d^4}$
86. A cantilever beam is deflected by due to load P if load is doubled, then deflection compared to earlier case will be changed by a factor of:
- (a) 2
 - (b) 1/2
 - (c) 1/8
 - (d) 8

87. A uniform simply supported beam of span (l) carries a point load (W) at the center. The downward deflection at the center will be=
- (a) $Wl^2/8EI$
 - (b) $Wl^3/3EI$
 - (c) $5 Wl^3/384 EI$
 - (d) $Wl^3/48 EI$
88. The longitudinal stress in a thin (thickness) cylinder pressure vessel of diameter d and internal pressure, p is
- (a) $\frac{pd}{t}$
 - (b) $\frac{pd}{2t}$
 - (c) $\frac{pd}{4t}$
 - (d) $\frac{pd}{8t}$
89. For a thin spherical shell subjected to internal pressure, the ratio of volumetric strain to diametrical strain is ____.
- (a) 5: 4
 - (b) 3: 2
 - (c) 2: 1
 - (d) 3: 1
90. The angular speed of a Watt's governor when its height is 20 cm, will be equal to:
- (a) 10 rad/sec
 - (b) 20 rad/sec
 - (c) 6 rad/sec
 - (d) 7 rad/sec
91. In grinding operation, for grinding harder material:
- (a) coarser grain size is used
 - (b) fine grain size is used
 - (c) medium grain size is used
 - (d) any grain size may be used
92. Partial balancing in locomotives results in:
- (a) hammer blow, variation of tractive effort, swaying couple
 - (b) least wear
 - (c) most smooth operation
 - (d) better performance of engine
93. In order to facilitate the starting of locomotive in any position, the cranks of a locomotive with two cylinders are placed at following angle to each other
- (a) 45°
 - (b) 90°
 - (c) 135°
 - (d) 180°

94. Consider the following characteristics

1. The cutting edge is normal to the cutting velocity
2. The cutting forces occur in two directions only.
3. The cutting edge is wider than the depth of cut.
4. The characteristics applicable to orthogonal cutting would include

- (a) 1 and 2
- (b) 1 and 3
- (c) 2 and 3
- (d) 1, 2 and 3

95. Plain milling of mild steel plate produces

- (a) irregular shaped discontinuous chips
- (b) Regular shaped discontinuous chip
- (c) Continuous chips without built up edge
- (d) Joined chips

96. A strip is to be rolled from a thickness of 30 mm to 15 mm using a two-high mill having rolls of diameter 300 mm. the coefficient of friction for unaided bite should nearly be

- (a) 0.35
- (b) 0.5
- (c) 0.25
- (d) 0.07

97. Match list – I with List – II and select the correct answer using the codes gives below the Lists:

List – I

- A. Drawing
- B. Rolling
- C. Wire drawing
- D. Sheet metal operations

List – II

1. Soap solution
2. Camber
3. Pilots
4. Crater

using Progressive dies 5. Ironing

Code:

- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 5 | 1 | 4 |
| (b) | 4 | 1 | 5 | 3 |
| (c) | 5 | 2 | 3 | 4 |
| (d) | 5 | 2 | 1 | 3 |

98. A work piece is turned on a lathe at 100m/min cutting speed, 0.4 mm/rev feed and 1.5 mm depth of cut. What is the rate of metal removal?

- (a) 20000mm³/min
- (b) 60000 mm³/min
- (c) 1000 mm³/min
- (d) 155 mm³/min

99. Rankine's theory is valid to

- (a) long column
- (b) short column
- (c) both
- (d) None of the above

100. A long circular cylinder has a diameter D and length L. the slenderness ratio of the column is

- (a) $\sqrt{\frac{L}{D}}$
- (b) $\left(\frac{L}{D}\right)$
- (c) $\left(\frac{2L}{D}\right)$
- (d) $\left(\frac{4L}{D}\right)$

Solutions

1. (d)

Sol. for a helical spring index (C) = $\frac{D}{d}$

$$C = \frac{\text{Mean coil diameter (D)}}{\text{Wire diameter (d)}}$$

2. (a)

Sol. Spring stiffness, $K = \frac{Gd^4}{8D^3N}$

$$K' = \frac{G \times 2^4 \cdot d^4}{8 \times 2^3 \times D^3 N} = 2 \left[\frac{Gd^4}{8D^3N} \right] = 2K$$

3. (a)

Sol. Kinetic energy = Potential energy of spring of body

$$= \frac{1}{2} Kx^2 = mg(h + x)$$

But 'k' is in kg/cm.

So, to convert in N/cm multiply by 9.81 in stiffness.

Then

$$\frac{1}{2} \times 500 \times 9.81 \times x^2 = 1000 \times 9.81 \times (8 + x)$$

$$\Rightarrow x^2 = 4x + 32$$

$$x = 8 \text{ cm}$$

So, the deformation of spring will be 8 cm

4. (c)

Sol. In cam-follower mechanism,

$\frac{Wds}{d\theta} \rightarrow$ velocity of follower

$\frac{W^2 d^2 s}{d\theta^2} \rightarrow$ Acceleration of follower

$$\frac{W^3 d^3 s}{d\theta^3} \rightarrow \text{jerk of follower}$$

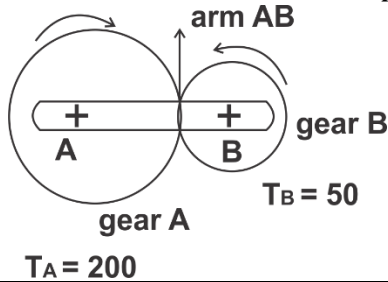
5. (c)

Sol. back gear mechanism uses reverted gear train.

Back gears are mounted on eccentric shaft and used to reduce speed in lathe.

6. (d)

Sol. we can follow tabular approach,



Element Position	Arm N _{arm}	A N _A	B N _B = $\frac{T_A}{T_B}$
Arm-stationary	0	1	$\frac{T_A}{T_B}$
Arm speed y and Gear A speed x clockwise	y	y + x	y - x $\frac{T_A}{T_B}$

So, $N_B = 5$ (after putting values)

7. (b)

Sol. for a simple gear train speed ratio can be defined as

$$\frac{N_{\text{driver}}}{N_{\text{driven}}} = \frac{N_1}{N_2} = \frac{T_2}{T_1}$$

T_1 = No. of teeth on gear 1 or driver gear

T_2 = No. of teeth on gear 2 or driven gear

8. (c)

Sol. given, amplitude (a) = 10 cm, frequency (f) = 10 vibrations/sec

$$\omega = 2\pi f$$

Max velocity $V_{\text{max}} = ?$

We know,

$$V_{\text{max}} = a\omega \text{ [S. H. M.]}$$

$$= 10 \times 2\pi \times 10$$

$$V_{\text{max}} = 200\pi \text{ cm/sec}$$

9. (a)

Sol. Given,

1 Main scale division (MSD) = 0.1 mm

Also, 9 Vernier scale division (VSD) = 10 MSD

1 VSD = 0.9 MSD

$$= 0.9 \times 0.1 \text{ mm}$$

$$= 0.09 \text{ mm}$$

We know that

$$\text{Least count (LC)} = \text{MSD} - \text{VSD}$$

$$= 0.1 - 0.09$$

$$= 0.01 \text{ mm}$$

10. (c)

Sol. An optical gauge works on the principle of interference of light rays. Interference of light is the phenomenon in which two waves are superimpose to form a resultant wave of the lower, higher or same amplitude.

11. (b)

Sol.

Given:

Plate thickness (t) = 16 mm

Tensile load = 60 kN

We know that,

From unwin formula's

$$d = 6\sqrt{t}$$

$$= 6\sqrt{16} = 6 \times 4$$

$$= 24 \text{ mm}$$

12. (b)

Sol.

In NC machine tools, the binary systems is used. In this system, the base of the system is 2 and only two characters 0 and 1 are required. Binary system is also used in computer programming therefore it is more compatible with NC machine.

Operations based NC machine tools is based on prepared programmes which consists of blocks or series of numbers in a coded language.

13. (c)

Sol.

In part programming for CNC machine, program done for the production of a component by using standard codes known as part program.

Code M06 is used for tool change.

Code M03 is used for the spindle start clockwise

Code M04 is used for the spindle start anti-clockwise

Code M05 is used for the spindle stop.

14. (b)

Sol.

Floating zero is the CNC feature that allows the zero reference point to be set at any place on the machine table. The zero position of a CNC machine can be placed anywhere as needed.

Fixed zero is the origin of CNC coordinate system, which is always situated at the same point on machine tool and used for reference.

Fixed origin is a fixed position assigned as machine origin by manufacturer that cannot be changed.

15. (a)

Sol.

Oldham's coupling is a third inversion of slider crank chain and which is obtain by fixing the connecting link. It is used to join two shafts which have lateral miss alignment.

It is used to connect two shafts together at their ends for the purpose of transmitting power

An Oldham's coupling has three discs, one coupled to the input, one coupled to the output and the middle disc that is joined to the first two by tongue and groove. Middle disk rotates with input and output disc about its centre.

16. (c)

Sol.

We know that

$$dQ = dW + dU$$

for reversible isothermal process

$$dU = 0$$

$$\therefore dQ = dW$$

$$dW = 200 \text{ kW}$$

17. (a)

Sol.

A pyrometer or infrared thermometer is a device for non – contact temperature measurement. Pyrometer is used for measuring relatively high temperature, such as in furnace.

A pyrometer works by measuring radiation from the body whose temperature is to be measured. Radiation devices have the advantages of not touch the material being measured.

18. (c)

Sol.

Given, work input (W) = 2 kJ = 2000J (-ve)

Rejected heat (Q) = 1400 J (-ve)

mass = 2 kg

first law of thermodynamics,

$$dQ = dW + dU$$

$$dU = 2000 - 1400$$

$$= 600 \text{ J}$$

$$\text{Sp. Internal energy}(u) = \frac{\text{Internal energy}}{\text{mass}} = \frac{600}{2}$$

$$u = 300 \text{ J/kg}$$

19. (c)

Sol.

According to chvorinov rule,

$$\text{Solidification time} = K \left(\frac{V}{SA} \right)^2$$

Where V = Volume of casting

SA = Surface area of casting

20. (c)

Sol.

Centrifugal casting moulding processes does not require use of core.

In this process the molten metal is poured in a mould and allowed to solidify while the mould is revolving the metal solidifies under the pressure of centrifugal force.

21. (b)

Sol.

According to kelvin – Planck statement,” It is impossible to create a device, which produces work while exchanging heat from a single reservoir.

PMM2 is defined as such type of device, which violates the second law of thermodynamics because such machines will absorb continuously heat energy from a single thermal reservoir and will convert the absorbed heat energy completely into work energy.

Such machines will have 100% efficiency, which is impossible in practical.

22. (d)

Sol.

Casting defects are:

(i) Blow hole and open blow

(ii) Cuts and washes

(iii)

(iv)

(v) Misruns and cold shuts

(vi)

(vii)

(viii)

(ix)

(x) Hot spot

Fusion

Hot tear

Pin hole porosity

Metal penetration

Runout

Slag inclusion

23. (a)

Sol.

Strouhal number is expressed as,

$$S = 0.2 \left[1 - \frac{20}{Re} \right] = \frac{fD}{V}$$

Strouhal number is inverse of Reynold's number but Strouhal number decreases very slowly with increase in Re .

24. (c)

Sol.

In advance pressure gradient boundary layer flow the boundary layer may at some section leave the boundary. This is called as separation and downstream of the separation section turbulent eddies exist and this distorted region is called as wake.

25. (b)

Sol.

Reynold number is the factor by which type of flow is decided i.e. laminar or turbulent.

For laminar flow,

$$R_e < 2000$$

For transition flow,

$$2000 < R_e < 4000$$

For turbulent flow,

$$R_e > 4000$$

26. (a)

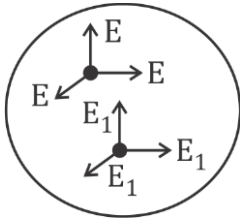
Sol.

When adhesion force is more than cohesion force then angle of contact between fluid and surface will be less than 90° and fluid will wet the surface.

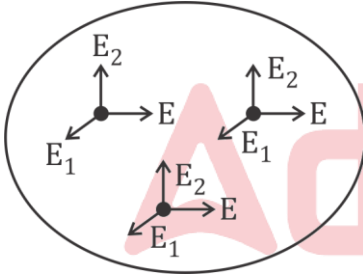
When adhesion force is less than cohesion force then angle of contact between fluid and surface will be greater than 90° and fluid will not wet the surface.

27. (c)

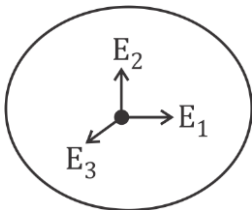
Sol.



Isotropic – The materials which exhibit the same elastic properties in all directions at a given point.



Homogeneous – Those materials which have same elastic properties at all the points in any particular direction.



Anisotropic – Those materials which exhibit different elastic properties in different direction at a given point.

28. (a)

Sol.

α -iron is body centered cubing having each atom at the corner of the cube.

$$\text{Share of each atom} = \frac{1}{8}$$

$$\text{So total atom} = \frac{1}{8} \times 8 = 1$$

and one at the center, so total = 1 + 1 = 2 atoms.

29. (c)

Sol.

Fundamental tolerance in terms of mean diameter D is given by

$$i = 0.45(D)^{1/3} + 0.001D.$$

Fundamental tolerance is varies with basic size; if basic size increases then tolerances will also increases.

30. (a)

Sol.

For equal bilateral tolerances, the tolerance of the gap.

$$x = (40_{-0.5}^{+0.5}) - (10_{-0.3}^{+0.3}) = (40 - 10)_{-0.5-0.3}^{+0.5+0.3} = 30 \pm 0.8 \text{ mm}$$

31. (a)

Sol.

(i) Low carbon steel – (< 0.25)% carbon

(ii) Medium carbon steel – (0.25 to 0.60)% carbon

(iii) High carbon steel – (0.60 to 1.4)% carbon

32. (b)

Sol.

The stress-strain relationship of rubber can be defined as non-linearly elastic, isotropic, incompressible and generally independent of strain rate.

33. (d)

Sol.

A crucible is a pot that is used to keep metals for melting in a furnace. Furnace crucibles are designed to withstand the highest temperatures encountered in the metal casting works and it is made of graphite.

34. (c)

Sol.

Given, Hole – $30_{+0.02}^{+0.07}$ and shaft – $30_{-0.01}^{+0.05}$ mm.

Upper limit of shaft = $30 + 0.05 = 30.05$ mm

Lower limit of hole = $30 + 0.02 = 30.02$ mm

Maximum interference = Upper limit of the shaft – Lower limit of hole

$$= (30.05 - 30.02) \text{ mm}$$

$$= 0.03 \text{ mm}$$

35. (a)

Sol.

The spindle on which the milling cutter is mounted may be horizontal for slab milling or vertical for face and end miling. Hence, milling machine is classified as horizontal or vertical type, depending on the position of spindle.

36. (a)

Sol.

Size of shaper is specified by length of stroke. In the shaper, the cutting tool has a reciprocating motion and it cuts only during the forward stroke only.

37. (b)

Sol.

Orthogonal cutting system is also called two-dimensional cutting system, while oblique cutting system is defined as three-dimensional cutting system.

38. (c)

Sol.

In a drill operation, torque is less than the axial force, as axial force comprises of thrust component (P_x) on the web which is greater than force required (P_z) to twist the drill.

39. (a)

Sol. Motion is not from σ_M of Six-Sigma.

Six sigma is an business statistical strategy. It is used to identify defects and removing them from the process of products to improve quality.

Biu Smith, "Father of Six Sigma" introduces this quality improvement methodology to Motorola.

σ_M of Six-Sigma :

- i) Method
- ii) Man
- iii) Machine
- iv) Materials
- v) Measurement
- vi) Mother Nature

40. (c)

Sol.

Infeasible solution – In the simplex method, if artificial variables are present in the basis, then the solution obtained is infeasible.

For feasible solution, at least one of the basic variable is zero and at any iteration of simplex method more than one variable is eligible to leave the basis.

41. (d)

Sol.

Standard deviation of critical path, σ_{cp}

$$\sigma_{cp} = \sqrt{\text{sum of variance along critical path}}$$

$$\sigma_{cp} = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 + \sigma_4^2}$$

$$\sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = 2 \text{ (given)}$$

$$\sigma_{cp} = \sqrt{2^2 + 2^2 + 2^2 + 2^2} = \sqrt{16}$$

$$\sigma_{cp} = 4$$

42. (b)

Sol. In ideal case, the maximum possible draw stress is equal to the yield strength of the work material.

$$\text{Drawing stress } \sigma_d = \sigma_o \ln \left(\frac{A_o}{A_f} \right)$$

A_o = initial area A_f = final area

For maximum reduction, $\sigma_d = \sigma_o$

$$\sigma_o = \sigma_o \ln \left(\frac{A_o}{A_f} \right)$$

$$\therefore \frac{A_o}{A_f} = e^1 = 2.7183$$

$$\Rightarrow r_{\max} = 1 - \frac{A_f}{A_o} = 1 - 1/e = \frac{e-1}{e} = 0.632$$

$\therefore$ Maximum possible reduction per pass is 63.2%

43. (c)

Sol. In extrusion process, static force is applied and material flows into the desired shape due to this force. Hence tooling cost is saved.

44. (c)

Sol.

The double slider crank mechanism has two sliding pairs and two twist pairs.

There are three important inversions of the double slider crank chain. These are as follows–

1. Elliptical trammel
2. Scotch yoke mechanism
3. Oldham's coupling

Whitworth quick return mechanism, Reciprocating compressor and rotary engine are the inversion of single slider crank chain.

45. (b)

Sol.

Quick return mechanism is used in crank and slotted lever type mechanism.

Quick return mechanism is known as a principle used to convert circular motion into reciprocating motion, allowing slider to move forward and backward.

The cutting process occurs in the forward motion but there is no corresponding cutting in the reverse direction so the tool returns at its initial position quickly.

46. (c)

Sol.

Break even point indicates the recovery of both fixed and variable costs.

At Break even point, Total cost is equal to the sales revenue and it establishes the relationship among factors affecting profit. It is the simple method of presenting to management the effect of changes in volume on profit.

$$\text{Break even quantity} = \frac{\text{Fixed cost (F)}}{\text{Sales price per unit (S)} - \text{Variable cost per unit (V)}}$$

47. (b)

Sol.

NC machining is the form of programmable automation in which the process is controlled by the number letters and symbols which used in binary coding system, here automation of medium and small volume production is done by some controls under the instructions of a program. It requires more time for the execution of the job in comparison with special purpose machine tool.

48. (b)

Sol.

GO-NO GO gauges are used for inspection of attributes.

NO GO gauges are design at minimum material limit condition and NO gauges are designed at maximum material limit condition.

GO gauges are designed to check shape as well size and has to be in full form.

49. (b)

Sol.

Comparator is an instrument used for comparing the dimensions of a component with a standard of length. Purpose of a comparator is to detect and display the small differences between the unknown linear dimensions and standard length.

To maintain precision in the measurement comparators are not allowed to move large distances.

50. (b)

Sol.

$$[EOQ]_1 = \sqrt{\frac{2DC_o}{C_c}}, \text{ where, } C_o = \text{ordering cost}$$

CC = Carrying or holding cost

D = Demand

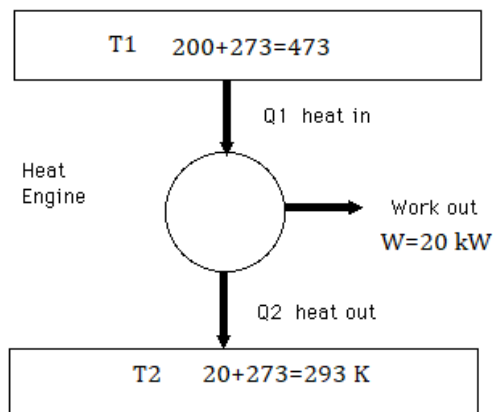
If C_o increased to $16C_o$

$$\therefore [EOQ]_2 = \sqrt{\frac{2D(16C_o)}{C_c}} = 4 \times \sqrt{\frac{2D.C_o}{C_c}}$$

$$[EOQ]_2 = 4. [EOQ]_1$$

51. (b)

Sol.



Given,

Work output (W)=20 kW

Heat rejected Q_2 =?

Efficiency of Carnot cycle engine (η)= $1 - \frac{T_2}{T_1} = \frac{W}{Q_1}$

$$(\eta) = 1 - \frac{293}{473} = \frac{20}{Q_1}$$

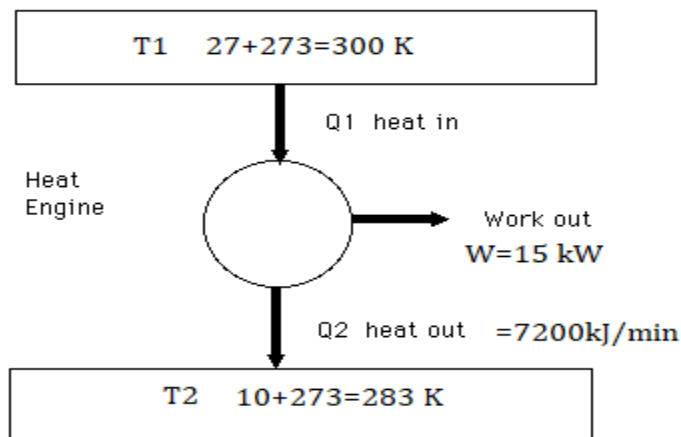
$$Q_1 = 52.55 \text{ kW}$$

Hence, Heat rejected $Q_2 = Q_1 - W$

$$Q_2 = 52.55 - 20 = 32.55 \text{ kW}$$

52. (a)

Sol.



Efficiency of Carnot Cycle engine (η)= $1 - \frac{T_2}{T_1} = 1 - \frac{283}{300}$

$$(\eta) = 0.0566 \text{ or } 5.66\%$$

Efficiency of engine invented by inventor (η')= $\frac{W}{Q_1} = \frac{W}{Q_2 + W}$

$$(\eta') = \frac{15}{120 + 15} = 0.111 \text{ or } 11.11\% \text{ (Here, } Q_2 = \frac{7200}{60} = 120 \text{ kW)}$$

As, Efficiency of engine invented by inventor (η') > Efficiency of Carnot Cycle engine (η)

Which is impossible because no heat engine will have more efficiency than that of Carnot cycle engine when both engines working between the same temperature limits.

53. (a)

Sol.

In a taper turning operation,

$$\tan \alpha = \frac{D-d}{2L}$$

where

α = Half taper angle

D = Maximum diameter of job

d = Minimum diameter of job

L = Job length

$\Rightarrow$ Taper angle,

$$2\alpha = 2 \tan^{-1} \left(\frac{D-d}{2L} \right)$$

54. (b)

Sol. When a system is in equilibrium, any conceivable change in entropy would be zero.

Because when a system reaches in equilibrium state then its entropy will be maximum at that state.

55. (b)

Sol. We know that,

$$TdS = dH - VdP$$

$$TdS = dH \text{ (for constant pressure process } dP = 0)$$

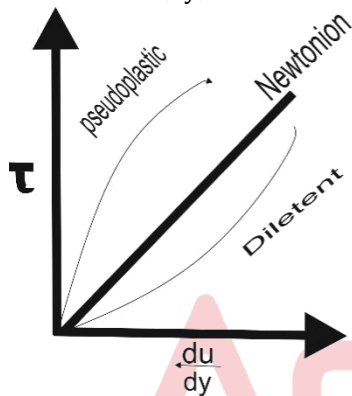
$$TdS = C_p dT$$

$$\frac{dT}{dS} = \frac{T}{C_p} \text{ (Slope of T-S curve for constant pressure process)}$$

56. (d)

Sol. For pseudoplastic fluid follows power law

$$\tau = B + k \left(\frac{dV}{dy} \right)^n$$



$$\tau = k \left(\frac{dV}{dy} \right)^n \text{ if } B = 0$$

$$\tau = \left[k \left[\frac{dV}{dy} \right]^{n-1} \right] \cdot \frac{dV}{dy}$$

$$\tau = \mu_{app} \cdot \frac{dV}{dy} \text{ [Where } \mu_{app} = k \left[\frac{dV}{dy} \right]^{n-1}]$$

$$\tau = B + \mu_{app} \left(\frac{dV}{dy} \right) \quad \text{from figure we can see that}$$

pseudo – plastic follows decreasing slope

Which indicates that as the rate of shear increases than dynamic viscosity is decreases.

57. (a)

Sol. A redwood viscometer is used to measure redwood viscosity which is further converted into kinematic viscosity. It is used to measure the flow of different fluids like petrol, glycol, engine oil and further find out kinematic viscosity with help of constant.

58. (d)

Sol. Thickness of the chip during slab milling operation is directly proportional to the feed rate of the workpiece. i.e. $t_c \propto f$

Here, t_c is thickness of chip (in mm) and f is table feed (in mm/rev).

59. (c)

Sol. The angle of contact depends upon both the cohesion force and adhesion force both. Therefore both statements are correct.

60. (d)

Sol. Maximum shear stress theory also known as Guest & Tresca theory because it is postulated by Tresca.

61. (b)

Sol. Given

$$\sigma_1 = 200 \text{ MPa}, \sigma_2 = 150 \text{ MPa}, \sigma_3 = 100 \text{ MPa}$$

Maximum shear stress

$$\left(\frac{\sigma_1 - \sigma_2}{2} \right) \text{ or } \left(\frac{\sigma_2 - \sigma_3}{2} \right) \text{ or } \left(\frac{\sigma_3 - \sigma_1}{2} \right)$$

$$\text{So, } \left(\frac{200 - 100}{2} \right) = 50 \text{ MPa}$$

62. (a)

Sol. The spindle of a machine tool is subjected to torsional load. the spindle undergoes rotation, loading to torsional stress.

63. (c)

Sol. Torque transmitted torque shaft

$$T = \frac{\pi}{16} D^3 \tau$$

$$T \propto D^3$$

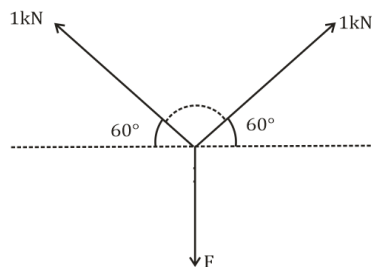
$$\text{Power, } P = T\omega$$

$$P \propto T \propto D^3$$

$$\frac{P_A}{P_B} = \frac{D_A^3}{D_B^3} = \left[\frac{1}{2} \right]^3 = \frac{1}{8}$$

64. (a)

Fig.



Sol. from lami's theorem

$$\frac{1}{\sin 150} = \frac{F}{\sin 60^\circ}$$

$$F = \frac{\sin 60^\circ}{\sin 150^\circ}$$

$$F = \sqrt{3} \text{ N}$$

65. (d)

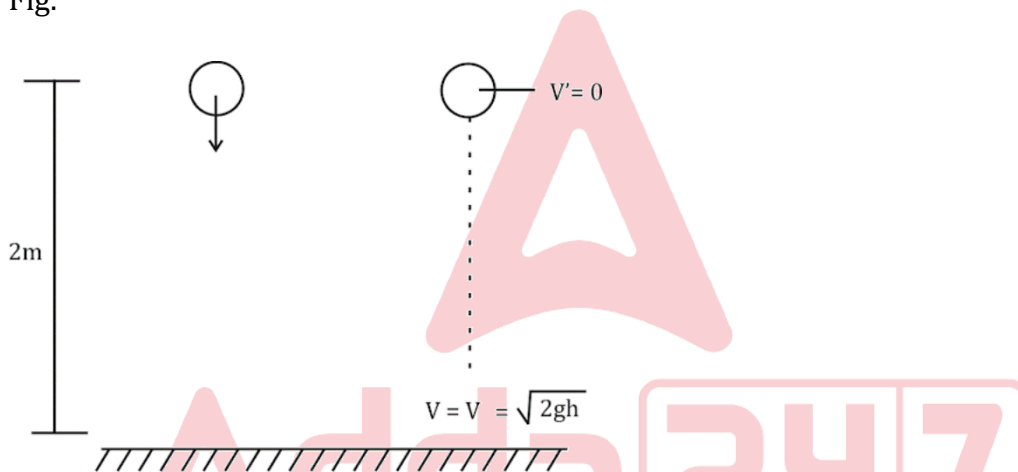
Sol. The machine is called to be an ideal Machine when It convert Total Input Total output without any Loss. i.e. 100% efficiency.

66. (b)

Sol. For a system if degree of freedom is zero than it can be called truss or frame because there is no relative motion between the member of the system. A machine part is designed as a strut, when it is subjected to an axial compressive stress.

67. (b)

Fig.



Sol. When it comes to the floor its velocity is

$$V = \sqrt{2gh}$$

After rebounding it will go with the same speed.

$$\therefore v^2 = u^2 + 2gh$$

$$v'^2 = v^2 - 2gh$$

$$0 = (\sqrt{2g} \times 2)^2 - 2gh$$

$$h = 2m$$

68. (d)

Sol.

$$\text{For spherical casting, } \frac{V}{A} = \frac{\frac{4}{3}\pi r^3}{4\pi r^2} = \frac{r}{3}$$

$$\text{and solidification time } (t_{s_1}) = K \left(\frac{V}{A}\right)^2 = K \left(\frac{r_1}{3}\right)^2 \quad \dots(i)$$

$$\text{For, } r_2, \quad t_{s_2} = K \left(\frac{r_2}{3}\right)^2 \quad \dots(ii)$$

From (i) & (ii), we get

$$\frac{t_{s1}}{t_{s2}} = \frac{K\left(\frac{r_1}{3}\right)^2}{K\left(\frac{r_2}{3}\right)^2} = \left(\frac{r_1}{r_2}\right)^2$$

$$\Rightarrow \frac{10}{t_{s2}} = \left(\frac{2}{4}\right)^2 \Rightarrow t_{s2} = 40 \text{ sec.}$$

69. (d)

Sol. We know,

$$\text{No. of instantaneous center (N)} = \frac{n(n-1)}{2} \text{ ----- (1)}$$

n – No. of links

From eqn. (1)

$$N = \frac{5(5-1)}{2}$$

$$\boxed{N = 10}$$

70. (a)

Sol. A flywheel is a device which resists the fluctuation of speed of engine during each cycle of engine due to its inertia.

It stores excess energy and also provide energy to engine wheels when there is requirement of more energy.

Max fluctuation of energy

$$\boxed{\Delta E = I\omega^2 k}$$

71. (d)

Sol. Power of a governor = Mean force on the sleeve × Sleeve movement

$$\text{Power of a porter governor} = c(m + m)g \times \frac{4hc}{(1+2c)}$$

$$\boxed{P = \frac{4c^2}{1+2c} (m + M)g \cdot h}$$

72. (c)

Sol. Pickering Governor is centrifugal type governor and used in gramophone.

Hartung governor is used to regulate the mean speed of an engine when there are variations in the load. Working of Hartnell governor is also same as hartung.

Intertia governors are used in the steam turbines.

73. (b)

Sol. For reversible adiabatic process, $\Delta S = 0$

After expansion in the turbine there would be an enthalpy change i.e. $\Delta H \neq 0$

74. (b)

Sol. The process of sublimation is found to occur in case of solid carbon di-oxide.

75. (b)

Sol. Thermodynamics properties are the macroscopic coordinates significant only for systems existing in states of thermodynamic equilibrium. Engineering thermodynamics studies about storage, transfer and transformation of energy.

76. (a);

Sol. Let T_H is the temperature at which heat is rejected and T_L is the temperature at which heat is absorbed in heat pump and refrigerator.

$$(\text{COP})_R = \frac{T_L}{T_H - T_L} \dots\dots\dots(1)$$

$$(\text{COP})_{HP} = \frac{T_H}{T_H - T_L} \dots\dots\dots(2)$$

From equation (1) and (2)

$$(\text{COP})_{HP} = 1 + (\text{COP})_R$$

77. (a);

Sol. We know that

$$\text{COP} = \frac{\text{Refrigeration effect in ton}}{\text{external power given}}$$

$$\text{External power given in kW} = \frac{3.5}{\text{COP}} \quad (\text{If refrigeration effect} = 1 \text{ ton}) \text{ and } (1 \text{ ton} = 3.5 \text{ kW})$$

$$\text{External power given in HP} = \frac{4.75}{\text{COP}} \quad (\text{If refrigeration effect} = 1 \text{ ton}) \text{ and } (1 \text{ ton} = 4.78 \text{ HP})$$

78. (d);

Sol. Most of the water cooler work on the principle of adiabatic saturation. Evaporative humidification processes normally occur without external heat transfer and are therefore adiabatic.

In adiabatic saturation or evaporative cooling, we get cooling of the air as sensible heat is used as latent heat of vaporization to vaporize the moisture at khas-khas surface. This moisture is removed by moving air. This transfer of moisture takes place due to differences in vapor pressures of khas-khas and dry-air. The vapor pressure depends upon moisture content and temperature of the cooling surface.

79. (a);

Sol. Due to sensible heating of atmospheric air at constant pressure, its dew point temperature and humidity ratio remain constant.

80. (b)

Sol. Boiler accessories are those equipments that are used to increase boiler effectiveness and efficiency. Such as- Superheater, Air-preheater, economizer, Reheater, feed pumps etc.

Boiler mountings are those devices that are used in the boiler for its safety. Such as- Fusible plug, safety valves, pressure gauge, steam stop valve, feed check valve, blow-off cock, water level sensor etc.

81. (a)

Sol. There are following effects of regeneration in Rankine cycle:

Regeneration increases mean temperature of heat addition, in turn increases thermal efficiency.

For same output of the cycle, boiler capacity has to be increased.

The capacity of the condenser is reduced due to less steam exit from the turbine.

82. (d)

Sol. We know that

$$\tau = \mu \frac{dv}{dy}$$

$$\mu_1 = \frac{\tau}{dv/dy}$$

$$\mu_1 = \frac{1.4}{2} = 0.7 \text{ pa. sec}$$

$$\mu_2 = \frac{2.6}{3} = 0.866 \text{ pa. sec}$$

$$\mu_3 = \frac{4}{4} = 1 \text{ pa sec}$$

We can see that μ_{app} is increasing which means $n > 1$ for power law of viscosity. This is the condition for dilatant fluid.

83. (c)

Sol. Hydrostatic force on Vertical wall

$$f = \rho \cdot g \cdot A \bar{X}$$

$$f_v = \rho \cdot g (2 \times 4) \left[\frac{4}{2} \right]$$

$$f_v = 16 \rho \cdot g$$

Hydrostatic force on bottom plate.

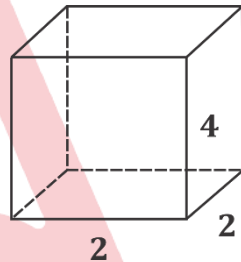
$$f_b = \rho g h \cdot A$$

$$f_b = \rho \cdot g \times 4 \times (2 \times 2)$$

$$f_b = 16 \rho g$$

Ratio of hydrostatic force on vertical wall to bottom plate is

$$\frac{f_v}{f_b} = \frac{16\rho g}{16\rho g} = 1$$



84. (d)

Sol. Tangential acceleration

$$a_t = \frac{dv}{dt} = \frac{dv}{ds} \cdot \frac{ds}{dt} = \frac{dv}{ds} \cdot v$$

$$= \frac{1}{3} \times 3 = 1 \text{ m/sec}^2$$

Radial acceleration

$$a_r = \frac{v^2}{r} = \frac{(3)^2}{9} = 1$$

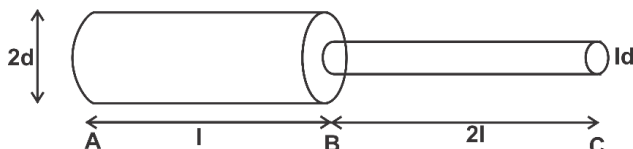
$$a = \sqrt{a_t^2 + a_r^2} = \sqrt{1^2 + 1^2} = \sqrt{2} \text{ m/s}^2$$

$$\left[\because v = \frac{ds}{dt} \right]$$

$$\left[\because \frac{dv}{ds} = \frac{1}{3} \text{ m/sec/m} \right]$$

85. (b)

Sol.



Torque will be same in both

$$\text{For AB } \theta_{AB} = \frac{Tl}{GJ} = \frac{Tl \times 32}{G\pi(2d)^4} = \frac{2Tl}{G\pi d^4}$$

$$\text{FOR BC } \theta_{AB} = \frac{Tl}{GJ} = \frac{T \times 2l \times 32}{G \times \pi d^4} = \frac{64Tl}{G\pi d^4}$$

Total angle of twist

$$\theta = \theta_{AB} + \theta_{BC} = \frac{2Tl}{G\pi d^4} + \frac{64Tl}{G\pi d^4} = \frac{66Tl}{G\pi d^4}$$

86. (a)

Sol. deflection when cantilever beam is subjected to load P

$$\delta_1 = \frac{PL^3}{3EI}$$

deflection when load is doubled,

$$\delta_2 = \frac{(2P)L^3}{3EI}$$

$$\delta_2 = 2\delta_1$$

87. (d)

Sol. for a uniform simply supported beam of span (l) carries a point load (W) at the center, the downward deflection at the center ($y_{\max}$)

$$y_{\max} = \frac{WL^3}{48EI}$$

88. (c)

Sol. in a thin cylindrical pressure vessel,

Longitudinal stress (σ_l) = $pd/4t$

Circumferential (Hoop) stress, (σ_h) = $Pd/2t$

89. (d)

Sol. We know that

$$V = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi \times \left(\frac{D^3}{8}\right) = \frac{\pi}{6}D^3$$

$$\delta \quad V = \frac{\pi}{6} \times 3 D^2 \cdot \delta D = 3 \left(\frac{\pi}{6} D^2\right) \delta D$$

$$= 3 \left(\frac{\pi}{6} D^2\right) \frac{\delta D}{D} \times D = 3 \times V \left(\frac{\delta D}{D}\right)$$

$$\frac{\delta V}{V} = 3 \left(\frac{\delta D}{D}\right)$$

90. (d)

Sol. For Watt's governor,

Speed of governor,

$$N^2 = \frac{895}{h}$$

$h \rightarrow$ height of governor

$$N^2 = \frac{895}{0.2}$$

$$N = 66.89 \text{ rpm}$$

$$\text{Angular velocity, } \omega = \frac{2\pi N}{60}$$

$$= \frac{2\pi \times 66.89}{60}$$

$$= 7 \text{ rad/sec}$$

91. (d)

Sol.

In grinding operation, for grinding harder material any grain size may be used, because harder material grinding requires softer wheel and vice-versa. The bounding strength of grits is of importance, not the size of grains. Grain size plays role for accommodating chips.

92. (a)

Sol. Due to partial balancing in reciprocating engines of reciprocating masses following effects occur,

Hammer blow

Swaying couple

Variation of tractive forces

93. (b)

Sol. in order to start a locomotive of two cylinders, cranks are kept at 90° .

Due to partial balancing of the reciprocating parts, there is an unbalanced primary force perpendicular to line of stroke.

94. (d)

Sol. there are some following characteristics must follow in orthogonal cutting.

1. The cutting edge is normal to the cutting velocity.

2. The cutting forces occur in two directions only.

3. The cutting edge is wider than depth of cut.

4. The width of cutting edge must be wider so that it can cover the width of workpiece from both sides.

95. (b)

Sol. ductile material – so regular size and shape.

Milling cutter – multipoint cutting tool - discontinuous chip

96. (a)

Sol. for unaided bite.

$$h_0 - h_f = \mu^2 R$$

$$30 - 15 = \mu^2 \times (150)$$

$$\frac{15}{150} = \mu^2$$

$$\mu^2 = 0.1$$

$$\mu = 0.356 \approx 0.35$$

97. (d)

Sol. Ironing is done to make the thickness of wall of the cup uniform during deep drawing.

Camber is difference between length and overall deformation.

Soap solution is used to slow the drawing speed in drawing operation.

98. (b)

Sol. Metal removal rate for turning operation on a lathe machine is given by,

$$\text{MRR} = f \times d \times V$$

$$f = \text{feed per rev} = 0.4 \text{ mm/rev}$$

$$d = \text{depth of cut} = 1.5 \text{ mm}$$

$$v = \text{cutting speed} = 100 \text{ m/min}$$

$$\text{So, MRR} = 0.4 \times 1.5 \times 100 \times 10^3$$

$$\boxed{\text{MRR} = 60000 \text{ mm}^3/\text{min}}$$

99. (c)

Sol. Euler's formula is valid for long columns, while Rankine's theory is valid for short, medium and long, all types of column.

100. (d)

$$\text{Sol. Slenderness ratio, } S = \frac{Le}{K}$$

$$K = \sqrt{\frac{I_{\min}}{A}} = \sqrt{\frac{\frac{\pi}{64}d^4}{\frac{\pi}{4}d^2}} = \frac{d}{4}$$

$$S = \frac{L}{d/4} = \frac{4L}{d}$$

