

ENGINEERING SERVICES
EXAMINATION-2016

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

T.B.C. : B-HUF-P-EEA

Test Booklet Series

Serial

1035761



TEST BOOKLET
CIVIL ENGINEERING
Paper I

Time Allowed : Two Hours

Maximum Marks : 200

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET **DOES NOT** HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
2. Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Test Booklet Series Code A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet. Any omission/discrepancy will render the Answer Sheet liable for rejection.
3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside.
DO NOT write anything else on the Test Booklet.
4. This Test Booklet contains **120** items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case, you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose **ONLY ONE** response for each item.
5. You have to mark all your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator **only the Answer Sheet**. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.

10. Penalty for wrong answers :

THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE.

- (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third (0.33)** of the marks assigned to that question will be deducted as penalty.
- (ii) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
- (iii) If a question is left blank, i.e., no answer is given by the candidate, there will be **no penalty** for that question.

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(1 - A)

1. Consider the following statements :

1. There will be no defects in select grade timbers.
2. The codal values for strength of grade-II timber without defects may be reduced by 37.5%.
3. For timber used as columns, the permissible stress in ungraded timbers is adopted with a multiplying factor of 0.50.
4. In case of wind force and earthquakes, a modification factor of 1.33 is adopted.

Which of the above statements are correct ?

- (a) 1 and 3 only
- (b) 1 and 4 only
- (c) 2 and 4 only
- (d) 2 and 3 only

2. Consider the following statements regarding timber :

1. The strength of timber increases by Kiln seasoning.
2. Cutting of wood is to be done prior to treatment.
3. Water seasoning is good for prevention of warping.
4. ASCU treatment enhances the strength of wood.

Which of the above statements are correct ?

- (a) 1, 2 and 3 only
- (b) 2, 3 and 4 only
- (c) 1, 3 and 4 only
- (d) 1, 2, 3 and 4

3. Gase(s) emitted during rotting or decomposition of timber is/are mainly

- (a) Methane and Hydrogen
- (b) Hydrogen Sulphide
- (c) Carbonic acid and Hydrogen
- (d) Ammonia

4. Efflorescence of bricks is due to

- (a) Excessive burning of bricks
- (b) High silt content in brick clay
- (c) High porosity of bricks
- (d) Soluble salts present in parent clay

5. Disintegration of brick masonry walls is primarily due to

1. Efflorescence
2. Magnesium sulphate in bricks
3. Calcined clay admixtures
4. Kankar nodules

Which of the above statements are correct ?

- (a) 1, 2 and 3 only
- (b) 1, 2 and 4 only
- (c) 3 and 4 only
- (d) 1, 2, 3 and 4

6. Consider the following tests :

1. Transverse strength test
2. Water absorption test
3. Impact test
4. Breaking strength test

Which of the above are relevant to testing of tiles ?

- (a) 1, 2 and 3 only
- (b) 1, 2 and 4 only
- (c) 3 and 4 only
- (d) 1, 2, 3 and 4

7. Which of the following statements is/are correct regarding the strength of cement ?
1. Particle sizes less than $3 \mu\text{m}$ increase the viscous nature of the cement.
 2. Finer particles in cement can be replaced by fly-ash to improve the strength.
- (a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2
8. The constituent compound in Portland cement which reacts immediately with water, and also sets earliest, is
- (a) Tricalcium silicate
(b) Dicalcium silicate
(c) Tricalcium aluminate
(d) Tetracalcium aluminoferrite
9. Which of the following statements are correct with regard to cement mortar ?
1. Workability of cement mortar can be improved by addition of lime.
 2. Fly-ash cement is economical in plastering jobs.
 3. Addition of saw dust improves workability.
 4. Sand in mortar can be replaced by finely crushed fire bricks.
- (a) 1, 2, 3 and 4
(b) 1, 2 and 3 only
(c) 3 and 4 only
(d) 1, 2 and 4 only
10. In a concrete mix of proportion 1 : 3 : 6, the actual quantity of sand, which is judged to have undergone 15% bulking, per unit volume of cement, will be
- (a) 3.00
(b) 3.45
(c) 4.50
(d) 6.00
11. The Rheological behaviour of concrete, when represented by shear stress vs rate of shear, is characterized as
- (a) $\tau = \tau_0 + \mu \cdot \dot{\gamma}$
(b) $\tau_0 = \tau + \mu \cdot \dot{\gamma}$
(c) $\frac{\tau}{\tau_0} = \mu \cdot \dot{\gamma}$
(d) $\tau = \mu \cdot \dot{\gamma}$
- where : τ = shear stress,
 τ_0 = (initial) yield value,
 μ = at-point plastic viscosity,
 $\dot{\gamma}$ = at-point rate of shear.
12. Which method of curing of concrete is recommendable for rapid gain of strength of concrete ?
- (a) Sprinkling water
(b) Membrane curing
(c) High-pressure steam curing
(d) Infrared radiation curing

13. Which of the following is appropriate as a simple field method for assessing consistency of concrete ?
- Compacting factor
 - Slump test
 - Vee-Bee test
 - Kelly Ball test
14. Which of the following are relatable to Autoclaved Aerated Concrete ?
- Light weight
 - Strong
 - Inorganic
 - Non-toxic
- 1, 2 and 3 only
 - 1, 2 and 4 only
 - 3 and 4 only
 - 1, 2, 3 and 4
15. The workability of concrete becomes more reliable depending on
- Aggregate-cement ratio
 - Time of transit
 - Grading of the aggregate
- 1 only
 - 2 only
 - 3 only
 - 1, 2 and 3
16. The longitudinal strain of a cylindrical bar of 25 mm diameter and 1.5 m length is found to be 3 times its lateral strain in a tensile test. What is the value of Bulk Modulus by assuming $E = 1 \times 10^5 \text{ N/mm}^2$?
- $2 \times 10^5 \text{ N/mm}^2$
 - $1.1 \times 10^5 \text{ N/mm}^2$
 - $1 \times 10^5 \text{ N/mm}^2$
 - $2.1 \times 10^5 \text{ N/mm}^2$
17. For an elastic material, Poisson's ratio is μ , Modulus of Elasticity is E, Modulus of Rigidity is C and Bulk Modulus is K. μ is expressible in terms of K and C as
- $\frac{6K - 2C}{3K - 2C}$
 - $\frac{6K + 2C}{3K - 2C}$
 - $\frac{3K - 2C}{6K + 2C}$
 - $\frac{3K + 2C}{6K + 2C}$
18. A mild steel bar of length 450 mm tapers uniformly. The diameters at the ends are 36 mm and 18 mm, respectively. An axial load of 12 kN is applied on the bar. $E = 2 \times 10^5 \text{ N/mm}^2$. The elongation of the bar will be
- $\frac{1}{3\pi} \text{ mm}$
 - $\frac{1}{6\pi} \text{ mm}$
 - $\frac{3\pi}{2} \text{ mm}$
 - $\frac{2}{3\pi} \text{ mm}$

19. Which of the following statements are correct for stresses acting on mutually perpendicular faces of a plane element ?

1. The sum of the normal stresses in mutually perpendicular planes is equal to the sum of the principal stresses.
2. The shearing stresses in two mutually perpendicular planes are equal in magnitude and direction.
3. Maximum shear stress is half of the difference between principal stresses.

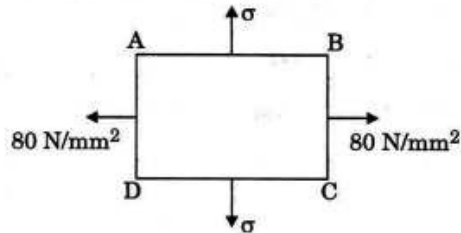
- (a) 1, 2 and 3
 (b) 1 and 2 only
 (c) 2 and 3 only
 (d) 1 and 3 only

20. Which of the following statements are correct ?

1. Strain in the direction of applied stress is known as longitudinal strain.
2. Tensile stress results in tensile strain in linear and lateral directions.
3. Strains in all directions perpendicular to the applied stress are known as lateral strain.
4. Ratio of change in volume to original volume is known as volumetric strain.

- (a) 1, 2 and 3 only
 (b) 1, 3 and 4 only
 (c) 3 and 4 only
 (d) 1, 2, 3 and 4

21. The state of stress on an element is as shown in the figure. If $E = 2 \times 10^5 \text{ N/mm}^2$ and Poisson's ratio = 0.3, the magnitude of the stress σ for no strain in BC is



- (a) 84 N/mm^2
 (b) 64 N/mm^2
 (c) 34 N/mm^2
 (d) 24 N/mm^2

22. In the cross-section of a timber, cambium layer can occur in

- (a) Inner Bark and Sap Wood
 (b) Pith and Heart Wood
 (c) Sap Wood and Heart Wood
 (d) Outer Bark and Sap Wood

23. Consider the following statements :

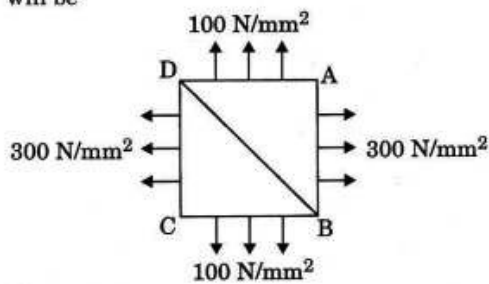
1. In the infinitesimal strain theory, dilatation is taken as an invariant.
2. Dilatation is not proportional to the algebraic sum of all normal stresses.
3. The shearing modulus is always less than the elastic modulus.

Which of the above statements is/are correct ?

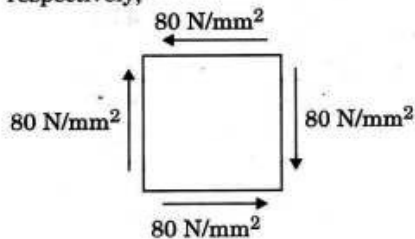
- (a) 1 only
 (b) 1 and 2 only
 (c) 2 only
 (d) 1, 2 and 3

24. Which one of the following represents 'constitutive relationship' ?
- Vertical displacements in a structure
 - Rotational displacements in a structure
 - System of forces in equilibrium
 - Stress - strain behaviour of a material

25. A square element of a structural part is subjected to biaxial stresses as shown in the figure. On a plane along BD, the intensity of the resultant stress due to these conditions will be



- $25\sqrt{5}$ N/mm²
 - $50\sqrt{5}$ N/mm²
 - $75\sqrt{5}$ N/mm²
 - $100\sqrt{5}$ N/mm²
26. A structural element is subjected to pure shear of 80 N/mm², as shown in the figure. The yield stresses both in tension and in compression are 240 N/mm². According to the maximum normal stress theory, the factors of safety in tension and compression are, respectively,



- 2 and 2
- 2.5 and 2.5
- 3 and 3
- 4 and 4

27. Principal stresses at a point are 80 N/mm² and 40 N/mm², both tensile. The yield stress in simple tension for this material is 200 N/mm². The values of factors of safety according to maximum principal stress theory and maximum shear stress theory, respectively, are

- 2.5 and 2.5
- 2.5 and 5
- 5 and 5
- 5 and 1.67

28. The principal stresses at a point are 2σ (tensile) and σ (compressive), and the stress at elastic limit for the material in simple tension is 210 N/mm². According to maximum shear strain theory, the value of σ at failure is

- 70 N/mm²
- 105 N/mm²
- 140 N/mm²
- 210 N/mm²

29. A thin steel ruler having its cross-section of 0.0625 cm × 2.5 cm is bent by couples applied at its ends so that its length l equal to 25 cm, when bent, as a circular arc, subtends a central angle $\theta = 60^\circ$. Take $E = 2 \times 10^6$ kg/cm². The maximum stress induced in the ruler and the magnitude is

- 2618 kg/cm²
- 2512 kg/cm²
- 2406 kg/cm²
- 2301 kg/cm²

30. Which of the following statements are correct ?

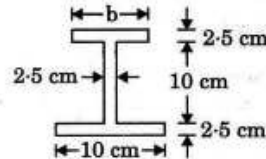
1. Cranes are employable in moving and/or hoisting loads.
2. With the use of dipper and stick, power shovels can be used as hoes.
3. Overdrive for higher speeds is a facility often used comfortably in the working of a tractor.
4. Clam shells are less desirable than draglines if the material is water-saturated.

- (a) 1 and 4 only
 (b) 1 and 2 only
 (c) 2 and 3 only
 (d) 3 and 4 only

31. Two similar bars of Steel and Aluminium are heated to a same temperature. Forces are applied at the ends of the bars to maintain their lengths unaltered. If the ratio of Young's moduli of Steel and Aluminium is 3, and the ratio of the coefficients of thermal expansion of Steel to that of Aluminium is 0.5, what is the stress on the Aluminium bar if the stress on the Steel bar is 100 MPa ?

- (a) 16.7 MPa
 (b) 66.7 MPa
 (c) 136.7 MPa
 (d) 150.0 MPa

32. In order that the extreme fibre stresses in bending will be in the ratio 4 : 3 in the beam shown in the following figure, the width b of the upper flange ($b < 10$ cm) of the beam section is to be

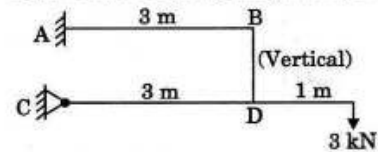


- (a) 6.1 cm
 (b) 6.6 cm
 (c) 5.1 cm
 (d) 5.6 cm

33. A structural steel beam has an unsymmetrical I-cross-section. The overall depth of the beam is 200 mm. The flange stresses at the top and bottom are 120 N/mm^2 and 80 N/mm^2 , respectively. The depth of the neutral axis from the top of the beam will be

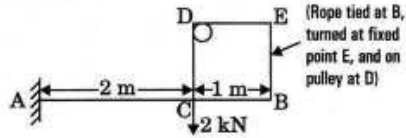
- (a) 120 mm
 (b) 100 mm
 (c) 80 mm
 (d) 60 mm

34. The bending moment at A for the beam shown below (with BD being a rigid bar) is



- (a) Zero
 (b) 12 kN-m
 (c) 8 kN-m
 (d) 6 kN-m

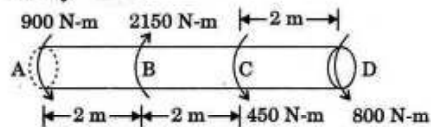
35. The bending moment diagram for the beam shown below is



- (a)
- (b)
- (c)
- (d)
36. A circular shaft rotates at 200 rpm and is subject to a torque of 1500 Nm. The power transmitted would be

- (a) 10π kW
 (b) 15π kW
 (c) 20π kW
 (d) 30π kW

37. Torques are transmitted to the solid circular shaft as shown in the figure below. If the corresponding permissible stress in the shaft is 60 N/mm^2 , the diameter of the shaft is nearly



- (a) 57.3 mm
 (b) 47.5 mm
 (c) 37.3 mm
 (d) 27.3 mm

38. A solid circular shaft has a diameter d . Its polar modulus will be

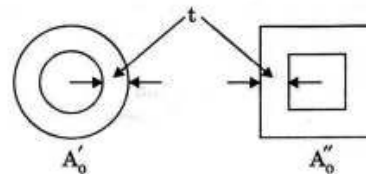
- (a) $\frac{\pi}{16} d^2$
 (b) $\frac{\pi}{64} d^3$
 (c) $\frac{\pi}{16} d^3$
 (d) $\frac{\pi}{32} d^2$

39. A hollow steel shaft has outside diameter d and inside diameter $\frac{d}{2}$. The value of d for the shaft, if it has to transmit 200 hp at 105 rpm with a working shear stress of 420 kg/cm^2 , is

- (a) 5.6 cm
 (b) 2.6 cm
 (c) 12.1 cm
 (d) 15.5 cm

40. Two thin-walled tubular members made of the same material have the same length, same wall thickness and same total weight and are both subjected to the same torque of magnitude T . If the individual cross-sections are circular and square, respectively, as in the figures, then the ratios of the shear stress τ , reckoned for the circular member in relation to the square member will be

Figures not to scale



- (a) 0.785
 (b) 0.905
 (c) 0.616
 (d) 0.513

41. In the analysis of beams subjected to loads, the point with Nil Bending Moment can be a
1. Point of Contraflexure
 2. Point of Maximum Shear Force
 3. Point of Inflexion

Which of the above statements is/are correct ?

- 1 only
- 2 only
- 3 only
- 1, 2 and 3

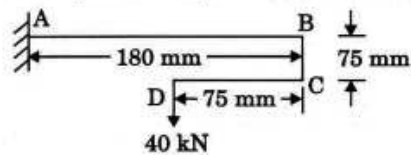
42. A mild steel bar, 1.5 m long, has a square section 40 mm × 40 mm. The bar is subjected to a two-dimensional stress, $\sigma_x = 310 \text{ N/mm}^2$ (tensile) and $\sigma_y = 300 \text{ N/mm}^2$ (compressive). $E = 2 \times 10^5 \text{ N/mm}^2$, Poisson's ratio $\mu = 0.3$. The elongation of the bar in the direction of σ_x will be

- 1.25 mm
- 1.75 mm
- 2.25 mm
- 3 mm

43. A tractor has a permissible loaded speed of 200 m/minute, which can increase by 25% when the load is removed/deposited. Generally, it is operated at 80% of the permissible speed (loaded or unloaded). It works at a location where haul distance is 120 m. Rest allowance per round-trip is taken as 50 seconds on an average. Fixed time per trip, for loading and unloading and turnaround, etc., is 30 seconds. What is its effective cycle time ?

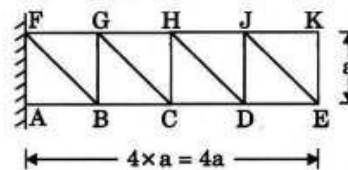
- 157 seconds
- 161 seconds
- 173 seconds
- 182 seconds

44. The bending moment at A for the beam shown below (not to scale) is



- 3200 kN.mm
- 3600 kN.mm
- 4200 kN.mm
- 4800 kN.mm

45. In the pin-end cantilever truss shown below, member FG had been fabricated 10 mm longer than required. How much will point E deflect vertically ?



- 10 mm
- 20 mm
- 30 mm
- 40 mm

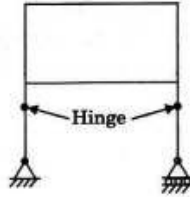
46. The purpose of lateral ties in a short RC column is to

- Avoid buckling of longitudinal bars
- Facilitate compaction of concrete
- Increase the load carrying capacity of the column
- Facilitate construction

47. When a two-hinged parabolic arch is subjected to a rise in ambient temperature, the horizontal thrust at the support will

- Increase
- Decrease
- Remain same
- Increase or decrease depending on the span

48. The degree of static indeterminacy for a rigid frame as shown below is



- (a) 0
(b) 1
(c) 2
(d) 3
49. In the slope-deflection equations, deformations are considered to be caused by
- (a) Shear forces and bending moments only
(b) Axial forces, shear forces and bending moments
(c) Axial forces and bending moments only
(d) Bending moments only
50. The maximum bending moment caused by a set of concentrated moving loads is
- (a) Always at the mid-point of span
(b) Between the mid-point and concentrated load next to the mid-point of the span
(c) Not definable
(d) Always under a load close to the centroid of the set of loads
51. Force method of analysis of a structure is particularly preferred when
1. The degrees of freedom of the structure become large
 2. The structure has less numbers of static, and more numbers of kinematic, indeterminacies
 3. The structure has more numbers of static, and less numbers of kinematic, indeterminacies
- (a) 1 only
(b) 2 only
(c) 3 only
(d) 1, 2 and 3

52. Stiffness matrix method is in the category of

1. Compatibility method
 2. Displacement method
 3. Force method
 4. Equilibrium method
- (a) 1 and 3 only
(b) 1 and 4 only
(c) 2 and 3 only
(d) 2 and 4 only

53. Müller-Breslau Principle for obtaining influence lines is applicable to

1. Statically determinate beams and frame
 2. Statically indeterminate structures, the material of which is elastic, and follows Hooke's law
 3. Any statically indeterminate structure
- (a) 1 and 2 only
(b) 1 only
(c) 2 only
(d) 1 and 3 only

54. The plastic neutral axis

1. Divides the given section into two equal halves
 2. Divides the given section into two unequal parts
 3. Lies on the centroidal axis of the section
- (a) 1 only
(b) 2 only
(c) 3 only
(d) 2 and 3 only

55. The plastic moment capacity M_p is

- (a) Less than the yield moment
(b) Equal to the yield moment
(c) Greater than the yield moment
(d) Dependent on section dimensions

56. Web crippling is caused by
- Excessive bending moment
 - Failure of web under point loads
 - Width of flanges
 - Column action of web
57. The block shear failure of a bolted joint in tension occurs because of
- Use of high shear strength bolts
 - Use of plates with higher bearing strength
- 1 only
 - 2 only
 - Both 1 and 2
 - Neither 1 nor 2
58. As per IS code, the maximum longitudinal pitch allowed in bolted joints of tension members is nominally
- 12 times the thickness of the plate
 - 12 times the diameter of the bolt
 - 16 times the thickness of the plate
 - 16 times the diameter of the bolt
59. ISMB 100 ($r_x = 40$ mm, $r_y = 10$ mm) has been used as a column in an industrial shed. Along the minor axis, the column has restraints in the form of purlins at 1.0 m intervals. Effective length factor along major and minor axes are 1.2 and 1.0, respectively. If the slenderness ratio is restricted to 120, the maximum column height will be
- 1.0 m
 - 2.4 m
 - 4.0 m
 - 4.8 m
60. As per IS 800 - 2007, the permitted slenderness ratio for a bracing member in case of hangers shall be
- 140
 - 145
 - 150
 - 160
61. A rectangular beam of depth d is under bending. Load has been gradually increased when the top fibre has obtained five times the strain at the first yield. What depth of the beam will still respond by elastic conditions ?
- 0.16 d
 - 0.20 d
 - 0.25 d
 - 0.40 d
62. The ultimate moment capacity of a mild steel section is usually
- Equal to the plastic moment capacity
 - More than the yield moment capacity
 - Less than the plastic moment capacity but more than the yield moment capacity
 - More than the plastic moment capacity
63. The portal bracing in a truss-bridge is used to
- Transfer load from top of end posts to bearings
 - Maintain the rectangular shape of the bridge cross-section
 - Stiffen the structure laterally
 - Prevent the buckling of top chord under side sway
64. Consider the following cases in the design of reinforced concrete members in flexure :
- Over-reinforced section
 - Tension failure
 - Compression failure
 - Under-reinforced section
- Which of the above cases are considered for safe design of R.C. members in flexure ?
- 1 and 2 only
 - 2 and 4 only
 - 3 and 4 only
 - 1 and 3 only

65. The bond between steel and concrete is mainly due to
1. Mechanical resistance
 2. Pure adhesive resistance
 3. Frictional resistance
- (a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3
66. The carbonation process is demonstrated more by
- (a) Atmospheric corrosion
 - (b) Chloride corrosion
 - (c) Stress corrosion
 - (d) Hydrogen embrittlement
67. When a spirally reinforced short column is loaded axially, the concrete inside the core is subjected to
- (a) Bending and compression
 - (b) Biaxial compression
 - (c) Triaxial compression
 - (d) Uniaxial compression
68. In a reinforced concrete section, shear stress distribution is diagrammatically
- (a) Wholly Parabolic
 - (b) Wholly Rectangular
 - (c) Parabolic above NA and Rectangular below NA
 - (d) Rectangular above NA and Parabolic below NA
69. As per IS 456 - 2000, the maximum permissible shear stress, $\tau_{C \max}$, is based on
- (a) Diagonal tension failure
 - (b) Diagonal compression failure
 - (c) Flexural tension failure
 - (d) Flexural compression failure
70. Footings shall be designed to sustain the
1. Applied loads
 2. Moments and forces under reliable loading conditions
 3. Induced reactions
- (a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3
71. Reinforced concrete slabs are designed for
1. Shear
 2. Flexure
 3. Positive bending moment
 4. Negative bending moment
- (a) 1, 2 and 3 only
(b) 1 and 4 only
(c) 2, 3 and 4 only
(d) 1, 2, 3 and 4
72. As compared to the working stress method of design, the limit state method of design premises that the concrete can admit
- (a) A lower stress level
 - (b) A higher stress level
 - (c) Occasionally higher, but usually lower, stress level
 - (d) Only the same stress level
73. The bending stress in a T-beam section is maximum
1. At top fibre
 2. At centroidal fibre
 3. At bottom fibre
- (a) 1 only
(b) 2 only
(c) 3 only
(d) At a level which is dependent on the loading condition

74. If the loading on a simply supported pre-stressed concrete beam is uniformly distributed, the centroid of the pre-stressing tendon should be as
- A straight profile along the lower edge of the kern
 - A parabolic profile with convexity downward
 - A straight profile along the centriodal axis
 - A circular profile with convexity upward
75. In a post-tension pre-stressed concrete beam, the end block zone is in between the end of the beam and the section where
- The shear stresses are maximum
 - Only shear stresses exist
 - No lateral stresses exist
 - Only longitudinal stresses exist
76. In the pre-tensioning method
- Tension in concrete is induced directly by external force
 - Tension is induced in the tendons before concreting
 - Concrete continues to be in tension after pre-stressing
- 1 only
 - 2 only
 - 3 only
 - 1 and 3 only
77. Flexural collapse in over-reinforced beams is due to
- Primary compression failure
 - Secondary compression failure
 - Primary tension failure
 - Bond failure
78. If a beam is likely to fail due to high bonding stresses, then its bond strength can be increased most economically by
- Providing vertical stirrups
 - Increasing the depth of the beam
 - Using smaller diameter bars in correspondingly more numbers
 - Using higher diameter bars by reducing their numbers
79. A single-acting reciprocating pump has a stroke of 25 cm, speed of 135 rpm, and a piston of 30 cm diameter. If its slip has been estimated as 4% at a particular operating condition, what is the corresponding realized discharge through a height of 14 m ?
- 33.2 lps
 - 35.6 lps
 - 37.0 lps
 - 38.2 lps
80. In the design of pre-stressed concrete structures, which of the following limit states will qualify as the limit states of serviceability ?
- Flexural
 - Shear
 - Deflection
 - Cracking
- 1 and 2 only
 - 3 and 4 only
 - 1 and 4 only
 - 2 and 3 only

81. Consider the following statements :

1. Pumps used in series are generally of the centrifugal type.
2. Centrifugal pumps, though yielding comparatively smaller discharges than axial flow pumps, yield higher heads (at each stage) compared to axial flow pumps.

Which of the above statements is/are correct ?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

82. When steel reinforcing bars are provided in masonry, the bars shall have an embedment with adequate cover in cement-sand mortar not leaner than

- (a) 1 : 3
- (b) 1 : 4
- (c) 1 : 5
- (d) 1 : 6

83. The efficacy of pumpcrete is based primarily on

1. The capacity of pump
2. The aggregate size, which should not exceed 8 cm
3. The diameter of pipe being large, with more than 30 cm being desirable
4. The performance of the agitator

- (a) 1 and 4 only
- (b) 1 and 2 only
- (c) 3 and 4 only
- (d) 2 and 3 only

84. In a non-tilting type drum mixer,

1. Large size aggregate up to 20 - 25 cm can be handled
2. Mixing time is less than 2 minutes
3. Discharge is through buckets onto the platform
4. For large-size mixers, the mixing time should be slightly increased if handling more than 800 litres of the mix

Which of the above statements are correct ?

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1, 2 and 4 only
- (d) 3 and 4 only

85. How many impellers are required for a multi-stage pump to lift 4000 lpm against a total head of 80 m at a speed of 750 rpm; given that N_s for each impeller should be between 720 to 780 units ?

- (a) 6
- (b) 5
- (c) 4
- (d) 3

86. A 15 cm centrifugal pump delivers 6 lps at a head of 26 m running at a speed of 1350 rpm. A similarly designed pump of 20 cm size runs at the same speed. What are the most likely nearest magnitudes of discharge and delivery head provided by the latter pump ?

- (a) 11 lps and 46 m
- (b) 14 lps and 52 m
- (c) 11 lps and 52 m
- (d) 14 lps and 46 m

87. Which of the following statements are correct as operating characteristics of a centrifugal pump ?

1. As discharge increases from zero value, head slightly increases; then the head declines gently; and beyond a certain discharge, the head falls steeply.
2. As discharge increases, efficiency increases from zero, rising fast to a maximum value and then falls rapidly, more rapidly than the head-discharge curve.
3. BHP increases from a non-zero (positive) value at zero discharge, the increase being only moderate before it starts falling beyond a certain discharge.

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

88. Engines used in earthwork equipment are qualified by the power developed under specified conditions. As operating conditions change, the power developed will increase with local ambience, if

1. Ambient temperature increases
2. Ambient temperature decreases
3. Ambient pressure increases
4. Ambient pressure decreases

Which of the above statements are correct ?

- (a) 1 and 3 only
 (b) 1 and 4 only
 (c) 2 and 3 only
 (d) 2 and 4 only

89. Manometric head developed h_m in m, and discharge Q in lps in respect of two pumps, 1 and 2, are tabulated. The pumps are connected in series against a static head of 100 m. Total head losses for a discharge of Q are as $\frac{Q^2}{100}$ (m). What is the delivered discharge ?

Q in lps	15	18	20	22	25
h_{m1} in m	60.6	61.2	62.0	55.0	48.0
h_{m2} in m	50.8	51.0	48.8	45.8	40.0

- (a) 20.15 lps
 (b) 21.25 lps
 (c) 21.95 lps
 (d) 22.20 lps

90. A reciprocating pump has a stroke of 30 cm, speed of 100 rpm, and a piston of 22.5 cm diameter. It discharges 18.9 lps. What is the slip of the pump ?

- (a) 3.12%
 (b) 3.54%
 (c) 4.15%
 (d) 4.95%

91. The following data were recorded when a centrifugal pump worked at its maximum efficiency : $Q = 40$ lps; Manometric head developed = 25 m; Input shaft horse power = 11.9 W. What is the non-dimensional specific speed of the pump if it was running at 1500 rpm ? (May adopt the following (all in S.I. units) :

$$g^{1/4} = 1.77, g^{1/2} = 3.132, g^{3/4} = 5.544,$$

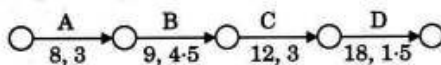
$$\sqrt{2} = 1.414, \sqrt{5} = 2.236 \text{ and } \sqrt{10} = 3.162$$

- (a) 165
 (b) 155
 (c) 145
 (d) 135

92. The total head to be developed by a centrifugal pump is expected to be up to 50 m. The normal ratio of radii of impeller rim and impeller eye of 2 is maintained. The design is for a speed of 1300 rpm. What is the nominal diameter of the impeller? Take $\sqrt{g} = 3.13$ and $\frac{1}{\pi} = 0.318$.

- (a) 53 cm
- (b) 57 cm
- (c) 60 cm
- (d) 64 cm

93. Activities A, B, C and D constitute a small project; their interrelationship, expected duration and standard deviation of this expected duration are shown in the figure, respectively.



With a view to improving the speed of implementation, each of B, C and D are split into three equal segments, maintaining appropriate inter-relationships between A and each of these nine segments. What will be the standard deviation of the modified project duration after segmentation (to the nearest $\frac{1}{10}$ unit)?

- (a) 6.2
- (b) 5.6
- (c) 5.2
- (d) 4.6

94. Which of the following is/are the main drawback(s) in adopting bar charts?

1. All the activities are shown as being independent of each other
 2. The sequence of activities is not defined at all
 3. It is difficult to judge whether an activity is completed or not
- (a) 1 only
 - (b) 2 only
 - (c) 3 only
 - (d) 1, 2 and 3

95. The purpose of work-break-down structure in project planning is mainly to

1. Facilitate and improve the decision-making on procurement of resources
 2. Relate activities under particular trade specializations to help in organizing for project staff
 3. Co-ordinate regarding milestone events across trade specializations to improve the synergy between the trades
- (a) 1 and 2 only
 - (b) 1 and 3 only
 - (c) 2 and 3 only
 - (d) 1, 2 and 3

96. Which of the following statements is/are correct?

1. An activity is in between two node numbers, which need not be in an increasing order in the activity progress sequence.
 2. The length of the arrow in a network has certain significance.
 3. Concurrent activities are mutually independent and can possibly be taken up simultaneously.
- (a) 1 only
 - (b) 3 only
 - (c) 2 only
 - (d) 1, 2 and 3

97. Which of the following statements are implicit in developing the critical path network?

1. Only one time estimate is required for any activity
 2. Time only is the controlling factor at this stage
 3. Time and cost both are controlling factors at this stage
 4. Critical events may have positive, negative, or zero float
- (a) 1 and 2 only
 - (b) 1 and 3 only
 - (c) 1 and 4 only
 - (d) 2 and 4 only

98. In the Critical Path Method of project planning, free float can be

- (a) Greater than independent float
- (b) Greater than total float
- (c) Less than independent float
- (d) Equal to total float

99. Slack time in PERT analysis

- (a) Can never be greater than zero
- (b) Is always zero for critical activities
- (c) Can never be less than zero
- (d) Is minimum for critical events

100. A small project consists of 3 activities P, Q and R to be executed in that sequence. The relationship between Time Duration (in 'Units' of time-T) and corresponding total direct cost (C units) for each of the activities, for alternate mutually exclusive possible durations for each activity, are tabulated herewith :

P		Q		R	
T	C	T	C	T	C
8	250	6	340	8	400
9	235	7	320	10	375
10	225	8	295	12	350
11	215	9	275		

For a total duration of 25 units of time, the least total direct cost for the complete project will be

- (a) 965 units
- (b) 950 units
- (c) 940 units
- (d) 925 units

Directions : Each of the next twenty (20) items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below :

Codes :

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is *not* the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

101. *Statement (I) :*

Splitting of fibres is a type of seasoning defect in wood.

Statement (II) :

Seasoning of timber is a general requirement for structural purposes.

102. *Statement (I) :*

Hardwoods are used in special purpose heavy constructions.

Statement (II) :

Hardwoods too are porous in nature.

103. Statement (I) :

In general, bricks cannot be used in industrial foundations.

Statement (II) :

Heavy duty bricks can withstand higher temperatures.

104. Statement (I) :

In multistoried constructions, burnt clay perforated bricks are used to reduce the cost of construction.

Statement (II) :

Perforated bricks are economical and they also provide thermal insulation.

105. Statement (I) :

Positive displacement pumps can be used for pumping of ready-mixed concrete.

Statement (II) :

The coarse aggregate in the mix is unlikely to be crushed during positive displacement.

106. Statement (I) :

Fire resistance of plastering can be achieved by mixing surkhi to the cement mortar.

Statement (II) :

Insulation against sound and fire can be achieved by adding sufficient water in-situ just before applying the mortar.

107. Statement (I) :

Water containing less than 2000 ppm of dissolved solids can generally be used satisfactorily for making concrete.

Statement (II) :

The presence of any of zinc, manganese, tin, copper or lead reduces the strength of concrete considerably.

108. Statement (I) :

Though a non-elastic material, yet concrete exhibits a linear relationship between stress and strain at low values of stress.

Statement (II) :

The modulus of elasticity of concrete is dependent on the elastic properties of aggregate and on curing.

109. Statement (I) :

Finer the cement, greater is the need for water for hydration and workability.

Statement (II) :

Bleeding of a mix occurs due to low water-cement ratio.

110. Statement (I) :

The failure of a mild steel specimen of circular cross-section, subjected to a torque occurs along its cross-section.

Statement (II) :

The failure occurs on a plane of the specimen subjected to maximum shear stress; and mild steel is relatively weak in shear.

111. Statement (I) :

In elastic analysis of structures, the Neutral Axis is the intersection between the plane of bending and the neutral plane.

Statement (II) :

Neutral Axis in the context of plastic analysis of structures is always the Equal Area Axis of the cross-section.

112. Statement (I) :

Whereas shutter vibrators are preferred for use with pre-stressed beams, needle vibrators are preferred in foundation concreting.

Statement (II) :

Needle vibrators are susceptible to get dysfunctional with leaking-in of cement slurry — which is not the case with the shutter vibrator.

113. Statement (I) :

The forward edge of wheels or outriggers acts as a fulcrum in determining the lifting capacity of a mobile crane.

Statement (II) :

There is in-built security and safety against sudden dropping of load, as well as against abrupt swinging, in the working of a mobile crane.

114. Statement (I) :

Hand-operated chain-hoists include differential screw-gear types within their range.

Statement (II) :

In case of a hoist-winch, the capacity of the hoist is increased by a number of gear reductions.

115. Statement (I) :

When employing weigh-batching for mix preparation, bulking of sand has to be accounted for.

Statement (II) :

Bulked sand will affect the proportional composition of the ingredients to be used in making wet concrete of the desired eventual strength.

116. Statement (I) :

Critical path(s) through a CPM network can be identified even without working out the backward pass computations by a competent user.

Statement (II) :

Critical path is the progressive chain of activities from start to finish (not excluding between splitting and merging nodes) through the network where Total Float is absent throughout (including through dummy arrows, if appropriate).

117. Statement (I) :

For implementing weigh-batching, separate compartments are made for storing large quantities of the aggregates. Besides lifting and loading equipments, there must be regular assessment of grading and also of moisture content.

Statement (II) :

Whereas eventual strength of the mix depends also on the grading of the ingredients, the water needs too must be properly computed and implemented.

118. Statement (I) :

Resources Optimization is largely a pre-implementation pursuit whereas Resources Allocation is a through-implementation dynamic process.

Statement (II) :

Resources Allocation has a larger bearing on Inventory Management than Resources Optimization.

119. Statement (I) :

Crashing of project duration always increases the cost of the project on its completion, no matter what the indirect, or overhead, costs are.

Statement (II) :

The critical path along the project activities network diagram is compressed in the process of investigating the crashing of the project duration, and not the non-critical activities, up to a certain stage of crashing.

120. Statement (I) :

In the operation of reciprocating pumps, slip can sometimes be negative.

Statement (II) :

Under conditions of high speed, long suction pipes (without capitation) and short delivery pipes, inertia pressure can be relatively rather high, causing the delivery valve to open before the discharge stroke begins.

SPACE FOR ROUGH WORK

B-HUF-P-EEA

(21-A)

ABE-4

SPACE FOR ROUGH WORK

B-HUF-P-EEA

(22 - A)

SPACE FOR ROUGH WORK

B-HUF-P-EEA

(23 - A)

ABB-P-EEA

SPACE FOR ROUGH WORK

B-HUF-P-EEA

(24 - A)

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EXAMINATION-2016

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CIVIL ENGINEERING

Paper II

A

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Maximum Marks : 200

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1. A solid cylinder of length H , diameter D and of relative density S floats in neutral equilibrium in water with its axis vertical. What is the ratio of H to D if $S = 0.6$?

- (a) 0.86
- (b) 0.72
- (c) 0.52
- (d) 0.46

2. In a two-dimensional flow, with its stream function $\psi = 2xy$, the velocity at a point (3, 4) is

- (a) 12.0 units
- (b) 10.0 units
- (c) 8.0 units
- (d) 6.0 units

3. An open rectangular tank of dimensions $4\text{ m} \times 3\text{ m} \times 2\text{ m}$ contains water to a height of 1.6 m. It is then accelerated along the longer side. What is the maximum acceleration possible without spilling the water? If this acceleration is then increased by 10%, what amount of water will be spilt off?

- (a) 1.472 m/s^2 and 0.48 m^3
- (b) 1.962 m/s^2 and 0.48 m^3
- (c) 1.472 m/s^2 and 0.52 m^3
- (d) 1.962 m/s^2 and 0.52 m^3

4. In a laminar flow between two fixed plates held parallel to each other at a distance d , the shear stress is:

- 1. Maximum at plane $\frac{d}{2}$ away from each plate and zero at the plate boundaries.

2. Zero throughout the passage.

3. Maximum at the plate boundaries and zero at a plane $\frac{d}{2}$ away from each plate.

Which of the above statements is/are correct?

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

5. While conducting the flow measurement using a triangular notch, an error of +2% in head over the notch is observed. The percentage error in the computed discharge would be

- (a) +7%
- (b) -3%
- (c) +5%
- (d) -4%

6. An orifice is located in the side of a tank with its centre 10 cm above the base of the tank. The constant water level is 1.0 m above the centre of orifice. The coefficient of velocity is 0.98. On the issuing jet, the horizontal distance from the vena-contracta to where the jet is 10 cm below vena-contracta is

- (a) 1.62 m
- (b) 1.00 m
- (c) 0.62 m
- (d) 0.32 m

7. The velocity of water at the outer edge of a 60 cm diameter whirlpool, where the water level is horizontal is 2.5 m/s. The velocity of water at a level where the diameter of the whirlpool is 15 cm, is
- 1 m/s
 - 5 m/s
 - 8 m/s
 - 10 m/s
8. In a trapezoidal channel with bed width of 2 m, and side slopes of 2 v on 1 h, critical flow occurs at a depth of 1 m. What will be the quantity of flow and the flow velocity? Take g as 10 m/s^2 .
- $7.22 \text{ m}^3/\text{s}$ and 3.10 m/s
 - $6.82 \text{ m}^3/\text{s}$ and 2.89 m/s
 - $7.22 \text{ m}^3/\text{s}$ and 2.89 m/s
 - $6.82 \text{ m}^3/\text{s}$ and 3.10 m/s
9. A 7.5 m wide rectangular channel conveys $12 \text{ m}^3/\text{s}$ of water with a velocity of 1.5 m/s. The specific energy head of the flow is
- 1.18 m
 - 1.78 m
 - 2.18 m
 - 2.78 m
10. A cylindrical vessel with closed bottom and open top is 0.9 m in diameter. What is the rotational speed about its vertical axis (with closed bottom below and open top above) when the contained incompressible fluid will rise 0.5 m at the inner circumference of the vessel and a space of 0.4 m diameter at the bottom will have no fluid thereon? Take $g = 10 \text{ m/s}^2$.
- 650 rpm
 - 600 rpm
 - 580 rpm
 - 470 rpm
11. The sequent depth ratio in a hydraulic jump formed in a rectangular horizontal channel is 10. The Froude number of the supercritical flow is
- 12.2
 - 10.4
 - 7.42
 - 4.21
12. A fluid flow is described by a velocity field $\vec{U} = 4x^2\vec{i} - 5x^2y\vec{j} + 1\vec{k}$
- What is the absolute velocity (in magnitude) at the point (2, 2, 1)?
- $\sqrt{1802}$
 - $\sqrt{1828}$
 - $\sqrt{1840}$
 - $\sqrt{1857}$
13. A partially open sluice gate discharges water at 6 m/s with a depth of 40 cm in a rectangular horizontal channel of width 5 m. What would be the post-jump depth of flow on the downstream of the gate by taking g as 10 m/s^2 ?
- 1.51 m
 - 1.70 m
 - 1.85 m
 - 1.95 m

14. What is the maximum power available at the downstream end of a pipeline 3 km long, 20 cm in diameter, if water enters at the upstream end at a pressure of 720 m of water, with taking pipe friction coefficient as 0.03 and g as 10 m/s^2 ?

- (a) 770 mhp
- (b) 740 mhp
- (c) 700 mhp
- (d) 660 mhp

15. In the design of pipeline the usual practice is to assume that due to aging of pipelines :

- 1. The effective roughness increases linearly with time.
- 2. The friction factor increases linearly with time.
- 3. The flow through the pipe becomes linearly lesser with time.

Which of the above statements is/are correct ?

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

16. Consider the following statements :

- 1. In flow through hydro-dynamically smooth pipes, the friction factor f is always a constant.
- 2. In flow through hydro-dynamically smooth pipes, the friction factor f is always a function of the flow Reynolds number.

3. In a fully developed rough turbulent pipe flow, the friction factor f is a function of relative roughness only.

4. In a fully developed rough turbulent pipe flow, the friction factor f is a function of the flow Reynolds number and relative roughness.

Which of the above statements are correct ?

- (a) 1 and 3
- (b) 2 and 3
- (c) 2 and 4
- (d) 1 and 4

17. Two identical centrifugal pumps are connected in parallel to a common delivery pipe of a system. The pump curve of each of the pumps is represented by $H = 20 - 60Q^2$ where H is manometric head of the pump and Q is the discharge of the pump. The head loss equation when two such fully-similar pumps jointly deliver the same discharge Q will be

- (a) $H = 40 - 15Q^2$
- (b) $H = 20 - 60Q^2$
- (c) $H = 40 - 60Q^2$
- (d) $H = 20 - 15Q^2$

18. A line source of strength $15\pi \text{ m/s}$ is situated within a uniform stream flowing at -12 m/s (i.e., right to left). At a distance of 0.6 m downstream from the source is an equal sink. How far will the stagnation points be from the nearest source/sink ?

- (a) 0.38 m
- (b) 0.46 m
- (c) 0.52 m
- (d) 0.58 m

19. At the point of operation with maximum efficiency, a turbine indicated unit power of 12 units and unit speed of 98 units and operates with 3300 kgf/s of flow. What are the speed in rpm and the specific speed of the machine respectively when its design head is 8.5 m?

- (a) 285 rpm and 339
- (b) 270 rpm and 360
- (c) 285 rpm and 360
- (d) 270 rpm and 339

20. A hydraulic turbine develops 8000 kW when running at 300 rpm under a head of 45 m. The speed of the same turbine under a head of 60 m is

- (a) 224.4 rpm
- (b) 346.4 rpm
- (c) 424.8 rpm
- (d) 485.8 rpm

21. In a single-acting reciprocating pump, the acceleration head at the beginning of the suction stroke is 3.5 m. If the pump is 1.5 m below the water level in the supply reservoir, the pressure head at the cylinder at that instant, considering the atmospheric pressure as 10.0 m is

- (a) 2 m (abs)
- (b) 4 m (abs)
- (c) 8 m (abs)
- (d) 16 m (abs)

22. A solid cylinder of circular section of diameter d is of material with specific gravity S_s . This floats in a liquid of specific gravity S_l . What is the maximum length of the cylinder if equilibrium is to be stable with the cylinder axis vertical?

(a) $\frac{dS_s}{2\sqrt{S_s(S_l - S_s)}}$

(b) $\frac{dS_l}{\sqrt{8S_s(S_l - S_s)}}$

(c) $\frac{dS_l}{\sqrt{2S_s(S_l - S_s)}}$

(d) $\frac{d}{\sqrt{8(S_l - S_s)}}$

23. A tank is 1.8 m deep and square length of 4.5 m at the top and square length of 3 m at the bottom. The four sides are plane and each has the same trapezoidal shape. The tank is completely full of oil weighing 936 kg/m³. What is the resultant pressure on each side?

- (a) 5750 kgf
- (b) 5500 kgf
- (c) 5250 kgf
- (d) 5140 kgf

24. Over a basin of area 333 km², there was a storm for 6 h with a uniform intensity of 2 cm/h. The observed runoff was 20×10^6 m³. The average rate of infiltration for the basin was

- (a) 5 mm/h
- (b) 10 mm/h
- (c) 20 mm/h
- (d) 40 mm/h

25. International Traffic Intelligent Survey Data are related with

- (a) Origin and destination studies
- (b) Speed and delay studies
- (c) Classified traffic volume studies
- (d) Accident profiling studies

26. A peak flow of a flood hydrograph due to a six-hour storm is $470 \text{ m}^3/\text{s}$. The corresponding average depth of rainfall is 8 cm. Assume an infiltration loss of $0.25 \text{ cm}/\text{hour}$ and a constant base flow of $15 \text{ m}^3/\text{s}$. What is the peak discharge of 6 hour unit hydrograph for this catchment ?
- $60 \text{ m}^3/\text{s}$
 - $70 \text{ m}^3/\text{s}$
 - $80 \text{ m}^3/\text{s}$
 - $90 \text{ m}^3/\text{s}$
27. A new reservoir has a capacity of 12 Mm^3 and its catchment area is 400 km^2 . The annual sediment yield from this catchment is $0.1 \text{ ha.m}/\text{km}^2$ and the trap efficiency can be assumed constant at 90%. The number of years it takes for the reservoir to lose 50% of its initial capacity is, nearly
- 177 years
 - 77 years
 - 17 years
 - 7 years
28. Cavitation is likely to occur if
1. Pressure becomes very high.
 2. Temperature becomes low.
 3. Pressure at the specific point falls below vapour pressure.
 4. Energy is released with the onset of a high intensity wave due to noise and vibration of the machine.
- Which of the above statements are correct ?
- 1 and 3
 - 2 and 3
 - 3 and 4
 - 2 and 4
29. Which of the following statements are correct as regards aquifer characteristics ?
1. The storage coefficient is the volume of water released from storage from the entire aquifer due to unit depression of piezometric head.
 2. The storage coefficient is the same as the specific yield for water table aquifer.
 3. Both the aquifer constants, viz. storage coefficient S and Transmissivity T are dimensionless numbers.
- 1 only
 - 2 only
 - 3 only
 - 1, 2 and 3
30. The important parameters describing the performance of a hydraulic machine are : P the power input, H the head produced across the machine and the efficiency, η . For a given geometrical design of the machine, the performance is characterized by the variables :
- H – the head increase across the machine, ρ – the fluid density, ω – the angular velocity of the rotor, D – the diameter of the rotor, μ – the fluid viscosity and Q – the flow rate; and both P and η are expressed through these variables. How many non-dimensional parameters are involved herein ? Gravitational acceleration g has also to be considered necessarily ?
- 7
 - 6
 - 5
 - 4

31. What are the values of coefficients a and c if velocity distribution in a laminar boundary layer on a flat plate is :

$$f(n) = \frac{u}{U_0} = a + bn + cn^2 + dn^3$$

$$\text{where, } n = \frac{y}{\delta}$$

- (a) $\frac{1}{2}$ and 1
 (b) 0 and 1
 (c) $-\frac{1}{2}$ and 0
 (d) 0 and 0
32. The conditions to be satisfied for a channel in 'Regime' as per Lacey are
1. Constant discharge.
 2. Silt grade and silt concentration are constant.
 3. The channel is flowing in unlimited incoherent alluvium of the same alluvial character as that transported.

Which of the above statements are correct ?

- (a) 1 and 2 only
 (b) 1, 2 and 3
 (c) 1 and 3 only
 (d) 2 and 3 only
33. Consider the following statements related to uplift pressure in gravity dams :
1. A drainage gallery reduces the uplift pressure at all levels below the gallery.
 2. A drainage gallery below upstream water level reduces the uplift pressure at all levels below the upstream water level.
 3. A grout curtain near the heel reduces seepage and uplift pressure everywhere on the gravity dam whatever the upstream water level.

Which of the above statements are correct ?

- (a) 2 and 3 only
 (b) 1 and 2 only
 (c) 1 and 3 only
 (d) 1, 2 and 3
34. A barrage on a major river in the Gangetic plains has been designed for a flood discharge $7000 \text{ m}^3/\text{s}$. It has been provided with a waterway of 360 m length. The looseness factor of this barrage is
- (a) 1.7
 (b) 1.1
 (c) 0.7
 (d) 0.1
35. A 20 m long horizontal concrete floor under a barrage on a permeable foundation retains a 5 m head of water and has a 5 m deep downstream end pile. The exit gradient is
- (a) 1 in 4
 (b) 1 in 5
 (c) 1 in 6
 (d) 1 in 8
36. Electrical conductivity (EC) of water and total dissolved solids (TDS) are related as :
- The value of EC will
- (a) Decrease with increase in TDS
 (b) Increase with increase in TDS
 (c) Decrease initially and then increase with increase in TDS
 (d) Increase initially and then decrease with increase in TDS

37. Consider the following properties of fluorine :

1. It is a member of the halogen family.
2. It is a greenish yellow diatomic gas.
3. Chlorine, iodine, bromine and Helium are members of the halogen family.
4. Even fireproof asbestos burns in the ambience of fluorine.

Which of the above are correct ?

- (a) 1, 2 and 3 only
- (b) 3 and 4 only
- (c) 1, 2 and 4 only
- (d) 1, 2, 3 and 4

38. The following are certain operating problems of a rapid sand filter :

1. Sand depth should never be depleted by more than 10 cm.
2. Air binding results due to development of negative head and formation of air bubbles in the filter sand.
3. Water softening with lime-soda leads to incrustation of sand.
4. Bumping of filter bed is caused due to negative head.

Which of the above statements are correct ?

- (a) 1, 2 and 4 only
- (b) 1, 2 and 3 only
- (c) 3 and 4 only
- (d) 1, 2, 3 and 4

39. Consider the following characteristics of E. coli bacteria :

1. Gram negative
2. Spore-forming
3. Facultative anaerobic
4. Bacillus

Which of the above are correct ?

- (a) 1, 2 and 3 only
- (b) 2 and 4 only
- (c) 1, 3 and 4 only
- (d) 1, 2, 3 and 4

40. How much bleaching powder is needed to chlorinate 5000 l of water whose chlorine demand is 2 mg/l, assuming that the bleaching powder has 25% available chlorine ?

- (a) 4 g
- (b) 40 g
- (c) 140 g
- (d) 400 g

41. A water supply distribution system for an averagely-populated township is to be designed for

- (a) Maximum daily demand
- (b) Maximum hourly demand and fire demand
- (c) Average demand
- (d) Maximum daily demand and fire demand, or maximum hourly demand, whichever is higher

42. A combined sewerage system is more appropriate for developed areas where

- (a) Rainfall occurs for a very few days in a year
- (b) Rainfall occurs almost uniformly throughout the year
- (c) Air temperatures are nearly uniform throughout the year
- (d) Air temperatures through the year include extremes during certain runs of days

43. The velocity distribution in the boundary layer is given by $\frac{u}{U} = \frac{y}{\delta}$, where u is the velocity at a distance of y from the boundary and $u = U$ at $y = \delta$, δ being boundary layer thickness. Then the value of momentum thickness will be

(a) $\frac{\delta}{2}$

(b) $\frac{\delta}{4}$

(c) $\frac{\delta}{6}$

(d) $\frac{\delta}{8}$

44. 100 m³ of sludge holds a moisture content of 95%. If its moisture content changes to 90%, the volume of this sludge will then be

(a) 40.5 m³

(b) 50 m³

(c) 75 m³

(d) 94.7 m³

45. The design overflow rate of a sedimentation tank is chosen considering

(a) Flow rate through the tank

(b) Diameter of the particle intended to be removed

(c) Volume of the sedimentation tank

(d) Detention time in the tank

46. Consider the following statements in respect of flow equalization in a wastewater treatment plant :

1. Biological treatment is enhanced because shock loadings are eliminated or minimized.

2. Flow equalization is an attractive option for upgrading the performance of overloaded treatment plants.

3. Inhibiting substances can be diluted and pH can be stabilized.

4. Thickening performance of primary sedimentation tanks following grit removal is improved.

Which of the above statements are correct ?

(a) 1, 2, 3 and 4

(b) 1, 2 and 3 only

(c) 1, 2 and 4 only

(d) 3 and 4 only

47. A drain carrying 5 m³/s of wastewater with its BOD of 100 mg/l joins a stream carrying 50 m³/s flow with its BOD of 5 mg/l. What will be the value of the BOD of the combined flow after complete mixing ?

(a) 3.6 mg/l

(b) 13.6 mg/l

(c) 33.6 mg/l

(d) 53.6 mg/l

48. Consider the following statements in respect of aerated grit chamber :

1. The grit accumulates at the bottom in advancing spiral-flow aeration tanks, locationally preceded by grit chambers, led to the eventual development of aerated grit chambers.
2. The excessive wear on grit handling equipment is a major factor for the popularity of aerated grit chambers.
3. Aerated grit chambers are designed to provide detention period of 1 minute at maximum rate of flow.
4. Diffusers are located at 0.45 m to 0.6 m above the bottom of the chamber.

Which of the above statements are correct ?

- (a) 1, 2 and 3 only
- (b) 3 and 4 only
- (c) 1, 2 and 4 only
- (d) 1, 2, 3 and 4

49. The side of a square land was measured as 150 m and is in error by 0.05 m. What is the corresponding error in the computed area of the land ?

- (a) 5 m²
- (b) 10 m²
- (c) 15 m²
- (d) 20 m²

50. Consider the following statements in respect of anaerobic sludge digester :

1. It is less expensive compared to several other methods available.
2. Processing of separable solids impacts the environment to a minimum.
3. Quantity of separated solids requiring disposal is minimal.
4. Digested sludge is very readily dewaterable.

Which of the above statements are correct ?

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 3 only
- (c) 3 and 4 only
- (d) 1, 2 and 4 only

51. Consider the following statements as regards a Septic Tank :

1. The size required is large and uneconomical when serving more than roughly 100 persons.
2. It can remove around 90% of BOD and 80% of suspended solids.
3. As compared to the sludge holding of a plain sedimentation tank, a septic tank can hold about 90% less of sludge volume.
4. Frequent removal of sludge is not required.

Which of the above statements are correct ?

- (a) 1 and 2
- (b) 2 and 3
- (c) 3 and 4
- (d) 1 and 4

52. Sewage sickness relates to
- Toxicity of sewage interfering with 'response' to treatment
 - Destruction of aquatic flora and fauna due to gross pollution of receiving bodies of water by the sewage
 - Reduction in the waste purifying capacity of the soil
 - Clogging of pores in soil due to excessive application of sewage leading to obstruction of land aeration thereby leading to septic conditions in the land

53. The waste water of a certain large colony contains $10^{-5.6}$ mmol/l of OH^- ions at 25°C . The pH of this sample is

- 8.6
- 7.9
- 5.4
- 4.5

54. Consider the relevance of the following features for causing photochemical smog:

- Air stagnation.
- Abundant sunlight.
- High concentration of NO_x in atmosphere.
- High concentration of SO_2 in atmosphere.

Which of the above features are correct?

- 1, 2 and 4 only
- 3 and 4 only
- 1, 2 and 3 only
- 1, 2, 3 and 4

55. Consider the following statements related to ecology:

- All the physical, chemical and biological factors that a species needs in order to live and reproduce is called ecological niche.
- The boundary zone between two ecosystems is known as ecotone.
- The forests in the Arctics are known as tundra.
- A biome usually has a distinct climate and life forms adapted to that climate. Biome is more extensive and complex than an ecosystem.

Which of the above statements are correct?

- 1, 2 and 3 only
- 1, 2 and 4 only
- 3 and 4 only
- 1, 2, 3 and 4

56. Consider the following laws of ecology suggested by Barry Commoner:

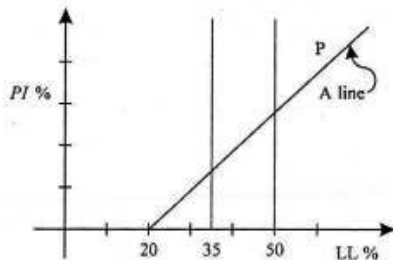
- Everything is connected to everything else.
- Everything must go somewhere.
- Nature knows best.
- There is no such thing as a free lunch.

Which of the above statements are correct?

- 1, 2 and 3 only
- 1, 2 and 4 only
- 3 and 4 only
- 1, 2, 3 and 4

57. For a hydraulically efficient rectangular channel of bed width 5 m, the hydraulic radius is
- 0.5 m
 - 1.25 m
 - 2.75 m
 - 4.25 m

58. The standard plasticity chart by Casagrande to classify fine-grained soils is shown in the figure.



The area marked *P* represents

- Inorganic clays of high plasticity
 - Organic clays and highly plastic organic silts
 - Organic and inorganic silts and silt-clays
 - Clays
59. A soil sample has shrinkage limit of 6%; and the specific gravity of the soil grains is 2.6. The porosity of soil at shrinkage limit is
- 7.5%
 - 9.5%
 - 13.5%
 - 16.5%

60. What is the dry unit weight of a clay soil when the void ratio of a sample thereof is 0.50, the degree of saturation is 70%, and the specific gravity of the soil grains is 2.7? Take the value of γ_w to be 9.81 kN/m³.
- 13.65 kN/m²
 - 19.95 kN/m²
 - 23.65 kN/m²
 - 29.95 kN/m²

61. Which technique of stabilization for the sub-base is preferred for a heavy plastic soil?
- Cement stabilization
 - Mechanical stabilization
 - Lime stabilization
 - Bitumen stabilization

62. A fill having volume of 150000 m³ is to be constructed at a void ratio of 0.8. The borrow pit solid has a void ratio of 1.4. The volume of soil required to be excavated from the borrow pit will be
- 150000 m³
 - 200000 m³
 - 250000 m³
 - 300000 m³

63. A channel designed by Lacey's theory has a mean velocity of 1.1 m/s. The silt factor is 1.1. Then hydraulic mean radius will be
- 1.13 m
 - 2.27 m
 - 3.13 m
 - 4.27 m

64. Consider the following assumptions as regards field permeability test :

1. The flow is laminar and Darcy's law is valid.
2. The flow is horizontal and uniform at all points in the vertical section.
3. The velocity of flow is proportional to the 'tangent magnitude' of the hydraulic gradient.

Which of the above assumptions are correct ?

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

65. In a three-layered soil system, the thicknesses of the top and bottom layers each are half the thickness of the middle layer. The coefficients of permeability of top and bottom layers each are double the coefficient of permeability k of the middle layer. When horizontal flow occurs, the equivalent coefficient of permeability of the system will be

- (a) $1.5 k$
- (b) $3.0 k$
- (c) $4.5 k$
- (d) $6.0 k$

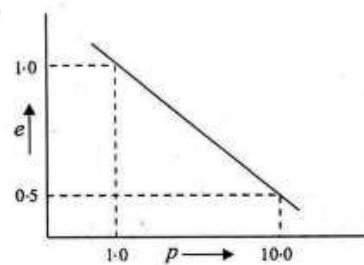
66. A uniform collapsible sand stratum, 2.5 m thick, has specific gravity of its sand as 2.65, with a natural void ratio of 0.65. The hydraulic head required to cause quick collapsible sand condition is

- (a) 2.50 m
- (b) 2.75 m
- (c) 3.25 m
- (d) 3.50 m

67. The ratio of dry unit weight to unit weight of water represents

- (a) Specific gravity of soil solids
- (b) Specific gravity of soil mass
- (c) Specific gravity of dry soil
- (d) Shrinkage ratio

68.



The virgin compression curve with axes adopted as per convention in this regard for a clay soil is shown in the figure. The compression index of the soil is

- (a) 0.25
- (b) 0.50
- (c) 1.00
- (d) 1.25

69. Proctor's compaction test for the maximum dry density of a certain soil gave the results as : 1.77 gm/cc and OMC 14.44%. The specific gravity of the clay soil grain was 2.66. What was the saturation degree for this soil ?

- (a) 44%
- (b) 55%
- (c) 66%
- (d) 77%

70. A rigid retaining wall of 6 m height has a saturated backfill of soft clay soil. What is the critical height when the properties of the clay soil are :

$$\gamma_{\text{sat}} = 17.56 \text{ kN/m}^3 \text{ and cohesion } C = 18 \text{ kN/m}^2.$$

- (a) 1.1 m
- (b) 2.1 m
- (c) 3.1 m
- (d) 4.1 m

71. The Engineering News Record Formula,

$$Q_a = \frac{Wh}{6(s+0.25)}, \text{ is used for the case of}$$

- 1. Drop hammer
- 2. Single-acting hammer
- 3. Double-acting hammer

Which of the above is/are correct ?

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

72. In a certain sea shore, the height of a retaining wall with smooth vertical back is 4.4 m. The foundation is over an expansive collapsible soil and has a horizontal surface at the level of the top of the wall and carries a udl of 197 kPa. The unit weight and angle of internal friction are 19 kN/m^3 and 30° , respectively. What is the nearest magnitude of the total active pressure per metre length of this sea shore wall ?

- (a) 270 kN/m
- (b) 360 kN/m
- (c) 450 kN/m
- (d) 640 kN/m

73. Which of the following statements are rightly associated with the laws of weights in the theory of errors ?

- 1. If an equation is multiplied by its own weight, then the weight of the resulting equation is equal to the reciprocal of the weight of the original equation.
- 2. The weight of the algebraic sum of two or more quantities is equal to the reciprocal of the sum of the individual weights.
- 3. If the quantity of a given weight is multiplied with a factor, then the weight of the resulting quantity is obtained by dividing the original weight by the square root of that factor.
- 4. If the quantity of a given weight is divided by a factor, then the weight of the resulting quantity is obtained by multiplying the original weight by the square of that factor.

- (a) 2 and 3
- (b) 2 and 4
- (c) 1 and 4
- (d) 1 and 3

74. Hypotenusal allowance is given by the expression (adopting standard conventions)

- (a) $(1 - \sec\theta) \times \text{measured distance}$
- (b) $(1 - \cos\theta) \times \text{measured distance}$
- (c) $(\sec\theta - 1) \times \text{measured distance}$
- (d) $(\cos\theta - 1) \times \text{measured distance}$

75. The clogging of chain rings with mud introduces (with 'error' defined in the standard way)→
1. Negative cumulative error
 2. Positive cumulative error
 3. Compensating error
- (a) 1 only
 (b) 2 only
 (c) 3 only
 (d) 1, 2 and 3
76. The magnetic bearing of a line (on full-circle mensuration basis) is $55^{\circ} 30'$ and the magnetic declination is $5^{\circ} 30'$ East. The true magnetic bearing of the line will be
- (a) $61^{\circ} 00'$
 (b) $55^{\circ} 30'$
 (c) $40^{\circ} 00'$
 (d) $50^{\circ} 00'$
77. In any closed traverse, if the survey work is error free, then
1. The algebraic sum of all the latitudes should be equal to zero.
 2. The algebraic sum of all the departures should be equal to zero.
 3. The sum of the northings should be equal to the sum of the southings.
- Which of the above statements are correct ?
- (a) 1 and 2 only
 (b) 1 and 3 only
 (c) 2 and 3 only
 (d) 1, 2 and 3
78. The rise and fall method for obtaining the reduced levels of points provides a check on
1. Foresight
 2. Backsight
 3. Intermediate sight
- Which of the above statements are correct ?
- (a) 1 and 2 only
 (b) 1 and 3 only
 (c) 2 and 3 only
 (d) 1, 2 and 3
79. Turning of the theodolite telescope in vertical plane by 180° about the horizontal axis is known as
- (a) Setting
 (b) Centering
 (c) Transiting
 (d) Swinging
80. Which of the following are among the fundamental lines of a theodolite ?
1. The vertical and horizontal axes
 2. The lines of collimation and axis of the plate levels
 3. The bubble line of the altitude level
- (a) 1 and 2 only
 (b) 1 and 3 only
 (c) 2 and 3 only
 (d) 1, 2 and 3

81. Local mean time of a place of longitude of $42^{\circ}36'$ W is 8 h 42 m 15 s AM. The corresponding Greenwich Mean Time is
- (a) 10 h 32 m 40 s AM
 (b) 11 h 32 m 39 s PM
 (c) 0 h 32 m 39 s PM
 (d) 11 h 32 m 39 s AM
82. A vertical photograph of a flat area having an average elevation of 250 m above mean sea level was taken with a camera of focal length 25 cm. A section line AB 300 m long in the area measures 15 cm on the photograph; a tower BP in the area also appears on the photograph. The distance between images of top and bottom of the tower measures 0.5 cm on the photograph. The distance of the image of the top of the tower is 10 cm. The actual height of the tower is
- (a) 10 m
 (b) 15 m
 (c) 20 m
 (d) 25 m
83. A transportation trip survey was undertaken between private car, and public car transportation. The proportion of those using private cars is 0.45. While using the public transport, the further choices available are Metro Rail and Mono Rail, out of which commuting by a Mono Rail has a proportion of 0.55. In such a situation, the choice of interest in using a Metro Rail, Mono Rail and private car would be, respectively
- (a) 0.25, 0.3 and 0.45
 (b) 0.45, 0.25 and 0.3
 (c) 0.25, 0.45 and 0.3
 (d) 0.3, 0.25 and 0.45
84. An airfoil of surface area 0.1 m^2 is tested for lift L in a wind tunnel. (Conditions can be considered as incompressible flow.) At an angle of attack of 5° , with standard air of density 1.22 kg/m^3 , at a speed of 30 m/sec, the lift is measured to be 3.2 kgf. What is the lift coefficient? For a prototype wing of area 10 m^2 , what is the approximate lift at an air speed of 160 kmph at the same angle of attack of 5° ?
- (a) 0.572 and 700 kgf
 (b) 0.603 and 700 kgf
 (c) 0.572 and 570 kgf
 (d) 0.603 and 570 kgf
85. Two tanks A and B , of constant cross-sectional areas of 10 m^2 and 2.5 m^2 , respectively, are connected by a 5 cm pipe, 100 m long, with $f = 0.03$. If the initial difference of water levels is 3 m, how long will it take for 2.5 m^3 of water to flow from A to B ? Considering entry and exit losses, it can be grossly assumed that the flow velocity, in m/s, through the pipe is $1.75\sqrt{h}$, where h is in m, taking $g = 10 \text{ m/sec}^2$; also, may take area of pipe as $2 \times 10^{-3} \text{ m}^2$.
- (a) 535 seconds
 (b) 516 seconds
 (c) 485 seconds
 (d) 467 seconds

86. The consistency and flow resistance of a sample of bitumen can be determined through which of the following tests ?

- (a) Viscosity test
- (b) Penetration test
- (c) Ductility test
- (d) Softening point test

87. A pipe of 324 mm diameter, having friction coefficient as 0.04, connects two reservoirs with 15 m difference in their water levels through a 1500 m long pipe. What will be the discharge through the pipe ?

- (a) 104 lps
- (b) 134 lps
- (c) 165 lps
- (d) 196 lps

88. Flexible concrete is a mix comprising of

- (a) Gravel, filler and 30/40 bitumen
- (b) Sand, filler and 30/40 bitumen only
- (c) Gravel, sand, filler and 60/70 bitumen
- (d) Sand, filler and 60/70 bitumen only

89. Consider a soil sample, for which tests yield the following results :

Passing 75 micron sieve	62%
Liquid limit	35%
Plasticity Index	14%

As per the group index classification of soil, what is the soil condition of the above soil sample ?

- (a) Poor
- (b) Fair
- (c) Good
- (d) Excellent

90. Consider the following statements regarding ductility of bitumen :

1. Ductility is the property which does not permit bitumen to undergo large deformation without breaking
2. Bitumens with high ductility are generally adhesive but do not have good cementing properties
3. Ductility must be ascertained at two different temperatures in order to pronounce on the suitability of the material

Which of the above statements is/are correct ?

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

91. A collapsible soil sub-grade sample was tested using Standard California Bearing Ratio apparatus; and the observations are given below :

Sl.No	Load	Penetration
1.	60.55 kg	2.5 mm
2.	80.55 kg	5.0 mm

Taking the standard assumptions regarding the load penetration curve, CBR value of the sample will be taken as

- (a) 3.9%
- (b) 4.0%
- (c) 4.4%
- (d) 5.5%

92. What is the critical thickness of a prestressed concrete pavement (using Westergaard's Corner Load Formula) to support a maximum wheel load of 4200 kg? Allow 10% for impact. Tyre pressure may be taken as 7 kg/cm². Assume flexural strength of concrete as 50 kg/cm², factor of safety as 2, subgrade reaction for plastic mix road as 6 kg/cm³, and modulus of elasticity as 3×10^5 kg/cm².
- (a) 19.6 cm
 (b) 21.6 cm
 (c) 23.6 cm
 (d) 25.6 cm
93. At a hydraulic jump, the flow depths are 0.4 m and 5 m at the upstream and downstream, respectively. The channel is wide rectangular. The discharge per unit width is nearly
- (a) 5.8 m²/s
 (b) 6.4 m²/s
 (c) 7.3 m²/s
 (d) 8.3 m²/s
94. Overspeed and delay studies on a pre-selected section of a Highway are conducted by
- (a) Fast moving car method
 (b) Enoscope
 (c) Radar
 (d) Traffic contours
95. The surface tension of water at 20°C is 75×10^{-3} N/m. The difference in water surfaces within and outside an open-ended capillary tube of 1 mm internal bore, inserted at the water surface, would nearly be
- (a) 7 mm
 (b) 11 mm
 (c) 15 mm
 (d) 19 mm
96. Survey of India was publishing toposheets using a scale of
- (a) 1 : 1000
 (b) 1 : 5000
 (c) 1 : 10000
 (d) 1 : 50000
97. The maximum speed of a train on B.G. track having a curvature of 3° and a cant of 10 cm with allowable cant deficiency of 76 mm, for conditions obtaining in India, is
- (a) 87.6 km/h
 (b) 99.6 km/h
 (c) 76.6 km/h
 (d) 65.6 km/h
98. The gradient for a B.G. railway line such that the grade resistance together with curve resistance due to a 4° curve which will be equivalent to a simple ruling gradient of 1 in 150 is
- (a) 1 : 180
 (b) 1 : 200
 (c) 1 : 300
 (d) 1 : 400

99. A Pelton wheel works under a head of 400 m. Friction loss through the pipe flow is limited to 10%. The coefficient of velocity for the jet is 0.98. What is the velocity of the jet? Take $g = 10 \text{ m/s}^2$.

- (a) 83 m/s
- (b) 71 m/s
- (c) 65 m/s
- (d) 56 m/s

100. The value of porosity of a soil sample in which the total volume of soil grains is equal to twice the total volume of voids would be

- (a) 30%
- (b) 40%
- (c) 50%
- (d) 60%

101. Consider the following statements :

1. In an Impulse turbine, the pressure of the flowing water remains unchanged and is equal to atmospheric pressure.
2. In Impulse turbines, the water impinges on the buckets with 'pressure energy'.
3. In a Reaction turbine, the pressure of the flowing water remains unchanged and is equal to atmospheric pressure.

Which of the above statements is/are correct ?

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

102. A Pelton wheel with single jet rotates at 600 rpm. The velocity of the jet from the nozzle is 100 m/s. If the ratio of the bucket velocity to jet velocity is 0.44 and the speed ratio is 0.43, what is the coefficient of velocity of the nozzle ?

- (a) 0.817
- (b) 0.882
- (c) 0.913
- (d) 0.977

Directions :

Each of the next **Eighteen (18)** items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below :

Codes :

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is *not* the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

103. Statement (I) : The shear strain graph for a Newtonian fluid is linear.

Statement (II) : The coefficient of viscosity μ of the fluid is not a constant.

104. Statement (I) : Reynolds number must be the same for model and the prototype when both are tested as immersed in a subsonic flow.

Statement (II) : A model should be geometrically similar to the prototype.

105. Statement (I) : The ogee spillway is a control weir having an S-shaped crest profile which provides a high discharge coefficient without causing cavitations.

Statement (II) : The crest profile of ogee spillway conforms to the lower nappe of flow over a ventilated sharp-crested weir and ensures a constant discharge coefficient for all heads.

106. Statement (I) : In open channel flow, the maximum velocity does not occur on the free surface.

Statement (II) : There is wind drag on the free surface of an open channel.

107. Statement (I) : The deeper a lake, the lesser the evaporation in summer and the more in winter.

Statement (II) : Heat storage in water bodies affects seasonal evaporation.

108. Statement (I) : Flow over sharp-crested weirs, standing wave flumes and abrupt free overfalls at ends of long straight channels are examples of rapidly varied flow.

Statement (II) : The above-listed flows are all essentially local phenomena and can be utilized for flow measurement in open channels.

109. Statement (I) : Negative skin friction will act on the piles of a group in filled-up reclaimed soils or peat soil.

Statement (II) : The filled-up or peat soils are not fully consolidated but start consolidating under their own overburden pressure, developing a drag on the surface of the piles.

110. Statement (I) : The possibility of quicksand condition occurring is more on the downstream of a weir on a permeable foundation than on the upstream end with an upward component of seepage velocity.

Statement (II) : Seepage lines end with an upward component of seepage velocity at the downstream reaches of such a weir.

111. Statement (I) : Multistage centrifugal pumps are used to produce very high delivery heads.

Statement (II) : Roto-dynamic pumps must have to be centrifugal rather than centripetal, from the very basic principles of hydrodynamics. Also, the stages are in series.

112. Statement (I) : The speed of a hydraulic turbine has to be maintained constant irrespective of the load on the machine for keeping the electrical power generation frequency constant.

Statement (II) : Governing of hydraulic turbines can be done by controlling the discharge through the turbines by adjusting the spear valve in Pelton turbines and the wicket in Francis or Kaplan turbines.

113. Statement (I) : A channel in alluvium running with constant discharge and constant sediment charge will first form its flow section and then its final longitudinal slope.

Statement (II) : If a channel in alluvium has a section too small for a given discharge and slope steeper than required, degradation and aggradation happen and then the flow section attains final regime.

114. Statement (I) : The shear stress exerted by the stream flow on the bed is responsible for the movement of bed sediment particles.

Statement (II) : The sediment will move when the shear stress crosses a threshold limit designated as a critical shear stress τ_c .

115. Statement (I) : The trap efficiency of a reservoir increases with age as the reservoir capacity is reduced by sediment accumulation.

Statement (II) : The trap efficiency is a function of the ratio of reservoir capacity to the total inflow. A small reservoir on a large stream has a low trap efficiency.

116. Statement (I) : Recarbonation of water softened by lime-soda process results in increased hardness of the water.

Statement (II) : Suspended solids, like CaSO_4 and MgSO_4 , which have not settled in the sedimentation tank, get dissolved due to passage of CO_2 .

117. Statement (I) : Pipes carrying water are anchored at bends and other points of unbalanced thrusts.

Statement (II) : Pipes are anchored by firmly embedding in massive blocks of concrete or masonry to counter side thrusts due to hydrodynamic forces exerted on the joints.

118. Statement (I) : Aerobic condition in composting of refuse can be confirmed by temperature measurements.

Statement (II) : Aerobic reactions are exothermic.

119. Statement (I) : For a given soil, optimum moisture content increases with the increase in compactive effort.

Statement (II) : Higher the compactive effort, higher is the dry density at the same moisture content.

120. Statement (I) : Rate of settlement of a consolidating layer depends upon its coefficient of consolidation, which is directly proportional to the permeability and number of drainage paths available.

Statement (II) : The excess hydrostatic pore pressure is relieved fast in soil of higher permeability, in turn, depending on the number of drainage paths available in the consolidating layer.

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