

1. Consider the following statements :

1. Building Information Modeling has the ability to produce 3D CAD model.
2. Sequencing of the construction operations can be studied and the schedule can be incorporated into the BIM model.
3. BIM has the capability of adding what some refer to as the fifth dimension, the verbal definition of installed items.

Which of the above statements are correct ?

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

2. Match the following lists: *CPM*

List I	List II
P. Resource management	1. Getting the correct materials to the workface when needed
Q. Manpower leveling	2. Judicious allocation of the physical resources
R. Supply chain management	3. Practical improvement of the allocation of labor resources

Select the correct option using the code given below :

	P	Q	R
(a)	2	3	1
(b)	3	1	2
(c)	1	3	2
(d)	1	2	3

3. For repetitive operations, better information can be obtained from *CPM*

- (a) Gantt chart
- (b) Line of balance
- (c) Precedence diagram
- (d) Bar Chart

4. The density of wood used for construction in the ranges between

- (a) 1.2 to 1.3 g/cm³
- (b) 1.5 to 1.6 g/cm³
- (c) 2.3 to 2.6 g/cm³
- (d) 2.6 to 2.9 g/cm³

5. Which one of the following statements is NOT correct ?

- (a) Rustic Brick has mechanically textured finish, varying in pattern.
- (b) Arch Bricks are over-burnt also known as clinker bricks obtained from inner portion of the kiln.
- (c) Pale Bricks are over-burnt bricks obtained from outer portion of the kiln.
- (d) Body Bricks are well burnt bricks occupying central portion of the kiln.

6. Consider the following statements related to the glass :

1. The addition of lime makes the glass fluid and suitable for blowing.
2. Excess of soda increases the safety.
3. Silica is used in the form of pure quartz.

Which of the above statements are correct ?

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

7. As per IS : 303 and 10701, the thickness of 5 ply plywood boards for structural purpose are available in

- (a) 6 mm and 9 mm
- (b) 12 mm and 16 mm
- (c) 16 mm and 19 mm
- (d) 10 mm and 15 mm

8. As per IS 8112 : 1989, the minimum required compressive strength of 43 grade ordinary portland cement for 72 hours is

- (a) 23 MPa
- (b) 33 MPa
- (c) 43 MPa
- (d) 53 MPa

$72 \text{ hrs} = 72 \times 24 \text{ hrs} = 1728 \text{ hrs}$
 $1728 \text{ hrs} = 1728 \times \frac{1}{24} = 72 \times \frac{1}{2} = 36 \times \frac{1}{2} = 18 \times \frac{1}{2} = 9 \times \frac{1}{2} = 4.5$
 $4.5 \times 43 = 193.5 \text{ MPa}$

9. Consider the following oxides :

1. Al_2O_3
2. CaO
3. SiO_2

Which one of the following is the correct sequence in increasing order of their percentage analysis for an ordinary portland cement ?

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

10. Excess of Silica makes the brick

- (a) brittle on burning
- (b) crack on drying
- (c) melt on burning
- (d) warp

11. Match the following lists :

- | List I
(Property of Cement) | List II
(Apparatus) |
|--------------------------------|-------------------------|
| P. Specific gravity | 1. Blain's apparatus |
| Q. Setting time | 2. Le-Chatelier's flask |
| R. Soundness | 3. Autoclave |
| S. Fineness | 4. Vicat's apparatus |

Select the correct answer using the code given below :

- | | P | Q | R | S |
|-----|---|---|---|---|
| (a) | 1 | 2 | 3 | 4 |
| (b) | 2 | 1 | 4 | 3 |
| (c) | 2 | 4 | 3 | 1 |
| (d) | 4 | 2 | 1 | 3 |

12. Which of the following is/are used to measure the workability of lime?

- (a) Standard Flow table and a truncated conical mould
- (b) Autoclave apparatus
- (c) Vicat's apparatus
- (d) Slump cone test

13. Which one of the following is NOT correct for characteristics of lime?

- (a) Lime possesses good plasticity and is easy to work with.
- (b) It stiffens easily and is resistant to moisture.
- (c) The excellent cementitious properties make it most suitable for masonry work.
- (d) The shrinkage on drying is large because of its high water retentivity.

14. Consider the following statements:

- 1. Slaking takes place on adding water in lime.
- 2. Hardening takes place on adding water in cement.

Which of the above statements is/are correct?

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

15. Which one of the following statements is NOT correct with respect to mix design?

- (a) The mix must be workable so that it can be placed and finished easily.
- (b) The cement is the most costly ingredient in the concrete mix.
- (c) The strength and water tightness increase with the density of the mix.
- (d) Increasing the water content beyond that required for plasticity causes the strength to increase constantly.

16. What is the percentage of reinforcement of an axially loaded short square column of 400 mm side to support a factored load of 1600 kN? (Use M20 concrete and Fe415 steel)

- (a) 0.64
- (b) 7.40
- (c) 0.74
- (d) 6.40

17. A simply supported RCC one-way slab for an office floor has clear dimensions of 4 m × 10 m with 230 mm walls all-around. What is the effective length of the slab? (Take the effective depth of the slab as 160 mm)

- (a) 2.23 m
- (b) 4.16 m
- (c) 6.84 m
- (d) 10.23 m

$CaO + H_2O \rightarrow Ca(OH)_2$

SSD
= $\frac{L_0 + d/2}{L_0 + d/2}$
= $\frac{4m + 0.16m}{4.16m}$
= 1.16

18. The members in which the entire cross-section of concrete has a uniform compressive pressure is called

- (a) Axial prestressing ✓
- (b) Concordant prestressing
- (c) Eccentric prestressing
- (d) Non-distortional prestressing



19. For M-45 concrete as per IS : 1343-2012, in prestressed concrete structures, which is the correct value for autogenous shrinkage ($\epsilon_{ca} \times 10^{-6}$)?

- (a) 45
- (b) 65
- (c) 75
- (d) 95

$$\frac{120 \times 300^2}{12} \times CD = 50$$

20. A prestressed concrete beam of section $120 \text{ mm} \times 300 \text{ mm}$ is used over an effective span of 6000 mm to support a uniformly distributed load of 4 kN/m including the self-weight of the beam. The beam is prestressed by a straight cable carrying a force of 180 kN located at an eccentricity of 50 mm . What is the stress due to prestressing force?

- (a) 500 N/mm^2
- (b) 50 N/mm^2
- (c) 5 N/mm^2
- (d) 0.5 N/mm^2

$$\frac{180 \times 10^3}{120 \times 300} = \frac{180}{120} = 1.5$$

$$\frac{180 \times 10^3}{120 \times 300} = 5 \text{ N/mm}^2$$

$$\frac{1 \times 6^2}{8} = 18 \text{ kN/m}$$

$$P_{ce} = \frac{1800 \times 6000 \times 50}{12 \times 27 \times 10^6} = 5$$

$$5 \frac{6 \times 18 \times 5}{9 \times 27} = \frac{30}{9} = 3$$

~~10-0-11~~

21. Consider the following statements :

1. The viscosity-modifying agents allow the concrete to remain cohesive even with a high degree of fluidity.
2. Self-consolidating concrete can be used for beam-column joints in earthquake resistant structures.
3. Self-consolidating concrete is not recommended for precast prestressed concrete.

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

22. Which one of the following statements CPM is correct?

- (a) CPM is developed especially for scheduling of research and development work. ✗
- (b) PERT is developed for the quality control laboratory work at construction site.
- (c) PERT is a method of statistically evaluating project duration over a time-sensitive domain. ✓
- (d) A project schedule is a rough time table of construction operation. ✓

D - MNGY-D-CVL

(13/4) ✓

23. Which one of the following is NOT considered for the estimation of activity duration? ^{CPM}

- (a) Evaluate activities one at a time, independently of all others.
- (b) For each activity, assume a normal level of manpower and or equipment.
- (c) If time units of working days are being used, assume an exceptional day with maximum working hours.
- (d) Normal weather conditions is considered for the estimation of duration of each activity.

24. Which one of the following statements is NOT correct related to total float?

- (a) Total float of an activity is obtained by subtracting its early start time from its late start time.
- (b) Subtracting the early finish from late finish provides total float.
- (c) Activities with zero total float is called critical activities.
- (d) Total float can be calculated by subtracting its early finish time from the earliest of the early start time of the activities directly following.

25. For heavy civil projects, examination of weight and dimension limit of the road is related to

- (a) equipment planning
- (b) support planning
- (c) quality planning
- (d) safety planning

26. The basic objective of which one of the following is to supply and support the field operations so that established time objectives can be met and costs can be kept within the construction budget?

- (a) Time management
- (b) Resource management
- (c) Financial management
- (d) Equipment management

27. Which one of the following is NOT the characteristic of equipment management and scheduling?

- (a) Work should be planned and scheduled to achieve the fullest use of every equipment item, minimizing idle equipment time.
- (b) To the maximum extent possible, equipment sent to the job should be of the type that will best perform the work under actual job conditions.
- (c) The temptation to overload equipment in an effort to get more production is common but counterproductive.
- (d) Examination of weight and dimension limit of the road for carrying heavy equipment.

28. Which one of the following statements is NOT correct according to Gantt chart?

- (a) Activities are illustrated as bars on a horizontal time line. ✓
- (b) Beginning and end of a bar coincides with the activity's starting and ending dates. ✓
- (c) The time and operational concurrency aspects of the schedule is missed in this chart.
- (d) Illustrations are given that how the activities are to be distributed over the project time line.

29. Which one of the following statements is NOT correct related to line-of-balance schedule?

- (a) It represents both a presentation format and a scheduling technique.
- (b) It is a very visual method of representing a particular type of project.
- (c) It allows the planning team a single sequence without any option.
- (d) Using a combination of sloping lines, bars and blocks, operations can be sequenced so that space and resource conflicts are quickly identified and addressed.

30. Which one of the following statements is correct?

- (a) PERT is commonly used in the construction work. ✓
- (b) PERT is suitable for the estimation of activity duration where high levels of uncertainty is there. ✓
- (c) PERT does not provide time duration. ✗
- (d) PERT is a deterministic approach for estimating the time duration of an activity. ✗

31. The value of Poisson's ratio for cast iron is in the range of *SOM*

- (a) 0.09 - 0.19
- (b) 0.20 - 0.30
- (c) 0.31 - 0.41
- (d) 0.42 - 0.52

32. A cylindrical bar of 25 mm diameter *SOM* and 1.20 m length is subjected to a longitudinal strain during a tensile test is four times the lateral strain, what is the value of shear modulus? (Take the modulus of elasticity as $1.2 \times 10^5 \text{ N/mm}^2$)

- (a) 5.8 kN/mm²
- (b) 4.8 kN/mm²
- (c) 58 kN/mm²
- (d) 48 kN/mm² ✓

$$\mu = 0.25$$

$$E = 2G(1 + \mu)$$

$$\frac{1.2 \times 10^5}{2 \times 1.25} = \frac{1.2 \times 10^5}{2.5}$$

$$\frac{120 \times 10^4}{2.5} = 4.8 \times 10^4 \frac{\text{N}}{\text{mm}^2} = 48 \text{ kN/mm}^2$$

D - MNGY-D-CVL
48 kN/mm²

33. Which one of the following statements is NOT correct ?

- (a) For structural steel, the rupture strength is higher than the ultimate strength.
- (b) Yield stress is the lowest stress at which extension of the test piece increases without further increase in load.
- (c) The ultimate strength is commonly taken as the maximum stress of the material.
- (d) Ultimate strength is the ratio of maximum load to the original cross sectional area.

34. A prismatic bar has a cross section of 25 mm × 50 mm and a length of 2 m. If the bar is subjected to an axial tensile force of 90 kN, the bar is elongated by 1.5 mm. What is the tensile stress ?

- (a) 3.6 N/mm²
- (b) 7.2 N/mm²
- (c) 36 N/mm²
- (d) 72 N/mm²

$$G = \frac{90 \times 10^3}{25 \times 50} = \frac{90 \times 4}{5} = 72 \text{ N/mm}^2$$

35. The normal stress across the principal plane is known as

- (a) Shear stress
- (b) Maximum shear stress
- (c) Principal stress
- (d) Tangential stress



36. If the principal stresses at a point in an elastic material are $2f$ tensile, $1.5f$ tensile and f compressive. What is the value of f at failure using maximum principal stress theory? (Take the elastic limit in simple tension as 210 N/mm^2 and $\mu = 0.3$)

- (a) 210 N/mm^2
- (b) 420 N/mm^2
- (c) 170 N/mm^2
- (d) 105 N/mm^2

$$\sigma_1 \leq \frac{f_y}{F_s} \quad \text{Com shear } F=1$$

$$2f \leq \frac{210}{1}$$

$$f \leq 105$$

37. Consider the following statements related to maximum shear stress theory (Guest's theory):

1. This theory is well justified for ductile materials.
2. It gives accurate results for the state of stress of pure shear in which maximum amount of shear is developed. *over estimate in pure shear*
3. The results of this theory differ from the experimental results for materials having large differences in elastic stress limits in tension and compression.

Which of the above statements is/are NOT correct ?

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

38. Which one of the following statements is correct for an isotropic material?

- (a) Shear modulus is independent of Young's modulus only. \uparrow
- (b) Shear modulus is independent of Poisson's ratio only. ρ
- (c) Shear modulus is independent of Young's modulus and Poisson's ratio.
- (d) Shear modulus is not independent of Young's modulus and Poisson's ratio.



39. A body is loaded elastically so that strain in y -direction (e_y) = 0 and $\sigma_z = 0$. Take σ_x and σ_y as finite. What is the value of strain in z -direction (e_z) in terms of stress in x -direction (σ_x), Young's Modulus (E), and Poisson's ratio (ν)?

- (a) $e_z = \sigma_x \nu (1 + 2\nu) / E$
- (b) $e_z = \sigma_x \nu (1 - 4\nu) / E$
- (c) $e_z = \sigma_x (1 + \nu) / E$
- (d) $e_z = -\sigma_x \nu (1 + \nu) / E$

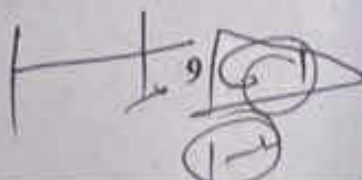
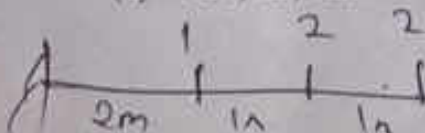


$e_y = 0$

$\sigma_z = 0$

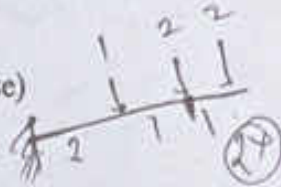
40. What are the three stress invariants (in MPa) respectively in a body under the stress states of, $\sigma_x = 10$, $\sigma_y = 8$, $\sigma_z = -5$, $\tau_{yz} = \tau_{zy} = 5$, $\tau_{zx} = \tau_{xz} = -4$, and $\tau_{xy} = \tau_{yx} = -8$, where all stresses are in MPa?

- (a) 23, -128 and 125
- (b) 13, 115 and -138
- (c) 115, 13, -128
- (d) -138, 23, 125



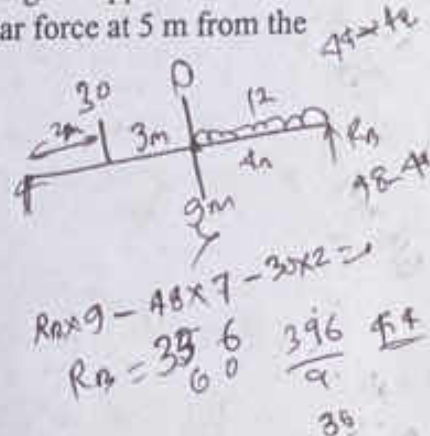
41. A cantilever beam of 4 m span carries three point loads of 1 kN, 2 kN and 2 kN at 2 m, 3 m and 4 m from the fixed end respectively. What is the bending moment at 3 m from fixed support?

- (a) -4 kNm (Anticlockwise)
- (b) 6 kNm (Clockwise)
- (c) 3 kNm (Clockwise)
- (d) 2 kNm (Anticlockwise)



42. A simply supported beam of 9 m span carries a point load of 30 kN at 2 m from the left end of the support. It also carries a UDL of 12 kN/m over 4 m span from the right support. What is the value of shear force at 5 m from the left support?

- (a) 4 kN
- (b) 44 kN
- (c) 3 kN
- (d) 33 kN



43. What is the ratio of elongation of a rectangular bar due to self-weight to the elongation if total weight of the bar is applied at its end?

- (a) $\frac{1}{2}$
- (b) 2
- (c) $\frac{1}{3}$
- (d) 3

$$\frac{WL}{2AE} \div \frac{WL}{AE} = \frac{1}{2}$$

44. The stresses on two perpendicular planes through a point are 60 N/mm^2 tension, 40 N/mm^2 compression and 30 N/mm^2 shear. What is the absolute normal stress on a plane at 60° to that of the tensile stress?

- (a) 10.98 N/mm^2
 (b) 17.63 N/mm^2
 (c) 20.98 N/mm^2
 (d) 32.63 N/mm^2

Handwritten calculations for Q44:

$$\frac{60+40}{2} + \frac{60-40}{2} \cos 120^\circ + 30 \sin 120^\circ$$

$$= 10 + 10 \times (-\frac{1}{2}) + 30 \times \frac{\sqrt{3}}{2}$$

$$= 10 - 5 + 15\sqrt{3}$$

$$= 10 - 5 + 25.98 = 30.98$$

Which of the above statements is/are correct?

- (a) 1 only
 (b) 2 only

- (c) Both 1 and 2
 (d) Neither 1 nor 2

45. Which one of the following statements is correct?

- (a) The rate of change of shear force along the length of the beam is equal to bending moment.
 (b) The bending moment is zero at the point where shear force changes sign.
 (c) Shear force changes abruptly at the point of application of couple.
 (d) Rate of change of bending moment changes abruptly at the location of point load.

Handwritten notes for Q45:

$$\frac{dF}{dx} = w$$

$$\frac{dM}{dx} = F$$

47. Nominal shear capacity of a bolt is 82335 N . What is the design capacity of the bolt, if slip resistance is designated at service load?

- (a) 82335 N
 (b) 74850 N
 (c) 449099 N
 (d) 395208 N

Handwritten calculations for Q47:

$$82335 \times \frac{3}{4} = 61751.25$$

$$82335 \times \frac{5}{8} = 51459.375$$

48. Which one of the following is an advantage of welded connection?

- (a) Noise produced in welding process is relatively less.
 (b) Proper welding in field condition is difficult.
 (c) The inspection of welded joint requires non-destructive testing.
 (d) There is a greater possibility of brittle fracture in welding.

46. Consider the following statements related to principles of design of connections:

- The centre of gravity of bolts should coincide with the centre of gravity of the connected members.
- The length of connection should be kept as small as possible.

49. Consider the following statements related to lug angle :

If the main member is an angle,

1. the strength of lug angles and fastener connecting lug angle to gusset plate should be at least 20% more than the force in outstanding leg.
2. the strength of the fastener connecting lug angle and main member should be at least 40% more than the force in outstanding leg.
3. the whole area of the member is net area less deduction for bolt holes.

Which of the above statements are correct ?

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

50. The shear force for which each lacing shall be designed if two parallel systems of lacing is there in the column is

- (a) 2.5% of axial force in the column
- (b) 1.25% of axial force in the column
- (c) 50% of axial force in the column
- (d) 25% of axial force in the column

51. To account for shear deformation, the effective slenderness ratio of battened columns shall be taken as

- (a) 1.1 times the maximum actual slenderness ratio of the column
- (b) 2.5 times the maximum actual slenderness ratio of the column
- (c) 1.25 times the maximum actual slenderness ratio of the column
- (d) 0.9 times the maximum actual slenderness ratio of the column

52. The maximum pitch for tension and compression members respectively are

- (a) (12t or 200 mm, whichever is less) and (16t or 200 mm, whichever is less)
- (b) (12t or 300 mm, whichever is less) and (16t or 300 mm, whichever is less)
- (c) (16t or 200 mm, whichever is less) and (12t or 200 mm, whichever is less)
- (d) (16t or 300 mm, whichever is less) and (12t or 300 mm, whichever is less)

53. The minimum size of fillet weld for 20 mm to 32 mm plate is

- (a) 3 mm
- (b) 5 mm
- (c) 6 mm
- (d) 8 mm



30

3

5

4

10

54. What is the section modulus required to design an angle Purlin which experiences a maximum bending moment of 10 kNm, if the section is made with Fe250 grade steel ?

- (a) 4.55 cm³
- (b) 45.57 cm³
- (c) 75.57 cm³
- (d) 7.55 cm³

55. A rectangular simply supported beam of span 4 m is 300 mm × 700 mm in cross section and is reinforced with 3 bars of 20 mm on tension side at an effective cover of 50 mm. The beam experiences an imposed working load of 20 kN/m. Assume the density of concrete as 25 kN/m³ (excluding self-weight). What is the maximum bending moment ?

- (a) 5.05 kNm
- (b) 50.5 kNm
- (c) 55.0 kNm
- (d) 5.5 kNm

56. A rectangular concrete cantilever beam is made of M25 grade concrete and Fe415 grade steel is used. What is the modular ratio of the section assuming the modulus of elasticity of steel as 2×10^5 MPa ?

- (a) $\frac{1}{8}$
- (b) $\frac{1}{4}$

$$m = \left(\frac{E_s}{E_c} \right)$$

$$\Rightarrow \frac{2 \times 10^5}{50000}$$

$$\Rightarrow \frac{20 \times 10^4}{5 \times 10^4}$$

(c) 4

(d) 8

57. Consider the following statements related to the limit state design criterion for a safe design of the structure :

1. The structure or its elements should not collapse when subjected to the design loads.
2. The structure should not become unfit for use due to cracking or excessive deflection.
3. The structure should reach a limit state during its design life.

Which of the above statements are correct ?

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

58. What is the theoretical value of effective length of a compression member when it is 'effectively held in position at both ends but not restrained against rotation' ?

- (a) 0.50 L
- (b) 0.65 L
- (c) 1.00 L
- (d) 2.00 L

59. An RCC beam 200 mm wide and 450 mm deep, is reinforced with Fe415 grade steel of area 1000 mm^2 on tension side with an effective cover of 50 mm. If the shear reinforcement of 100 mm^2 stirrups is provided at a spacing of 150 mm centre to centre (c/c). What is the ultimate shear strength (V_{us}) corresponding to the shear reinforcement?

- (a) 96.3 kN
- (b) 90.6 kN
- (c) 9.63 kN
- (d) 9.06 kN

60. An RCC beam having 200 mm wide and 400 mm effective depth is reinforced with Fe415 grade steel of area 1000 mm^2 in tension. Assume M20 grade concrete, what is approximate value of the depth of neutral axis for the equilibrium of forces at the limit state of collapse?

- (a) 200 mm
- (b) 250 mm
- (c) 300 mm
- (d) 350 mm

0.46×400
 $\Rightarrow 184$
 depth = load

61. A cantilever beam is subjected to a point load against gravity at its free end. The variation and nature of the bending moment will be

- (a) linear and hogging
- (b) linear and sagging
- (c) parabolic and hogging
- (d) parabolic and sagging

62. A cast iron pipe has 300 mm bore and 10 mm metal thickness, and is supported at two points 8 m apart. What is the internal area of pipe?

- (a) 0.07069 m^2
- (b) 1.57059 m^2
- (c) 2.67069 m^2
- (d) 3.47059 m^2

$D = 46, 0.51, 0.59$

$$\frac{\pi}{4} (300)^2 - \frac{\pi}{4} (290)^2$$

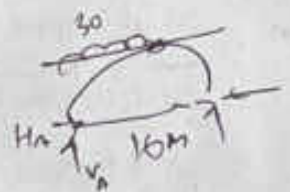
$$\Rightarrow \frac{\pi}{4} (10^4) (9 - 8.41)$$

$$0.59 \times 0.286 \times \pi$$

$2.9 \times 2.7 = 8.1$
 2.61
 5.8
 59

63. A parabolic 3 hinged arch (AB) carries a u.d.l. of 30 kN/m on the left half of the span. It has a span of 16 m and a central rise of 3 m. What is the resultant thrust at 'A' (left hand end)?

- (a) 271 kN
- (b) 141 kN
- (c) 241 kN
- (d) 171 kN



64. A fixed beam subjected to a central point load against gravity, the number of points of contraflexure and their positions respectively are

- (a) 1 and $L/2$ from centre of the beam
- (b) 2 and $L/3$ from both the supports
- (c) 2 and $L/4$ from centre of the beam
- (d) 3 and $L/4$ from both the supports and at centre of the beam



65. If one support of a fixed-ended beam settles, then what is the nature of the end moments?

- (a) One will be clockwise and another will be anticlockwise.
- (b) Both will be either clockwise or anticlockwise.
- (c) No moments will be induced at the ends.
- (d) The moments will be $3EI/L$ and in same sense.

66. A rectangular c/s beam of size $300 \text{ mm} \times 500 \text{ mm}$ is subjected to shear force of 20 kN . What is the shear stress at 150 mm above neutral axis?

- (a) 0.30 MPa
- (b) 0.60 MPa
- (c) 0.26 MPa
- (d) 0.13 MPa

Handwritten calculation for Q66:

$$\tau = \frac{FAS}{Ib}$$

$$\tau_{NA} = \frac{F}{A} \left(\frac{y^2}{2} - y^2 \right)$$

$$\tau_{NA} = \frac{20}{300 \times 500} \left(\frac{(250)^2}{2} - (250)^2 \right)$$

67. Which one of the following is NOT the assumption of Euler's column theory?

- (a) The direct stress is very small compared to the bending stress.
- (b) The self-weight of the column is considerable.
- (c) The cross-section of the column is uniform throughout.
- (d) The column will fail by buckling only.

68. In a rigid joint plane frame structure, introduction of pins to all members at a joint produces additional equations equal to

- (a) Number of members at the joint - 4
- (b) Number of members at the joint - 2
- (c) Number of members at the joint - 1
- (d) Number of members at the joint - 3

69. Consider the following statements:

1. The distribution factor for fixed and pin support is zero since any moment is resisted by an equal and opposite moment within the support and no balancing is required.
2. In the case of pinned supports, the distribution factor is equal to 1.0 since 100% of any applied moment must be balanced and a carry-over of $\frac{1}{2}$ of the balancing moment transferred to the remote end at the internal support.

Which of the above statements is/are correct?

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

Directions :

Each of the next Six (06) items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. You are to 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

70. Statement (I) : Wood is essentially an organic substance, made up of a skeleton of cellulose impregnated with lignin.

Statement(II) : The organic substances are not susceptible to attack by both bacteria and fungi.

71. Statement (I) : Any orthogonal set of axes are 180° to one another on Mohr's circle.

Statement(II) : The distance between these axes is half the diameter of the circle.

72. Statement (I) : There may be as many unknown forces as there are equations of equilibrium; however, instability or movement of a structure or its members can develop because of improper constraining by the supports.

Statement(II) : This can occur if all the support reactions are concurrent at a point and when the reactive forces are all parallel.

73. Statement (I) : The negative derivative of velocity potential function with respect to any direction gives the fluid velocity in that direction.

$$\frac{d\phi}{dx} = -u_x$$

Statement(II) : The partial derivative of stream function in any direction gives the velocity component in that direction.

74. Statement (I) : In Hardy cross method, a trial distribution of discharges is made arbitrary.

Statement(II) : The continuity equation must satisfy at each junction.

75. Statement (I) : Cross drainage structure, aqueduct is constructed to negotiate an aligned channel over, below or at the same level of a stream.

Statement (II) : Aqueduct is constructed, when full supply level (FSL) of canal is much higher than high flood level (HFL) of a stream.

76. According to Terzaghi, a foundation is shallow if its

- (a) depth is equal to or less than its width
- (b) depth is twice the width
- (c) width is thrice the depth
- (d) width is one fourth of depth

77. The ultimate bearing capacity is

- (a) the minimum net pressure intensity causing shear failure of soil
- (b) the minimum gross pressure intensity at the base of the foundation at which the soil fails in shear
- (c) the difference in intensities of the gross pressure after the construction of the structure
- (d) the total pressure at the base of the footing due to the weight of the superstructure

78. Which one of the following is NOT the common nomenclature of geosynthetics ?

- (a) Geotextiles
- (b) Geogrids
- (c) Geogroups
- (d) Geonets

79. Which one of the following is an advantage when geotextiles is used in road works ?

- (a) Prior stripping of the natural soil
- (b) Economy of aggregate
- (c) Increase of differential settlements
- (d) Slower consolidation of fills

80. Consider the following statements related to ultimate bearing capacity of footing based on the SPT and CPT values :

1. The empirical correlations established in the USA between N and soil properties indicate the value of N conforms to certain standard energy ratios.
2. The value of N to be used for getting ϕ is the corrected value for standard energy.
3. The angle ϕ obtained by this method can't be used for obtaining the bearing capacity factors.

Which of the above statements are correct ?

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

81. The unified classification system is based on the recognition of the type and predominance of the constituents considering

- (a) grain length
- (b) gradation
- (c) elasticity
- (d) non-compressibility

82. Which one of the following coffer dams is suitable for small heights?

- (a) Cantilever sheet pile coffer dam
- (b) Braced coffer dam
- (c) Embankment protected coffer dam
- (d) Double wall coffer dam

83. A footing $3\text{ m} \times 1.5\text{ m}$ in plan transmits a pressure of 160 kN/m^2 on a cohesive soil having $E = 8 \times 10^4\text{ kN/m}^2$ and $\mu = 0.48$. What is the immediate settlement at the centre, assuming the footing to be flexible? (Take $I_w = 1.52$)

- (a) 2.11 mm
- (b) 3.21 mm
- (c) 3.51 mm
- (d) 4.62 mm

$$\begin{aligned}
 & \frac{q(1-\mu^2)}{E} \cdot I_w \\
 & \Rightarrow \frac{160(1-0.48^2)}{8 \times 10^4} \times 1.52 \\
 & \Rightarrow \frac{160 \times 0.76}{8 \times 10^4} \times 1.52 \\
 & \Rightarrow \frac{20 \times 80}{16 \times 1.52} \\
 & \Rightarrow 3.51
 \end{aligned}$$

84. By means of Boussinesq's stress distribution theory, which one of the following pressure distribution diagrams can be prepared?



- (a) Strain isobar
- (b) Vertical pressure distribution on a horizontal plane
- (c) Vertical pressure distribution on an inclined plane
- (d) Pressure distribution diagram on an oblique plane

85. Which one of the following is an assumption made by Coulomb in the development of his earth pressure theory for sand and for active state?

- (a) The rupture surface is non-uniform surface
- (b) There is a wall friction on the pressure surface
- (c) Failure is three dimensional
- (d) The soil is cohesive

86. Which one of the following is a correct general consideration for a mechanically stabilized earth wall failure?

- (a) Compression in reinforcement
- (b) Bearing capacity failure
- (c) Shearing in the wall
- (d) Partly sliding of wall soil

87. Which one of the following is the part of assumptions made by Terzaghi while developing the mathematical statement of the consolidation process?

- (a) The soil is non-homogeneous ✓
- (b) The soil particles and water are incompressible ✓
- (c) The partial deformation of soil is due to partial change in volume
- (d) Co-efficient of permeability is variable during consolidation ✓

88. Which one of the following statements is NOT correct?

- (a) The porosity of a rock depends upon size and shape of the rock grains
- (b) Specific gravity is useful for calculating the rock over burden stress
- (c) The porosity does not depend on rock mechanical processes ✓
- (d) The porosity of spherical rock grains is high in case of cubic packing

89. Consider the following objectives related to the sub-surface investigation:

1. To establish the geological profile. ✓
2. To establish Hydrogeological conditions. ✓
3. To monitor future changes in ground conditions through instrumentation.

Which of the above objectives are correct?

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

90. Dip fault is a fault plane

- (a) parallel to the dip of beds
- (b) parallel to the strike of a bedding plane
- (c) diagonal to the dip of a bedding plane
- (d) with no relationship to the bedding plane

91. Consider the following aspects of human vision which are important for a traffic engineer:

1. Field of vision
2. Visual acuity
3. Colour perception

Which of the above aspects are correct?

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

92. The survey of the highway construction work for preparation of longitudinal and cross sections, computations of earth work quantities; and other construction material and checking details of geometric design elements is carried out in
- Reconnaissance survey
 - Preliminary survey
 - Location of final alignment
 - Detailed survey
93. The raising of outer rail over inner rail is called
- Cant deficiency
 - Cant
 - Capacity of the track
 - Centre bound sleepers
94. The distance between successive vehicles moving in the same line measured from head at any instance is
- the space headway
 - the time headway
 - the one-way stream
 - the head-way stream
95. The roads which are provided with a hard pavement course having at least a water bound macadam (WBM) layer are classified as
- Paved roads
 - Unpaved roads
 - Surface roads
 - Unsurfaced roads
96. The planning surveys about engineering studies consists of
- Income per capita
 - Living standard
 - Traffic volume
 - Road location and alignment studies
97. A cipolletti weir has length of 2.0 m and head over the weir is 1 m. What is the discharge over the weir? (Take $c_d = 0.62$)
- 10.35 m³/s
 - 3.66 m³/s
 - 45.21 m³/s
 - 75.68 m³/s

98. Which one of the following is an advantage using a triangular notch over a rectangular notch?

- (a) Ventilation of a triangular notch is necessary
- (b) The same triangular notch cannot measure a wide range of flows accurately
- (c) For heavy discharges, a triangular notch gives more accurate results than a rectangular notch
- (d) In a given triangular notch, only one reading is required to be taken for the measurement of discharge

99. Which one of the following statements is correct for flow in open channels?

- (a) When the depth of flow in a channel is greater than the critical depth, the flow is said to be super-critical flow ✗
- (b) When the depth of flow in a channel is equal to critical depth, the flow is said to be super-critical flow ✗
- (c) When the depth of flow in a channel is less than the critical depth, the flow is said to be sub-critical flow ✓
- (d) When the depth of flow in a channel is greater than the critical depth, the flow is said to be sub-critical flow

100. Water flows through a pipe of 200 mm in diameter 60 m long with a velocity of 2.5 m/s. What is the head loss due to friction using Darcy's formulae? (Assume $f = 0.005$)

- (a) 1.52 m
- (b) 1.79 m
- (c) 1.85 m
- (d) 1.91 m

Handwritten calculation for Q100:

$$\frac{fLV}{2gD} = \frac{0.005 \times 60 \times 2.5^2}{2 \times 9.81 \times 0.2} = 1.85$$

101. The pressure distribution in a liquid subjected to a constant horizontal acceleration is

- (a) same as hydrostatic pressure distribution
- (b) less than the hydrostatic pressure distribution
- (c) more than the hydrostatic pressure distribution
- (d) equal to hydrostatic pressure distribution minus weight of liquid

102. A convergent mouthpiece is discharging water under a constant head of 5 metres. If the diameter of the mouthpiece is 75 mm, then what is the discharge?

- (a) 38.2 litres/sec
- (b) 40.4 litres/sec
- (c) 43.8 litres/sec
- (d) 46.1 litres/sec

Handwritten calculation for Q102:

$$Q = C_d A v = 0.7 \times \frac{\pi}{4} \times 0.075^2 \times \sqrt{2 \times 9.81 \times 5} = 43.8$$

103. A flat plate $1.5 \text{ m} \times 1.5 \text{ m}$ moves at 45 km/hour in stationary air of specific weight 11.3 N/m^3 . If the coefficient of lift is 0.75 , then what is the lift force?

- (a) 120.4 N
- (b) 151.9 N
- (c) 180.4 N
- (d) 225.9 N

$$F = \frac{\rho V^2 A C_L}{2}$$

104. A submarine which may be supposed to approximate a cylinder 3 m in diameter and 15 m long travels submerged at 1.54 m/s in sea water at 4°C . What is the drag exerted on it? (Take $C_d = 0.7$ and $\rho = 1025 \text{ kg/m}^3$)

- (a) 30129 N
- (b) 34517 N
- (c) 37112 N
- (d) 38287 N



105. If the pressure heads at the different sections of the pipe are plotted to scale as vertical ordinates above the axis of the pipe and all these points are joined by a sloping straight line, which is known as

- (a) Hydraulic gradient line
- (b) Total energy line
- (c) Total head line
- (d) Energy grade line

106. Which one of the following consists of horizontal and vertical location of certain points by linear and angular measurements and is made to determine the natural features of a country?

- (a) Cadastral survey
- (b) Topographical survey
- (c) Astronomical survey
- (d) Military survey

107. Which one of the following statements is NOT correct?

- (a) Trigonometric levelling has never been used in geodetic surveys
- (b) The differences in elevation are determined indirectly by trigonometric levelling ✓
- (c) The electronic distance measurement devices can be used for measuring the vertical distances ✓
- (d) The combined effects of curvature and refraction produce vertical readings that are slightly too short

108. A line AB between the stations A and B was measured as 348.28 m using a 20 m tape, too short by 0.05 m . What is the correct length of line AB?

- (a) 349.15 m
- (b) 348.41 m
- (c) 347.41 m
- (d) 346.15 m

$$348.28 \times \left(\frac{19.95}{20} \right)$$

$$\left(1 - \frac{0.05}{20} \right) \times \frac{0.05}{20}$$

$$\left(1 - \frac{0.01}{2000} \right) \times \frac{0.05}{20}$$

$$2000 \frac{1999}{2000}$$

109. The levelling is carried out between two stations P and Q separated by 1000 m. The Back Sight (BS) reading is noted as 0.70 m on station P, whose BM is 240.00 m. Next, the Fore Sight (FS) reading is taken on an intermediate point and the value is 1.25 m. Then the instrument is shifted to a new location and BS is taken on intermediate point as 0.85 m. Finally, the FS reading is taken on station Q as 1.10 m. What is the Reduced Level of Q?

- (a) 239.20 m
- (b) 240.80 m
- (c) 241.25 m
- (d) 241.80 m

110. The length of a line originally 100 mm long on a map plotted to a scale of 1/1000, was found to be 96 mm due to shrinkage of the map. The map prepared using a tape of length 20 m was later found to be actually 20.03 m. If a certain area on the map, measured using a planimeter, is 282 mm², what is the correct area on the ground?

- (a) 237 m²
- (b) 307 m²
- (c) 347 m²
- (d) 397 m²

111. In Map versus Aerial photograph, due to symbolic representation the clarity of details is

- (a) less on map than on a photo
- (b) more on map than on a photo
- (c) less on a photo than on map
- (d) more on a photo than on map

112. In multilevel classification system, Level IV classification is suitable for

- (a) Landsat MSS images
- (b) High-altitude aerial photographs
- (c) Low-altitude aerial photographs
- (d) Medium-altitude aerial photographs

Directions for the following TWO (02) items :

Read the following information and answer the two items that follow :

The chainage of the intersection point of two straights is 1060 m, and the angle of intersection is 120°. If radius of a circular curve to be set out is 570 m, and peg interval is 30 m

$1060 \times \frac{100}{96}$
113. What is the length of the curve?

- (a) 190π m
- (b) 185π m
- (c) 180π m
- (d) 170π m

114. What is the length of the long chord ?

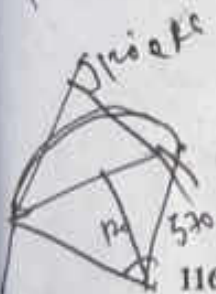
- (a) 370 m
- (b) 470 m
- (c) 670 m
- (d) 570 m

2R sin 60
 $\frac{2 \times 570}{2}$
 $\frac{570}{1}$

115. The design speed for a two-way traffic on a two way lane road is 50 kmph. What is the value of safe stopping sight distance, if co-efficient of friction is 0.37 and reaction time of driver as 2.5 sec ?

- (a) 34.8 sec
- (b) 61.4 sec
- (c) 122.8 sec
- (d) 193.5 sec

2R sin 60
 $= 2 \times 570 \times \frac{\sqrt{3}}{2}$
 $R = 570$



116. Consider the following statements related to economic design of modern track :

1. Axle loading, possible weight reduction of the rolling stock and increase in number of axles should be rationalized.
2. Rail to sleeper fastenings for different type of sleepers at high speeds should have definite standards.
3. The weight of the sleeper and the rail may not be related to each other.

$\frac{10}{360} = \frac{2 \times 570}{2 \times \pi \times 570}$
 $\frac{10}{360} = \frac{5}{2 \times \pi \times 570}$
 $\frac{370 \times 2 \times \pi}{3} = 4$
 12

Which of the above statements are correct ?

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

117. The longitudinal joints in cement concrete pavements are constructed with suitable

- (a) tie bars.
- (b) torsion rods
- (c) small spacing
- (d) shear rods

118. In which one of the following systems the optimum road length is calculated for an area based on the concept of obtaining maximum utility per unit length of road ?

- (a) Saturation system
- (b) Unsaturated system
- (c) Minimum utility system
- (d) Average utility system

119. Which one of the following alignments is obtained by development accompanied by tunneling ?

- (a) Valley alignment
- (b) Cross country alignment
- (c) Mountain alignment
- (d) Zig-Zag alignment

120. Which one of the following tests is carried out using a relatively large diameter plate to evaluate the load supporting capacity of pavement layers?

- (a) California bearing ratio test
- (b) California resistance value test
- (c) Triaxial compression test
- (d) Plate bearing test

121. A sewage has a suspended solid contents as 250 mg/litre. The sedimentation tank removes 55% of the suspended solids and the water content of the sludge is 95%. What is the quantity of sludge produced after treating 6.5×10^6 litres of sewage? (Assume the specific gravity of sludge as 1.0)

- (a) 11.875 cu.m
- (b) 14.275 cu.m
- (c) 17.875 cu.m
- (d) 20.275 cu.m

122. With standard notations, the total subsurface soil area required for the soak pits or dispersion trenches is given by

- (a) $Q = 100/\sqrt{t}$
- (b) $Q = 130/\sqrt{t}$
- (c) $Q = 200/\sqrt{t}$
- (d) $Q = 260/\sqrt{t}$

123. Which one of the following is NOT the common method of disinfection of water?

- (a) By boiling of water
- (b) By ultra-violet rays
- (c) By use of ozone
- (d) By use of sodium chloride

124. Which one of the following is an essential requirement of swimming pool water?

- (a) It should not have disinfectant dissolved in it
- (b) Minimum amount of chemical should be added in treating water of the swimming pools
- (c) The water of the pool need not be visible at maximum depth
- (d) The pool need not have an efficient surface water removal system

125. The first stage of sewage purification by the action of anaerobic bacteria is termed as

- (a) Putrefaction
- (b) Liquefaction
- (c) Clarification
- (d) Oxidation

126. Which one of the following is a measure of light-emitting properties of waste water ?

- (a) Turbidity ✓
- (b) pH
- (c) Alkalinity
- (d) Volatility

127. Which one of the following is defined as the oxygen required for the micro-organisms to carry out biological decomposition of dissolved solids or organic matter in the water under aerobic conditions at standard temperature ?

- (a) Biochemical oxygen demand ✓
- (b) Chemical oxygen demand
- (c) Total oxygen demand
- (d) Theoretical oxygen demand

128. Chlorination, liming and recarbonation are the part of which one of the following in the context of unit operations for waste water treatment ?

- (a) Ion transfer
- (b) Solute stabilization ✓
- (c) Solid transfer
- (d) Solid concentration


129. Which one of the following is the process of driving, pouring or forcing lead oakum plastic or other material into a joint to make it leak proof ?

- (a) Caulking
- (b) Bedding
- (c) Benching
- (d) Haunching

130. Which one of the following is the ability of a material to absorb moisture from air and thus to dissolve and become liquid ?

- (a) Deliquescence
- (b) Hygroscopicity
- (c) Wilting
- (d) Capillarity

131. The theoretical time taken by a particle of water to pass between entry and exit of a settling tank is known as

- (a) Weir loading
- (b) Detention period ✓ 
- (c) Velocity of flow
- (d) Overflow rate

132. The most commonly adopted detention period for grit chambers may vary from

- (a) 10 to 40 seconds
- (b) 45 to 90 seconds
- (c) 90 to 120 seconds
- (d) 120 to 135 seconds

133. Match the following lists :

List I (Member)	List II (Maximum effective slenderness ratio)
P. A member carrying compressive loads resulting from dead and imposed load	1. 400
	2. 180
	3. 250
Q. A member subjected to compression forces resulting only from combination with wind/earthquake actions, provided the deformation of such members does not adversely affect the stress in any part of the structure	4. 300
R. Compression flange of a beam against lateral torsional buckling	
S. Members always under tension (other than pre-tensioned members)	

Select the correct answer using the code given below :

	P	Q	R	S
(a)	2	3	4	1
(b)	3	2	1	4
(c)	1	4	3	2
(d)	4	1	2	3

134. Thickness of flat lacing bars shall not be less than

- (a) one-seventieth of the effective length for single lacings
- (b) one-fortieth of the effective length for double lacings
- (c) one-sixtieth of the effective length for double lacings
- (d) one-fiftieth of the effective length for single lacings

135. An 18 mm thick plate is joined to a 16 mm plate by 200 mm long (effective) butt weld. What is the strength of joint if a double V butt weld is used? (Assume that Fe410 grade plates and shop welds are used)

- (a) 605.987 kN
- (b) 378.742 kN
- (c) 467.535 kN
- (d) 478.348 kN

136. The difference in the water surface level of two reservoirs which are connected by a siphon is 8 m. The length of siphon is 600 m and its diameter 0.3 m. If the siphon is running full, then what is the discharge? (Take $f = 0.02$)

- (a) 3.242 m³/s
- (b) 2.117 m³/s
- (c) 1.842 m³/s
- (d) 0.137 m³/s

137. The air vessel is not required for multi-cylinder pump because it has

- (a) much smaller fluctuations of velocity in both the delivery and suction pipes
- (b) large fluctuations of velocity in delivery pipes
- (c) large fluctuations of velocity in suction pipes
- (d) moderate variation of speed of fluid reciprocating pump

138. Which one of the following is the correct assumption for the derivation of Bernoulli's equation?

- (a) The flow is compressible
- (b) Viscosity is zero
- (c) The flow is unsteady
- (d) The flow is rotational

139. A fully penetrating well in a confined sandy aquifer has a maximum discharge capacity of 1200 l/min. The aquifer is overlain and underlain by impervious formations. The thickness of the aquifer is 20 m. Assume the percentage of the open area of an available strainer to be 15% and bore hole diameter as 15 cm. What is the length of the well screen? (Take safe entrance velocity as 0.02 m/s)

- (a) 10.5 m
- (b) 12.3 m
- (c) 13.1 m
- (d) 14.1 m

140. Which one of the following is the total area, bounded within the irrigation boundary of a project, which can be economically irrigated without considering the limitation of the quantity of available water?

- (a) Gross command area
- (b) Cultivable command area
- (c) Net and gross sown area
- (d) Net and gross irrigated area

141. Which one of the following techniques of water distribution in the farms is sometimes called wild flooding?

- (a) Free flooding
- (b) Check flooding
- (c) Border flooding
- (d) Furrow irrigation method

142. Which one of the following conditions is favorable for sprinkler irrigation method?

- (a) When the land topography is regular
- (b) When the soil is not easily erodible
- (c) When the water table is low
- (d) When the land soil is excessively permeable

143. If the sodium ions increase to about 10% or more, the soil becomes

- (a) less permeable and of poorer tilth
- (b) more permeable
- (c) good tilth
- (d) more permeable and of better tilth

144. In drip irrigation method, the drip nozzles are fixed on laterals, discharging water at a very small rate of the order of

- (a) 0.1 to 1 litre per hour
- (b) 1 to 2 litres per hour
- (c) 2 to 10 litres per hour
- (d) 10 to 15 litres per hour

145. If the cultivation method is faulty and less efficient, resulting in the wastage of water, the duty of the water will naturally be

- (a) less
- (b) more
- (c) average
- (d) depending upon cultivators

146. In which one of the following types of falls, the energy dissipation on a straight glacis remain incomplete due to vertical component of velocity remaining unaffected?

- (a) Montage type falls
- (b) Gravity falls
- (c) Inglis falls
- (d) Baffle falls

147. Which one of the following is the correct assumption made in two dimensional design of gravity dams?

- (a) The loads are transferred to the abutments by beam action
- (b) The foundation and dam behave as separate units
- (c) The materials in the foundation and body of the dam are isotropic and homogeneous
- (d) The stresses developed in the foundation and body of the dam are not within elastic limit

148. Which one of the following is the cause of water logging?

- (a) Adequate natural drainage
- (b) Adequate surface drainage
- (c) Normal rains
- (d) Submergence due to floods

149. Which of the following is a very effective method to control water logging?

- (a) Lining of canals and water courses
- (b) Flat topography
- (c) Adequate natural drainage
- (d) Adequate surface drainage

150. What should be done to dissipate the residual energy, if the tail water deficiency is small?

- (a) Construction of baffle wall
- (b) Sloping apron
- (c) Stilling basin
- (d) Ski jump bucket