BYJU'S EXAM PREP

ESE 2023

Civil Engineering

Paper-2　　**Set-D**

Official Questions with Detailed Solutions

ESE 2023 Prelims Paper-2: Major Highlights

- ➢ **Overall Difficulty Level:** Moderate but Calculative
- ➢ **Subject wise difficulty level: SOM -** Easy, BMC Tough, CPM- Moderate, Geotech - Moderate, Hydrology - 1 Question
- ➢ **Theoretical & Numerical:** Almost Equal
- ➢ **Assertion/Reason:** 6 Questions
- ➢ **Comparison from last year:** More weightage from SOM, Building Material and less from Geotechnical Engg., Hydraulic Machines.

ESE 2023 Prelims Paper-2 : Subject-wise Weightage Distribution

S. No.	Subjects	Total Questions	Difficulty Level
1.	Strength of Materials	18	Easy
2.	Engineering Hydrology	1	Moderate
3.	Geotechnical Engineering	14	Moderate
4.	Structural Analysis	7	Moderate
5.	Surveying	11	Moderate
6.	Building Materials	13	Tough
7.	Construction Planning Management	12	Moderate
8.	Design of Steel Structures	12	Tough
9.	Irrigation Engineering	12	Easy
10.	Highway Engineering	9	Easy
11.	Open Channel Flow	1	Easy
12.	Environmental Engineering	12	Tough
13.	Fluid Mechanics	12	Moderate
14.	Railways and Airport	2	Easy
15.	Design of Concrete Structures	13	Moderate
16.	Hydraulic Machines	1	Moderate
	Total	**150**	**Total**

ESE 2023 Prelims Paper-2 : Comparison with Last 4 Years' Data

S.No.	Subjects	2023	2022	2021	2020	2019
1.	Surveying	11	11	12	9	12
2.	Highway Engineering	9	10	10	9	4
3.	Engineering Hydrology	1	2	5	0	8
4.	Environmental Engineering	12	12	11	12	11
5.	Fluid Mechanics	12	10	10	9	11
6.	Hydraulic Machines	1	4	2	4	3
7.	Railways, Airport and Tunneling	2	1	2	3	3
8.	Building Material	13	11	14	15	13
9.	Construction Planning Management	12	12	14	12	12
10.	Strength of Materials	18	14	14	14	20
11.	Design of Steel Structures	12	14	13	13	12
12.	Open Channel Flow	1	1	2	5	3
13.	Irrigation Engineering	12	11	9	11	6
14.	Geotechnical Engineering	14	12	12	15	12
15.	Structural Analysis	7	9	6	6	8
16.	Design of Concrete Structures	13	16	14	13	12
Total	150	150	150	150	150	Total

ESE 2023 Prelims Paper-2 : Previous Year's Cut off

S. No.	Year	Generel	EWS	OBC	SC	ST
1.	2023	238-242	238-242	234-238	200-205	175-180
2.	2022	233	233	233	197	198
3.	2021	249	246	243	196	213
4.	2020	238	238	238	202	227
5.	2019	188	NA	185	143	159
6.	2018	207	NA	194	169	188
7.	2017	202	NA	177	148	151

Civil Engineering (Set–D)

1. Consider the following statements:

1. Building Information Modeling has the ability to produce 3D 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

Ans. C

Sol.

- 3 D Models can be created using BIM.
- BIM can be used for scheduling and sequencing of the construction.
- BIM has the capability of adding verbal definition of installed items.

2. Match the following lists:

	List–I		**List–II**
P.	Resoruce	1.	Getting the correct materials to the workface when needed
Q.	Manpower levelling	2.	Judicious allocation of the physical resources
R.	Supply chain managment	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

Ans. C

Sol. Supply Chain management means providing the correct resource in sufficient quantity at the time of need it means correct match for R is 1. Based on that only option a is the right pair

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

A. Gantt chart

B. Line of balance

C. Precedence diagram

D. Bar Chart

Ans. C

Sol. for repetitive operations better information can be obtained from precedence diagram

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

A. 1.2 to 1.3 g/cm^3

B. 1.5 to 1.6 g/cm^3

C. 2.3 to 2.6 g/cm^3

D. 2.6 to 2.9 g/cm^3

Ans. B

Sol. Density of wood used in construction ranges from 1.5 g/cc to 1.6 g/cc

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 will burnt bricks occupying central portion of the kiln.

Ans. C

Sol. Pale bricks are under-burnt bricks obtained from the outer 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

Ans. D

Sol. Statement 1 and 3 are correct.

Excess soda can be harmful for the glass. So, statement 2 is incorrect.

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

Ans. A

Sol. As per IS : 303 and 10701, thickness of plywood board

Board	Thickness (mm)
3 ply	3, 4, 5, 6
5 phy	5, 6, 8, 9
7 ply	9, 12, 15, 16
9 ply	12, 15, 16, 19
11 ply	19, 22, 25
> 11 ply	As ordered
3 ply	3, 4, 5, 6

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

Ans. A

Sol.

Grade	3 day (72 hours Strength)
33	$\not< 16$ MPa
43	$\not< 23$ MPa
53	$\not< 27$ MPa

Easy way to December: –

Strength after 3 days $\simeq 0.5\, f_{ck}$

Strength after 7 days $\simeq\, \simeq \dfrac{2}{3} f_{ck}$

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

Ans. D

Sol. Constituents of OPC:–

S.No.	Constituents	Percentage
1.	Lime (CaO)	62–67
2.	Silica (SiO$_2$)	17–25
3.	Alumina (Al$_2$O$_3$)	3–8
4.	Calcium Solphate (CaSO$_4$)	3–4
5.	Iron Oxide (Fe$_2$O$_3$)	3–4
6.	Magnesia (MgO)	1–3
7.	Sulphur (S)	1–3
8.	Alkalis (Na$_2$O, K$_2$O)	0.2–1

10. Excess of Silica makes the brick

A. brittle on burning   B. crack on drying

C. melt on burning   D. warp

Ans. A

Sol. Amount of silica in a brick is 50 - 60%. It imparts uniform shape and size to the bricks. If it is in excess, it will destroy the cohesion between the particles and the brick will become brittle on burning.

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

Ans. C

Sol. Specific Gravity   -   Le-Chatelier's flask

Setting Time   -   Vicat needle apparatus

Soundness   -   Autoclave

Fineness   -   Blaine's apparatus

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

Ans. A

Sol.

1. Workability of lime is measured by standard flow table and truncated conical mould.
2. Autoclave apparatus - Soundness of cement.
3. Vicat's apparatus - setting time of cement and lime.

Slump cone test - workability of concrete.

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.

Ans. B

Sol.

1. Workability of lime is measured by standard flow table and truncated conical mould.
2. Autoclave apparatus - Soundness of cement.
3. Vicat's apparatus - setting time of cement and lime.
4. Slump cone test - workability of concrete.

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

Ans. C

Sol.

1. Slaking is the chemical reaction that takes plane when quicklime is mixed with water.

CaO Quick lime + H_2O $\xrightarrow{\text{Slaking}}$ $C\alpha(OH)_2$ Hydrated or Slaked lime + Heat+ $\uparrow$.

2. Hardening of cement is the strength gain of cement due to crystallization when cement is mixed with water.

Hardening of cement is the strength gain of cement due to crystallization when cement is mixed with water.

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.

Ans. D

Sol.

- Workability is the ease with which concrete can be mixed, transported, placed and finished. Concrete needs to be sufficiently workable.
- Cement is the most costly ingredient in the concrete mix.
- Density $\uparrow$ - Strength and water tightness $\uparrow$
- Water cement ratio $\uparrow$ - strength $\downarrow$

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

Ans. C

Sol. Given, P_u = 1600 kN = 1600 × 10^3 N

f_{ck} = 20 MPa, f_y = 415 MPa

P_u = 0.4 f_{ck} A_c + 0.67 $f_y A_{sc}$

1600 × 10^3 = 0.4 × 20 × (400 × 400 − A_{sc}) + 0.67 × 415 × A_{sc}

A_{sc} = 1184.96 mm^2

% A_{sc} = $\dfrac{A_{sc}}{B \times d} \times 100\%$

= $\dfrac{1184.96}{400 \times 400} \times 100\%$

= 0.74%

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

Ans. B

Sol. Given, $l_o = 4$ m, $d = 160$ mm $= 0.16$ m

$w = 230$ mm $= 0.23$ m

$l_{eff} =$ minimum $(l_o + d, l_o + w)$

$=$ min $(4 + 0.16, 4 + 0.23)$

$=$ min $(4.16, 4.23)$

$= 4.16$ m

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

Ans. A

Sol. The members in which entire cross–section of concrete has a uniform compressive pressure is called axial prestressing.

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

    A. 45   B. 65

    C. 75   D. 95

Ans. B

Sol. Total shrinkage = Drying shrinkage + Autogenous shrinkage

Grade of concrete	$\epsilon_{ca} \times 10^{-6}$
M30	35
M35	45
M45	65

∴ For, M45, $\epsilon_{ca} = 65 \times 10^{-6}$

20. A prestressed concrete beam of section 120 mm × 300 mm is used over an effective span of 6000 mm to support and 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/mm²

    B. 50 N/mm²

    C. 5 N/mm²

    D. 0.5 N/mm²

Ans. C

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Sol. Stress due to pressing force = Direct stress + Sending stress

Direct stress = $\dfrac{P}{A} = \dfrac{180 \times 10^3}{120 \times 300}$ = 5 N/mm²

Bending stress due to pre–stressing force

$= \dfrac{P_e y}{I} = \dfrac{180 \times 10^3 \times 50 \times 150}{\dfrac{120 \times 300^3}{12}}$ = 5 N/mm²

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 resistance 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

Ans. D

Sol. All the above mentioned statements are correct.

22. Which one of the following statements 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.

Ans. C

Sol.

1. CDM is based on deterministic approach and it is done for the work that is repeated in nature.

2. At a construction site we use CPM not PERT.

3. PERT we estimate three times, and it is time sensitive.

4. Project schedule provide us the exact time for construction operation.

The statement 3 is correct.

23. Which one of the following is NOT considered for the estimation of activity duration?

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.

Ans. D

Sol. While estimating the activity duration we do not consider the weather condition, So the statement D is wrong.

Rest of statement are true.

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.

Ans. C

Sol. Total float: It is the difference between maximum time available and central time required for the completion of the activity

Total float (TF) = LST – EST

Or

(TF) = LFT – EFT

The total float is zero for critical activities.

The statement (D) is wrong.

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

Ans. A

Sol. In equipment planning we selects the tools and machinery which work be used on site. Factors like space, weight of equipment, dimension of road etc. influences our selection

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

Ans. B

Sol. Since we have to manage both time and cost hence out of all four resource management is best possible option. If we properly manage the resource then time, cost will be properly used making our project financially viable.

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 the 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.

Ans. A

Sol. We plan the work to proper use of equipment not the fullest use of equipment. It means based on field condition we may use some equipment below its full capacity. So out of all four options, option A is not correct.

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.

Ans. D

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

    A. It represents both a presentations

    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 sequence so that space and resource conflicts are quickly identified and addressed.

Ans. C

Sol. LOB gives us multiple options to achieve the task hence statement c is incorrect.

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.

Ans. B

Sol. Pert is best suited for project where no past data is available. Due to this uncertainty 3 time estimates are given. Hence option B is correct.

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

    A. 0.09 – 0.19   B. 0.20 – 0.30

    C. 0.31 – 0.41d   D. 0.42 – 0.52

Ans. B

Sol. The value of various materials are given in the table:

Material	Poison ratio (μ)
Cork	0
Concrete	0.1-0.2
Cast iron	0.2-0.30
Wrought iron	0.30
Copper	0.35
Ruber	0.50
Hamman tissue	−1 to 0

32. A cylindrical bar of 25 mm diameter 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 1.2×10^5 N/mm^2)

    A. 5.8 kN/mm^2 B. 4.8 kN/mm^2

    C. 58 kN/mm^2 D. 48 kN/mm^2

Ans. D

Sol. Longitudinal strain = 4 Lateral strain

We know
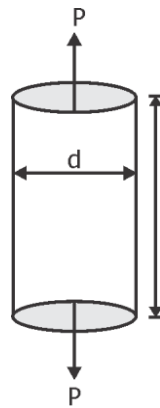
Poisson's ratio = $\left| -\dfrac{\text{Lateral strain}}{\text{Longitudenal strain}} \right|$

$= \dfrac{1}{4}$ = 0.25

E = 24 (1 + μ)

$1.2 \times 10^5 = 2 \times G\,(1 + 0.25)$

G = $\dfrac{1.2 \times 10^5}{2\,(1 + 0.25)}$ = 48 × 10³ N/mm²

G = 48 kN/m²

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.

Ans. A

Sol. Of curve represents the engineering stress-strain diagram and OF' represents the true stress-strain diagram.

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A = Proportional limit B = Elastic limit

C = Upper yield point C' = Lower yield point

E = Ultimate strength F = Rupture strength or Fracture strength

It is customary to base all the stress calculations on the original cross-sectional area of the specimen. Since the latter is not constant, the calculated stresses are known as nominal stresses.

The diagram of real stresses (i.e., load divided by the reduced cross-section area) is shown by the dotted curve in figure.

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/mm^2
B. 7.2 N/mm^2
C. 36 N/mm^2
D. 72 N/mm^2

Ans. D

Sol. Tensile stress $(\sigma) = \dfrac{P}{A}$

$$= \frac{90 \times 10^3}{25 \times 50}$$

$$= 72 \frac{N}{mm^2}$$

35. The normal stress across the principal place is know as

A. Shear stress
B. Maximum shear stress
C. Principal stress
D. Tangential stress

Ans. C

Sol. By definition, the principal plane is the plane at which shear stress is zero and normal stress is maximum. The normal stresses acting on principal planes are called principal stresses.

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 μ = 0.3)

A. 210 N/mm^2
B. 420 N/mm^2
C. 170 N/mm^2
D. 105 N/mm^2

Ans. D

Sol. For no failure, maximum principal stress should be less than or equal to yield stress under uniaxial loading.

$\sigma_{max} \leq f_y$

For design $\sigma = \dfrac{f_y}{FOS}$

σ_{max} = Max of (2f, 1.5 f, − f)

σ_{max} = 2f

$2f = \dfrac{210}{1}$

F = 105 N/mm^2

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

1. The 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.

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

Ans. B

Sol. Maximum Shear Stress Theory (M.S.S.T.)

According to this theory, failure is likely to occur when shear stress developed at a critical point under combined loading conditions exceeds yield strength in a uniaxial tension test. This theory is also called as Guest & Tresca's Theory or Coulombs Theory.

Some key points of maximum principal stress theory:

1. As ductile materials are weak in shear, the maximum shear stress theory is best suited for ductile materials.

2. In the pure shear it gives over a safe design for ductile materials.

3. This failure theory is suitable for ductile material under every loading condition except under hydrostatic stress conditions.

4. The results of this theory differ from experimental results.

5. M.S.S.T. and M.P.S.T. will give the same result for ductile materials under the following

Conditions:

• Uniaxial state of stress condition.

• Biaxial state of stress condition when

Principal stresses are like in nature.

Hence statement 2 is not correct.

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

A. Shear modulus is independent of Young's modulus only.

B. Shear modulus is independent of Poisson's ratio only.

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.

Ans. D

Sol. E = 2G (1 + μ)

$G = \dfrac{E}{2(1+4)}$

Shear modulus is dependent of young's modulus and poison's ratio.

39. A body is loaded elastically so that strain y–direction (e_y) = 0 and σ_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. $e_z = -\sigma_x (1 + \nu)/E$

Ans. D

Sol. Strain in y – direction (e_y) = 0

And stress in z – direction (σ_z) = 0

The strain in z direction (e_z) = $\dfrac{\sigma_z}{E} - \mu \left(\dfrac{\sigma_x}{E} + \dfrac{\sigma_y}{E} \right)$

$e_z = 0 - \mu \left(\dfrac{\sigma_x}{E} + \dfrac{\sigma_y}{E} \right)$

Also, Strain in the y direction

$e_y = \dfrac{\sigma_y}{E} - \mu \left(\dfrac{\sigma_x}{E} + \dfrac{\sigma_z}{E} \right)$

$O = \dfrac{\sigma_y}{E} - \mu \left(\dfrac{\sigma_x}{E} \right)$

$\dfrac{\sigma_y}{E} - \mu \dfrac{\sigma_x}{E}$

$e_z = - -\mu \left[\dfrac{\sigma_x}{E} + \mu \dfrac{\sigma_x}{E} \right]$

$e_z = - \dfrac{\sigma_x \mu [1 + \mu]}{E}$

40. What are the three stress invariants (in MPa) respectively in a body under the stress states of, σ_x = 10, $\sigma_y = 8$, $\sigma_z = -5$, $\tau_{zy} = 5$, $\tau_{zy} = \tau_{xz}$ −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, 25

Ans. B

Sol. Stress invariants

$I_1 = \sigma_x + \sigma_y + \sigma_z = 10 + 8 - 5 = 13$ MPa

$I_2 = \sigma_x + \sigma_y + \sigma_y \sigma_z + \sigma_z \sigma_x - \tau_{xy}^2 - \tau_{yz}^2 - \tau_{zx}^2$

$= 10 \times 8 + 8 \times (-5) + (-5) \times 10 - (-8)^2 - 5^2 - (-4)^2$

$= -115$ MPa

$I_3 = \sigma_x \sigma_y \sigma_z + 2 - \tau_{xy} \tau_{yz} \tau_{zx} - \sigma_x \tau_{yz}^2 - \sigma_y \tau_{xz}^2 - \sigma_2 \tau_{xy}^2$

$= 10 \times 8 \times (-5) + 2(-8)(5)(-4) - 16 \times 5^2 - 8(-4)^2 - (-5) \times (-8)^2$

$= -138$ MPa

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)

Ans. D

Sol.

$\Sigma V = 0$

$R_A = 1 + 2 + z = 5$ kN

$M_A = 2 \times 4 + 2 \times 3 + 1 \times 2 = 16$ Kn-m

Moment at 3 m from fixed support

$M_C = 16 - 5 \times 3 + 1 \times 1$

$M_C = 16 - 15 + 1 = 2$ kN-m 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

Ans. A

Sol.

Calculation of Reaction

$\Sigma M_A = 0$

$R_B \times 9 - 12 \times 4 \left(5 + \dfrac{4}{2}\right) - 30 \times 2 = 0$

$R_B = 44$ kN

Shear force at 5 from left support at point D.

Algebraic sum of force at D.

Sign convention

$- 44 + 12 \times 4$ SF at D = 4 kN

18

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. $\dfrac{1}{2}$

B. 2

C. $\dfrac{1}{3}$

D. 3

Ans. A

Sol.

(a)   (b)
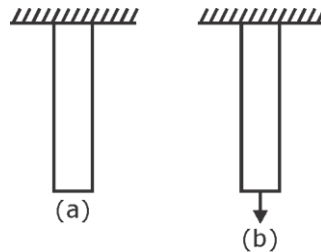
Elongation of rectangular bar due to self weight (δ_1) = $\dfrac{WL}{2AE}$

Elongation of rectangular bar due to total weight W (δ_2) = $\dfrac{WL}{AE}$

$\dfrac{\delta_1}{\delta_2} = \dfrac{WL/2AE}{WL/AE} = \dfrac{1}{2}d$

44. The stress on two perpendicular planes through a poit are 60 N/mm² tension, 40 N/mm² compression and 30 N/mm² shear. What is the absolute normal stress on a plane at 60° to that of the tensile stress?

A. 10.98 N/mm²

B. 17.63 N/mm²

C. 20.98 N/mm²

D. 32.63 N/mm²

Ans. A

Sol.

Angle, θ = – 30°
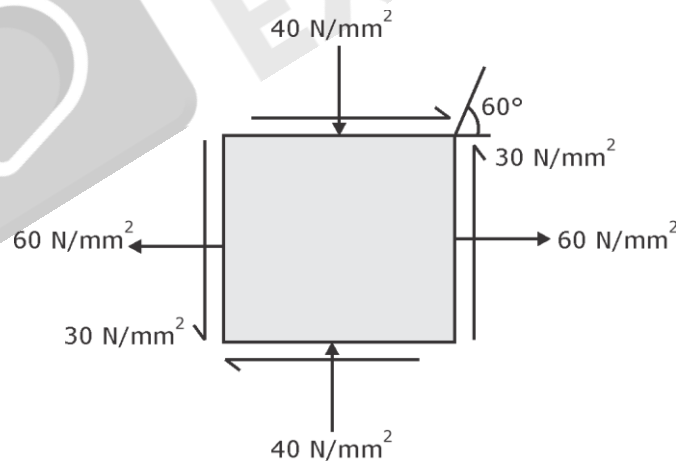
We know

$\sigma' = \dfrac{\sigma_x + \sigma_y}{2} + \dfrac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$

$= \dfrac{60 - 40}{2} + \dfrac{60 - (-40)}{2}\cos(-60°) + 30 \times \sin(-60°)$

$\bar{\sigma} = 9.01\ \text{N/mm}^2 \approx 10.98\ \text{N/mm}^2$

19

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.

Ans. D

Sol. Rate of change of bending moment = Shear force

$$\frac{dM}{dx} = F \text{ (Shear Force)}$$

The shear force changes abruptly at the location of point load.

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

1. The centre of gravity of bolts should coincide with the centre of gravity of the connected members.

2. The length of connection should be kept as small possible.

Which of the above statements is/are correct?

A. 1 only

B. 2 only

C. Both 1 and 2

D. Neither 1 nor 2

Ans. C

Sol.

• To avoid the on desirable bending stress in the connections the bolt should consider with the centre of gravity of connected members.

• The length of connection should be kept as small as possible because if the large length of connection we provide that induced non uniform stress distribution. So, both the statements are correct.

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. 449–099 N

D. 395–208 N

Ans. B

Sol. As per the IS 800 : 2007 Clause 10.4

The partial safety factor for bolt = 1.10 [if slip resistance is designed at service load]

Nominal shear capacity (V_{nsf}) = 82335 N

Design shear capacity (V_{dsf}) = $\dfrac{V_{nsf}}{\gamma_{mf}} = \dfrac{82335}{1.10}$ = 74850 N

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.

Ans. A

Sol. The noise produced in the welding process is relatively less as compare to riveting, it is the one of the advantage. Rest of statements are true but those are considered as disadvantages of welding.

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 the 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

Ans. D

Sol. Is code 800 : 2007 Clause

In the case of angle members, the lug angles and their connections to the gusset or other supporting member shall be capable of developing a strength not less than 20 percent in excess of the force in the outstanding leg of the member, and the attachment of the lug angle to the main angle shall be capable of developing a strength not less than 40 percent in excess of the force in the outstanding leg of the angle.

In the case of channel members and the like, the lug angles and their connection to the gusset or other supporting member shall be capable of developing a strength of not less than 10 percent in excess of the force not accounted for by the direct connection of the member, and the attachment of the lug angles to the member shall be capable of developing 20 percent in excess of that force.
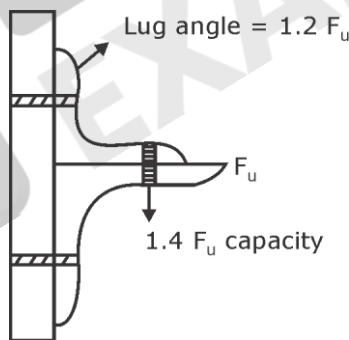
50. The shear force for which each lacing shall be designed if two parallel systems of loading is there in the columns is

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

Ans. A

Sol. The lacing shall be proportioned to resist a total transverse shear, V_t, at any point in the member, equal to at least 2.5 percent of the axial force in the member and shall be divided equally among all transverse lacing system in parallel planes.

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

Ans. A

Sol. The effective slenderness ratio $(KL/r)_e$ of battened columns, shall be taken as 1.1 times the $(KL/r)_0$, the maximum actual slenderness ratio of the column, to account for shear deformation effects.

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 30 mm, whichever is less) and (16t or 30 mm, whichever is less)

C. (16t or 200 mm, whichever is less) and (12t or 200 mm, whichever is less)

D. (16t or 200 mm, whichever is less) and (12t or 200 mm, whichever is less)

Ans. C

Sol. 10.2.3.1 The distance between the centres of any two adjacent fasteners shall not exceed 32: or 300 mm, whichever is less, where: is the thickness of the thinner plate.

10.2.3.2 The distance between the centres of two adjacent fasteners (pitch) in a line lying in the direction of stress, shall not exceed 16t or 200 mm, whichever is less, in tension members and 12(or 200 mm, whichever is less, in compression members: where t is the thickness of the thinner plate. In the case of compression members wherein forces are transferred through butting faces, this distance shall not exceed 43 times the diameter of the fasteners for a distance equal to 1.5 times the width of the member from the hutting faces.

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

Ans. C

Sol.

SI No.	Thickness of Thicker Part mm		Minimum size mm
(1)	Over (2)	Up to and Including (3)	(4)
i	–	10	3
ii	10	20	5
iii	20	32	6
iv	32	50	8 of first run 10 for minimum size of weld

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

A. 4.55 cm^3 B. 45.57 cm^3

C. 75.57 cm^3 D. 7.55 cm^3

Ans. B

Sol. We know,

The permissible stress in any beam = $\dfrac{BM_{max}}{z}$

Section modular (z) = $\dfrac{BM_{max}}{\sigma_{per}}$

BM_{max} = 10 kN/m = 10×10^6 N-mm

σ_{per} = permissible stresses in bending is = 0.66 f_y = 0.66 × 250 = 165 N/mm^2

$\therefore$ z = $\dfrac{10 \times 10^6 \text{ N/mm}}{1.33 \times 0.67 \times 250 \text{ N/mm}^2}$ = 45.57 cm^3

55. A rectangular simply supported beam of span 4 m is 300 mill x 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/m^3 (excluding self-weight). What is the maximum bending moment?

A. 5.05 kN/m
B. 50.5 kN/m
C. 55.0 kN/m
D. 5.5 kN/m

Ans. B

Sol. Given,

B = 300 mm, D = 700 mm, L = 4 m

Concrete = 25 × 1 × 0.3 × 0.7 = 5.25 kN/m

Working load = 20 kN/m

Total load = 20 + 5.25 = 25.25 kN/m

BM_{max} = $\left(\dfrac{25.25 \times 4^2}{8}\right)$ = 50.5 KN/m

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 × 15 MPa?

A. $\dfrac{1}{8}$
B. $\dfrac{1}{4}$
C. 4
D. 8

Ans. D

Sol. Given, E_s = 2 × 10^5 MPa

E_c = 5000 $\sqrt{f_{ck}}$

= 5000 $\sqrt{25}$

= 25000 MPa

m = $\dfrac{E_s}{E_c}$ = $\dfrac{2 \times 10^5}{25,000}$ = 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

Ans. A

Sol. 1. The structure or its elements should neve collapse when subjected to the designed loads.

2. The structure is still usable even after development of cracks or deflections.

3. The structure is not designed to reach its limit state during design life.

Hene, option A is correct.

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

Ans. C

Sol.

$\ell_{eff} = \ell_o = 1.00\,L$

59. An RCC beam 200 mm wide and 450 mm deep, is reinforced with Fe415 grade steel of area 1000 mm^2 tension side with an effective cover of 50 mm. If the shear reinforcement of 100 mm2 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

Ans. A

Sol. Given, B = 200 m, D = 450 mm, cover = 50 mm

A_{st} = 1000 mm^2, A_{sv} = 100 mm^2, S_v = 150 mm

$V_{su} = \dfrac{d}{S_v} \times A_{sv} \times 0.87\,f_y$

$= \left(\dfrac{400}{150} \times 100 \times 0.87 \times 415\right) \times 10^{-3} = 96.28$ kN $\simeq$ 96.3 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 m

D. 350 mm

Ans. B

Sol. Given, B = 200 mm, d = 400 mm, A_{st} = 1000 m^2

C = T

$0.36\,f_{ck}\,Bx_u = 0.87\,f_y\,A_{st}$

$0.36 \times 20 \times 200 \times x_u = 0.87 \times 415 \times 1000$

x_u = 250 mm

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. liner and sagging

C. parabolic

D. parabolic and sagging

Ans. A

Sol.

$$M = -Px \text{ (Hogging)}$$
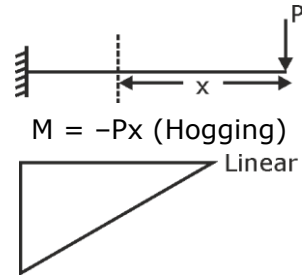
∴ Nature of BM will be linear and hogging.

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. 0.0769 m²

B. 1.57059 m²

C. 2.67069 m²

D. 3.47059 m²

Ans. A

Sol. Outer dia = 300 mm

Inner dia = 300 − 2 × 10 = 280 mm

Internal area = $\frac{\pi}{4} \times 0.28^2$ **= 0.0616 m²**

Closest option is (A)

63. A parabolic 3 hinged arch (AB) carries a u.d.l of 30 kN/m on the left half of the span. If has a span of 16 m and 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

Ans. C

Sol.
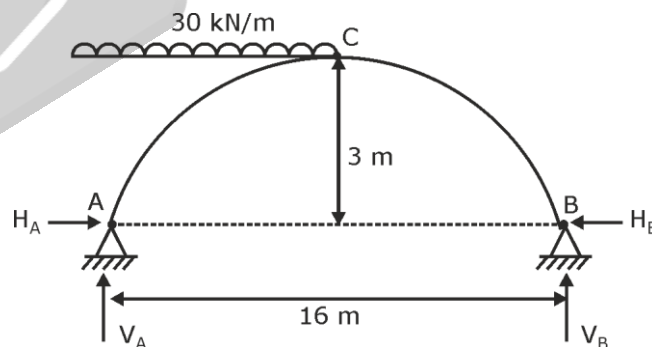
Σfy = 0

$V_A + V_B = 30 \times 8 = 240$ kN

$\Sigma M_B = 0$

$V_A \times 16 = 30 \times 8 \times (8 + 4)$

$V_A = 180$ kN

$\Sigma M_C = 0$ (left span)

$V_{A \times 8} - H_A \times 3 - 30 \times 8 \times 4 = 0$

$H_A = 160$ kN

$R_A = \sqrt{H_A^2 + V_A^2}$

$= \sqrt{160^2 + 180^2} \simeq 240$ 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 1/2 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 the centre of the beam

Ans. C

Sol. Let x be the distance of point of contraflexure from left end.
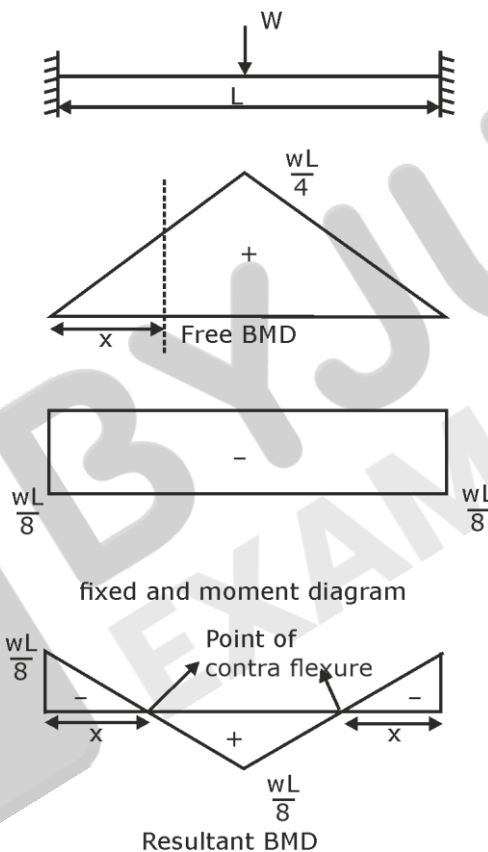
Free BM at x $= \dfrac{wL}{4} \times \dfrac{x}{L/2} = \dfrac{wx}{2}$

$\dfrac{wx}{2} - \dfrac{wL}{8} = 0$

$x = \dfrac{L}{4}$

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.

Ans. B

Sol.

$\dfrac{6EIS}{L^2}$ is the fixed and moment developed to make the slope zero.

In the above example, end moments are anticlockwise at both end A and B.

If support A satellites instead of B, end moments will be clockwise at both ends.

66. A rectangular c/s beam of size 300 mm × 500 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

Ans. D

Sol.

$$\tau = \frac{FA\bar{y}}{Ib} = \frac{6E}{bd^3}\left[\left(\frac{d}{2}\right)^2 - y^2\right]$$

$$= \frac{6 \times 20 \times 10^3}{300 \times 500^3}\left[\left(\frac{500}{2}\right)^2 - (150)^2\right]$$

$$\boxed{\tau = 0.128 \text{ MPa}}$$

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

A. The direct stress is very small compared 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

Ans. B

Sol. Assumptions of Euler's Theory

Euler's theory of failure is based on the following assumptions given below:

1. The axis of the column is perfectly straight when unloaded.

2. The line of thrust coincides exactly with the unstrained axis of the column.

3. Column is long and prismatic, i.e., Flexural rigidity EI is constant.

4. Material of the column is isotropic, homogeneous, and linear elastic (Hooke's law is valid).

5. The buckling load value of P = Pe is assumed to obtain for all degrees of flexure.

6. The effect of the self-weight of the column is neglected.

7. column will fail in buckling only.

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

A. Number of members at the joint − 4

B. Number of member at the joint − 2

C. Number of member at the joint − 1

D. Number of member at the joint − 3

Ans. C

Sol. If n number of member is meeting at the joint where pin is introduced then the number of additional equation = n - 1

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 end a carry-over of $\frac{1}{2}$ × 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

Ans. B

Sol.
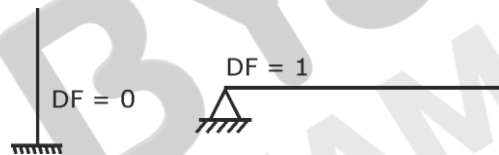
(i) DF of fixed support is zero since any applied moment is resisted by an equal and opposite moment within reaction.

(ii) Df of pin support is 1. Any applied moment needs to balanced and carry over moment should be transferred to bar end at an internal support.

Direction: 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 statements (II) are individually true and statement (II) is the correct explanation of statement (I)

(b) Both statement (I) and statements (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 substance are not susceptible to attack by both bacteria and fungi.

Ans. C

Sol. Wood is a natural organic substance composed of -

Cellulose - it is an organic polymer that crystallises to form fibres and provide strength to wood.

Lignin -It is also an polymer and it acts as a matrix for the cellulose.

So, statement (I) is true

Organic substances are susceptible to attack by bacteria and fungi as they use organic compounds as a source of energy and nutrients.

So, statement (II) is false

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.

Ans. C

Sol.
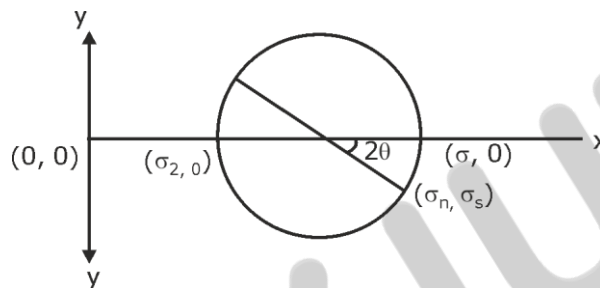
Statements I correct

Orthogonal means – 90° to the plane

But the set of axis = 2θ = 180° the each other

Statements-II-wrong

The distance between there axes is equal to the diameter of the circle.

72. Statement (I): There may be as many unknown forces as there are equations of equilibrium; however instability or moment 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.

Ans. A

Sol. 1. If support reaction are all parallel, rigid body translation will take place making the structure unstable.
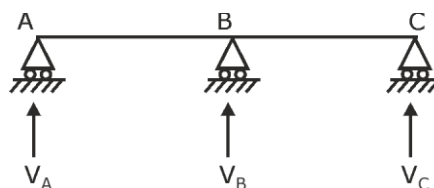
2. If support reaction are concurrent at a point then rigid body translation will take place making the structure unstable.
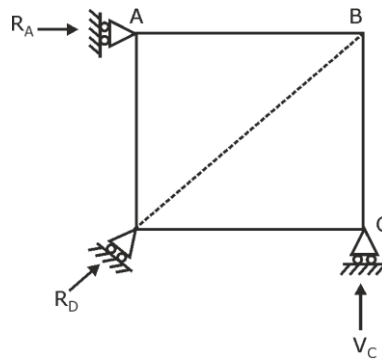
So, even if in the structure.

No. of unknown forces = No. of available equilibrium equations.

The structure can still be unstable because of improper arrangement of support as shown above.

Statement (II) is correct explanation of statement (I).

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

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

Ans. C

Sol. 1. Velocity potential function (ϕ)

$$u = \frac{\partial \phi}{\partial x}, \quad v = -\frac{\partial \phi}{\partial y}, \quad w = -\frac{\partial \phi}{\partial z}$$

u, v and w are velocity component in x, y and z direction respectively.

So, statement I is true.

2. Stream function (ψ)

$$u = -\frac{\partial \psi}{\partial y}, \quad v = \frac{\partial \psi}{\partial x}$$

Statement (II) is false.

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

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

Ans. D

Sol. First step in Hardy cross method for the analysis of pipe network requires the assumption of discharge in each pipe which satisfies the continuity equation at each junction.

So, trial distribution is not completely arbitrary.

Therefore, Statement (I) is false and Statement (II) is true

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.

Ans. D

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

Ans. A

Sol. According to Terzaghi, a foundation is shallow if the depth is less than equal to the width.
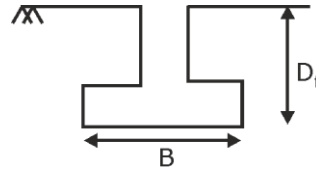
$$\frac{D_f}{B} \leq 1$$

Or $D_f \leq B$

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

Ans. B

Sol. Ultimate bearing capacity is the minimum gross pressure intensity at the base of the foundation, at which the soil fails in shear.
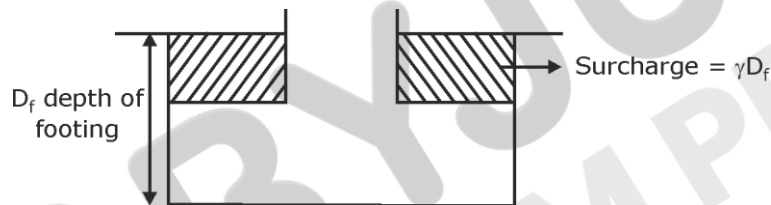
Gross pressure intensity is due to the weight of the superstructure, footing, and surcharge.

Net pressure intensity is gross pressure intensity minus surcharge.

78. Which one of the following is NOT the common nomenclature of geo-synthetics?

A. Geotextiles   B. Geogrids

C. Geogrouts   D. Geonets

Ans. C

Sol. Geosynthetics are synthetic polymeric products.

The main categories of Geosynthetics are geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells, and geo composites.

79. Which 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 different settlings

D. Slower consolidation of fills

Ans. A

Sol. Geotextiles are used to improve stability and decreases wind are water erosion. It is used for separation. It protects the small aggregates from irrigation.

Economy of aggregate is therefore an advantage when geotextiles is used in road works.

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

1. The empirical correlation 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 cannot 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

Ans. A

Sol. ϕ obtained from SPT and CPT values can be used for obtaining the bearing capacity factors N_c, N_q, and N_γ

Statement 3 is incorrect

The correct answer is (a) 1 and 2 only.

SPT and CPT values are often used to estimate soil parameters using empirical correlations. These values depend on the amount of energy that is effectively transmitted to the sample during the hammer fall.

The N values are therefore corrected for the standard energy ratio.

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

A. grain length   B. graduation

C. elasticity   D. non-compressibility

Ans. B

Sol. A unified classification system (UCS) is based on grain distribution (gradation), and compressibility which depends on the liquid limit and plasticity of the soil. Therefore correct option is (B).

82. Which 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

Ans. A

Sol. A Coffer dam can be defined as a temporary structure that is built to keep the water away from the execution site, so that structure can be built on a dry surface.

Coffer dam can be divided into the following categories.

1. Earthern or embankment-protected coffer dam:

Generally used when the water depth is shallow (1.2 to 1.5 m). Rockfill coffer dam is useful up to a water depth of 3m.

2. Braced cofferdam: For a height of 6 to 12 m.

3. Cantilever sheet pile coffer dam: For small heights < 6 m

4. Cellular coffer dam: For heights more than 20 m.

The appropriate answer is (a) since embankment coffer dams can have higher heights if there is availability of space for construction.

83. A footing 3 m × 1.5 m in plan transmits a pressure of 160 kN/m² on a cohesive soil having E = 8×10^4 kN/m² and μ = 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

Ans. C

Sol. Immediate settlement $s_i = \dfrac{q_B \left(1 - \mu^2\right) I_w}{E_s}$

q = Load intensity

B = Width of footing

μ = poison's ratio

I_w = Influence factor

E_s = Modulus of elasticity of soil

Given,

q = 160 kN/m^2

E_s = 8 × 104 kN/m^2

B = 1.5 m = 150 mm

I_w = 1.52

$s_i = \dfrac{160 \times 1500 \times \left(1 - 0.48^2\right) \times 1.52}{8 \times 10^4}$ = 3.51 mm

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

A. Strain isobar

B. Vertical pressure distribution on horizontal plane

C. Vertical pressure distribution on an inclined plane

D. Pressure distribution diagram on an oblique plane

Ans. B

Sol. As per Boussinesq's stress distribution theory, the vertical stress increment at a point having radial distance of 'r' and depth 'z' from point of application of point load 'Q' is

$$\sigma_z = \frac{3Q}{2\pi z^2} \left[\frac{1}{1 + \left(\dfrac{r}{z}\right)^2} \right]^{\frac{5}{2}}$$
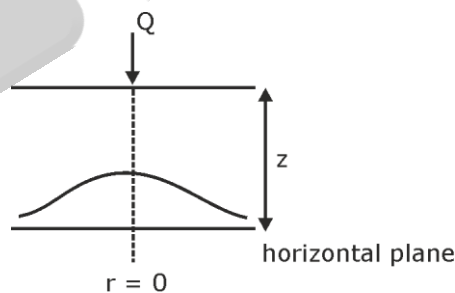
At a particular depth, on a horizontal plane, the vertical pressure distribution can be plotted as shown in figure.

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

Ans. B

Sol. Assumptions of coulomb theory for active earth pressure for sands

    1. soil is homogenous, isotropic and plastic

    2. Backfill soil is dry and cohesion less.

    3. Back of wall is rough. There is wall friction on friction surface.

    4. Failure surface is planar

    5. Failure is two dimensional

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

Ans. B

Sol. Bearing capacity failure is generally considered for a mechanically stabilized earth wall failure.

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

    A. The soil is non-homogenous

    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

Ans. B

Sol. Assumption of Terzaghi's theory of consolidation

    1. Soil is homogenous and isotropic.

    2. Soil particles and water are incompressible.

    3. Coefficient of permeability (k) is constant during consolidation.

    4. Only Hydrodynamic lag is considered. The change in volume is due to the expulsion of water from pores.

    5. Darcy's law is valid.

    6. Soil is laterally confined. Drainage of water and consolidation takes place only in the vertical direction.

    7. Soil is fully saturated

    8. Applicable for small load increment ratio.

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

    A. The porosity of a rock depends up 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 process

    D. The porosity of spherical rock grains is high in case of cubic packing

Ans. C

Sol. The porosity of a rock varies with the shape and size of rock grains.

Overburden pressure is the pressure on the rock from the weight of the rock and the earth above it. The weight of a rock depends on its specific gravity. Mechanical processes like thermal expansion, frost weathering, exfoliation, abrasion, and salt crystal growth affect the porosity of the rock. Porosity depends upon rock mechanical processes.

In cube packing of spherical rock grains, the porosity obtained is 47.6% which is the highest.

Arrangement	Porosity %
Cubic	47.6%
Hexagonal	39.5%
Orthorhombic	39.5%
Rhombohedral	26%
Tetragonal	30.2%
Triclinic	26%

89. Consider the following objective related to the sub-surface investigation

1. The 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

Ans. D

Sol. The purpose of conducting sub-surface exploration/investigation is to establish a geological profile. (Outline of earth soil as seen from side view), hydrological conditions (groundwater hydrology)

Instruments like inclinometers, piezometers, tilt meters, strain gauges, etc are used to monitor current and future changes.

90. Dip fault is fault plane

A. Parallel to the dip of beds

B. parallel to the strike of a bedding plane

C. Diagonal to the dip of bedding plane

D. with no relationship to the bedding plane

Ans. B

Sol. Dip fault is fault plane parallel to the strike of a bedding plane

91. Consider the following aspects of human vison 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 2

Ans. D

Sol. Aspects of vision important for traffic engineer

i. Field of Vision

The field of vision is that portion of space in which objects are visible at the same moment during steady fixation of gaze in one direction.

ii. Visual acuity Visual acuity (VA) is a measure of the ability of the eye to distinguish shapes and the details of objects at a given distance.

iii. Colour Perception

It helps in identifying the different signal colours and signs

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 detail of geomatic design elements is carried out in

A. Reconnaissance survey

B. Preliminary survey

C. Location of final alignment

D. Detailed survey

Ans. B

Sol. Computation of earth work quantities and other construction materials and checking details of geometric design elements is carried out in detailed survey

93. The raising of outer over inner rail is called

A. Cant deficiency

B. Cant

C. Capacity of the track

D. Centre bound sleepers

Ans. B

Sol. Raising of outer rail with respect to inner rail at a curved track is called cant.

94. The distance between successive vehicles moving in the same line measured from bead at any instance is

A. the space headway

B. the time headway

C. the one-way stream

D. the head-way stream

Ans. A

Sol. Space headway is defined as the distance between corresponding points of two successive vehicles at any given time.

Time headway is defined as the time difference between any two successive vehicles when they cross a given point.

Since in question space with two vehicles at a given instant is asked it means it is asking about space headway.

95. The roads which are provided with a hard pavement course having at least a water bound macadam (WBM) layer are classified as

A. Paved roads

B. Unpaved roads

C. Surface roads

D. Unsurfaced roads

Ans. A

Sol. The roads which are designed with a hard pavement course such as Cement concrete, Bituminous and WBM are called Paved roads.

96. The planning surveys about engineering studies consist of

A. Income per capita

B. Living standard

C. Traffic volume

D. Road location and alignment studies

Ans. D

Sol. The planning surveys about engineering studies consists of Road location and alignment studies

PLANNING SURVEYS		
Economic studies		Population, its distribution and classification. Trend of population growth; Listing of agricultural and industrial development, their future trends-classification and listing of these details; other activities viz. Income per capita, banking, post office etc.
Financial Studies	Data Collected Must Confirm To : Adequacy, Accuracy Availability, Accessibility	Source of income, Revenue from taxation on road transport. Living standard, future trends-details like vehicle registration, Court fees and Local taxes etc.
Traffic or road use studies		Traffic volume, traffic flow patterns- O and D studies, Mass transportation facilities, Accidents - their costs, trends; Growth of vehicular traffic, passenger trips and good movements.
Engineering studies		Road location and alignment studies, Classification; Types of roads in use; Maintenance problems - Soil and topography studies; Road life studies.

97. The Cipolletti weir has length of 2.0 m and head over the weir is 1 m. What is the discharge over the weir? (Take cd = 0.62)

A. 10.35 m³/s

B. 3.66 m³/s

C. 45.21 m³/d

D. 75.68 m³/s

Ans. B

Sol. Given, L = 2 m

H = 1 m

C_d = 0.62

For Cipolletti weir,

$C_d = \dfrac{2}{3} C_d \sqrt{2g} \, LH^{3/2}$

$= \dfrac{2}{2} \times 0.62 \times \sqrt{2 \times 9.851} \times 2 \times 1^{3/2}$

$= 3.66$ 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 given triangular notch, only one reading is required to be taken for the measurement of discharge.

Ans. D

Sol. Advantage of triangular notch over rectangular notch:

Ventilation of triangular notch is not necessary.

Triangular notch is preferred for low discharge. For smaller discharge, measurement of height of free water surface becomes difficult in rectangular notch. Whereas, triangular notch produces higher head even for low discharge.

Velocity of approach can be neglected without causing much error. Hence, only one reading is required to be taken for discharge calculation.

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

A. When the depth of flow in a channel is greater than critical depth, the flow is said to supercritical 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 grater than the critical depth, the flow is said to be sub-critical flow

Ans. D

Sol. • For a given discharge, if we decrease the specific energy, the depth of flow will decrease in subcritical flow, and the depth of flow will increase in supercritical flow.

• For a given discharge, if we increase the specific energy, the depth of flow will increase in subcritical flow, and the depth of flow will decrease in supercritical flow.

• For a given specific energy, if we decrease the discharge, the depth of flow will increase in subcritical flow and decrease in supercritical flow.

• For a given specific energy, if we increase the discharge, the depth of flow will decrease in subcritical flow, and the depth of flow will increase in supercritical 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

Ans. D

Sol. Given;

d = 200 mm = 0.2 m

L = 60 m

v = 2.5 m/s

f = 0.005 According to Darcy's formula

$h_f = \dfrac{fLV^2}{2gd} = \dfrac{4 \times 0.005 \times 60 \times 2.5^2}{2 \times 9.81 \times 0.2} = 1.91$ m

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

Ans. A

Sol. If only horizontal acceleration is applied on the liquid then the water surface level of the liquid will become sloped but the pressure distribution along the depth is still hydrostatic.
It will only deter from hydrostatic distribution if there is acceleration in the vertical direction.

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. 43.8litres/sec
    D. 46.1 litres /sec

Ans. C

Sol. Given H = 5m
d = 75 mm

$$Q = a \times v = a \times \sqrt{2gH}$$

$$= \frac{\pi}{4} \times 0.075^2 \times \sqrt{2 \times 9.81 \times 5}$$

0.0438 m^3/s = 43.8 l/s

103. A flat plate 1.5 m × 1.5 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 N   B. 151.9 N
    C. 180.4 N   D. 225.9 N

Ans. B

Sol. $F_2 = \frac{1}{2}C_L \rho A V^2$

$$= \frac{1}{2} \times 0.75 \times \frac{113}{9.81} \times 1.5 \times 1.5 \times \left(\frac{45 \times 5}{18}\right)^2$$

= 151.9 N

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 ρ =1025 kg/m^3)
    A. 30129 N   B. 34517 N
    C. 37112 N   D. 38287 N

Ans. D

Sol. $F_D = \frac{1}{2}C_D \rho A V^2$

$$= \frac{1}{2} \times 0.7 \times 1025 \times 3 \times 15 \times 1.54^2$$

[A = Projected area = d × L]
= 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 slopping straight line, which is known as

A. Hydraulic gradient line

B. Total energy line

C. Total head line

D. Energy grade line

Ans. A

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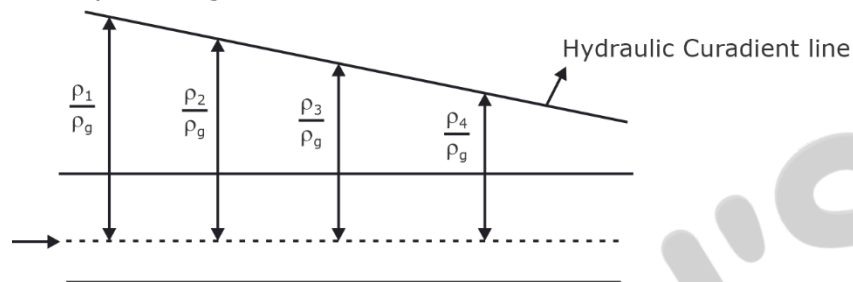
106. Which one of the following consists of horizontal and vertical location of certain points by linear and angular measurements and is made to determine the natural features of a country?

A. Cadastral survey

B. Topographical survey

C. Astronomical survey

D. Military survey

Ans. B

Sol. (i) Topographical surveying

It is used to determine the natural features (topography) of a country, such as rivers, streams, lakes, mountains, and artificial features such as roads, railway tracks, canals, towns, etc.

(ii) Cadastral surveying

It Shows boundaries of properties like fields, buildings, etc., useful for revenue engineers for fixing property lines and transferring land property from one owner to another. They are also made to set boundaries of municipalities, cities, and states, etc.

(iii) Astronomical survey

These surveys are done to determine the position of celestial bodies like stars and planets and satellites, spaceships, etc.

(iv) Military survey

Military Survey is done to determining the points of strategic importance for the country.

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

Ans. D

Sol. Combined Correction, C = −0.0673d^2

Since combined correction is -ve sign, it means we had taken reading too long hence option d is incorrect

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

Ans. C

Sol. l′=348.28 m

L=20 m

L′= 20-0.05=19.95 m

True length $= \dfrac{1'}{L} \times L$

True length $= \dfrac{348.28}{20} \times 19.95$

True length=347.41 m

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

Ans. A

Sol.
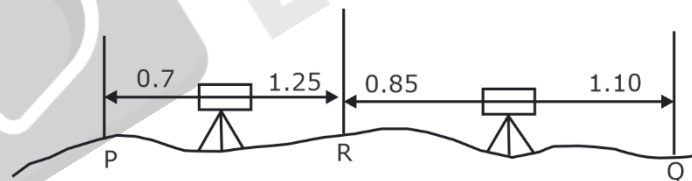
RL$_{BM}$ = 240

HI = 240 + 0.7 = 240.7 m

RL$_R$ = HI — FS$_1$

= 240.7 — 1.25 = 239.45 m

RL$_{I\,TBS}$ = 239.45 + 0.85 = 240.3 m

RL$_Q$ = HI$_2$ — FS$_2$ = 240.3 — 1.10 = 239.2 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 mm^2, what is the correct area on the ground?

A. 237 m^2 B. 307 m^2

C. 347 m^2 D. 397 m^2

Ans. B

Sol. 100 mm line now measure as 96 mm.

Shrunk Factor $(SF) = \dfrac{96}{100}$

Shrunk Scale = SF × Original Scale

Shrunk Scale $= \dfrac{96}{100} \times \dfrac{1}{1000}$

1:1000 can be written as 1 mm :1 m

$= \dfrac{96}{100} \times \dfrac{1 \text{ mm}}{1 \text{ m}}$

$= \dfrac{1 \text{ mm}}{(1/0.96) \text{m}}$

So, shrunk scale is 1 mm $= \dfrac{1}{0.96}$ m

Measured area, $A = 282 \times \left(\dfrac{1}{0.96}\right)^2 = 305.98 \text{m}^2$

L′= 29.03 m

L = 20 m

True area $= \left[\dfrac{L'}{L}\right]^2 \times$ Measured area

True area $= \left(\dfrac{20.03}{20}\right)^2 \times 305.98$

True area $= 306.89 \cong 307\text{m}$

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

Ans. *

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

Ans. B

Sol. Multilevel classification system Level IV is suitable for High altitude aerial photograps

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.

113. What is the length of the curve?

    A. 190 π m   B. 185 π m

    C. 180 π m   D. 170 π m

Ans. A

Sol.
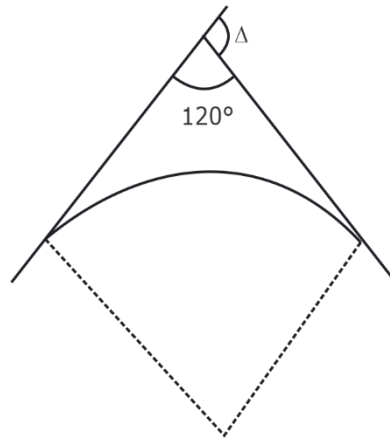
R = 570 m

Δ = 180 — 120 = 60°

Length of long chord = $2R\sin\left(\dfrac{\Delta}{2}\right)$

$= 2 \times 570\sin\left(\dfrac{60}{2}\right)$

$= 2 \times \sin(30) \times 570$

$= 2 \times \dfrac{1}{2} \times 570$

= 570 m

114. What is the length of the long chord?

A. 370 m   B. 470 m

C. 670 m   D. 570 m

Ans. D

Sol. Length of long chord = $2R\sin\left(\dfrac{\Delta}{2}\right)$

$= 2 \times 570\sin\left(\dfrac{60}{2}\right)$

$= 2 \times \sin(30) \times 570$

$= 2 \times \dfrac{1}{2} \times 570$

= 570 m

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

Ans. B

Sol.

V= 50 kmph

f=0.37

t=2.5 sec

SSD= Lag distance+ Breaking distance

$$SSD= 0.278Vt + \frac{V^2}{254f}$$

$$SSD = 0.278 \times 50 \times 2.5 + \frac{50^2}{254 \times 0.37}$$

SSD=34.8+ 26.60

SSD=61.4 m

Road	SSD
One lane one way	SSD
Two-lane one way	SSD
Two-lane two way	SSD
One lane two way	2SSD ($SSD_1 + SSD_2$)

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.

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

Ans. A

Sol. Weight of sleepers can affects the rails hence they are considered while design of rails. Hence statement 3 is wrong

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

A. tie bars.

B. torsion rods

C. small spacing

D. shear rods

Ans. A

Sol. Longitudinal joints in cement concrete pavements are constructed with tie bars. Tie bars are either deformed steel bars or connectors used to hold the faces of slabs in contact.

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

Ans. A

Sol. The determination of optimum length is based on the saturation system for the highway planning.

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

Ans. C

Sol.

1. Valley alignment - If two control points lie in the same valley then track is provided along a straight line between this point with uniform gradient.

2. Cross-country alignment - This type of alignment is when the alignment crosses the watershed of two or more streams of different size. Grade of such alignment is steep and varying.

3. Mountain alignment - This alignment is obtained by development accompanied by tunneling. In mountains, the elevation varies considerably and the grade of a normal alignment may become too steep. To keep it within the ruling gradient, different development process accompanied by tunnels is used.

   Different types of development techniques used in mountain alignment:

   a. Zig-zag alignment - follows a zig-zag pattern

   b. Switch-back method- adopted when side slopes are too steep.

   c. spiral method - adopted in case of a narrow valley where a small bridge can be provided.

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

Ans. D

Sol.

➢ Plate bearing test is used to evaluate the supporting power of subgrade for use in pavement design by using large diameter plates.

➢ Triaxial Compression Test is used to find the shear strength of soil

➢ California Resistance Value method gives the R-value and it is an indication of the stiffness of the material.

- The California Bearing Ratio (CBR) is a measure of the strength of the subgrade of a road or other paved area, and of the materials used in its construction.

Note:

i. For CBR test a standard circular plunger of 50 mm diameter is used.

ii. For plate bearing test setup consists of plate of diameter 75 cm, 60 cm, 45 cm and 30 cm.

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

Ans. C

Sol.

Given, SS = 250 mg/l

Q = 6.5×10^6 l/day

SS settled = 0.55 × 250 = 137.5 mg/l

Total quantity of solids settled

$$= \frac{137.5 mg/l \times 6.5 \times 10^6 l/d}{10^6 mg/kg}$$

= 893.75 kg/day (5% of total mass)

Quantity of sludge = $\frac{893.75}{0.05} = 17875\,kg\,sludge$

$G_s = \frac{\rho_s}{\rho_w} = \frac{m}{\frac{v}{\rho_w}} = \frac{17875}{1000} = 17.875\,cum$

Option (C)

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

A. Q=100 √t B. Q=130 √t

C. Q=200 √t D. Q=260 √t

Ans. B

Sol. The total subsurface soil area required for the soak pit is given by:-

$$q = \frac{204}{\sqrt{t}}$$

∴ Nearest option is $\frac{200}{\sqrt{t}}$

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

Ans. D

Sol. Sodium chloride is not a common distraction method of water.

 Boiling UV rays & 0 zone are all commonly used for disinfection methods for water.

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

Ans. B

Sol. 1. Swimming pool water can have disinfectant dissolved in it like bleaching powder.

   2. Minimum amount of chemicals should be added to avoid skin infections & irritation.

   3. The water in the pool needs to be visible at maximum depth.

   4. The pool needs to 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

Ans. A

Sol. The first stage of sewage purification by the action of anaerobic bacteria is called putrefaction. It is the decomposition of organic matter into simpler compounds with a production of a foul smell.

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

   A. Turbidity

   B. pH

   C. Alkalinity

   D. Volatility

Ans. A

Sol. Turbidity is the measure of the extent to which light is either absorbed or scattered. It is not a quantitative measure of suspended solids. Therefore, it is the measure of the light-emitting properties of wastewater.

127. Which one of the following is defined as the oxygen required for the microorganisms 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

Ans. A

Sol. Biochemical oxygen demand (BOD) is defined as the oxygen required for microorganisms to carry out the biological decomposition of organic matter in water under aerobic conditions at standard temperature.

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

Ans. B

Sol. Chlorination, liming, and recarbonation are a part of the solute stabilization context of unit operations for wastewater treatment.

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

Ans. A

Sol. Caulking is the process of driving pouring or forcing lead oakum plastic or other material in to a joint to make it "leak proof".

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

Ans. A

Sol. Deliquescence is the property by virtue a material absorbs moisture from the air and dissolves in it to become liquid.

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

Ans. B

Sol. The detention period is the time taken by a particle of water to pass between the entry and exit of a settling tank.

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

Ans. B

Sol. Commonly adopted detention period for grit chamber varies between 40-60 seconds. So, nearest option is 45-90 seconds.

133. Match the following lists:

List I	List II
P. A member carrying compressive loads resulting from dead	1.400
From dead and impose load	2. 180
Q.A member subjected to compression forces resulting	3. 250
only from combination with wind/earthquake actions,	4. 300
provided the deformation of such members does not	
adversely affect the stress in any part of the structure	
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

Ans. A

Sol.

SI NO. (1)	Member (2)	Maximum Effective Slenderness Ratio (KL/r) (3)
i.	A member carrying compressive loads resulting from dead loads and imposed loads	180
ii.	A tension member in which a reversal of direct stress occurs due to loads other than wind or seismic forces	180
iii.	A member subjected to compression forces resulting only from combination with wind/earthquake actions, provided the deformation of such member does not adversely affect the stress in any part of the structure	250
iv.	Compression flange of a beam against lateral torsional buckling	300
v.	A member normally acting as a tie in a roof truss or a bracing system not considered effective when subject to possible reversal of stress into compression resulting from the action of wind or earthquake forces	350
vi.	Members always under tension (other than pre-tensioned members)	400

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

Ans. C

Sol. The thickness of flat lacing bars shall not be less than one-fortieth of its effective length for single lacings and one-sixtieth of the effective length for double lacings.

135. An 18 mm thick plate is joined to a 16mm 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

Ans. A

Sol. Given: Grade of Steel = Fe410

F_y = 250 MPa

Effective throat thickness t_e = t_{min} [18 mm, 16 mm]

t_e = 16mm [Fully penetration]

L_e = 400 mm
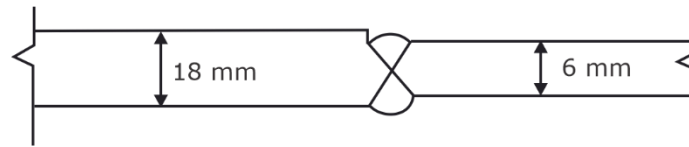
Design strength of weld = $\dfrac{f_y}{\gamma_{mw}} \times L_e \times t_e$

$= \dfrac{250}{1.25} \times 200 \times 16 = 640000N \simeq 640kN$

A is the nearest answer.

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

Ans. D

Sol. $h_f = \dfrac{FLQ^2}{R.ld^5}$

$0.8 = \dfrac{0.02 \times 600 \times Q^2}{12.1 \times 0.3^5}$

Q = 0.137 m³/s

137. The air vessel is not required for multicylinder 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

Ans. A

Sol. Air vessel is used to maintain a uniform velocity but since in multi cylinder reciprocating pump the velocity has small fluctuations in delivery and suction pipe, air vessels is not required.

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

Ans. B

Sol. In Bernoulli's equation, viscosity is assumed to be zero.

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)
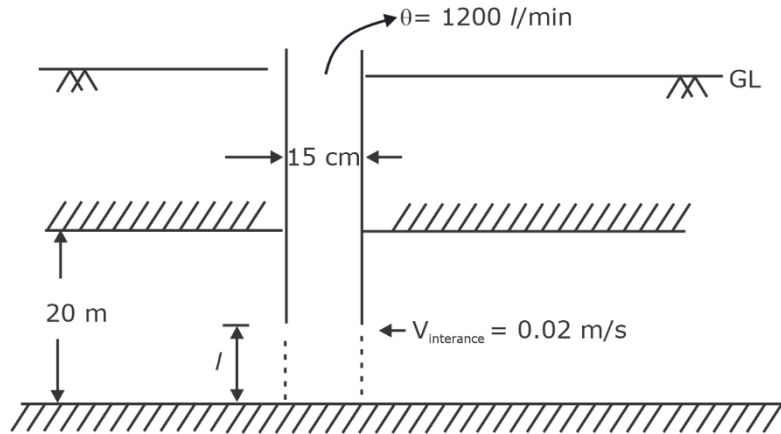
A. 10.5 m　　　　　　　　　　　　　　B. 12.3 m

C. 13.1 m　　　　　　　　　　　　　　D. 14.1 m

Ans. D

Sol.

Discharge (θ) = Area × Velocity

$$\frac{1200 \times 10^{-3} m^3}{60 \sec} = \left(\pi \times 0.15 \times l \times 0.02\right) \times 0.15$$

(15%) available strains)

l = 14.14 m

l = 14.14m

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

Ans. A

Sol. 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, is called as cross command area.

Note: If it was mentioned that there is a limitation of the quantity of available water then the answer would have been cultivable command 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

Ans. A

Sol. Wild flooding is the type of irrigation technique in which the water from the lateral ditches is allowed to flow freely without any sort of control. Hence, it is also called as free or uncontrolled flooding.

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

Ans. D

Sol. Favourable conditions for sprinkler irrigation method are:

i. Land topography is irregular

ii. Water table is high.

iii. 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

Ans. A

Sol. If the sodium ions increase to about 10% or more, the soil becomes less permeable and of power tilth.

Due to increased sodium ions concentration, we add water for leaching so that the salts gets dissolved and then, can be removed by drainage.

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

Ans. C

Sol. In Drip irrigation method, the drip nozzles are fixed on laterals, and discharges water at a very small rate of the order of 2 to 10 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

Ans. A

Sol. Since the cultivation method is faulty and less efficient, it means losses in the irrigation system will be higher.

And, $\text{Duty} \times \dfrac{1}{\text{Losses}}$ and $\text{Duty} = \dfrac{\text{Area}}{\text{Discharge}}$

Because, more are the losses, more will be the requirement of discharge to irrigated the same area, hence duty will be lesser or, we can say more are the losser lesser area will be lesser.

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

Ans. A

Sol. In montage type falls, the energy dissipation on a straight glacis remain incomplete due to vertical component of velocity remaining unaffected.

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

Ans. C

Sol. Assumptions made in two-dimensional design of gravity dams are as follows:

i. No loads are transferred to the abutments by beam action.

ii. The foundation and dam behave as single units.

iii. The material in the foundation and body of the dam are isotropic and homogeneous.

iv. The stresses developed in the foundation and body of the dam are 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

Ans. D

Sol. Natural factors may include poor natural drainage as a consequence of unfavorable sub-soil geology like existence of hardpan at shallow depths; spilling of rivers resulting in submergence of agricultural lands; heavy storm rainfall coupled with poor natural drainage etc.

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

Ans. D

Sol. Some of the popular methods to control water logging are

- Controlled Traffic Farming (CTF) ...
- Strategic Deep Tillage and Subsoil Manuring. ...
- Drainage Systems. ...
- Surface Drainage. ...
- Raised Bed System. ...
- Subsurface Drainage. ...
- Subsurface Pipe Drains. ...
- Vertical Subsurface 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

Ans. D

Sol. Ski-jump Bucket: It is one type of energy dissipater in form of buckets provided in spillways. It is suitable when the tail water depth is less than the depth required for the formation of hydraulic jump.

***

Answer Key

Set-D

Q. No.	Answer	Q. No.	Answer	Q. No.	Answer	Q. No.	Answer
1.	C	26.	B	51.	A	76.	A
2.	C	27.	A	52.	C	77.	B
3.	C	28.	D	53.	C	78.	C
4.	B	29.	C	54.	B	79.	A
5.	C	30.	B	55.	B	80.	A
6.	D	31.	B	56.	D	81.	B
7.	A	32.	D	57.	A	82.	A
8.	A	33.	A	58.	C	83.	C
9.	D	34.	D	59.	A	84.	B
10.	A	35.	C	60.	B	85.	B
11.	C	36.	D	61.	A	86.	B
12.	A	37.	B	62.	A	87.	B
13.	B	38.	D	63.	C	88.	C
14.	C	39.	D	64.	C	89.	D
15.	D	40.	B	65.	B	90.	B
16.	C	41.	D	66.	D	91.	A
17.	B	42.	A	67.	B	92.	B
18.	A	43.	A	68.	C	93.	B
19.	B	44.	A	69.	B	94.	A
20.	C	45.	D	70.	C	95.	A
21.	D	46.	C	71.	C	96.	D
22.	C	47.	B	72.	A	97.	B
23.	D	48.	A	73.	C	98.	D
24.	C	49.	D	74.	D	99.	D
25.	A	50.	A	75.	D	100.	D

Q. No.	Answer	Q. No.	Answer
101.	A	**126.**	A
102.	C	**127.**	A
103.	B	**128.**	B
104.	D	**129.**	A
105.	A	**130.**	A
106.	B	**131.**	B
107.	D	**132.**	B
108.	C	**133.**	A
109.	A	**134.**	C
110.	B	**135.**	A
111.	*	**136.**	D
112.	B	**137.**	A
113.	A	**138.**	B
114.	D	**139.**	D
115.	B	**140.**	A
116.	A	**141.**	A
117.	A	**142.**	D
118.	A	**143.**	A
119.	C	**144.**	C
120.	D	**145.**	A
121.	C	**146.**	A
122.	B	**147.**	C
123.	D	**148.**	D
124.	B	**149.**	D
125	A	**150.**	D

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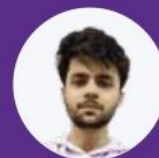|			
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