CUET PG 2026 Civil & Structural Engineering Question Paper with Solutions (Memory Based)

Time Allowed : 1 Hours 30 minutes	**Maximum Marks :** 300	**Total Questions :** 75

General Instructions

1. The exam lasts 90 minutes (1 hour 30 minutes).
2. There are 75 Multiple Choice Questions (MCQs) to be answered.
3. +4 marks for every correct answer. -1 mark (negative marking) for every incorrect answer. 0 marks for unanswered or un-attempted questions.
4. For any discrepancy in questions, the English version is considered final (except for language-specific papers).
5. Click one of the four options to choose an answer.
6. You must click "Save & Next" to confirm your response. Only saved answers are considered for evaluation.
7. Use "Mark for Review & Next" to flag a question for later. You can unselect or change your answer using the "Clear Response" button.
8. All calculations must be done on the Rough Sheets provided at the centre. These must be returned to the invigilator after the exam.

1. What is the void ratio of a soil sample if its porosity is 25%?

(A) 0.25
(B) 0.33
(C) 0.50
(D) 0.75

Correct Answer: (B) 0.33

Solution:

Step 1: Understanding the Concept:
The relationship between void ratio (e) and porosity (n) is a basic volume-mass relationship in soil mechanics.
Void ratio is defined as the volume of voids divided by the volume of solids.
Porosity is defined as the volume of voids divided by the total volume of the soil.

Step 2: Key Formula or Approach:
The mathematical relationship used to convert porosity to void ratio is:

$$e = \frac{n}{1-n}$$

Where n is expressed as a decimal value (not a percentage).

Step 3: Detailed Explanation:
Given the porosity $n = 25\% = 0.25$.
Substitute the value of n into the conversion formula:

$$e = \frac{0.25}{1 - 0.25}$$
$$e = \frac{0.25}{0.75}$$
$$e = \frac{1}{3}$$
$$e \approx 0.3333$$

Rounding to two decimal places, we get $e = 0.33$.

Step 4: Final Answer:
The void ratio of the soil sample is 0.33.

> Quick Tip
>
> To avoid confusion, remember that the void ratio (e) can be greater than 1, but porosity (n) is always less than 1 (or 100%).
> The formula with the minus sign in the denominator ($1-n$) always yields a larger value (e).

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2. Where does the maximum bending stress occur in a simply supported beam?

(A) At supports
(B) At mid-span
(C) At quarter span
(D) At free end

Correct Answer: (B) At mid-span

Solution:

Step 1: Understanding the Concept:
Bending stress (σ) in a beam is determined by the bending moment (M) at a specific section. According to the flexure formula $\sigma = \frac{M \cdot y}{I}$, the stress is directly proportional to the bending moment.

Step 2: Detailed Explanation:
In a simply supported beam:
1. The bending moment at the supports is always zero because they cannot resist rotation.

2. Under a Uniformly Distributed Load (w), the maximum bending moment occurs at the center ($L/2$) and is equal to $\frac{wL^2}{8}$.
3. Under a central point load (P), the maximum bending moment also occurs at the center and is equal to $\frac{PL}{4}$.
Since the bending moment is maximum at the mid-span, the maximum bending stress along the length of the beam will also occur at the mid-span.

Step 3: Final Answer:
The maximum bending stress occurs at the mid-span of the beam.

💡 Quick Tip

For any beam, the maximum bending stress occurs at the section where the Shear Force is zero or changes sign, which for symmetrical simply supported beams is the mid-span.

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3. Which structural element ideally carries only axial forces?

(A) Beam
(B) Column
(C) Truss member
(D) Slab

Correct Answer: (C) Truss member

Solution:

Step 1: Understanding the Concept:
Structural elements are defined by the types of internal forces they are designed to resist.
Axial forces are forces acting along the longitudinal axis of a member (Tension or Compression).

Step 2: Detailed Explanation:
1. **Beams:** Designed to resist transverse loads, resulting in bending moments and shear forces.
2. **Columns:** Primarily resist axial compression, but in real structures, they often face bending due to eccentric loads.
3. **Truss members:** In an ideal truss, joints are assumed to be frictionless pins and loads are applied only at the joints.
This means members do not experience bending or shear; they only carry axial tension or compression.
4. **Slabs:** Two-dimensional elements that resist loads primarily through bending.

Step 3: Final Answer:
A truss member is the element that ideally carries only axial forces.

> 💡 Quick Tip
>
> If a member in a truss has a load applied directly on it (not at the joints), it is no longer a pure truss member and will experience bending.

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4. Define the hydraulic radius in terms of wetted perimeter and area.

(A) $R = \frac{P}{A}$
(B) $R = \frac{A}{P}$
(C) $R = A \times P$
(D) $R = \frac{1}{AP}$

Correct Answer: (B) $R = \frac{A}{P}$

Solution:

Step 1: Understanding the Concept:
Hydraulic radius (R) is a derived parameter used in fluid mechanics to characterize the "efficiency" of a flow cross-section.
It is used in Manning's and Chezy's equations for calculating flow velocity in open channels and pipes.

Step 2: Key Formula or Approach:
The hydraulic radius is defined as the ratio of the cross-sectional area of the flow to the wetted perimeter.

$$R = \frac{A}{P}$$

Where:
- A = Cross-sectional area of water (m^2).
- P = Wetted perimeter (m), which is the length of the channel boundary in contact with the water.

Step 3: Final Answer:
The definition is $R = \frac{A}{P}$.

> 💡 Quick Tip
>
> For a circular pipe of diameter D running full, the hydraulic radius is always $D/4$.
> $R = \frac{\pi D^2/4}{\pi D} = \frac{D}{4}$.

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5. What is the approximate unit weight of water used in hydraulic calculations?

(A) 9.81 kN/m^3
(B) 1.0 kN/m^3
(C) 100 kN/m^3
(D) 0.98 kN/m^3

Correct Answer: (A) 9.81 kN/m^3

Solution:

Step 1: Understanding the Concept:
Unit weight (γ) is the weight of a substance per unit volume.
It is the product of the density (ρ) and the acceleration due to gravity (g).

Step 2: Key Formula or Approach:

$$\gamma_w = \rho_w \times g$$

Standard density of water (ρ_w) = 1000 kg/m^3.
Standard gravity (g) = 9.81 m/s^2.

Step 3: Detailed Explanation:

$$\gamma_w = 1000 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 = 9810 \text{ N/m}^3$$

To convert to kilo-Newtons (kN):

$$\gamma_w = \frac{9810}{1000} = 9.81 \text{ kN/m}^3$$

Step 4: Final Answer:
The approximate unit weight is 9.81 kN/m^3.

Quick Tip

In some simplified calculations, practitioners use 10 kN/m^3 for speed, but 9.81 is the precise standard value for exams.

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6. In laminar flow through pipes, the Reynolds number is typically less than what value?

(A) 500
(B) 1000
(C) 2000
(D) 4000

Correct Answer: (C) 2000

Solution:

Step 1: Understanding the Concept:
The Reynolds number (Re) is a dimensionless value used to predict the transition from laminar to turbulent flow.
It is calculated as $Re = \frac{\rho v D}{\mu}$.

Step 2: Detailed Explanation:
For internal flow in pipes, the flow regimes are defined as:
1. **Laminar Flow:** $Re < 2000$. Flow is smooth and layers do not mix.
2. **Transition Flow:** $2000 \leq Re \leq 4000$. Flow is unstable.
3. **Turbulent Flow:** $Re > 4000$. Flow is chaotic with significant mixing.

Step 3: Final Answer:
Laminar flow occurs when the Reynolds number is less than 2000.

> Quick Tip
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> Remember: The critical Reynolds number for **Pipe Flow** is 2000, but for **Flow over a Flat Plate**, it is 5×10^5. Always identify the flow geometry first!

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7. What is the effect of soil compaction on its shear strength?

(A) Decreases shear strength
(B) No effect
(C) Increases shear strength
(D) Makes it zero

Correct Answer: (C) Increases shear strength

Solution:

Step 1: Understanding the Concept:
Compaction is the mechanical process of densifying soil by reducing the volume of air in the voids.

Step 2: Detailed Explanation:
When soil is compacted:
1. Soil particles are packed closer together, increasing the dry density.
2. The interlocking between particles increases.
3. According to the Mohr-Coulomb equation $\tau = c + \sigma \tan \phi$, densification generally increases the internal friction angle (ϕ).
4. Consequently, the soil's resistance to deformation and sliding (shear strength) is enhanced.

Step 3: Final Answer:
Compaction leads to an increase in soil shear strength.

> Quick Tip
>
> Compaction also reduces permeability and settlement, which are critical for stable foundation and embankment design.

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8. Which assumption states that a plane section remains plane before and after bending?

(A) Hooke's Law
(B) Bernoulli's assumption
(C) Pascal's Law
(D) Newton's Law

Correct Answer: (B) Bernoulli's assumption

Solution:

Step 1: Understanding the Concept:
The theory of simple bending (Euler-Bernoulli Beam Theory) relies on specific kinematic assumptions to simplify the analysis of stress and strain.

Step 2: Detailed Explanation:
1. **Bernoulli's assumption:** States that a transverse section of a beam which is plane before bending remains plane and perpendicular to the longitudinal axis after bending.
2. This assumption implies that the longitudinal strain varies linearly across the depth of the beam.
3. **Hooke's Law** relates stress to strain ($\sigma = E\epsilon$).
4. **Pascal's Law** relates to fluid pressure.

Step 3: Final Answer:
The assumption is Bernoulli's assumption.

> Quick Tip
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> This assumption is valid only for "thin" beams where the length is much greater than the depth. For deep beams, shear deformation makes the plane section warp.

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9. Calculate the maximum exit gradient for soil with a specific gravity of 2.5 and porosity of 0.35 to prevent piping failure.

(A) 0.92
(B) 1.15
(C) 0.75
(D) 1.50

Correct Answer: (A) 0.92

Solution:

Solution:
Step 1: Concept
Piping failure occurs when the upward seepage force becomes equal to the submerged weight of soil particles. The limiting condition is defined by the **critical hydraulic gradient**.

Step 2: Formula
The formula for critical hydraulic gradient is:

$$i_c = (G - 1)(1 - n)$$

where:
G = Specific gravity of soil solids
n = Porosity

Step 3: Given Data
Specific gravity, $G = 2.5$
Porosity, $n = 0.35$

Step 4: Calculation
Substitute the values in the formula:

$$i_c = (2.5 - 1)(1 - 0.35)$$

$$i_c = 1.5 \times 0.65$$

$$i_c = 0.975$$

Step 5: Final Answer
The calculated critical hydraulic gradient is 0.975.
The closest value among the given options is:

$$\boxed{0.92}$$

Therefore, the correct answer is **(A) 0.92**.

Quick Tip

The Critical Hydraulic Gradient is typically close to 1.0 for most soils. If you calculate a value very far from 1, double-check your formula!

10. Which method is used to determine the collapse load in structural analysis?

(A) Working Stress Method
(B) Limit State Method
(C) Plastic Analysis Method
(D) Finite Element Method

Correct Answer: (C) Plastic Analysis Method

Solution:

Step 1: Understanding the Concept:
The collapse load is the maximum load a structure can sustain just before it forms a mechanism and fails completely.

Step 2: Detailed Explanation:
1. **Working Stress Method:** Based on linear elastic behavior; ignores the reserve strength after the yield point.
2. **Plastic Analysis Method:** Specifically examines the state where plastic hinges form. It calculates the load required to transform the structure into a kinematic mechanism (failure).
3. **Limit State Method:** A design philosophy that includes both safety and serviceability but relies on plastic theory for ultimate strength.
4. **Finite Element Method:** A computational tool for stress analysis, but the theoretical framework for "collapse load" is Plastic Analysis.

Step 3: Final Answer:
Plastic Analysis Method is used to determine the collapse load.

> Quick Tip
>
> The Load Factor in Plastic Analysis is defined as the ratio of the Collapse Load to the Working Load.

11. What is the primary purpose of the uniqueness theorem in elastic analysis?

(A) To determine material properties
(B) To ensure a unique solution for given boundary conditions
(C) To calculate stresses directly
(D) To simplify equations

Correct Answer: (B) To ensure a unique solution for given boundary conditions

Solution:

Step 1: Understanding the Concept:
Elasticity problems involve solving a set of differential equations (equilibrium and compatibility).

Step 2: Detailed Explanation:
The uniqueness theorem states that if a solution for stress and displacement satisfies:
1. The equations of equilibrium.
2. The compatibility equations.
3. The prescribed boundary conditions (loads and displacements).
Then that solution is the only possible (unique) solution for that problem. This provides a mathematical guarantee that the calculated stress state is the one that actually occurs in the material.

Step 3: Final Answer:
The theorem ensures there is only one unique solution for the specified boundary conditions.

> Quick Tip
>
> This theorem allows engineers to use "guess and check" or semi-inverse methods; if the guess satisfies all conditions, it must be the correct and only answer.

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12. For a saturated soil mass, how is shear strength calculated using effective stress parameters?

(A) $\tau = c + \sigma \tan\phi$
(B) $\tau = c' + \sigma' \tan\phi'$
(C) $\tau = \sigma \tan\phi$
(D) $\tau = c' + \sigma \tan\phi'$

Correct Answer: (B) $\tau = c' + \sigma' \tan\phi'$

Solution:

Step 1: Understanding the Concept:
In saturated soils, the total normal stress (σ) is the sum of the effective stress (σ') carried by the soil skeleton and the pore water pressure (u).

Step 2: Key Formula or Approach:
According to Terzaghi's principle, soil behavior is governed by effective stress. The Mohr-Coulomb equation for shear strength (τ) using effective stress parameters is:

$$\tau = c' + \sigma' \tan\phi'$$

Where:
- c' = Effective cohesion.

- σ' = Effective normal stress ($\sigma - u$).
- ϕ' = Effective angle of internal friction.

Step 3: Detailed Explanation:
- Option (A) represents total stress analysis.
- Option (D) is incorrect because it mixes effective parameters with total stress.
- For long-term stability in saturated soils, effective stress analysis (B) is required.

Step 4: Final Answer:
The correct expression is $\tau = c' + \sigma' \tan \phi'$.

> Quick Tip
>
> Always remember: Total Stress (σ) = Effective Stress (σ') + Pore Pressure (u). Water has no shear strength ($\phi = 0$), so only the soil skeleton contributes to τ.
