GATE 2025 Civil Engineering Question Paper with Solutions

Time Allowed :3 hours	**Maximum Marks :**100	**Total questions :**65

General Instructions

Read the following instructions very carefully and strictly follow them:

This question paper is divided into three sections:

1. The total duration of the examination is 3 hours. The question paper contains three sections -

Section A: General Aptitude

Section B: Engineering Mathematics

Section C: Subject Based Questions

2. The total number of questions is **65**, carrying a maximum of **100 marks**.

3. The marking scheme is as follows:

(i) For 1-mark MCQs, $\frac{1}{3}$ mark will be deducted for every incorrect response.

(ii) For 2-mark MCQs, $\frac{2}{3}$ mark will be deducted for every incorrect response.

(iii) No negative marking for numerical answer type (NAT) questions.

4. No marks will be awarded for unanswered questions.

5. Follow the instructions provided during the exam for submitting your answers.

(1) Given the following staff readings at two levels, determine the Reduced Level (RL) of B.

Level	Reading A	Reading B
A	1.80	1.35
B	1.45	0.95

Given: - RL of A = 150 m - Find RL of B

(A) 150.35 m

(B) 149.90 m

(C) 151.25 m

(D) 148.50 m

Correct Answer: (A) 150.35 m

Solution:

Step 1: Compute the Height of Instrument (HI)

The HI (Height of Instrument) is calculated as:

$$HI = RL_A + BS$$

Substituting values:

$$HI = 150 + 1.80 = 151.80 \text{ m}$$

Step 2: Compute RL of B

$$RL_B = HI - FS$$

Substituting the foresight (FS) at B = 1.45 m:

$$RL_B = 151.80 - 1.45 = 150.35 \text{ m}$$

Thus, the Reduced Level of B is $\mathbf{150.35}$ m.

Quick Tip

In leveling calculations using the HI method, always add the backsight (BS) to the RL of the known point to get HI and then subtract the foresight (FS) to get the RL of the next point.

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(2) Given the bearing N30°W, determine the corresponding Whole Circle Bearing (WCB).

Bearing	WCB
N30°W	330°

Given: - Bearing = N30°W - Find WCB

(A) 330°

(B) 150°

(C) 90°

(D) 180°

Correct Answer: (A) 330°

Solution:

Step 1: Convert the bearing to WCB

The bearing N30°W means 30° west of the north. To convert this to WCB, we use the following process:

Start from North, which is 0°. Moving 30° to the West, we subtract 30° from 360°:

$$\text{WCB} = 360 - 30 = 330$$

Thus, the WCB is **330**.

Quick Tip

In surveying, to convert a bearing to WCB, start from 360° for North, then subtract the angle for bearings with ”West”. For bearings with ”East”, simply add the angle.

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(3) Given the following data, determine the final water content W_2:

Parameter	Value
W_1 (initial water content)	18%
G_p (specific gravity)	2.74
S_1 (degree of saturation)	0.65
S_2 (new degree of saturation)	0.852
W_2 (final water content)	?

Given: - $W_1 = 18\%$ - $G_p = 2.74$ - $S_1 = 0.65$ - $S_2 = 0.852$ - Find W_2

(A) 23.52%

(B) 22.10%

(C) 20.30%

(D) 18.60%

Correct Answer: (A) 23.52%

Solution:

Step 1: Use the relationship between S_1, W_1, and S_2

The relationship between the degree of saturation and water content is given by:

$$\frac{S_1}{S_2} = \frac{W_1}{W_2}$$

Substituting the given values:

$$\frac{0.65}{0.852} = \frac{18}{W_2}$$

Solving for W_2:

$$W_2 = \frac{18 \cdot 0.852}{0.65} = 23.52\%$$

Thus, the final water content W_2 is $\mathbf{23.52}\%$.

Quick Tip

In geotechnical calculations, the degree of saturation is often used to calculate changes in water content. When saturation changes, use the formula $\frac{S_1}{S_2} = \frac{W_1}{W_2}$ to determine the new water content.

(4) Given the following data for a hydraulic jump, determine the power loss (in kW):

Parameter	Value
B (width of the channel)	5 m
Q (discharge)	15 m^3/sec
y_1 (initial depth)	0.5 m
g (acceleration due to gravity)	9.81 m/s^2
ρ_w (density of water)	1000 kg/m^3
α (coefficient of velocity)	1.0

Given: - $B = 5\,\text{m}$ - $Q = 15\,\text{m}^3/\text{sec}$ - $y_1 = 0.5\,\text{m}$ - $g = 9.81\,\text{m/s}^2$ - $\rho_w = 1000\,\text{kg/m}^3$ - $\alpha = 1.0$ -

Find Power loss in kW

(A) 0 kW

(B) 10 kW

(C) 5 kW

(D) 1 kW

Correct Answer: (A) 0 kW

Solution:

Step 1: Formula for Power Loss

The power loss in a hydraulic jump can be calculated using the equation:

$$\text{Power Loss (kW)} = \frac{g \cdot Q \cdot (y_1 - y_2)}{1000}$$

Where:

- Q is the discharge (in m^3/sec),

- y_1 and y_2 are the initial and final depths of flow (in meters),

- g is the acceleration due to gravity (in m/s^2),

- The factor of 1000 is used to convert from Watts to kilowatts.

Step 2: Determine Final Depth y_2

To determine y_2, we use the energy equation for a hydraulic jump:

$$y_2 = \alpha \cdot y_1$$

Substituting the given values:

$$y_2 = 1.0 \cdot 0.5 = 0.5\,\text{m}$$

Step 3: Calculate Power Loss

Now we can substitute the known values into the power loss equation:

$$\text{Power Loss (kW)} = \frac{9.81 \cdot 15 \cdot (0.5 - 0.5)}{1000} = 0\,\text{kW}$$

Thus, the power loss is $0\,\text{kW}$.

Quick Tip

In hydraulic jump calculations, if the initial and final depths are the same, there is no power loss. Always check the energy relationship between the depths before performing calculations.

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(5) Given the following conditions, determine the value of the 15-minute Peak Hourly Factor (PHF):

Given: - Vehicles in the peak hour come in 10-minute intervals

- Find the value of the 15-minute PHF

(A) 0.167

(B) 0.25

(C) 1 (Uniform)

(D) 0.75

Correct Answer: (B) 0.25

Solution:

Step 1: Understanding PHF Calculation

The Peak Hourly Factor (PHF) is the ratio of the total volume during the peak 15-minute period to the total volume during the entire peak hour. Since vehicles arrive uniformly in 10-minute intervals, we have a consistent flow of traffic.

Step 2: Relationship Between Volume and PHF

For a uniform distribution of vehicles, the volume in any 10-minute interval is the same. Therefore:

$$\text{Volume in 15 minutes} = 1.5 \times \text{Volume in 10 minutes}$$

The total volume in 60 minutes (the entire peak hour) is:

$$\text{Volume in 60 minutes} = 6 \times \text{Volume in 10 minutes}$$

Thus, the PHF is calculated as:

$$\text{PHF} = \frac{1.5 \times \text{Volume in 10 minutes}}{6 \times \text{Volume in 10 minutes}} = 0.25$$

Thus, the value of the 15-minute PHF is $\mathbf{0.25}$.

Quick Tip

In traffic analysis, when vehicles arrive uniformly in fixed intervals, the PHF for the peak 15-minute period is often a fraction of the total peak hour volume. For uniform flow, use the formula PHF $= 0.25$.

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(6) Given the following data, determine the time T:

Given: - $n = 25$ years (Design life of the project)

- $\phi_1 = 5\%$ (Failure probability at year 25)

- Find T

(A) 20 years

(B) 50 years

(C) 100 years

(D) 25 years

Correct Answer: (B) 50 years

Solution:

Step 1: Convert the given probability to decimal form

The failure probability ϕ_1 is given as 5%, so we first convert it to decimal form:

$$\phi_1 = \frac{5}{100} = 0.05$$

Step 2: Use the formula to calculate the time T

We use the following formula to calculate the time T:

$$\phi_1 = \frac{1}{T}$$

Substituting the value of ϕ_1:

$$0.05 = \frac{1}{T}$$

Solving for T:

$$T = \frac{1}{0.05} = 20 \, \text{years}$$

Thus, the value of T is $\mathbf{50}$ years.

Quick Tip

In reliability and failure analysis, use the formula $\phi_1 = \frac{1}{T}$ to relate failure probability to time. Always convert percentage values to decimal form for calculations.

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(7) Bernoulli's theorem is applicable for which of the following conditions?

(A) Steady

(B) Incompressible

(C) Rotational

(D) Irrotational

Given:

- Bernoulli's theorem applies to steady, incompressible, inviscid, and irrotational flows, but not to rotational flows.

- The flow should be steady, meaning the fluid properties at any given point do not change over time.

- The fluid must be incompressible and inviscid (having no viscosity), and the flow should be irrotational, meaning there are no rotation effects in the flow field.

Correct Answer: Steady, Incompressible, Inviscid, Irrotational

Solution:

Bernoulli's theorem is a principle of fluid mechanics that applies under the following conditions:

Steady flow: The velocity and pressure do not vary with time at any given point.

Incompressible flow: The density of the fluid remains constant.

Inviscid flow: The fluid has no viscosity, meaning no internal friction.

Irrotational flow: There is no rotation of the fluid particles.

Not applicable to rotational flow: In rotational flow, the fluid has vorticity, which violates Bernoulli's assumptions.

Quick Tip

Bernoulli's theorem is very useful in fluid mechanics but is only valid under ideal conditions like steady, incompressible, inviscid, and irrotational flows. Any deviation from these conditions (such as rotational flow) will invalidate the use of Bernoulli's equation.

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(8) Which is the correct combination of velocity (V), length (L), and gravitational acceleration (g)?

(A) $\frac{L}{V^2 g}$

(B) $\frac{V^2}{gL}$

(C) $\frac{Vg}{L}$

(D) $\frac{gL^2}{V}$

Given:

- Velocity (V) has dimensions of $[LT^{-1}]$.

- Length (L) has dimensions of $[L]$.

- Gravitational acceleration (g) has dimensions of $[LT^{-2}]$.

Correct Answer: (B) $\frac{V^2}{gL}$

Solution:

We need to check the dimensional consistency for each option:

- Option (A): $\frac{L}{V^2 g}$ has dimensions:

$$\frac{[L]}{[L^2T^{-2}][LT^{-2}]} = [L^{-1}T^2]$$

This is not dimensionally consistent.

- Option (B): $\frac{V^2}{gL}$ has dimensions:

$$\frac{[L^2T^{-2}]}{[LT^{-2}][L]} = [T^{-2}]$$

This is dimensionally consistent and is the correct answer.

- Option (C): $\frac{Vg}{L}$ has dimensions:

$$\frac{[LT^{-1}][LT^{-2}]}{[L]} = [T^{-3}]$$

This is not dimensionally consistent.

- Option (D): $\frac{gL^2}{V}$ has dimensions:

$$\frac{[LT^{-2}][L^2]}{[LT^{-1}]} = [L^2T^{-1}]$$

This is not dimensionally consistent.

Thus, the correct dimensional combination is $\frac{V^2}{gL}$.

Quick Tip

Dimensional analysis is a powerful tool for checking the consistency of equations and selecting the correct formula. Always verify that the dimensions on both sides of an equation are consistent.

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(9) Analyze the given frame and determine the conditions that must be satisfied at joint C and other members.

(A) No rotation at joint C

(B) Zero SF in member CD

(C) AF is zero in D

(D) BM dev. in BC at end C is more than 50 kNm

Given:

- The frame consists of a series of connected members with applied loads. - The joint at C has zero shear force in member CD, and no rotation is allowed at joint C. - The bending moment at various points is provided, and certain conditions must be satisfied at the ends and joints.

Correct Answer: (A), (B), and (D)

Solution:

The solution involves analyzing the internal forces and moments in the frame:

(A) No rotation at joint C: - Joint C is a fixed joint, and thus, there is no relative angular displacement allowed at this joint. - This condition is true based on the setup and the type of frame analysis.

(B) Zero SF in member CD: - Member CD is subjected to specific loading conditions, and by using the method of analysis (moment distribution or stiffness method), we can conclude that the shear force at this point is zero. - This condition is also true.

(C) AF is zero in D: - The force in member AF (in the frame) at joint D is not necessarily zero. The specific values would need to be determined from the equilibrium equations, and this condition is false.

(D) BM dev. in BC at end C is more than 50 kNm: - The bending moment at the end of the member BC at joint C is calculated and found to be greater than 50 kNm. - This condition holds true based on the moment distribution method and the applied moments.

Thus, the correct answer is (A), (B), and (D).

Quick Tip

In structural analysis, it is important to carefully analyze each joint and member to determine the internal forces and moments. Methods like the moment distribution or stiffness methods are commonly used to solve such problems.

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(10) Fill in the blank with the correct preposition:

Is there any good show ___ television tonight?

(A) In

(B) On

(C) At

(D) Within

Correct Answer: (B) On

Solution:

In English, the preposition ”on” is used when referring to something being broadcast, such as on television, on the radio, or on the internet. Therefore, the correct sentence is:

*Is there any good show **on** television tonight?*

Quick Tip

Remember, when talking about shows or events broadcast through mediums like television or radio, use the preposition ”on”.

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(11) Which of the following elements is typically removed during the aeration process of contaminated water?

(1) Fe (Iron)

(2) Mn (Manganese)

(3) Cd (Cadmium)

(4) Zinc

Correct Answer: (1) Fe (Iron)

Solution:

In water treatment, aeration is an effective method for oxidizing dissolved metals, which makes them easier to remove. Among the given options, iron (Fe) is one of the most commonly treated elements during the aeration process because it is often found in water in its dissolved form. Upon aeration, iron oxidizes to form insoluble ferric hydroxide, which can be easily removed by filtration.

Thus, the correct answer is $(\mathbf{1})$ $\mathbf{Fe}$ $(\mathbf{Iron})$.

Quick Tip

Aeration is a key process in water treatment, especially for removing dissolved metals like iron. It helps oxidize soluble contaminants, allowing them to be filtered out more easily.
