GATE 2026 PE Question Paper with Solutions

Time Allowed :3 Hour	Maximum Marks :100	Total Questions :65

General Instructions

Please read the following instructions carefully:

1. This question paper is divided into three sections:
   - **General Aptitude (GA):** 10 questions (5 questions $\times$ 1 mark + 5 questions $\times$ 2 marks) for a total of 15 marks.
   - **Environmental Science and Engineering + Engineering Mathematics:**
     - **Part A (Mandatory):** 36 questions (1 questions $\times$ 1 mark + 19 questions $\times$ 2 marks) for a total of 55 marks.
     - **Part B (Section 1):** Candidates can choose either Part B1 (Surveying and Mapping) or Part B2 (Section 2). Each part contains 16 questions (8 questions $\times$ 1 mark + 11 questions $\times$ 2 marks) for a total of 30 marks.
2. The total number of questions is **65**, carrying a maximum of **100 marks**.
3. The duration of the exam is **3 hours**.
4. Marking scheme:
   - For 1-mark MCQs, $\frac{1}{3}$ mark will be deducted for every incorrect response.
   - For 2-mark MCQs, $\frac{2}{3}$ mark will be deducted for every incorrect response.
   - No negative marking for numerical answer type (NAT) questions.
   - No marks will be awarded for unanswered questions.
5. Ensure you attempt questions only from the optional section (Part B1 or Part B2) you have selected.
6. Follow the instructions provided during the exam for submitting your answers.

1. A vertical well is drilled up to a depth of 4000 ft. Further drilling starts with 10 ppg of fresh mud and 50000 lbf weight on bit (WOB). An equivalent circulation density (ECD) of 10.75 ppg was recorded. The total circulation pressure loss is estimated to be 110 psi. The steel density is 65.5 ppg. The decrease in hook load is _______ lbf (rounded off to one decimal place). (Note: 1 ppg mud is equivalent to 0.052 psi/ft.)

Correct Answer: 675.7 lbf

Solution:

Step 1: Use buoyancy factor for drillstring/BHA.
Buoyancy factor (BF) for steel in mud is:

$$BF = 1 - \frac{\rho_m}{\rho_s}$$

where ρ_m is mud density (ppg) and ρ_s is steel density (ppg).

Static mud density = 10 ppg:

$$BF_{\text{static}} = 1 - \frac{10}{65.5} = 0.84733$$

Circulating condition is represented by ECD = 10.75 ppg:

$$BF_{\text{circ}} = 1 - \frac{10.75}{65.5} = 0.83588$$

Step 2: Relate WOB to buoyed weight (set-down weight).
Assuming the applied WOB corresponds to the submerged (buoyed) weight contribution, the air-equivalent weight required is:

$$W_{\text{air}} = \frac{WOB}{BF_{\text{static}}} = \frac{50000}{0.84733} = 59009.01 \text{ lbf}$$

Step 3: Compute buoyed weight during circulation.

$$W_{\text{circ}} = W_{\text{air}} \times BF_{\text{circ}} = 59009.01 \times 0.83588 = 49324.32 \text{ lbf}$$

Step 4: Decrease in hook load due to increased buoyancy.
Extra buoyancy (hence decrease in hook load) is:

$$\Delta H = WOB - W_{\text{circ}} = 50000 - 49324.32 = 675.68 \text{ lbf}$$

Rounded to one decimal place:

$$\boxed{\Delta H = 675.7 \text{ lbf}}$$

Quick Tip

When ECD increases during circulation, the effective fluid density around the drillstring increases, which increases buoyancy and **reduces hook load**. Use $BF = 1 - \rho_m/\rho_s$ with ρ_m = mud density (or ECD) and $\rho_s \approx 65.5$ ppg for steel.

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2. The laboratory analysis data obtained from the core is as follows:
Weight of clean dry core in air = 30 g
Weight of core completely saturated with oil = 32 g
Weight of saturated core completely immersed in oil = 24 g
If the density of oil used for saturation of core during the experiment is 0.88 g/cc,

then the effective porosity of the core is ______% (rounded off to two decimal places).

Correct Answer: 25.00%

Solution:

Step 1: Find pore volume from oil uptake.
Oil mass in pores $= W_{\text{sat,air}} - W_{\text{dry,air}} = 32 - 30 = 2$ g.
Given oil density $\rho_o = 0.88$ g/cc, pore volume is:

$$V_p = \frac{2}{0.88} = 2.2727 \text{ cc}$$

Step 2: Find bulk volume using Archimedes' principle.
Loss of weight on immersion in oil:

$$\Delta W = W_{\text{sat,air}} - W_{\text{sat,oil}} = 32 - 24 = 8 \text{ g}$$

This equals the weight of displaced oil:

$$\Delta W = \rho_o V_b \Rightarrow V_b = \frac{8}{0.88} = 9.0909 \text{ cc}$$

Step 3: Compute effective porosity.

$$\phi_e = \frac{V_p}{V_b} = \frac{2.2727}{9.0909} = 0.25$$
$$\phi_e(\%) = 0.25 \times 100 = 25.00\%$$

Step 4: Conclusion.

$$\boxed{25.00\%}$$

Quick Tip

Core porosity from weights: Pore volume comes from **(saturated weight in air - dry weight in air)**$/\rho_f$. Bulk volume comes from **(saturated weight in air - immersed weight)**$/\rho_f$. Then $\phi = V_p/V_b$.

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3. The porosity of a formation with matrix density of 2.65 g/cc and fluid density of 1.0 g/cc is 0.15. The formation has shear modulus of 30 GPa and bulk modulus of 36 GPa. The compressional wave velocity in the formation is ______ $\times 10^3$ m/s

(rounded off to two decimal places).

Correct Answer: 5.62×10^3 m/s

Solution:

Step 1: Compute bulk density of the saturated formation.
Bulk density is:

$$\rho = (1-\phi)\rho_m + \phi\rho_f$$

Given $\phi = 0.15$, $\rho_m = 2.65$ g/cc, $\rho_f = 1.0$ g/cc:

$$\rho = 0.85(2.65) + 0.15(1.0) = 2.2525 + 0.15 = 2.4025 \text{ g/cc}$$

Convert to SI units:

$$2.4025 \text{ g/cc} = 2402.5 \text{ kg/m}^3$$

Step 2: Use P-wave velocity relation.
Compressional (P-wave) velocity is:

$$V_p = \sqrt{\frac{K + \frac{4}{3}G}{\rho}}$$

Given $K = 36$ GPa and $G = 30$ GPa:

$$K + \frac{4}{3}G = 36 + \frac{4}{3}(30) = 36 + 40 = 76 \text{ GPa}$$

$$76 \text{ GPa} = 76 \times 10^9 \text{ Pa}$$

Step 3: Calculate V_p.

$$V_p = \sqrt{\frac{76 \times 10^9}{2402.5}} = \sqrt{31.634 \times 10^6} \approx 5624.39 \text{ m/s}$$

Step 4: Express in the required form.

$$5624.39 \text{ m/s} = 5.62439 \times 10^3 \text{ m/s} \approx \boxed{5.62 \times 10^3 \text{ m/s}}$$

Quick Tip

For isotropic elastic media:

$$V_p = \sqrt{\frac{K + \frac{4}{3}G}{\rho}}$$

Always convert: g/cc $\rightarrow$ kg/m^3 (multiply by 1000), and GPa $\rightarrow$ Pa (multiply by 10^9).

4. In a capillary rise experiment with a capillary tube of length l_1, water rises to a height h such that $h < l_1$. If the capillary tube is cut to a length l_2 such that $l_2 < h$, and the experiment is repeated, which of the following statements is/are CORRECT?

(A) Water overflows from the top of the tube.
(B) Water does not overflow from the top of the tube.
(C) At equilibrium, radius of curvature of meniscus are same in both the experiments.
(D) At equilibrium, radius of curvature of meniscus are different in both the experiments.

Correct Answer: (B) and (D)

Solution:

Step 1: Recall the capillary rise relation.
For a capillary tube of radius r, the equilibrium capillary rise is:

$$h = \frac{2\sigma \cos\theta}{\rho g r}$$

This formula is obtained by balancing:
Upward force due to surface tension $\Rightarrow$ downward weight of the risen liquid column.

Step 2: What happens if the tube is shorter than the rise height?
Given the original tube length l_1 satisfies $h < l_1$, so equilibrium is reached inside the tube.
Now the tube is cut to l_2 such that $l_2 < h$.
If the liquid were to rise to h, the column would extend beyond the tube, which is not possible.

Therefore, the liquid rises only up to the top of the tube, i.e., height $= l_2$, and equilibrium must occur with a **different pressure drop across the meniscus** than in the original case.

Step 3: Check overflow condition (A) vs (B).
At the tube top, the meniscus adjusts (its curvature changes) such that the Laplace pressure drop balances the hydrostatic head corresponding to height l_2.
The system can reach equilibrium without spilling because the capillary pressure can reduce by changing curvature.
Hence, **water does not necessarily overflow**.
So, (B) is correct and (A) is incorrect.

Step 4: Compare meniscus curvature in both experiments (C) vs (D).
Capillary pressure (Laplace pressure) is:

$$\Delta P = \sigma \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$$

In a circular capillary, this is commonly written as:

$$\Delta P = \frac{2\sigma \cos\theta}{r_{\text{tube}}}$$

when the meniscus has its equilibrium shape corresponding to rise h.

In the shortened tube, the hydrostatic head is only $\rho g l_2$ (since rise stops at l_2), which is **smaller** than $\rho g h$.
Thus, the required pressure drop across the meniscus is smaller, so the meniscus must have a **different (less curved) radius of curvature**.
Therefore, the radius of curvature is **different** in the two experiments.
So, (D) is correct and (C) is incorrect.

Step 5: Conclusion.
The correct statements are:

$$\boxed{(B) \text{ and } (D)}$$

> **Quick Tip**
>
> If a capillary tube is shorter than the theoretical rise height, the liquid rises only up to the tube top. Equilibrium is achieved by changing the **meniscus curvature** (hence capillary pressure), so overflow is not necessary.

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5. Which of the following option(s) is/are CORRECT for well testing analysis of a reservoir?

(A) Permeability, skin and reservoir geometry are calculated using data from pseudo steady state.
(B) Permeability, skin and reservoir geometry are calculated using data from transient state.
(C) Reservoir geometry is calculated using data from pseudo steady state.
(D) Absolute open flow potential is calculated from back pressure test for a gas well.

Correct Answer: (C) and (D)

Solution:

Step 1: Identify what is obtained from transient (infinite-acting) data.
In well testing, the **transient (infinite-acting radial flow)** period is primarily used to estimate:
Permeability (k) from the semilog slope, and
Skin (s) from the semilog intercept (or equivalent transient relationships).

Hence, k and s are **transient-state** estimates, not pseudo-steady-state estimates.

Step 2: Identify what is obtained from pseudo-steady-state / boundary-dominated flow.
When the pressure response becomes **boundary-dominated** (pseudo-steady-state in closed/drainage systems),
the data reflect **reservoir size/geometry effects** (e.g., drainage area, boundaries).
Thus, **reservoir geometry** is commonly inferred from pseudo-steady-state / late-time behavior.
So, statement (C) is correct.

Step 3: Evaluate Absolute Open Flow Potential (AOFP) statement.
For a gas well, **back pressure (deliverability) tests** are used to determine the deliverability equation and estimate
the **absolute open flow potential (AOFP)** (rate at $p_{wf} \to 0$) by extrapolation.
So, statement (D) is correct.

Step 4: Check each option.
(A) Incorrect: k and s are not primarily calculated from pseudo-steady-state data.
(B) Incorrect: reservoir geometry is not generally obtained from early transient data unless boundary effects are observed; it is classically obtained from late-time/boundary-dominated behavior.
(C) Correct.
(D) Correct.

Step 5: Conclusion.
The correct options are:

$$\boxed{(C) \text{ and } (D)}$$

Quick Tip

In well testing: **Transient (IARF)** ⇒ estimate **permeability and skin**.
Late-time / pseudo-steady (boundary-dominated) ⇒ infer **reservoir geometry / boundaries**.
For gas wells, **back pressure (deliverability) tests** ⇒ **AOFP**.

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6. Classification of kerogen is based on the relative amount of Carbon (C), Hydrogen (H) and Oxygen (O). Which ONE of the following options is CORRECT about Type II kerogen?

(A) It is low in aliphatic compounds and H:C ratio < 0.84.
(B) It is rich in aliphatic compounds and H:C ratio < 0.84.
(C) It is low in aliphatic compounds and H:C ratio > 1.0.
(D) It is rich in aliphatic compounds and H:C ratio > 1.0.

Correct Answer: (D)

Solution:

Step 1: Recall kerogen classification.
Kerogen is classified into Types I, II, and III based on elemental ratios, primarily **H:C** and **O:C**, and organic composition.

Step 2: Characteristics of Type II kerogen.
Type II kerogen is typically derived from **marine planktonic material** and forms under **reducing conditions**.
Its key features are:
– Rich in **aliphatic hydrocarbons**
– Moderately hydrogen-rich
– Oil-prone kerogen

Elemental ratios for Type II kerogen are generally:

$$\text{H:C} > 1.0 \quad \text{and moderate O:C}$$

Step 3: Evaluate the given options.

(A) Low aliphatic content and low H:C ratio corresponds to Type III kerogen. Incorrect.

(B) Rich aliphatic content but low H:C ratio is inconsistent. Incorrect.

(C) Low aliphatic content with high H:C ratio is contradictory. Incorrect.

(D) Rich in aliphatic compounds with H:C ratio > 1.0 correctly describes Type II kerogen. Correct.

Step 4: Conclusion.
The correct description of Type II kerogen is:

$$\boxed{\text{Rich in aliphatic compounds and H:C ratio } > 1.0}$$

Quick Tip

Remember kerogen types: **Type I:** Very high H:C (algal, oil-prone)
Type II: High H:C, aliphatic-rich (marine, oil-prone)
Type III: Low H:C, aromatic-rich (terrestrial, gas-prone)
