GATE 2026 NM 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 × 1 mark + 5 questions × 2 marks) for a total of 15 marks.
   - **Environmental Science and Engineering + Engineering Mathematics:**
     - **Part A (Mandatory):** 36 questions (1 questions × 1 mark + 19 questions × 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 × 1 mark + 11 questions × 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. Let a Non-deterministic Finite Automaton (NFA) have 6 states over a finite alphabet. Which of the following cannot be the number of states in a minimal Deterministic Finite Automaton (DFA) that is equivalent to this NFA?

(A) 1
(B) 32
(C) 65
(D) 128

Correct Answer: (C) 65

Solution:

Step 1: Recall the NFA to DFA conversion rule.
An NFA with n states can be converted into an equivalent DFA using the subset construction method.
The maximum number of states in the resulting DFA is:

$$2^n$$

Step 2: Apply the rule for the given NFA.
Given number of NFA states:

$$n = 6$$

Maximum possible number of DFA states:

$$2^6 = 64$$

Thus, the equivalent DFA (before minimization) can have **at most 64 states**.

Step 3: Consider DFA minimization.
After minimization, the number of states in the DFA can be **any number from 1 up to 64**, depending on the language recognized.
However, it **cannot exceed 64**.

Step 4: Analyze the given options.

(A) 1: Possible (for example, if the language is Σ^* or $\emptyset$).

(B) 32: Possible, since $32 < 64$.

(C) 65: Not possible, as it exceeds the maximum limit of 64.

(D) 128: Also exceeds 64, but the smallest such impossible option is 65.

Step 5: Conclusion.
The number of states in a minimal DFA equivalent to a 6-state NFA cannot be:

$$\boxed{65}$$

Quick Tip

For GATE questions: An NFA with n states can result in a DFA with **at most** 2^n **states**. Any option strictly greater than 2^n is impossible.

2. Let P, Q, R, S be relational schemas. Let "$\rightarrow$" indicate a functional dependency (FD) in this context. Which of the following best describes the meaning of a functional dependency?

(a) if then or
(b) if then
(c) if then
(d) if and then

Correct Answer: (b) if then

Solution:

Step 1: Recall the definition of a functional dependency.
In relational database theory, a functional dependency $X \rightarrow Y$ means:
If two tuples have the same values for attribute set X, then they must have the same values for attribute set Y.

Step 2: Interpret the logical meaning.
The statement $X \rightarrow Y$ is logically read as:
"If X holds, then Y must hold."
It does *not* mean logical conjunction (AND), nor does it involve alternatives (OR).

Step 3: Analyze the options.

(a) if then or: This introduces an unnecessary logical OR. Incorrect.

(b) if then: Correct interpretation of a functional dependency.

(c) if then: Duplicate wording, but option (b) is the standard correct choice.

(d) if and then: Incorrect logical structure; functional dependency is not conjunctive.

Step 4: Conclusion.
A functional dependency in a relational schema is correctly interpreted as:

$$\boxed{\text{if then}}$$

Quick Tip

Always remember: A functional dependency $X \rightarrow Y$ means "X **uniquely determines** Y" or **"If X, then Y"**. It is a logical implication, not an AND/OR relationship.

3. With respect to a TCP connection between a client and a server, which of the following is true?

(a) TCP connection is half duplex
(b) The client and server use a three-way handshaking mechanism
(c) Before starting data transmission, client and server can initiate closing the connection at the same time
(d) The server cannot initiate closing of the connection unless the client initiates closing of the connection

Correct Answer: (b) The client and server use a three-way handshaking mechanism

Solution:

Step 1: Recall basic properties of TCP.
TCP (Transmission Control Protocol) is a **connection-oriented**, **reliable**, and **full-duplex** transport layer protocol.
It ensures reliable communication between a client and a server using well-defined connection establishment and termination procedures.

Step 2: Analyze option (a).
TCP supports simultaneous data transmission in both directions.
Hence, TCP is **full duplex**, not half duplex.
Option (a) is incorrect.

Step 3: Analyze option (b).
TCP connection establishment uses the **three-way handshake**:

$$\text{SYN} \rightarrow \text{SYN+ACK} \rightarrow \text{ACK}$$

This mechanism synchronizes sequence numbers and establishes a reliable connection.
Option (b) is correct.

Step 4: Analyze option (c).
Connection termination in TCP involves a **four-segment handshake**.
Although both sides may close independently, closing is not related to data transmission start and cannot occur simultaneously in the described manner.
Option (c) is incorrect.

Step 5: Analyze option (d).
In TCP, **either the client or the server can initiate connection termination**.

There is no restriction that only the client must initiate closing.
Option (d) is incorrect.

Step 6: Conclusion.
The correct statement regarding TCP connections is:

The client and server use a three-way handshaking mechanism

Quick Tip

Key TCP facts for GATE: **TCP is full duplex** and uses **3-way handshake for connection establishment** and **4-way handshake for connection termination**.

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4. A single degree of freedom system is undergoing free oscillation. The natural frequency and damping ratio of the system are 1 rad/s and 0.01 respectively. The reduction in peak amplitude over three cycles is _____% (rounded off to one decimal place).

Correct Answer: 17.2%

Solution:

Step 1: Recall logarithmic decrement.
For an underdamped single degree of freedom system, the logarithmic decrement δ is given by:

$$\delta = \frac{2\pi\zeta}{\sqrt{1-\zeta^2}}$$

where ζ is the damping ratio.

Step 2: Substitute the given values.
Given:

$$\zeta = 0.01$$

$$\delta = \frac{2\pi \times 0.01}{\sqrt{1-(0.01)^2}} \approx 2\pi \times 0.01 = 0.0628$$

Step 3: Reduction in amplitude over three cycles.
The ratio of amplitudes after n cycles is:

$$\frac{x_n}{x_0} = e^{-n\delta}$$

For three cycles:

$$\frac{x_3}{x_0} = e^{-3\delta} = e^{-3\times 0.0628} = e^{-0.1884} \approx 0.828$$

Step 4: Calculate percentage reduction in amplitude.

$$\text{Reduction} = (1 - 0.828) \times 100 = 17.2\%$$

Step 5: Conclusion.
The reduction in peak amplitude over three cycles is:

$$\boxed{17.2\%}$$

Quick Tip

For lightly damped systems ($\zeta \ll 1$),

$$\delta \approx 2\pi\zeta$$

This approximation greatly simplifies GATE numerical problems on vibrations.

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5. A ship moving at a steady forward speed of 10 m/s experiences a total resistance of 140 kN. The Quasi Propulsive Coefficient (QPC) is 0.70; the propeller shaft losses are 5% and the mechanical efficiency of the main engine is 80%. The indicated power of the main engine is _____ kW (rounded off to two decimal places).

Correct Answer: 2631.58 kW

Solution:

Step 1: Compute Effective Power (EHP).
Effective power is:

$$P_E = R \times V$$

Given $R = 140$ kN $= 140000$ N and $V = 10$ m/s:

$$P_E = 140000 \times 10 = 1{,}400{,}000 \text{ W} = 1400 \text{ kW}$$

Step 2: Use QPC to find Delivered Power to propeller (DHP).
Quasi Propulsive Coefficient:

$$\text{QPC} = \frac{P_E}{P_D} \Rightarrow P_D = \frac{P_E}{\text{QPC}}$$

$$P_D = \frac{1400}{0.70} = 2000 \text{ kW}$$

Step 3: Account for propeller shaft losses to get Brake Power (BP).
Shaft losses $= 5\% \Rightarrow$ shaft efficiency $\eta_s = 0.95$.

$$P_D = \eta_s P_B \Rightarrow P_B = \frac{P_D}{\eta_s}$$

$$P_B = \frac{2000}{0.95} = 2105.2632 \text{ kW}$$

Step 4: Use mechanical efficiency to get Indicated Power (IP).
Mechanical efficiency $\eta_m = \frac{P_B}{P_I} = 0.80$:

$$P_I = \frac{P_B}{\eta_m} = \frac{2105.2632}{0.80} = 2631.5790 \text{ kW}$$

Step 5: Conclusion (rounded to two decimals).

$$\boxed{P_I = 2631.58 \text{ kW}}$$

Quick Tip

Propulsion power chain to remember:

$$P_E \xrightarrow[\text{QPC}]{P_D = P_E/\text{QPC}} P_D \xrightarrow[\eta_s]{P_B = P_D/\eta_s} P_B \xrightarrow[\eta_m]{P_I = P_B/\eta_m} P_I$$

Always convert R to N and power to kW at the end.
