GATE 2026 NM Question Paper with Solutions PDF

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

General Instructions

Read the following instructions very carefully and strictly follow them:

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.
   - **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.

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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: Understanding the Concept:
To convert an NFA into an equivalent DFA, we use the subset construction (power set construction) method.
If an NFA has n states, the total number of possible states in the equivalent DFA is the number of subsets of the NFA states, which is 2^n.

Step 2: Key Formula or Approach:
The maximum number of states in a DFA equivalent to an n-state NFA is 2^n.
For a minimal DFA, the number of states S must satisfy: $1 \leq S \leq 2^n$.

Step 3: Detailed Explanation:
Given the number of states in the NFA is $n = 6$.
The maximum possible number of states in the equivalent DFA is:

$$2^6 = 64$$

This means any DFA representing the same language as this NFA, including the minimal one, must have a state count between 1 and 64.
Analyzing the options:
(A) 1: Possible (if the language is Σ^* or $\emptyset$).
(B) 32: Possible (since $32 \leq 64$).
(C) 65: Not possible (since $65 > 64$).
(D) 128: Not possible (since $128 > 64$).
In a standard single-choice question, (C) is the first value that exceeds the limit. Note: In some contexts, both (C) and (D) would be mathematically correct as "cannot be" values.

Step 4: Final Answer:
Since the maximum possible states is 64, the value 65 cannot be the number of states.

> Quick Tip
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> The conversion from NFA to DFA can result in an exponential increase in states. Always check if the option exceeds 2^n. For $n = 6$, $2^6 = 64$. Any number greater than 64 is impossible.

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2. Let P, Q, R, S be relational schemas. Let "→" 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: Understanding the Concept:
A functional dependency $X \to Y$ is a constraint between two sets of attributes in a relation.

Step 2: Detailed Explanation:
The formal definition of $X \to Y$ states that for any two tuples t_1 and t_2 in a relation R:
If $t_1[X] = t_2[X]$, then $t_1[Y] = t_2[Y]$.
This is a logical implication of the form $P \implies Q$, which translates to an "if... then..." statement.
This means that the value of X uniquely determines the value of Y.

Step 3: Final Answer:
The structure of a functional dependency is strictly an "if then" relationship between the determinant and the dependent attributes.

> Quick Tip
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> Functional Dependency is like a mathematical function $y = f(x)$. If you provide the same input x, you must get the same output y. This is why it's described as "if (same X) then (same Y)".

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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: Understanding the Concept:
TCP (Transmission Control Protocol) is a connection-oriented protocol that ensures reliable data transfer through specific connection management phases.

Step 2: Detailed Explanation:
(a) **False:** TCP is full-duplex, meaning both sides can send and receive data simultaneously.
(b) **True:** TCP establishes a connection using a 3-way handshake: SYN $\rightarrow$ SYN-ACK $\rightarrow$ ACK. This synchronizes sequence numbers and ensures both sides are ready.
(c) **False:** While simultaneous close exists, the question mentions "Before starting data transmission". The handshake must complete before any other state transition typically occurs.
(d) **False:** TCP supports "Active Close" from either end. The server can initiate the closing of a connection (sending a FIN segment) just as a client can.

Step 3: Final Answer: The use of the three-way handshaking mechanism is the defining characteristic of TCP connection establishment.

> Quick Tip
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> Remember: Connection = 3-way handshake (SYN, SYN-ACK, ACK). Termination = 4-way handshake (FIN, ACK, FIN, ACK). TCP is always Full Duplex.

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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: Understanding the Concept:
In a damped SDOF system, the amplitude of vibration decreases over time. The ratio of successive peaks is determined by the logarithmic decrement δ.

Step 2: Key Formula or Approach:
1. Logarithmic decrement δ:

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

2. Ratio of amplitude after n cycles:

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

3. Percentage reduction:

$$\% \text{ Reduction} = \left(1 - \frac{x_n}{x_0}\right) \times 100$$

Step 3: Detailed Explanation:
Given: $\zeta = 0.01$, $n = 3$.
Since ζ is very small, $\sqrt{1-\zeta^2} \approx 1$.

$$\delta \approx 2\pi\zeta = 2 \times 3.14159 \times 0.01 = 0.06283$$

Ratio of amplitude after 3 cycles:

$$\frac{x_3}{x_0} = e^{-3\times0.06283} = e^{-0.18849} \approx 0.8282$$

Percentage reduction:

$$\text{Reduction} = (1 - 0.8282) \times 100 = 17.18\%$$

Rounding to one decimal place, we get 17.2%.

Step 4: Final Answer:
The reduction in peak amplitude is 17.2%.

Quick Tip

For very small damping ($\zeta < 0.1$), the percentage reduction per cycle is approximately $2\pi\zeta \times 100\%$. For multiple cycles, use the exponential decay formula $e^{-n\delta}$ to avoid cumulative errors.

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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

Solution:

Step 1: Understanding the Concept:
Power transmission in ships follows a chain: Indicated Power (P_I) $\rightarrow$ Brake Power (P_B) $\rightarrow$ Shaft Power (P_S) $\rightarrow$ Delivered Power (P_D) $\rightarrow$ Effective Power (P_E).

Step 2: Key Formula or Approach:
1. Effective Power P_E = Resistance $\times$ Velocity

2. Delivered Power $P_D = \frac{P_E}{\text{QPC}}$
3. Shaft/Brake Power $P_B = \frac{P_D}{\eta_{\text{shaft}}}$
4. Indicated Power $P_I = \frac{P_B}{\eta_{\text{mech}}}$

Step 3: Detailed Explanation:
Given:
$R = 140$ kN, $V = 10$ m/s.
QPC $= 0.70$.
Shaft loss $= 5\% \implies \eta_{\text{shaft}} = 0.95$.
$\eta_{\text{mech}} = 0.80$.

Calculation:
1. $P_E = 140 \text{ kN} \times 10 \text{ m/s} = 1400$ kW.
2. $P_D = \frac{1400}{0.70} = 2000$ kW.
3. $P_B = \frac{2000}{0.95} = 2105.263$ kW.
4. $P_I = \frac{2105.263}{0.80} = 2631.578$ kW.

Rounding to two decimal places: 2631.58 kW.

Step 4: Final Answer:
The indicated power of the main engine is 2631.58 kW.

Quick Tip

Always remember: $P_E < P_D < P_B < P_I$. If you are moving from the hull back to the engine, you must divide by the efficiency at each stage.
