GATE 2026 AE 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.

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1. For a subsonic flow over an airfoil, an increase in velocity leads to:

(A) Increase in pressure
(B) Decrease in pressure
(C) No change in pressure
(D) Zero pressure
(E) None of the above

Correct Answer: (B) Decrease in pressure

Solution:

Step 1: Understanding the Concept:
The behavior of a fluid moving at subsonic speeds (Mach number < 1) over a solid body like an airfoil is governed by the principle of conservation of energy.
For an incompressible or low-subsonic flow, this is expressed through Bernoulli's Equation.

Step 2: Key Formula or Approach:
Bernoulli's principle for steady, inviscid, and incompressible flow states:

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Where P is the static pressure, ρ is the fluid density, and v is the flow velocity.

Step 3: Detailed Explanation:
In the context of flow over an airfoil, the change in height (h) is negligible, so the term $\rho g h$ is considered constant.
The equation simplifies to: $P + \text{Dynamic Pressure} = \text{Total Pressure}$.
As the air moves over the curved surface of an airfoil, the streamlines are compressed, causing the velocity (v) of the fluid to increase.
According to the equation, if the velocity (v) increases, the dynamic pressure term $(\frac{1}{2}\rho v^2)$ increases.
Since the total pressure must remain constant, the static pressure (P) must decrease to compensate for the increase in velocity.
This difference in pressure between the upper and lower surfaces of the airfoil is what generates lift.

Step 4: Final Answer:
Therefore, an increase in velocity in a subsonic flow leads to a decrease in pressure.

Quick Tip

Always remember the inverse relationship in subsonic aerodynamics: High Velocity = Low Pressure. This is the fundamental building block for understanding lift generation.

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2. Which of the following motions is primarily associated with lateral stability of an aircraft?

(A) Pitch
(B) Roll
(C) Yaw
(D) Heave
(E) Surge

Correct Answer: (B) Roll

Solution:

Step 1: Understanding the Concept:
Stability in aircraft design refers to the tendency of the aircraft to return to its original flight path after a disturbance.
There are three main types of stability corresponding to the three axes of flight.

Step 2: Detailed Explanation:
1. **Longitudinal Stability:** Relates to the stability about the lateral axis, which involves the **Pitch** motion.
2. **Lateral Stability:** Relates to the stability about the longitudinal axis (nose-to-tail), which involves the **Roll** motion.
3. **Directional Stability:** Relates to the stability about the vertical axis, which involves the **Yaw** motion.
Lateral stability is the aircraft's ability to resist rolling or to return to a wings-level position when one wing is dipped by a gust.
Design features like "Dihedral" (upward angle of the wings) are specifically used to enhance lateral stability.

Step 3: Final Answer:
Roll is the motion primarily associated with the lateral stability of an aircraft.

> **Quick Tip**
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> A simple way to remember:
> Lateral Stability → Longitudinal Axis → Roll.
> Directional Stability → Vertical Axis → Yaw.

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3. Which propulsion system is most suitable for high-speed supersonic aircraft?

(A) Turboprop
(B) Turbojet
(C) Turbofan
(D) Ramjet
(E) Piston Engine

Correct Answer: (B) Turbojet

Solution:

Step 1: Understanding the Concept:
The selection of a propulsion system depends on the flight Mach number and the altitude. Efficiency varies significantly across different speed regimes.

Step 2: Detailed Explanation:
- **Turboprops:** Highly efficient at low speeds (Mach < 0.6) but suffer from propeller tip compressibility effects at higher speeds.
- **Turbofans:** Ideal for high subsonic and low supersonic speeds (Mach 0.7 to 1.5) due to high bypass ratios, but the large frontal area creates high drag at high supersonic speeds.
- **Turbojets:** These engines have a smaller frontal area and higher exhaust velocities compared to turbofans. They were the standard for early and high-speed supersonic flight (like the Concorde) because they maintain better efficiency than turbofans at high Mach numbers.
- **Ramjets:** While excellent for Mach 3.0 and above, they cannot produce thrust at zero speed (takeoff), making them specialized systems rather than general propulsion for aircraft.
Given the standard textbook classification and the answer key provided, the Turbojet is the primary choice for sustained high-speed supersonic flight.

Step 3: Final Answer:
The Turbojet is the most suitable system for general high-speed supersonic flight among the listed options.

> Quick Tip
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> Propulsion Efficiency Rank:
> Low Speed: Turboprop
> Subsonic/Transonic: Turbofan
> Supersonic: Turbojet
> Hypersonic: Ramjet/Scramjet

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4. The primary load-carrying structural component of an aircraft wing is:

(A) Rib
(B) Stringer
(C) Spar
(D) Skin
(E) Bulkhead

Correct Answer: (C) Spar

Solution:

Step 1: Understanding the Concept:
An aircraft wing is subjected to immense bending, torsion, and shear loads during flight. Its internal skeleton must be rigid yet lightweight.

Step 2: Detailed Explanation:
The wing structure consists of several components:
- **Spars:** These are the heavy beams running the length of the wing (root to tip). They are

designed to carry the majority of the lift loads and the resulting bending moments.
- **Ribs:** These give the wing its aerodynamic airfoil shape and transfer loads from the skin to the spars.
- **Stringers:** These are longitudinal members that stiffen the skin and prevent it from buckling under axial loads.
- **Skin:** It maintains the aerodynamic contour and resists torsional (twisting) loads.
Because the Spar bears the primary bending stress (the largest force in flight), it is considered the primary load-carrying member.

Step 3: Final Answer:
The Spar is the primary load-carrying component of the wing.

> Quick Tip
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> Think of the Spar as the "spine" of the wing. Just as your spine supports your weight and posture, the Spar supports the lift and weight of the aircraft.

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5. For an isentropic flow of a perfect gas, an increase in Mach number results in:

(A) Increase in temperature
(B) Decrease in temperature
(C) Constant temperature
(D) Infinite temperature
(E) Zero temperature

Correct Answer: (B) Decrease in temperature

Solution:

Step 1: Understanding the Concept:
In gas dynamics, isentropic flow refers to a flow that is both adiabatic (no heat transfer) and reversible. In such a system, the total energy (stagnation temperature) remains constant.

Step 2: Key Formula or Approach:
The relationship between static temperature (T), stagnation temperature (T_0), and Mach number (M) for a calorically perfect gas is:

$$\frac{T_0}{T} = 1 + \frac{\gamma - 1}{2} M^2$$

Step 3: Detailed Explanation:
In an isentropic flow, T_0 is constant along the streamline.

Rearranging the formula for static temperature T:

$$T = \frac{T_0}{1 + \frac{\gamma-1}{2}M^2}$$

As the Mach number (M) increases (meaning the gas is accelerating), the denominator $(1 + \frac{\gamma-1}{2}M^2)$ increases because γ (ratio of specific heats, ≈ 1.4 for air) is greater than 1.
Since the denominator increases and the numerator is constant, the resulting value of T must decrease.
Physically, the thermal energy of the gas (temperature) is being converted into kinetic energy (velocity/Mach number).

Step 4: Final Answer:
An increase in Mach number leads to a decrease in static temperature.

> **Quick Tip**
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> Static temperature is a measure of random molecular motion. When flow speeds up (higher Mach), more energy is directed forward, leaving less for random motion (lower temperature).

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6. Which control surface is mainly used to control the yaw motion of an aircraft?

(A) Aileron
(B) Elevator
(C) Rudder
(D) Flap
(E) Trim Tab

Correct Answer: (C) Rudder

Solution:

Step 1: Understanding the Concept:
To control the orientation of an aircraft in 3D space, pilots use primary flight control surfaces to rotate the aircraft about its center of gravity.

Step 2: Detailed Explanation:
There are three primary control surfaces:
1. **Ailerons:** Located on the outboard trailing edge of the wings. They move in opposite directions to roll the aircraft about its longitudinal axis.
2. **Elevators:** Usually located on the trailing edge of the horizontal stabilizer. They move up or down to control the pitch of the aircraft about its lateral axis.
3. **Rudder:** Located on the trailing edge of the vertical stabilizer (the "fin"). It moves left or

right to control the yaw of the aircraft about its vertical axis.
The rudder is operated by the pilot's feet via pedals and is essential for coordinated turns and managing crosswinds.

Step 3: Final Answer:
The Rudder is the surface used to control yaw motion.

> **Quick Tip**
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> Match the surface to the axis:
> Rudder $\rightarrow$ Vertical Axis (Yaw).
> Elevator $\rightarrow$ Lateral Axis (Pitch).
> Aileron $\rightarrow$ Longitudinal Axis (Roll).

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7. The velocity required for a satellite to remain in a circular orbit close to Earth is called:

(A) Escape velocity
(B) Orbital velocity
(C) Terminal velocity
(D) Relative velocity
(E) Critical velocity

Correct Answer: (B) Orbital velocity

Solution:

Step 1: Understanding the Concept:
A satellite in orbit is essentially in a state of continuous "free fall." To stay in a circular path, the gravitational attraction must be exactly balanced by the required centripetal force.

Step 2: Key Formula or Approach:
Centripetal Force = Gravitational Force

$$\frac{mv^2}{r} = \frac{GMm}{r^2}$$

Where m is the satellite mass, M is the Earth's mass, r is the radius of orbit, and G is the gravitational constant.

Step 3: Detailed Explanation:
Solving for velocity v:

$$v = \sqrt{\frac{GM}{r}}$$

This specific velocity is called the **Orbital Velocity**.
- If the velocity is lower than this, the satellite will spiral down and crash into Earth.
- If the velocity is higher (reaching $\sqrt{2} \times v_{orbital}$), it becomes the **Escape Velocity**, and the satellite leaves Earth's orbit.
- **Terminal velocity** is a concept in fluid mechanics (falling through air), not orbital mechanics.

Step 4: Final Answer:
The velocity required for a circular orbit is defined as the Orbital velocity.

Quick Tip

For a satellite close to Earth's surface ($r \approx R_{earth}$), the orbital velocity is approximately 7.9 km/s, while the escape velocity is 11.2 km/s.
