

NIFE Aerodynamics Practice Exam (Sample)

Study Guide



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SAMPLE

Questions

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- 1. What is usually the result of increasing the angle of attack past the critical angle?**
 - A. Increased lift**
 - B. Decreased drag**
 - C. Loss of control**
 - D. Stall condition**
- 2. What must happen to maintain a constant mass airflow in a streamtube?**
 - A. The area must increase**
 - B. The velocity must increase**
 - C. The temperature must drop**
 - D. The pressure must be constant**
- 3. Slipstream swirl and P-factor are most prominent under which conditions?**
 - A. Low lift, low AOA, high power**
 - B. High lift, high AOA, low power**
 - C. High lift, high AOA, high power**
 - D. High lift, low AOA, low power**
- 4. What four airflow properties must remain constant on an airfoil to have steady airflow?**
 - A. Viscosity, temperature, pressure, density**
 - B. Velocity, temperature, pressure, density**
 - C. Lift, weight, thrust, drag**
 - D. Friction, viscosity, density, lift**
- 5. What does indicated airspeed represent?**
 - A. The actual velocity through the air mass**
 - B. The corrected instrument indication for errors**
 - C. The calibrated airspeed corrected for compressibility**
 - D. The instrument indication for specific flight conditions**

- 6. What happens to stall speed as weight increases in an aircraft?**
- A. Stall speed decreases and IAS increases**
 - B. Stall speed increases and IAS decreases**
 - C. Stall speed increases and IAS increases**
 - D. Stall speed decreases and IAS decreases**
- 7. Which flight condition leads to the greatest lift-to-drag ratio?**
- A. High speed, low AOA**
 - B. Low speed, high AOA**
 - C. Best L/D AOA**
 - D. Constant level flight**
- 8. What is a characteristic of operating in the region of reverse command?**
- A. Higher speed requires less power**
 - B. Higher power setting is needed for slower speed**
 - C. Better climb performance**
 - D. More efficient fuel consumption**
- 9. What is the primary factor that affects the density of air at any altitude?**
- A. Temperature**
 - B. Pressure**
 - C. Humidity**
 - D. Altitude**
- 10. What does the equation $A_1V_1 = A_2V_2$ express in terms of airflow?**
- A. Airflow velocity is independent of area**
 - B. Mass airflow is constant with area**
 - C. Pressure varies with area changes**
 - D. Aerodynamic forces are the same throughout**

Answers

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1. D
2. B
3. C
4. B
5. D
6. C
7. C
8. B
9. D
10. B

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Explanations

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1. What is usually the result of increasing the angle of attack past the critical angle?

- A. Increased lift
- B. Decreased drag
- C. Loss of control
- D. Stall condition**

When the angle of attack is increased past the critical angle, the airflow over the wings of an aircraft begins to separate, resulting in a significant loss of lift, commonly referred to as a stall condition. This critical angle represents the maximum angle of attack at which the wings can generate sufficient lift efficiently. Beyond this point, the airflow can no longer stay attached to the wing surface, leading to a dramatic reduction in lift and increased drag. In a stall condition, the aircraft may also experience a loss of control due to the suddenly reduced aerodynamic forces acting on it. Pilots must be trained to recognize and recover from this state to regain controlled flight. Understanding this phenomenon is crucial for safe aircraft operation, particularly during maneuvers that require varying angles of attack, such as takeoff, landing, and aggressive turns.

2. What must happen to maintain a constant mass airflow in a streamtube?

- A. The area must increase
- B. The velocity must increase**
- C. The temperature must drop
- D. The pressure must be constant

To maintain a constant mass airflow in a streamtube, it is crucial to understand the relationship between mass flow rate, density, velocity, and cross-sectional area as described by the continuity equation in fluid dynamics. The mass flow rate ($\dot{m}$) is defined as the product of density (ρ), velocity (V), and cross-sectional area (A) of the streamtube: $\dot{m} = \rho \cdot V \cdot A$. When the mass airflow is constant within the streamtube, any variation in one of these parameters must appropriately balance the others to keep the mass flow rate unchanged. If the area of the streamtube does not change, an increase in velocity is required to maintain the same mass flow rate because the density of the fluid may also change in certain scenarios, such as compressible flow. In situations where compressibility effects are significant—like with gases at varying temperatures or pressures—if the cross-sectional area remains constant and we need to maintain a constant mass flow rate, the velocity must necessarily increase. This increase in velocity compensates for changes in density or ensures that enough mass is being pushed through the same area over a unit time.

3. Slipstream swirl and P-factor are most prominent under which conditions?

- A. Low lift, low AOA, high power**
- B. High lift, high AOA, low power**
- C. High lift, high AOA, high power**
- D. High lift, low AOA, low power**

Slipstream swirl and P-factor are aerodynamic phenomena that occur prominently under conditions of high lift, high angle of attack (AOA), and high power settings. At high power settings, the engine produces a significant amount of thrust, which in turn generates a larger volume of airflow around the aircraft. When the aircraft is at a high angle of attack, particularly during maneuvers like takeoff or slow flight, the airflow over the wings is more turbulent and can create a pronounced slipstream. This slipstream tends to swirl around the aircraft due to the propeller's rotation, interacting with the wing and other surfaces. Additionally, when the angle of attack is high, the descending propeller blades will produce differential thrust, which is known as P-factor. This results in the aircraft yawing to the left (for a clockwise-turning propeller), necessitating corrective pilot inputs to maintain straight flight. Both slipstream swirl and P-factor become more significant at high lift and high AOA because the airflow is heavily influenced by the propeller's wake, thereby enhancing these effects. Understanding the conditions under which these aerodynamic effects become pronounced is crucial for pilots, particularly when navigating slow flight, takeoff, or climb scenarios where high lift and high power settings are used.

4. What four airflow properties must remain constant on an airfoil to have steady airflow?

- A. Viscosity, temperature, pressure, density**
- B. Velocity, temperature, pressure, density**
- C. Lift, weight, thrust, drag**
- D. Friction, viscosity, density, lift**

To achieve steady airflow over an airfoil, certain properties of the air must remain constant throughout the flow. The correct answer identifies four critical properties: velocity, temperature, pressure, and density. Velocity refers to the speed of the air flowing over the airfoil. For airflow to be considered steady, the velocity must not change over time at a given point on the airfoil; it must remain consistent as the air passes over it. Temperature is another property that must remain constant because variations in temperature can affect the air density and viscosity, both of which can influence how the air behaves around the airfoil. Pressure is essential in defining the aerodynamic forces acting on the airfoil. Maintaining constant pressure helps ensure that the flow characteristics around the airfoil do not vary with time, which is vital for achieving predictable lift and drag behavior. Density, which is influenced by both pressure and temperature, must also remain steady for similar reasons. Changes in density could lead to fluctuations in the airflow characteristics, which would prevent the airflow from being classified as steady. In contrast, the other options incorporate factors that do not directly pertain to the steady-state characteristics of the airflow over the airfoil. For instance, the properties related to lift, weight, thrust, and drag represent

5. What does indicated airspeed represent?

- A. The actual velocity through the air mass
- B. The corrected instrument indication for errors
- C. The calibrated airspeed corrected for compressibility
- D. The instrument indication for specific flight conditions**

Indicated airspeed represents the instrument reading of the speed of an aircraft relative to the air around it, without corrections for various factors. This means it reflects the airspeed indicated directly on the aircraft's airspeed indicator under specific flight conditions, typically at which the instrument is calibrated. In aerodynamics, indicated airspeed is vital for pilots as it relates to aircraft performance, stall speeds, and maneuvers. The indication on the airspeed indicator is due to the dynamic pressure created by the aircraft moving through the air, allowing for a useful reference during flight operations, especially during takeoff, landing, and in various phases of flight where the aircraft's performance needs to be correctly monitored. While other choices may provide a broader context for understanding airspeeds, such as accounting for errors, adjusting for compressibility, or relating to actual velocity through an air mass, indicated airspeed specifically denotes the raw instrument output before any adjustments are made for these factors. Understanding indicated airspeed is fundamental for managing flight safely and effectively.

6. What happens to stall speed as weight increases in an aircraft?

- A. Stall speed decreases and IAS increases
- B. Stall speed increases and IAS decreases
- C. Stall speed increases and IAS increases**
- D. Stall speed decreases and IAS decreases

As weight increases, the stall speed of an aircraft also increases. This is due to the fundamental relationship between weight and lift. The stall speed is the minimum speed at which an aircraft can maintain level flight and is dependent on the wing's lift characteristics and the aircraft's weight. When an aircraft's weight increases, the wings must generate more lift to counteract the increased weight in order to keep the aircraft in level flight. According to the lift equation $L = \frac{1}{2} \rho V^2 S C_L$, where L is lift, ρ is air density, V is true airspeed, S is wing area, and C_L is the lift coefficient, an increase in weight (L) requires an increase in the lift generated at any given airspeed. If the lift coefficient stays constant (as it typically does until the wing is nearing its stall angle), the aircraft needs to fly faster to achieve the additional lift required to counterbalance the increase in weight. Thus, the stall speed increases with an increase in weight, indicating that the aircraft must reach a higher indicated airspeed (IAS) to avoid stalling. Therefore, as weight goes up, both the stall speed and

7. Which flight condition leads to the greatest lift-to-drag ratio?

- A. High speed, low AOA**
- B. Low speed, high AOA**
- C. Best L/D AOA**
- D. Constant level flight**

The greatest lift-to-drag ratio occurs at the best lift-to-drag angle of attack, often referred to as the "best L/D AOA." At this specific angle of attack, the aerodynamic forces producing lift and drag are optimized, resulting in the highest efficiency for the aircraft. When an aircraft is operating at this angle, the lift generated is maximized relative to the drag experienced. Pilots and aerodynamics engineers use this information to determine the most efficient operating conditions for flight, especially during gliding or cruising phases when minimizing drag while maximizing lift is crucial for optimal performance. In contrast, other flight conditions such as high speed with low angle of attack or low speed with high angle of attack do not achieve the optimal balance between lift and drag, which leads to a lower lift-to-drag ratio. Constant level flight might maintain altitude but does not inherently guarantee the best lift-to-drag performance compared to flying at the best L/D AOA. Therefore, the best L/D angle of attack is central to achieving the highest lift-to-drag ratio in aerodynamic design and performance.

8. What is a characteristic of operating in the region of reverse command?

- A. Higher speed requires less power**
- B. Higher power setting is needed for slower speed**
- C. Better climb performance**
- D. More efficient fuel consumption**

Operating in the region of reverse command is characterized by the need for higher power settings to maintain slower speeds. This phenomenon typically occurs at lower airspeeds, where the aircraft's thrust-to-drag ratio decreases, resulting in a greater required power output to sustain flight. In this region, as the airspeed decreases, the drag increases relative to power available, which means that pilots must increase thrust (power) to maintain controlled flight at lower speeds. This contrasts with normal flight conditions, where higher speeds typically require less power for sustained flight. Understanding this concept is critical for pilots, particularly during takeoffs and landings, where they may need to operate at lower speeds, such as when approaching an airport or executing a go-around scenario. Mastery of power management in these situations helps ensure safe operation and effective maneuvering of the aircraft.

9. What is the primary factor that affects the density of air at any altitude?

- A. Temperature**
- B. Pressure**
- C. Humidity**
- D. Altitude**

The primary factor affecting the density of air at any altitude is altitude itself. As altitude increases, the air pressure decreases, which directly influences air density. At higher altitudes, the weight of the air above decreases due to lower atmospheric pressure, leading to a decrease in air density. While temperature, pressure, and humidity all impact air density, they are secondary factors influenced by altitude. For instance, at a given altitude, lower temperatures usually result in higher density, whereas higher humidity can decrease density. However, it is the increase in altitude that fundamentally drives the changes in pressure and temperature in the atmosphere. Thus, altitude is the key determinant affecting air density as one ascends through the atmosphere.

10. What does the equation $A_1V_1 = A_2V_2$ express in terms of airflow?

- A. Airflow velocity is independent of area**
- B. Mass airflow is constant with area**
- C. Pressure varies with area changes**
- D. Aerodynamic forces are the same throughout**

The equation $(A_1V_1 = A_2V_2)$ is derived from the principle of conservation of mass, specifically applied to a fluid (in this case, air) moving through a varying cross-sectional area. This equation states that the mass flow rate (the product of the cross-sectional area (A) and the airflow velocity (V)) remains constant along a streamline in an incompressible flow. In practical terms, when the cross-sectional area of a duct or passage decreases, the velocity of the airflow must increase to maintain constant mass flow. Conversely, if the area increases, the airflow velocity decreases. This relationship is critical in aerodynamics and fluid dynamics, as it helps predict how changes in area affect the velocity of airflow. Thus, the correct understanding of this equation is that mass airflow remains constant with changes in the area through which the fluid is flowing, supporting the choice regarding mass airflow being constant with area. The other options misconstrue the implications of changes in area, such as suggesting independence of velocity from area, or suggesting that pressure and aerodynamic forces behave uniformly throughout varying areas, which are not direct implications of the equation given.