NIFE Aerodynamics Practice Exam (Sample)

Study Guide

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Questions

1. **What is the primary reason for entering a spin?**
   - A. Excessive speed on takeoff
   - B. Stalling at a high angle of attack
   - C. Banking too sharply while cruising
   - D. Pushing forward on the yoke

2. **What is the effect of increased density on lift, assuming all other factors remain constant?**
   - A. It increases lift
   - B. It decreases lift
   - C. No effect on lift
   - D. It varies with altitude

3. **What effect does increasing temperature have on air density in aerodynamics?**
   - A. Air density increases
   - B. Air density decreases
   - C. Air density remains constant
   - D. Air density fluctuates randomly

4. **Airfoil efficiency at various angles of attack is expressed by the ratio of:**
   - A. Lift to dynamic pressure
   - B. Lift to drag
   - C. Lift to weight
   - D. Lift to velocity

5. **Which condition causes the most severe wake turbulence while landing?**
   - A. Light, fast, and clean
   - B. Heavy, slow, and clean
   - C. Light, fast, and dirty (flaps extended)
   - D. Heavy, slow, and dirty

6. When flying over the Atlantic Ocean, which glide profile should you follow if both engines flame out?
   A. Maximum Glide Range
   B. Maximum Glide Endurance
   C. Minimum Drag Profile
   D. Emergency Descent Profile

7. What happens to total drag when an aircraft changes its velocity away from L/Dmax AOA?
   A. Total drag decreases
   B. Total drag remains the same
   C. Total drag increases
   D. Total drag fluctuates

8. Which force acts vertically downwards on an aircraft during flight?
   A. Lift
   B. Weight
   C. Thrust
   D. Drag

9. What are the four fundamental forces acting on an aircraft in flight?
   A. Gravity, Acceleration, Thrust, Lift
   B. Lift, Weight, Thrust, Drag
   C. Drag, Weight, Gravity, Thrust
   D. Thrust, Lift, Drag, Pressure

10. According to the lift equation, in a slow speed situation such as landing, angle of attack will be:
   A. Smaller than at cruising speed because we need less lift
   B. Larger than at cruising speed in order to maintain the same lift at slower velocities
   C. Dependent upon drag
   D. None of the above

Answers

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

Explanations

1. What is the primary reason for entering a spin?

A. Excessive speed on takeoff

B. Stalling at a high angle of attack

C. Banking too sharply while cruising

D. Pushing forward on the yoke

The primary reason for entering a spin is stalling at a high angle of attack. A spin occurs when an aircraft exceeds its critical angle of attack, leading to an aerodynamic stall. At this point, one wing may start to stall more than the other, causing the aircraft to enter a state of autorotation. This is characterized by a yawing motion towards the stalled wing, resulting in the aircraft descending in a tight, spiraling path. Understanding this concept is essential for pilots, as it emphasizes the importance of maintaining proper speed and control during flight maneuvers, especially when approaching steep angles or executing turns. Other options, while they may lead to loss of control in different contexts, do not specifically lead to a spin in the same direct manner as exceeding the critical angle of attack and inducing a stall.

2. What is the effect of increased density on lift, assuming all other factors remain constant?

A. It increases lift

B. It decreases lift

C. No effect on lift

D. It varies with altitude

In aerodynamics, lift is generated primarily by the pressure difference between the upper and lower surfaces of an airfoil as it moves through the air. One of the key factors influencing this lift is the density of the air. According to the lift equation, which is given as $L = \frac{1}{2} \rho V^2 S C_L$, where L is lift, ρ is air density, V is velocity, S is the wing area, and C_L is the coefficient of lift, you can see that lift is directly proportional to air density. When the density of the air increases, while keeping all other factors constant (velocity, wing area, and the coefficient of lift), the lift produced by the wing also increases. This is because a denser medium contributes to a greater number of air molecules interacting with the wing, enhancing the pressure differential that produces lift. Consequently, in scenarios such as low altitudes or cold temperatures, where air density is greater, the lift capability of an aircraft is enhanced significantly compared to conditions where the air is less dense, such as at high altitudes or high temperatures. Hence, increased density will lead to

3. What effect does increasing temperature have on air density in aerodynamics?

A. Air density increases

B. Air density decreases

C. Air density remains constant

D. Air density fluctuates randomly

Increasing temperature has a direct impact on air density due to the fundamental relationship between temperature, pressure, and density described by the Ideal Gas Law. As the temperature of a gas increases, its molecules become more energetic and spread apart, which leads to a decrease in density. In terms of aerodynamics, lower air density at higher temperatures can affect aircraft performance. For example, a decrease in air density results in reduced lift generated by the wings and may require longer takeoff distances and a higher groundspeed for aircraft to achieve the same performance metrics. This is critically important for pilots and aerodynamics engineers to understand, as they must account for changes in atmospheric conditions when planning flights or designing aircraft. Thus, increasing temperature leads to a decrease in air density, confirming that option B is the correct choice.

4. Airfoil efficiency at various angles of attack is expressed by the ratio of:

A. Lift to dynamic pressure

B. Lift to drag

C. Lift to weight

D. Lift to velocity

The correct answer is the ratio of lift to drag, which is a critical measure of airfoil efficiency. This ratio, often referred to as the lift-to-drag ratio (L/D), indicates how effectively an airfoil generates lift compared to the drag it produces. A higher lift-to-drag ratio signifies that the airfoil is more efficient, as it can produce more lift for a given amount of drag. Understanding this concept is crucial in aerodynamics, as optimizing the lift-to-drag ratio allows for better performance in various flight conditions, enhancing aircraft maneuverability and fuel efficiency. When an airfoil operates at different angles of attack, the lift and drag forces change, making the evaluation of their ratio essential to assess performance. Other options do not accurately reflect the efficiency of an airfoil. For instance, lift to dynamic pressure represents a different aerodynamic parameter related to coefficient calculations rather than efficiency itself, lift to weight addresses the aircraft's ability to operate under gravity rather than performance efficiency, and lift to velocity does not provide a clear measure of performance as it mixes different types of physical quantities.

5. Which condition causes the most severe wake turbulence while landing?

A. Light, fast, and clean

B. Heavy, slow, and clean

C. Light, fast, and dirty (flaps extended)

D. Heavy, slow, and dirty

The condition that causes the most severe wake turbulence while landing is characterized as heavy, slow, and clean. This combination is significant due to several factors. When an aircraft is heavy, it generates more lift and, consequently, more wake turbulence as it passes through the air. Heavy aircraft displace a larger volume of air, creating stronger vortices behind them. The "slow" aspect indicates that the aircraft is flying at lower speeds, which increases the intensity and duration of the wake turbulence. This is particularly important because vortices tend to settle towards the ground and stay there longer when the aircraft is operating at slower speeds, such as during landing. Additionally, being "clean" means the flaps and slats are retracted, leading to a more streamlined configuration that enhances the generation of more pronounced vortices. In contrast, when an aircraft is dirty (with flaps extended), the turbulent flow caused by the lift devices can somewhat mitigate the strength of the wake turbulence as it creates more disruptive airflow. These combined factors make the heavy, slow, clean condition the most critical for wake turbulence, resulting in a potentially hazardous environment for following aircraft during the landing phase. Understanding these dynamics is essential for pilots to ensure safe separation between aircraft in landing patterns.

6. When flying over the Atlantic Ocean, which glide profile should you follow if both engines flame out?

A. Maximum Glide Range

B. Maximum Glide Endurance

C. Minimum Drag Profile

D. Emergency Descent Profile

The scenario of engine failure while flying over the ocean necessitates a careful consideration of glide profiles to enhance safety and optimize the chances of a successful landing. Opting for maximum glide endurance is the most suitable choice in this context. This glide profile focuses on achieving the longest duration in the air before touching down, allowing for the possibility of reaching a suitable landing area, such as a nearby ship or land. When maximizing glide endurance, the aircraft is flown at the best glide speed, which enables it to cover as much distance as possible while minimizing altitude loss over time. This strategy is particularly critical over vast areas like the Atlantic Ocean, where options for landing may be limited. In contrast, while maximum glide range is also a valid approach, it prioritizes covering the furthest horizontal distance relative to altitude rather than maximizing time aloft. This might not be as advantageous in an emergency situation where staying airborne for the longest possible duration is essential for assessing landing options. Choosing a minimum drag profile could theoretically contribute to maintaining altitude, but specific configurations and conditions may affect its effectiveness and reliability in an emergency. Emergency descent profiles focus on descending rapidly rather than sustaining flight, which contradicts the objective of prolonging the aircraft's time in the air. Overall, the decision to

7. What happens to total drag when an aircraft changes its velocity away from L/Dmax AOA?

A. Total drag decreases

B. Total drag remains the same

C. Total drag increases

D. Total drag fluctuates

When an aircraft operates away from the lift-to-drag ratio maximum angle of attack (L/Dmax AOA), the total drag will generally increase. The L/Dmax AOA represents the point at which the aircraft achieves the most efficient lift-to-drag ratio, balancing the effects of induced drag and parasite drag. As the aircraft's velocity changes from that optimal point, any increase or decrease in speed will shift the angle of attack away from the L/Dmax. If the aircraft is flying at a higher velocity, it is likely experiencing greater form drag due to increased skin friction and pressure drag. Similarly, if the aircraft slows down and the angle of attack increases, the induced drag will rise as well due to the larger lift being produced at lower speeds. Therefore, moving away from the L/Dmax AOA leads to an increase in total drag because the aircraft is no longer operating in its most aerodynamically efficient range. Ultimately, this relationship emphasizes the importance of maintaining optimal airspeed and angle of attack for maximizing performance and minimizing drag during flight.

8. Which force acts vertically downwards on an aircraft during flight?

A. Lift

B. Weight

C. Thrust

D. Drag

The force that acts vertically downwards on an aircraft during flight is weight. Weight is a gravitational force that acts on any mass, pulling it towards the center of the Earth. In the context of aircraft, it is responsible for counteracting lift, which is the upward force generated by the wings. Understanding the concept of weight is crucial in aerodynamics because it plays a vital role in an aircraft's ability to achieve and maintain flight. During flight, an aircraft's weight must be overcome by lift for it to ascend. Conversely, when an aircraft descends, the weight is greater than or equal to the lift, which causes a decrease in altitude. Other forces like lift, thrust, and drag also play significant roles in an aircraft's motion and performance, but they do not act vertically downward. Lift acts perpendicular to the wing's surface and opposes weight. Thrust is the forward force generated by the engines, propelling the aircraft forward, and drag is the resistance force acting against the aircraft's motion through the air. Understanding these distinctions is essential for grasping the fundamental principles of flight dynamics.

9. What are the four fundamental forces acting on an aircraft in flight?

A. Gravity, Acceleration, Thrust, Lift

B. Lift, Weight, Thrust, Drag

C. Drag, Weight, Gravity, Thrust

D. Thrust, Lift, Drag, Pressure

The four fundamental forces acting on an aircraft in flight are lift, weight, thrust, and drag. Lift is the upward force that counteracts the weight of the aircraft and is generated by the wings as air flows over them. The shape and angle of the wings (airfoil) significantly influence the amount of lift produced. Weight is the force exerted by gravity acting downward on the aircraft. It depends on the mass of the aircraft and is a crucial factor to consider during flight since it must be balanced by lift for sustained flight. Thrust is the forward force produced by the aircraft's engines, which propels it through the air. This force must overcome drag for the aircraft to accelerate. Drag, the aerodynamic resistance an aircraft experiences as it moves through the air, acts opposite to thrust. It arises from the friction of air particles against the aircraft's surfaces and must be minimized for efficient flight. Understanding these four forces is essential for analyzing flight dynamics and aircraft performance.

10. According to the lift equation, in a slow speed situation such as landing, angle of attack will be:

A. Smaller than at cruising speed because we need less lift

B. Larger than at cruising speed in order to maintain the same lift at slower velocities

C. Dependent upon drag

D. None of the above

In a slow speed situation like landing, the lift equation indicates a relationship between lift, angle of attack, airspeed, and air density. The lift generated by a wing is directly influenced by the angle of attack; as the airspeed decreases, maintaining sufficient lift becomes critical to ensure that the aircraft can safely land. At cruising speeds, the aircraft generates lift with a relatively small angle of attack due to the higher velocity of the air flowing over the wings. However, as speed decreases during the landing phase, a larger angle of attack is necessary to compensate for the reduced airflow over the wings. This increase allows the wings to maintain enough lift to support the weight of the aircraft in a slower-moving environment. Therefore, to keep the lift constant at lower airspeeds, the pilot must increase the angle of attack. This is why the angle of attack is larger during landing compared to cruising speeds, ensuring the aircraft remains adequately supported as it approaches the runway.