ME 480 Introduction To Aerospace
Midterm Test, Closed Notes, 15 min max.
(20 pts total)

Name_____

1. (2 pts) On an airfoil, the center of lift typically occurs at _____ % of the chord, while the center of twist typically occurs at _____ % of the chord.

2. Write down the formula for aerodynamic pressure, or q.

3. (2 pts) Control surfaces at the leading edges of airfoils are called _____, while those at the trailing edge are known as _____.

4. Stall occurs when the boundary layer on an airfoil _____.

5. (T F) In terms of total drag, pressure or separation drag is more for a turbulent boundary layer.

6. (3 pts) What are the three basic equations of aerodynamics?:
   _____
   _____
   _____

7. Write down the equation for Reynold's number.

8. Reynold's number is a ratio of what forces acting on a body as a consequence of flow?

9. Define the critical Mach number.

10. (3 pts) Write down three (3) of the five (5) variables which affect lift of a given shape airfoil at a given angle of attack.

11. As a fluid element flows through a shock wave, what happens to the temperature?

12. What recent event occurred in a control tower in the US which may mean that you are the last class to be able to visit a control tower?

13. (2 pts) Name two things that can be done to an airplane to improve its Short Take-Off and Landing (STOL) performance.

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1. A supersonic aircraft is in a rapid climb. At an instance, it passes through a standard atmosphere altitude of 25,000 ft. Its rate of climb is 500 ft/s. Calculate this rate of pressure change in lbf/in^2. (15 pts)

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2. An airplane is flying at a pressure altitude of 10 km with a velocity of 596 m/sec. The outside air temperature is 220 K. What is the pressure measured by a Pitot tube mounted on the nose of the airplane? (20 pts)
    a. Calculate the Mach number (5 pts)
    b. Calculate the Pitot pressure (15 pts)

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3. The Lift to Drag (L/D) of an aerospace flight vehicle is important parameter. It is a measurement of the "aerodynamic efficiency" of the vehicle. We will use the NACA 2412 airfoil for this problem. If this airfoil is pitched through a range of angle of attacks, the L/D first increases, reaches a maximum, then decreases. For the NACA 2412 airfoil, estimate the maximum L/D. Assume a Reynolds number of 9×10^6. (20 pts)

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4. Consider a Cessna Cardinal light aircraft. (A Cardinal is about halfway between the Cessna 182 and 172 aircraft in we have seen at Gallatin Field in terms of size and performance). It has a wing area of 16.2 m^2 and an aspect ratio of 7.31. Assume a span efficiency factor of 0.62. It has a total weight of 9,800 N. Assume sea level conditions with a velocity of 85.5 km/h (stalling speed). Calculate the induced drag with FLAPS DOWN (20 pts).

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5. The following performance characteristics are for a Beechcraft V-tailed Bonanza (sometimes called the "Fork Tailed Doctor and Lawyer Killer" because of its spotty safety record). The performance specifications are as follows:
    a. Wing aspect ratio = 6.2
    b. Wing area = 181 ft^2
    c. Oswald efficiency factor = 0.91
    d. Engine = 345 hp at sea level (assume power is proportional to free-stream density)
    e. Weight = 3000 lb
    f. Zero lift drag coefficient = 0.027
    g. Two blade propeller with an efficiency of 0.83
    h. The specific fuel consumption is 0.42 lb/hp/hr
    i. The fuel capacity is 44 gals
    j. Maximum gross weight is 3400 lbs

    Calculate the range and endurance at a standard altitude of 8,000 m (25 pts).