REVIEW PROBLEMS WILL NOT BE COLLECTED or GRADED (all DO-IT-YOURSELF)

(DO-IT-YOURSELF) Review Problem 2-1 (Unit A-4)

Answer the followings (explain in your own words).
(a) As we learned in class, the equation for speed of sound \( a = \sqrt{\gamma RT} \) is originally a continuity equation across a sound wave. List assumptions built into this equation.
(b) What is the difference between “static,” “dynamic,” “total,” and “stagnation” pressures?
(c) Are “total” and “stagnation” pressures exactly the same? YES or NO. Explain why.
(d) What is the difference between “true” and “equivalent” airspeed in incompressible subsonic airspeed measurement?
(e) What is the difference between “true” and “calibrated” airspeed in compressible subsonic airspeed measurement?

(DO-IT-YOURSELF) Review Problem 2-2 (Unit A-4)

Starting from Bernoulli’s equation: \( p + \frac{\rho v^2}{2} = \) constant (along a streamline), derive the equation of true airspeed for incompressible subsonic flow \( (M < 0.3) \).

(DO-IT-YOURSELF) Review Problem 2-3 (Unit A-4)

Starting from energy equation: \( c_sT + \frac{v^2}{2} = \) constant (along a streamline), derive the equation of true airspeed for compressible subsonic flow \( (1 > M > 0.3) \).

(DO-IT-YOURSELF) Review Problem 2-4 (Unit A-5)

Answer the followings (explain in your own words).
(a) What are the sources of aerodynamic forces and moments developed on an aircraft wing?
(b) What is the difference between coefficients of a finite wing \( (C_L, C_D, \text{ and } C_M) \) and coefficients of an airfoil \( (c_l, c_d, \text{ and } c_m) \)?
(c) The reference area \( (S) \) of aerodynamic coefficients of a finite wing \( C_L, C_D, \text{ and } C_M \) is defined differently between lift producing devices (i.e., a wing of airplane) and drag producing devices (i.e., a bar with circular cross-section). Explain the difference.
(d) What is the difference between center of pressure (cp) and aerodynamic center (ac)?
(e) The aerodynamic center is more important (or “useful”) in flight mechanics and aircraft design than the center of pressure. Explain why.

(DO-IT-YOURSELF) Review Problem 2-5 (Unit A-5)

Using the figure provided, derive equations for center of pressure location, in terms of:
(a) Leading edge moment coefficient \( (C_{m,le}) \) and lift coefficient \( (c_l) \), and
(b) Quarter chord moment coefficient \( (C_{m,cl}) \) and lift coefficient \( (c_l) \).
**DO-IT-YOURSELF** Review Problem 2-6 (Unit A-5)

![Diagram](image1)

Using the figure provided, derive the equation for aerodynamic center location, in terms of lift curve slope \(a_0\) and quarter chord moment curve slope \(m_0\).

**DO-IT-YOURSELF** Review Problem 2-7 (Unit A-5)

(a) A set of experimental data for a series of conventional airfoil is readily available in database. This is called “NACA conventional airfoil data.” NACA 2415 is one of these NACA conventional airfoils. Using the NACA 2415 airfoil data (available in course homepage), determine the location of the center of pressure \(c_{bp}\) at 4 degrees angle of attack.

(b) A set of experimental data for a series of conventional airfoil is readily available in database. This is called “NACA conventional airfoil data.” NACA 4412 is one of these NACA conventional airfoils. Using the NACA 4412 airfoil data (available in course homepage), determine the location of the aerodynamic center \(c_{ac}\).

(c) A set of experimental data for a series of conventional airfoil is readily available. This is called “NACA conventional airfoil data.” NACA 0006 is one of these NACA conventional airfoils. Using the NACA 0006 airfoil data (available in course homepage), determine the following:
  - The location of the center of pressure at 4 degrees angle of attack.
  - The location of the aerodynamic center.

Assume that (for all cases above) the Reynolds number is \(3.0 \times 10^6\) clean (no simulated split flap deflection).

**Answer Keys (No guarantee for 100% accuracy. For your “self-checking” purposes only. Do not “start” from answer keys!)**

(a) 0.325  
(b) 0.2439  
(c) ?