(DO-IT-YOURSELF) Review Problem 5-1 (Unit C-1)

Answer the followings (explain in your own words).
(a) What are “airfoils”?
(b) What is the difference between “geometric” and “aerodynamic” twist?
(c) What is the difference between “symmetric” and “cambered” airfoil?
(d) What are the “conventional NACA” airfoils?
(e) What are the “Natural Laminar Flow (NLF)” airfoils?

(DO-IT-YOURSELF) Review Problem 5-2 (Unit C-1)

Consider NACA 4415 airfoil.
(a) Determine the lift coefficient at an angle of attack of 10 degrees.
(b) When this airfoil is turned upside-down (but at the same 10 degrees angle of attack), determine its lift coefficient.
(c) At what angle of attack must the upside-down airfoil be set to generate the same amount of lift as that when it is right-side-up at a 10 degrees angle of attack?

Hints . . .
• There is a data for NACA 4415 airfoil. Take a look at Blackboard “Tools” menu.

Answer Keys (No guarantee for 100% accuracy. For your “self-checking” purposes only. Do not “start” from answer keys!)
(a) $c_l = 1.3$ (b) $c_l = 0.6$ (c) ?

(DO-IT-YOURSELF) Review Problem 5-3 (Unit C-2)

Answer the followings (explain in your own words).
(a) What is “Prandtl-Glauert rule”?
(b) What is the “critical Mach number”?
(c) Explain the mechanism of “drag divergence.” What causes such a rapid increase of drag?
(d) What is “supercritical” airfoil? What are the advantages of this airfoil?
(e) Explain the mechanism of “wave drag.” What causes such a large value of drag?

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

Lift force per unit span can be found by integrating the pressure distribution over the surface of an airfoil, such as:

$$ L' = \int_{LE}^{TE} p_r \cos \theta ds - \int_{LE}^{TE} p_a \cos \theta ds $$

Starting from this equation, derive the relationship between lift coefficient and pressure coefficient:

$$ c_l = \frac{1}{c} \int_c^2 (c_{p,l} - c_{p,a}) dx $$

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

Starting from the definition of pressure coefficient: $C_p = \frac{p - p_\infty}{q_\infty}$, derive the pressure coefficient at critical Mach number: $C_{p,c} = \frac{2}{\gamma M_c^2} \left[ \frac{2 + (\gamma - 1) M_c^2}{\gamma + 1} \right]^{\frac{\gamma}{\gamma - 1}} - 1$