Given an aircraft of which the weight is $W = 20000$ lb and the wing area $S = 250$ ft^2. Initially, the aircraft takes off at altitude $h = 100$ ft, where the air density is $\rho = 2.3769^{-3}$ slug/ft^3. The maximum lift coefficient is $C_{L_{max}} = 2.2$. Later on, the aircraft cruises at constant altitude $h = 30,000$ ft with constant Mach number $M = 0.85$. At such a cruise altitude, the air density $\rho = 0.8907 \times 10^{-3}$ slug/ft^3 and the speed of sound $V_s = 994.8$ ft/sec. At cruise condition, the lift coefficient C_L, the drag coefficient C_D, and the pitching moment coefficient C_m can be represented by

$$C_L = C_{L_0} + C_{L_\alpha}\alpha + C_{L_{\delta_E}}\delta_E$$
$$C_D = C_{D_0} + KC_L^2$$
$$C_m = C_{m_0} + C_{m_\alpha}\alpha + C_{m_{\delta_E}}\delta_E$$

where

$$C_{L_0} = 0.1 \quad C_{L_\alpha} = 0.09564 \quad C_{L_{\delta_E}} = 0.01047$$
$$C_{D_0} = 0.02 \quad K = 0.05$$
$$C_{m_0} = 0.05 \quad C_{m_\alpha} = -0.033 \quad C_{m_{\delta_E}} = -0.0349$$

Note that the units of C_{L_α}, $C_{L_{\delta_E}}$, C_{m_α} and $C_{m_{\delta_E}}$ are per degree.

According to the above data, work on problems 1–6.

Problem 1. What is the stall speed V_{stall} at the take-off altitude? (10%)

Problem 2. Determine the lift coefficient C_L at cruise condition. What is the lift-to-drag ratio? (10%)

Problem 3. Determine the angle of attack α and the elevator angle δ_E at cruise condition. (10%)

Problem 4. Determine the Mach number for minimum drag at cruise altitude. What is the lift-to-drag ratio for the Mach number determined? (10%)

Problem 5. Determine the required thrust for the cases in problem 2 and problem 4, respectively. (10%)

Problem 6. At the cruise condition, if the aircraft makes a constant speed level turn with bank angle $\phi = 30°$. What is the radius of turn? What is the lift-to-drag ratio? Determine the required thrust for this case. (10%)

Problem 7. 試推算出一同步衛星軌道之半徑。 (20%)

Problem 8. 試說明衛星姿態控制(attitude control) 的目的、控制種類及其特點。 (20%)