Chapter 5

Exercises

5.1 Obtain the maximum speed and minimum speed in steady level flight at sea level for the following airplane:

\[ W = 36,000 \text{ N}; \quad S = 26.0 \text{ m}^2; \quad C_D = 0.032 + 0.043C_L^2 \quad \text{BHP} = 503 \text{ kW}; \quad \text{Propeller efficiency} = 82\%; \quad C_{L_{\text{max}}} = 1.5 \]

\[
\text{Ans.:} \quad V_{\text{max}} = 324.6 \text{ kmph}; \quad V_{\text{min}} = 139.8 \text{ kmph}
\]

5.2 A jet engined airplane has a weight of 64,000 N and wing area of 20 m\(^2\). If the engine output at 5 km altitude be 8000 N, calculate the maximum and minimum speeds in level flight. Given that

\[ C_{D_0} = 0.017, \quad A = 6.5, \quad e = 0.80, \quad C_{L_{\text{max}}} = 1.4. \]

\[
\text{Ans.:} \quad V_{\text{max}} = 877 \text{ kmph}, V_{\text{min}} = 283.6 \text{ kmph}
\]

5.3 An airplane stalls at \(M=0.2\) at sea level. What will be the Mach number and equivalent airspeed when it stalls at 5 km altitude? Compare the thrust required to maintain level flight near stall at the two altitudes. Assume the weight of the airplane to be same at the two altitudes.

\[
\text{Ans.:} \quad M = 0.274, \quad V_e = 68.06 \text{ m/s}, \quad (T_r)_{5 \text{ km}} = (T_r)_{5 \text{ km}} \text{ as } C_L \text{ is same}
\]

5.4 (a) Show that the thrust required in steady level flight at a speed \(V\) for an airplane with parabolic drag polar is given by:

\[
T_r = D = AW \left( \frac{V}{V_{\text{md}}} \right)^2 + \frac{AW}{(V/V_{\text{md}})^2}
\]

where, \(V_{\text{md}}\) = speed for minimum drag, \(W\) = weight of airplane and \(A = (C_{D_0} K)^{1/2}\).

(b) Also show that if \(V = m V_{\text{md}}\), then the thrust required \((T_r)\) in terms of the minimum thrust required \((T_{r_{\text{min}}})\) is given by:

\[
\frac{T_r}{T_{r_{\text{min}}}} = \frac{1}{2} (m^2 + m^{-2})
\]