UE Fluids Problem 10 Solution S'08

a) In level flight, $V = \left(\frac{2\,W/S}{\rho\, C_L}\right)^{1/2}$

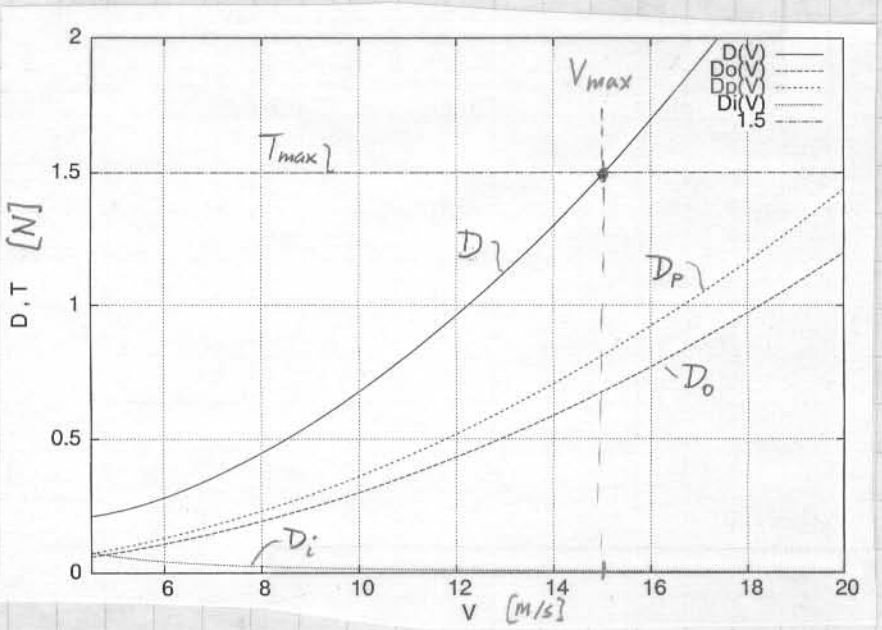
So V_{min} occurs at $C_{L_{max}} = 0.8 \rightarrow V_{min} = \left(\frac{2\,W/S}{\rho\, C_{L_{max}}}\right)^{1/2} = 4.56$ m/s

b) $D_o = \frac{1}{2}\rho V^2 C D A_o$

$D_p = \frac{1}{2}\rho V^2 C_d S$

$D_i = \frac{(W/b)^2}{\frac{1}{2}\rho V^2 \pi e}$

$D = D_o + D_p + D_i$ (plot)



c) Maximum speed V_{max} occurs when drag reaches max available thrust,

$D(V_{max}) = T_{max}$

or $\underbrace{\frac{1}{2}\rho\left[CDA_o + C_d S\right]}V^2 + \left[\frac{(W/b)^2}{\frac{1}{2}\rho\pi e}\right]\cdot\frac{1}{V^2} - T_{max} = 0$

$A V^4 - T_{max} V^2 + C = 0$

$A = 0.0066$, $T_{max} = 1.5$, $C = 1.551$

$\rightarrow V^2 = \frac{1}{2A}\left[T_{max} + \sqrt{T_{max}^2 - 4AC}\right] = 226.2$

$\boxed{V = 15.04 \text{ m/s}}$

Could also obtain graphically