Fluids Quiz 1 Solution - Problem 4 S'08

a) $C_D = c_d + C_{D_i} = c_d + \frac{C_L^2}{\pi AR}$; $e = 1$ in this case

$$\boxed{C_D = 0.015 + 0.01 C_L^2 + \frac{C_L^2}{\pi AR} = 0.015 + \left[0.01 + \frac{1}{\pi AR}\right] C_L^2 = 0.015 + 0.0259\, C_L^2}$$

b) $$\frac{C_D}{C_L^{3/2}} = \frac{0.015}{C_L^{3/2}} + \left[0.01 + \frac{1}{\pi AR}\right] C_L^{1/2}$$

(10)

At minimum: $\frac{d}{dC_L}\left(\frac{C_D}{C_L^{3/2}}\right) = 0$

$$-\frac{3}{2}\frac{0.015}{C_L^{5/2}} + \frac{1}{2}\left[0.01 + \frac{1}{\pi AR}\right]\frac{1}{C_L^{1/2}} = 0$$

$$\frac{3}{2} \cdot 0.015 = \frac{1}{2}\left[0.01 + \frac{1}{\pi AR}\right] C_L^2$$

$$C_L = \left[\frac{3 \cdot 0.015}{0.01 + 1/\pi AR}\right]^{1/2} = 1.318$$

(10)

Evaluate $\frac{C_D}{C_L^{3/2}}$ at minimum point: ($C_L = 1.318$)

$$\boxed{\frac{C_D}{C_L^{3/2}} = \frac{0.015 + [0.01 + 1/\pi AR] C_L^2}{C_L^{3/2}} = 0.0397}$$