5.21 $V_\infty = 251 \text{ km/h} = \left(251\dfrac{\text{km}}{\text{h}}\right)\left(\dfrac{1\text{h}}{3600\,\text{sec}}\right)\left(\dfrac{1000\text{m}}{1\text{km}}\right) = 69.7 \text{ m/sec}$

$\rho_\infty = 1.225 \text{ kg/m}^3$

$$q_\infty = \frac{1}{2}\rho_\infty V_\infty^2 = \frac{1}{2}(1.225)(69.7)^2 = 2976 \text{ N/m}^2$$

$$C_L = \frac{L}{q_\infty S} = \frac{9800}{(2976)(16.2)} = 0.203$$

$$C_{D_i} = \frac{C_L^{\,2}}{\pi e AR} = \frac{(0.203)^2}{\pi(0.62)(7.31)} = 0.002894$$

$$D_i = q_\infty\, S\, C_{D_i} = (2976)(16.2)(0.002894) = \boxed{139.5\ \text{N}}$$

5.22 $V_\infty = 85.5$ km/h = 23.75 m/sec

$$q_\infty = \frac{1}{2}\rho_\infty V_\infty^2 = \frac{1}{2}(1.225)(23.75)^2 = 345\ \text{N/m}^2$$

$$C_L = \frac{L}{q_\infty S} = \frac{9800}{(345)(16.2)} = 1.75$$

$$C_{D_i} = \frac{C_L^2}{\pi e AR} = \frac{(1.75)^2}{\pi(0.62)(7.31)} = 0.215$$

$$D_i = q_\infty\, S\, C_{D_i} = (345)(16.2)(0.215) = \boxed{1202\ \text{N}}$$

Note: The induced drag at low speeds, such as near stalling velocity, is considerably larger than at high speeds, near maximum velocity. Compare the results of problems 5.20 and 5.21.

5.23 First, obtain the infinite wing lift slope. From Appendix D for a NACA 65-210 airfoil,

$$C_\ell = 1.05 \text{ at } \alpha = 8^\circ$$

$$C_\ell = 0 \text{ at } \alpha_{L=0} = -1.5^\circ$$

Hence,

$$a_o = \frac{1.05 - 0}{8 - (-1.5)} = 0.11 \text{ per degree}$$

The lift slope for the finite wing is

$$a = \frac{a_o}{1 + \frac{57.3\ a_o}{\pi\ e_1 AR}} = \frac{0.11}{1 + \frac{57.3(0.11)}{\pi\ (.9)(5)}} = 0.076 \text{ per degree}$$

At $\alpha = 6^\circ$,

$$C_L = a(\alpha - \alpha_{L=0}) = (0.076)\ [6 - (-1.5)] = \boxed{0.57}$$

The total drag coefficient is

$$C_D = c_d + \frac{C_L^{\ 2}}{\pi e AR} = (0.004) + \frac{(0.57)^2}{\pi\ (0.9)(5)}$$

$$C_D = 0.004 + 0.023 = \boxed{0.027}$$