3.5

a. Mach number for drag divergence ($h = 30{,}000$ ft)

$$g_1 = \left[1 + 0.189\left(4\Lambda_{ps}^{.188} - 3\Lambda_{m+}^{.201}\right)\right]\left[1 - 1.4\left(t/c\right)_w^{.09} - 0.06\left(1 - x_{ps}^{.4}/c\right)\right] - 0.0368$$

$$= 1.028\,(.8380) - .0368 = .8247 = g_1$$

$$g_2 = .33\left[0.65 - x_{ps}^{.4}/c\right]\left[1 + .189\left(4\Lambda_{ps} - 3\Lambda_{m+}\right)\right]$$

$$= .33\,(0.25)\,1.028 = .0848 = g_2$$

$$C_L = \frac{2W}{\rho S_w V^2} = \frac{2\,(11{,}000)}{.000889\,(232)\,(.7 \times 994.7)^2} = .220$$

(696)

$$M_D = g_1 - g_2 C_L = .8247 - .0848\,(.220) = .806$$

The operating M is $< M_D$. ∴ No wave drag

b. C_{D_o} and K

For $M < M_D$ $\quad C_{D_o} = C_{D_f}$

$$R_e' = \frac{\rho V}{\mu} = \frac{.000889\,[696)}{3.107 \times 10^{-7}} = .199 \times 10^7 = 1.99 \times 10^6$$

$l_B = 41$ ft. $\quad R_{e_B} = 81.6 \times 10^6 \quad C_{f_B} = \dfrac{.455}{7.91^{2.58}} = .00220$

$\bar{c}_W = 7.00 \quad R_{e_W} = 13.9 \times 10^6 \quad C_{f_W} = \dfrac{.455}{7.14^{2.58}} = .00285$

$\bar{c}_H = 3.83 \quad R_{e_H} = 7.62 \times 10^6 \quad C_{f_H} = \dfrac{.455}{6.88^{2.58}} = .00314$

3.5 Cont'd

$\bar{c}_V = 6.92 \quad Re_V = 13.8 \times 10^6 \quad C_{f_V} = \frac{.455}{7.14^{2.58}} = .00285$

$\ell_N = 7.70 \quad Re_N = 15.3 \times 10^6 \quad C_{f_N} = \frac{.455}{7.18^{2.58}} = .00281$

$\ell_T = 14.0 \quad Re_T = 27.9 \times 10^6 \quad C_{f_T} = \frac{.455}{7.44^{2.58}} = .00257$

$CF_{all} = \left(1 + .2 \underset{.7}{M^2}\right)^{-.467} = 1.098^{-.467} = .957$

$IF_B = 1.2 \qquad IF_W = 1.2 \qquad IF_H = 1.1 \qquad IF_V = 1.1$

$IF_N = 1.5 \qquad IF_T = 1.25$

$(\ell/d)_B = 7.81 \qquad FF_B = 1 + \frac{60}{7.81^3} + .0025(7.81) = 1 + .126 + .0195 = 1.15$

$(t/c)_W = .09 \qquad FF_W = 1 + 1.6(.09) + 100(.09)^4 = 1 + .144 + .00656 = 1.15$

$(t/c)_H = .08 \qquad FF_H = 1 + 1.6(.08) + 100(.08)^4 = 1 + .128 + .00410 = 1.13$

$(t/c)_V = .10 \qquad FF_V = 1 + 1.6(.10) + 100(.10)^4 = 1 + .16 + .0001 = 1.16$

$(\ell/d)_N = 3.35 \qquad FF_N = 1 + \frac{.35}{3.35} = 1.04$

$(\ell/d)_T = 8.00^{48} \qquad FF_T = 1 + \frac{60}{8.00^3} + .0025(8.00) = 1 + .117 + .02 = 1.14$

$f_B = .00220\,(.957)\,1.2\,(1.15)\,456 = 1.32$

$f_W = .00285(.957)\;1.2(1.15)\;344 = 1.29$

$f_H = .00314(.957)\;1.1\;(1.13)\;108 = .403$

$f_V = .00285(.957)\;1.1\;(1.16)\;75.4 = .262$

$f_N = .00281(.957)\;1.5\;(1.04)\;55.6 = .233$

$f_T = .00257(.957)\;1.25(1.14)\;61.2 = .214$

3.5 Cont'd

$$f = 1.32 + 1.29 + .403 + .262 + 2(.233) + 2(.214) = 4.17$$

$$C_{D_f} = \frac{1.1\ (4.17)}{232} = .0198$$

$$K = \frac{1}{\pi A e \left(1 + .5\ \frac{d_T}{b_w}\right)}$$

$$e = \left(1 - .045\ A_w^{0.68}\right)\left(1 - 0.227\ \Lambda_{qc_w}^{1.615}\right)$$

$$= \left(1 - .045\ 5.10^{0.68}\right)\left(1 - .227\left(\frac{13}{573}\right)^{1.615}\right)$$

$$e = .864\ (.979) = .846$$

$$1 + .5\ \frac{1.75}{34.4} = 1.03$$

$$K = \frac{1}{3.14\ (5.10)\ .846\ (1.03)} = .0717$$

$$C_{D_o} = .0198\ ,\quad K = .0717$$