APPENDIX V

EQUATIONS

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EQUATIONS

		PAGE
CHAPTER 2		
$P = \rho\, g_c\, R\, T$	(Eq 2.1)	2.4
$dP_a = -\rho\, g\, dh$	(Eq 2.2)	2.4
$g_{ssl}\, dH = g\, dh$	(Eq 2.3)	2.4
$\theta = \frac{T_a}{T_{ssl}} = \left(1 - 6.8755856 \times 10^{-6} H\right)$	(Eq 2.4)	2.5
$\delta = \frac{P_a}{P_{ssl}} = \left(1 - 6.8755856 \times 10^{-6} H\right)^{5.255863}$	(Eq 2.5)	2.5
$\sigma = \frac{\rho_a}{\rho_{ssl}} = \left(1 - 6.8755856 \times 10^{-6} H\right)^{4.255863}$	(Eq 2.6)	2.6
$P_a = P_{ssl}\left(1 - 6.8755856 \times 10^{-6} H_P\right)^{5.255863}$	(Eq 2.7)	2.6
$T_a = -56.50^{\circ}C = 216.65^{\circ}K$	(Eq 2.8)	2.6
$\delta = \frac{P_a}{P_{ssl}} = 0.223358\, e^{-4.80614 \times 10^{-5} (H - 36089)}$	(Eq 2.9)	2.6
$\sigma = \frac{\rho_a}{\rho_{ssl}} = 0.297069\, e^{-4.80614 \times 10^{-5} (H - 36089)}$	(Eq 2.10)	2.6
$P_a = P_{ssl}\left(0.223358\, e^{-4.80614 \times 10^{-5} \left(H_P - 36089\right)}\right)$	(Eq 2.11)	2.6

$$V_T = \sqrt{\frac{2}{\rho_a}\left(P_T - P_a\right)} = \sqrt{\frac{2q}{\rho_a}} \qquad \text{(Eq 2.12)} \qquad 2.10$$

$$V_e = \sqrt{\frac{2q}{\rho_{ssl}}} = \sqrt{\frac{\sigma\, 2q}{\rho_a}} = \sqrt{\sigma}\, V_T \qquad \text{(Eq 2.13)} \qquad 2.11$$

$$V_{e_{Test}} = V_{e_{Std}} \qquad \text{(Eq 2.14)} \qquad 2.12$$

$$V_T^2 = \frac{2\gamma}{\gamma - 1}\frac{P_a}{\rho_a}\left[\left(\frac{P_T - P_a}{P_a} + 1\right)^{\frac{\gamma - 1}{\gamma}} - 1\right] \qquad \text{(Eq 2.15)} \qquad 2.13$$

$$V_T = \sqrt{\frac{2\gamma}{\gamma - 1}\frac{P_a}{\rho_a}\left[\left(\frac{q_c}{P_a} + 1\right)^{\frac{\gamma - 1}{\gamma}} - 1\right]} \qquad \text{(Eq 2.16)} \qquad 2.13$$

$$q_c = q\left(1 + \frac{M^2}{4} + \frac{M^4}{40} + \frac{M^6}{1600} + \ldots\right) \qquad \text{(Eq 2.17)} \qquad 2.13$$

$$V_c^2 = \frac{2\gamma}{\gamma - 1}\frac{P_{ssl}}{\rho_{ssl}}\left[\left(\frac{P_T - P_a}{P_{ssl}} + 1\right)^{\frac{\gamma - 1}{\gamma}} - 1\right] \qquad \text{(Eq 2.18)} \qquad 2.14$$

$$V_c = \sqrt{\frac{2\gamma}{\gamma - 1}\frac{P_{ssl}}{\rho_{ssl}}\left[\left(\frac{q_c}{P_{ssl}} + 1\right)^{\frac{\gamma - 1}{\gamma}} - 1\right]} \qquad \text{(Eq 2.19)} \qquad 2.14$$

$$V_c = f\left(P_T - P_a\right) = f\left(q_c\right) \qquad \text{(Eq 2.20)} \qquad 2.14$$

$$V_{c_{Test}} = V_{c_{Std}} \qquad \text{(Eq 2.21)} \qquad 2.14$$

$$\frac{P'_T}{P_a} = \left[\frac{\gamma+1}{2}\left(\frac{V}{a}\right)^2\right]^{\frac{\gamma}{\gamma-1}} \left[\frac{1}{\frac{2\gamma}{\gamma+1}\left(\frac{V}{a}\right)^2 - \frac{\gamma-1}{\gamma+1}}\right]^{\frac{1}{\gamma-1}}$$

(Eq 2.22) 2.15

$$\frac{q_c}{P_{ssl}} = \left[1 + 0.2\left(\frac{V_c}{a_{ssl}}\right)^2\right]^{3.5} - 1 \quad \text{(For } Vc \le a_{ssl}\text{)}$$

(Eq 2.23) 2.15

$$\frac{q_c}{P_{ssl}} = \left[\frac{166.921\left(\frac{V_c}{a_{ssl}}\right)^7}{\left[7\left(\frac{V_c}{a_{ssl}}\right)^2 - 1\right]^{2.5}}\right] - 1 \quad \text{(For } Vc \ge a_{ssl}\text{)}$$

(Eq 2.24) 2.15

$$V_e = \sqrt{\frac{2\gamma}{\gamma-1}\frac{P_a}{\rho_{ssl}}\left[\left(\frac{q_c}{P_a}+1\right)^{\frac{\gamma-1}{\gamma}} - 1\right]}$$

(Eq 2.25) 2.17

$$V_e = V_T\sqrt{\sigma}$$

(Eq 2.26) 2.17

$$M = \frac{V_T}{a} = \frac{V_T}{\sqrt{\gamma g_c R T}} = \frac{V_T}{\sqrt{\gamma\frac{P}{\rho}}}$$

(Eq 2.27) 2.17

$$M = \sqrt{\frac{2}{\gamma-1}\left[\left(\frac{P_T - P_a}{P_a}+1\right)^{\frac{\gamma-1}{\gamma}} - 1\right]}$$

(Eq 2.28) 2.17

$$\frac{P_T}{P_a} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{\frac{\gamma}{\gamma-1}}$$

(Eq 2.29) 2.18

$$\frac{q_c}{P_a} = \left(1 + 0.2\,M^2\right)^{3.5} - 1 \quad \text{for } M < 1 \qquad \text{(Eq 2.30)} \qquad 2.18$$

$$\frac{q_c}{P_a} = \left[\frac{166.921\,M^7}{\left(7M^2 - 1\right)^{2.5}}\right] - 1 \quad \text{for } M > 1 \qquad \text{(Eq 2.31)} \qquad 2.18$$

$$M = f\left(P_T - P_a, P_a\right) = f\left(V_c, H_P\right) \qquad \text{(Eq 2.32)} \qquad 2.19$$

$$M_{Test} = M \qquad \text{(Eq 2.33)} \qquad 2.19$$

$$\Delta H_{P_{ic}} = H_{P_i} - H_{P_o} \qquad \text{(Eq 2.34)} \qquad 2.22$$

$$\Delta V_{ic} = V_i - V_o \qquad \text{(Eq 2.35)} \qquad 2.22$$

$$H_{P_i} = H_{P_o} + \Delta H_{P_{ic}} \qquad \text{(Eq 2.36)} \qquad 2.22$$

$$V_i = V_o + \Delta V_{ic} \qquad \text{(Eq 2.37)} \qquad 2.22$$

$$\Delta P = P_s - P_a \qquad \text{(Eq 2.38)} \qquad 2.27$$

$$\Delta V_{pos} = V_c - V_i \qquad \text{(Eq 2.39)} \qquad 2.27$$

$$\Delta H_{pos} = H_{P_c} - H_{P_i} \qquad \text{(Eq 2.40)} \qquad 2.27$$

$$\Delta M_{pos} = M - M_i \qquad \text{(Eq 2.41)} \qquad 2.27$$

$$\frac{P_s}{P_a} = f_1\left(M, \alpha, \beta, R_e\right) \qquad \text{(Eq 2.42)} \qquad 2.28$$

$$\frac{P_s}{P_a} = f_2\left(M, \alpha\right) \qquad \text{(Eq 2.43)} \qquad 2.28$$

$$\frac{\Delta P}{q_c} = f_3\left(M, \alpha\right) \qquad \text{(Eq 2.44)} \qquad 2.28$$

$$\frac{\Delta P}{q_c} = f_4(M) \text{ (High speed)} \qquad \text{(Eq 2.45)} \qquad 2.28$$

$$\frac{\Delta P}{q_c} = f_5\left(C_L\right) \text{ (Low speed)} \qquad \text{(Eq 2.46)} \qquad 2.28$$

$$\frac{\Delta P}{q_{c_i}} = f_6\left(M_i\right) \text{ (High speed)} \qquad \text{(Eq 2.47)} \qquad 2.29$$

$$\frac{\Delta P}{q_c} = f_7\left(W, V_c\right) \text{ (Low speed)} \qquad \text{(Eq 2.48)} \qquad 2.29$$

$$V_{c_W} = V_{c_{Test}} \sqrt{\frac{W_{Std}}{W_{Test}}} \qquad \text{(Eq 2.49)} \qquad 2.30$$

$$\frac{\Delta P}{q_c} = f_8\left(V_{c_W}\right) \text{ (Low speed)} \qquad \text{(Eq 2.50)} \qquad 2.30$$

$$V_{i_W} = V_{i_{Test}} \sqrt{\frac{W_{Std}}{W_{Test}}} \qquad \text{(Eq 2.51)} \qquad 2.30$$

$$\frac{\Delta P}{q_{c_i}} = f_9\left(V_{i_W}\right) \text{ (Low speed)} \qquad \text{(Eq 2.52)} \qquad 2.30$$

$$\frac{T_T}{T} = 1 + \frac{\gamma - 1}{2} M^2 \qquad \text{(Eq 2.53)} \qquad 2.32$$

$$\frac{T_T}{T} = 1 + \frac{\gamma - 1}{2} \frac{V_T^2}{\gamma g_c R T} \qquad \text{(Eq 2.54)} \qquad 2.32$$

$$\frac{T_T}{T} = 1 + \frac{K_T(\gamma - 1)}{2} M^2 \qquad \text{(Eq 2.55)} \qquad 2.33$$

$$\frac{T_T}{T} = 1 + \frac{K_T(\gamma - 1)}{2} \frac{V_T^2}{\gamma g_c R T} \qquad \text{(Eq 2.56)} \qquad 2.33$$

$$\frac{T_T}{T_a} = \frac{T_i}{T_a} = 1 + \frac{K_T M^2}{5} \qquad \text{(Eq 2.57)} \qquad 2.33$$

$$T_T = T_i = T_a + \frac{K_T V_T^2}{7592}$$ (Eq 2.58) 2.33

$$T_i = T_o + \Delta T_{ic}$$ (Eq 2.59) 2.35

$$K_T = \left(\frac{T_i\,(^\circ K)}{T_a\,(^\circ K)} - 1 \right) \frac{5}{M^2}$$ (Eq 2.60) 2.35

$$V_{G_1} = 3600 \left(\frac{D}{\Delta t_1} \right)$$ (Eq 2.61) 2.50

$$V_{G_2} = 3600 \left(\frac{D}{\Delta t_2} \right)$$ (Eq 2.62) 2.50

$$V_T = \frac{V_{G_1} + V_{G_2}}{2}$$ (Eq 2.63) 2.50

$$\rho_a = \frac{P_a}{g_c R T_{a_{ref}}\,(^\circ K)}$$ (Eq 2.64) 2.50

$$\sigma = \frac{\rho_a}{\rho_{ssl}}$$ (Eq 2.65) 2.51

$$V_c = V_e - \Delta V_c$$ (Eq 2.66) 2.51

$$M = \frac{V_T}{38.9678 \sqrt{T_{a_{ref}}\,(^\circ K)}}$$ (Eq 2.67) 2.51

$$q_c = P_{ssl} \left\{ \left[1 + 0.2 \left(\frac{V_c}{a_{ssl}} \right)^2 \right]^{3.5} - 1 \right\}$$ (Eq 2.68) 2.51

$$q_{c_i} = P_{ssl} \left\{ \left[1 + 0.2 \left(\frac{V_i}{a_{ssl}} \right)^2 \right]^{3.5} - 1 \right\}$$ (Eq 2.69) 2.51

$$\Delta P = q_c - q_{c_i} \qquad \text{(Eq 2.70)} \qquad 2.51$$

$$V_{i_W} = V_i \sqrt{\frac{W_{Std}}{W_{Test}}} \qquad \text{(Eq 2.71)} \qquad 2.51$$

$$H_{P_{i_{ref}}} = H_{P_{o_{ref}}} + \Delta H_{P_{ic_{ref}}} \qquad \text{(Eq 2.72)} \qquad 2.54$$

$$H_{P_i} = \frac{T_{ssl}}{a_{ssl}} \left[1 - \left(\frac{P_s}{P_{ssl}} \right)^{\frac{1}{\left(\frac{g_{ssl}}{g_c \, a_{ssl} \, R} \right)}} \right] \qquad \text{(Eq 2.73)} \qquad 2.54$$

$$H_{P_{i_{ref}}} = \frac{T_{ssl}}{a_{ssl}} \left[1 - \left(\frac{P_a}{P_{ssl}} \right)^{\frac{1}{\left(\frac{g_{ssl}}{g_c \, a_{ssl} \, R} \right)}} \right] \qquad \text{(Eq 2.74)} \qquad 2.55$$

$$\Delta h = d \tan\theta \qquad \text{(Eq 2.75)} \qquad 2.57$$

$$\Delta h = L_{a/c} \, \frac{y}{x} \qquad \text{(Eq 2.76)} \qquad 2.57$$

$$H_{P_c} = H_{P_{c_{twr}}} + \Delta h \, \frac{T_{Std}\,(^\circ K)}{T_{Test}\,(^\circ K)} \qquad \text{(Eq 2.77)} \qquad 2.57$$

$$P_s = P_{ssl} \left(1 - 6.8755856 \times 10^{-6} \, H_{P_i} \right)^{5.255863} \qquad \text{(Eq 2.78)} \qquad 2.57$$

$$P_a = P_{ssl} \left(1 - 6.8755856 \times 10^{-6} \, H_{P_c} \right)^{5.255863} \qquad \text{(Eq 2.79)} \qquad 2.58$$

$$\text{Curve slope} = K_T \, \frac{\gamma - 1}{\gamma} \, T_a = 0.2 \, K_T \, T_a \, (^\circ K) \text{ (High speed)} \qquad \text{(Eq 2.80)} \qquad 2.60$$

$$\text{Curve slope} = K_T \frac{0.2\ T_a\ (^\circ K)}{a_{ssl}^2} \text{ (Low speed)} \qquad \text{(Eq 2.81)} \qquad 2.60$$

$$K_T = \frac{\text{slope}}{0.2\ T_a\ (^\circ K)} \text{ (High speed)} \qquad \text{(Eq 2.82)} \qquad 2.60$$

$$K_T = \frac{\text{slope}\ a_{ssl}^2}{0.2\ T_a\ (^\circ K)} \text{ (Low speed)} \qquad \text{(Eq 2.83)} \qquad 2.61$$

$$M_i = \sqrt{\frac{2}{\gamma - 1}\left[\left(\frac{q_{c_i}}{P_s} + 1\right)^{\frac{\gamma - 1}{\gamma}} - 1\right]} \qquad \text{(Eq 2.84)} \qquad 2.62$$

$$\Delta P = \left(\frac{\Delta P}{q_{c_i}}\right) q_{c_i} \qquad \text{(Eq 2.85)} \qquad 2.62$$

$$q_c = q_{c_i} + \Delta P \qquad \text{(Eq 2.86)} \qquad 2.62$$

$$\Delta V_{pos} = V_c - V_{i_W} \qquad \text{(Eq 2.87)} \qquad 2.63$$

$$P_a = P_s - \Delta P \qquad \text{(Eq 2.88)} \qquad 2.63$$

$$H_{P_c} = \frac{T_{ssl}}{a_{ssl}}\left[1 - \left(\frac{P_a}{P_{ssl}}\right)^{\frac{1}{\left(\frac{g_{ssl}}{g_c\ a_{ssl}\ R}\right)}}\right] \qquad \text{(Eq 2.89)} \qquad 2.63$$

CHAPTER 3

$$C_{L_{max\ (\Lambda)}} = C_{L_{max\ (\Lambda = 0)}} \cos(\Lambda) \qquad \text{(Eq 3.1)} \qquad 3.7$$

$$V_{e_s} = \sqrt{\frac{n_z W}{C_{L_s}\ q\ S}} \qquad \text{(Eq 3.2)} \qquad 3.10$$

$$\frac{V_{e_{s_1}}}{V_{e_{s_2}}} = \sqrt{\frac{C_{L_{s_2}}}{C_{L_{s_1}}}} \qquad \text{(Eq 3.3)} \qquad 3.10$$

$$\text{If} \quad \frac{V_{e_{s_1}}}{V_{e_{s_2}}} = 0.8\,, \quad \text{then} \quad \frac{C_{L_{s_2}}}{C_{L_{s_1}}} = 0.64 \qquad \text{(Eq 3.4)} \qquad 3.10$$

$$\frac{C_{L_{s_1}}}{C_{L_{s_2}}} = 1.56 \qquad \text{(Eq 3.5)} \qquad 3.10$$

$$\alpha_j = \alpha + \tau \qquad \text{(Eq 3.6)} \qquad 3.17$$

$$L = L_{aero} + L_{Thrust} \qquad \text{(Eq 3.7)} \qquad 3.17$$

$$L = n_z W \qquad \text{(Eq 3.8)} \qquad 3.17$$

$$L_{Thrust} = T_G \sin \alpha_j \qquad \text{(Eq 3.9)} \qquad 3.17$$

$$L = n_z W = L_{aero} + T_G \sin \alpha_j \qquad \text{(Eq 3.10)} \qquad 3.17$$

$$C_L = \frac{L}{q\,S} = \frac{n_z W}{q\,S} = \frac{L_{aero}}{q\,S} + \frac{T_G \sin \alpha_j}{q\,S} \qquad \text{(Eq 3.11)} \qquad 3.17$$

$$C_L = C_{L_{aero}} + \frac{T_G \sin \alpha_j}{q\,S} \qquad \text{(Eq 3.12)} \qquad 3.17$$

$$C_L = C_{L_{aero}} + \frac{T_G \sin \alpha_j}{\frac{n_z W}{C_L}} \qquad \text{(Eq 3.13)} \qquad 3.18$$

$$C_L = C_{L_{aero}} + C_L \left(\frac{T_G}{W} \frac{\sin \alpha_j}{n_z} \right) \qquad \text{(Eq 3.14)} \qquad 3.18$$

$$C_L\left(1 - \frac{T_G}{W}\frac{\sin\alpha_j}{n_z}\right) = C_{L_{aero}} \qquad \text{(Eq 3.15)} \qquad 3.18$$

$$C_L = \frac{C_{L_{aero}}}{\left(1 - \frac{T_G}{W}\frac{\sin\alpha_j}{n_z}\right)} \qquad \text{(Eq 3.16)} \qquad 3.18$$

$$C_L = f\left(C_{L_{aero}}, \frac{T_G}{W}, \sin\alpha_j, n_z\right) \qquad \text{(Eq 3.17)} \qquad 3.18$$

$$C_{L_{aero}} = f\left(\alpha, M, R_e\right) \qquad \text{(Eq 3.18)} \qquad 3.19$$

$$C_{L_{aero}} = \frac{n_z W}{q S} = \frac{n_z W}{\frac{\gamma}{2} P_{ssl} S \delta M^2} \qquad \text{(Eq 3.19)} \qquad 3.19$$

$$C_{L_{aero}} = \frac{n_z\left(\frac{W}{\delta}\right)}{\left(\frac{\gamma}{2} P_{ssl} S\right) M^2} \qquad \text{(Eq 3.20)} \qquad 3.19$$

$$V_s = V_{s_{Test}}\sqrt{\frac{R+2}{R+1}} \text{ (For decelerations)} \qquad \text{(Eq 3.21)} \qquad 3.21$$

$$C_{L_s} = C_{L_{Test}}\left(\frac{R+1}{R+2}\right) \text{ (For decelerations)} \qquad \text{(Eq 3.22)} \qquad 3.21$$

$$V_s = V_{s_{Test}}\sqrt{\frac{R+1}{R+2}} \text{ (For accelerations)} \qquad \text{(Eq 3.23)} \qquad 3.21$$

$$R = \frac{V_{s_{Test}}}{\frac{c}{2}\dot{V}} \qquad \text{(Eq 3.24)} \qquad 3.21$$

$$C_{L_{max_{Std\,\dot{V}}}} = C_{L_{max}} + K_d\left(\dot{V}_{Std} - \dot{V}_{Test}\right) \qquad \text{(Eq 3.25)} \qquad 3.22$$

$$C_{L_{max}}{}_{Std\,\dot{V},\,CG} = C_{L_{max}}{}_{Std\,\dot{V}} + K_c \left(CG_{Std} - CG_{Test} \right)$$ (Eq 3.26) 3.25

$$\Delta L_t \left(l_t \right) = T_G \, (Z) - D_R \, (Y)$$ (Eq 3.27) 3.26

$$\Delta C_{L_t} = \frac{T_G}{q\,S} \left(\frac{Z}{l_t} \right) - \frac{D_R}{q\,S} \left(\frac{Y}{l_t} \right)$$ (Eq 3.28) 3.26

$$R_e = \frac{\rho\, V\, c}{\mu} = V_e \sqrt{\rho} \left(\frac{\sqrt{\rho_{ssl}}\ c}{\mu} \right)$$ (Eq 3.29) 3.27

$$C_{T_G} = \frac{T_G \sin \alpha_j}{q\,S}$$ (Eq 3.30) 3.29

$$C_{L_{max}}{}_{Std\,\dot{V},\,CG,\,W} = C_{L_{max}}{}_{Std\,\dot{V},\,CG} + K_W \left(W_{Std} - W_{Test} \right)$$ (Eq 3.31) 3.31

$$V_i = V_o + \Delta V_{ic}$$ (Eq 3.32) 3.36

$$V_c = V_i + \Delta V_{pos}$$ (Eq 3.33) 3.36

$$H_{P_i} = H_{P_o} + \Delta H_{P_{ic}}$$ (Eq 3.34) 3.36

$$H_{P_c} = H_{P_i} + \Delta H_{pos}$$ (Eq 3.35) 3.36

$$n_{z_i} = n_{z_o} + \Delta n_{z_{ic}}$$ (Eq 3.36) 3.36

$$n_z = n_{z_i} + \Delta n_{z_{tare}}$$ (Eq 3.37) 3.36

$$C_{L_{max}}{}_{Test} = \frac{n_z\ W_{Test}}{0.7\ P_{ssl}\ \delta_{Test}\ M^2\ S}$$ (Eq 3.38) 3.37

$$R = \frac{V_c}{\frac{c}{2} \dot{V}_{Test}}$$ (Eq 3.39) 3.37

$$C_{L_{max}}{}_{\text{Std } \dot{V}} = C_{L_{max}}{}_{\text{Test}} \left(\frac{R + 1}{R + 2} \right)$$ (Eq 3.40) 3.37

$$\left(C_{L_{aero}}{}_{\text{Std } \dot{V},\ CG,\ W} \right)_{\text{Pwr ON}} = \left(C_{L_{max}}{}_{\text{Std } \dot{V},\ CG,\ W} \right)_{\text{Pwr ON}} - C_{T_G}$$ (Eq 3.41) 3.42

$$\left(C_{L_{aero}}{}_{\text{Std } \dot{V},\ CG,\ W} \right)_{\text{Pwr OFF}} = \left(C_{L_{aero}}{}_{\text{Std } \dot{V},\ CG,\ W} \right)_{\text{Pwr ON}} - \Delta C_{L_t} - \Delta C_{L_E}$$ (Eq 3.42) 3.42

$$V_{e_s} = \sqrt{\frac{841.5\ n_z\ W}{C_{L_{max}}\ S}}$$ (Eq 3.43) 3.44

CHAPTER 4

$$D_p = C_{D_p}\ qS$$ (Eq 4.1) 4.4

$$D_i = L\ \alpha_i = C_L\ q\ S\ \alpha_i$$ (Eq 4.2) 4.5

$$L = C_L\ qS$$ (Eq 4.3) 4.5

$$D_i = C_{D_i}\ qS$$ (Eq 4.4) 4.5

$$\alpha_i = \frac{C_L}{\pi\ AR}$$ (Eq 4.5) 4.5

$$C_{D_i} = \frac{C_L^2}{\pi\ AR}$$ (Eq 4.6) 4.6

$$C_{D_i} = \frac{C_L^2}{\pi\ e\ AR}$$ (Eq 4.7) 4.6

$$D = D_P + D_i + D_M$$ (Eq 4.8) 4.7

$$C_D = C_{D_P} + C_{D_i} + C_{D_M} \qquad \text{(Eq 4.9)} \qquad 4.7$$

$$D = C_D \, qS \qquad \text{(Eq 4.10)} \qquad 4.8$$

$$C_D = C_{D_p} + \frac{C_L^2}{\pi \, e \, AR} \qquad \text{(Eq 4.11)} \qquad 4.8$$

$$D = C_{D_P} \, q \, S + \frac{C_L^2}{\pi \, e \, AR} \, qS \qquad \text{(Eq 4.12)} \qquad 4.8$$

$$L - W + T_G \sin \alpha_j = 0 \qquad \text{(Eq 4.13)} \qquad 4.9$$

$$L = W - T_G \sin \alpha_j \qquad \text{(Eq 4.14)} \qquad 4.9$$

$$C_L = \frac{L}{qS} \qquad \text{(Eq 4.15)} \qquad 4.9$$

$$C_L = \frac{W - T_G \sin \alpha_j}{qS} \qquad \text{(Eq 4.16)} \qquad 4.9$$

$$D = C_{D_P} \, qS + \frac{\left(W - T_G \sin \alpha_j \right)^2}{\pi \, e \, AR \, qS} \qquad \text{(Eq 4.17)} \qquad 4.9$$

$$D = C_{D_P} \, qS \; + \frac{W^2}{\pi \, e \, AR \, qS} \qquad \text{(Eq 4.18)} \qquad 4.9$$

$$q = \frac{1}{2} \rho_{ssl} \, V_e^2 \qquad \text{(Eq 4.19)} \qquad 4.9$$

$$q = \frac{1}{2} \rho_a \, V_T^2 \qquad \text{(Eq 4.20)} \qquad 4.9$$

$$q = \frac{1}{2} \gamma \, P_a \, M^2 \qquad \text{(Eq 4.21)} \qquad 4.10$$

$$D = \frac{C_{D_p} \rho_{ssl} V_e^2 S}{2} + \frac{2 W^2}{\pi e AR S \rho_{ssl} V_e^2}$$ (Eq 4.22) 4.10

$$D = \frac{C_{D_p} \rho_a V_T^2 S}{2} + \frac{2 W^2}{\pi e AR S \rho_a V_T^2}$$ (Eq 4.23) 4.10

$$D = \frac{C_{D_p} \gamma P_a M^2 S}{2} + \frac{2W^2}{\pi e AR S \gamma P_a M^2}$$ (Eq 4.24) 4.10

$$D = \frac{C_{D_{p\,(M)}} \gamma P_a M^2 S}{2} + \frac{2W^2}{\pi e_{(M)} AR S \gamma P_a M^2}$$ (Eq 4.25) 4.12

$$\frac{D}{\delta} = \frac{C_{D_{P(M)}} \gamma P_{ssl} M^2 S}{2} + \frac{2 (W/\delta)^2}{\pi e_{(M)} AR S \gamma P_{ssl} M^2}$$ (Eq 4.26) 4.12

$$\frac{D}{\delta} = f\left(M, \frac{W}{\delta}\right)$$ (Eq 4.27) 4.13

$$\dot{W}_f = f\left(P, \rho, \mu, V, L, N\right)$$ (Eq 4.28) 4.14

$$\frac{\dot{W}_f}{\delta\sqrt{\theta}} = f\left(M, \frac{N}{\sqrt{\theta}}, R_e\right)$$ (Eq 4.29) 4.14

$$\frac{\dot{W}_f}{\delta\sqrt{\theta}} = f\left(M, \frac{N}{\sqrt{\theta}}\right)$$ (Eq 4.30) 4.15

$$\frac{T_{N_x}}{\delta} = f\left(M, \frac{N}{\sqrt{\theta}}\right)$$ (Eq 4.31) 4.15

$$\frac{\dot{W}_f}{\delta\sqrt{\theta}} = f\left(M, \frac{T_{N_x}}{\delta}\right)$$ (Eq 4.32) 4.15

$$T_{N_x} = T_G \cos \alpha_j - T_R$$ (Eq 4.33) 4.15

$$T_{N_x} = D \text{ (For small } \alpha_j \text{, where } \cos \alpha_j \cong 1)$$ (Eq 4.34) 4.15

$$\frac{T_{N_x}}{\delta} = \frac{D}{\delta}$$ (Eq 4.35) 4.15

$$\frac{\dot{W}_f}{\delta\sqrt{\theta}} = f\left(M, \frac{D}{\delta}\right)$$ (Eq 4.36) 4.15

$$\frac{\dot{W}_f}{\delta\sqrt{\theta}} = f\left(M, \frac{W}{\delta}\right)$$ (Eq 4.37) 4.16

$$\theta = \frac{T_a}{T_{ssl}}$$ (Eq 4.38) 4.21

$$\theta_T = \frac{T_T}{T_{ssl}} = \frac{OAT}{T_{ssl}}$$ (Eq 4.39) 4.21

$$\frac{\dot{W}_f}{\delta\sqrt{\theta}} = f\left(M, OAT\right)$$ (Eq 4.40) 4.22

$$T_T = T_a\left(1 + \frac{\gamma - 1}{2} M^2\right)$$ (Eq 4.41) 4.22

$$P_T = P_a\left(1 + \frac{\gamma - 1}{2} M^2\right)^{\frac{\gamma}{\gamma - 1}}$$ (Eq 4.42) 4.22

$$\delta = \frac{P_a}{P_{ssl}}$$ (Eq 4.43) 4.23

$$\delta_T = \frac{P_T}{P_{ssl}} \qquad \text{(Eq 4.44)} \qquad 4.23$$

$$\frac{\theta_T}{\theta} = \left(1 + 0.2\ M^2\right) \qquad \text{(Eq 4.45)} \qquad 4.23$$

$$\frac{\delta_T}{\delta} = \left(1 + 0.2\ M^2\right)^{3.5} \qquad \text{(Eq 4.46)} \qquad 4.23$$

$$\frac{\dot{W}_f}{\delta_T \sqrt{\theta_T}} = f\left(M, OAT\right) \qquad \text{(Eq 4.47)} \qquad 4.23$$

$$TSFC = \frac{\dot{W}_f}{T_{N_x}} \qquad \text{(Eq 4.48)} \qquad 4.25$$

$$T_{N_x} = D \qquad \text{(Eq 4.49)} \qquad 4.26$$

$$\dot{W}_f \approx D \qquad \text{(Eq 4.50)} \qquad 4.26$$

$$S.R. = \frac{nmi}{W_f} \qquad \text{(Eq 4.51)} \qquad 4.28$$

$$S.R. = \frac{V_T}{\dot{W}_f} \qquad \text{(Eq 4.52)} \qquad 4.28$$

$$S.E. = \frac{t}{W_{f_{Used}}} \qquad \text{(Eq 4.53)} \qquad 4.28$$

$$S.E. = \frac{1}{\dot{W}_f} \qquad \text{(Eq 4.54)} \qquad 4.29$$

$$Range = \left(S.R._{avg}\right)\left(Fuel\ Used\right) \qquad \text{(Eq 4.55)} \qquad 4.31$$

$$nmi = \frac{nmi}{lb}\ x\ lb \qquad \text{(Eq 4.56)} \qquad 4.31$$

$$THP = \frac{T\,V_T}{550} = \frac{D\,V_T}{550}$$ (Eq 4.57) 4.33

$$THP = \frac{C_{D_P}\,\rho_a\,V_T^3\,S}{1100} + \frac{W^2}{275\,\pi\,e\,AR\,S\,\rho_a\,V_T}$$ (Eq 4.58) 4.33

$$THP = THP_p + THP_i$$ (Eq 4.59) 4.34

$$D = \frac{C_D}{C_L} W$$ (Eq 4.60) 4.35

$$THP = \frac{C_D\,W\,V_T}{C_L\,550}$$ (Eq 4.61) 4.35

$$L = W = C_L \frac{1}{2}\,\rho_a\,V_T^2\,S$$ (Eq 4.62) 4.35

$$THP = \frac{\left(\frac{2}{S}\right)^{\frac{1}{2}} W^{\frac{3}{2}}\,C_D}{\rho_a^{\frac{1}{2}}\,C_L^{\frac{3}{2}}\,550}$$ (Eq 4.63) 4.35

$$\rho_a = \rho_{ssl}\,\sigma$$ (Eq 4.64) 4.35

$$THP = \frac{\sqrt{2}\,W^{\frac{3}{2}}\,C_D}{\left(S\,\rho_{ssl}\right)^{\frac{1}{2}}\sqrt{\sigma}\;C_L^{\frac{3}{2}}\;550}$$ (Eq 4.65) 4.35

$$THP_e = THP\,\sqrt{\sigma}$$ (Eq 4.66) 4.35

$$THP_e = \frac{\sqrt{2}\,W^{\frac{3}{2}}\,C_D}{\left(S\,\rho_{ssl}\right)^{\frac{1}{2}} C_L^{\frac{3}{2}}\;550}$$ (Eq 4.67) 4.36

$$THP = K_1 V_T^3 + K_2 V_T^{-1} \quad \text{(Eq 4.68)} \quad 4.37$$

$$3 K_1 V_T^2 - K_2 V_T^{-2} = 0 \quad \text{(Eq 4.69)} \quad 4.37$$

$$3 K_1 V_T^3 = K_2 V_T^{-1} \quad \text{(Eq 4.70)} \quad 4.37$$

$$3 THP_p = THP_i \quad \text{(Eq 4.71)} \quad 4.37$$

$$3 D_p = D_i \quad \text{(Eq 4.72)} \quad 4.37$$

$$3 C_{D_p} = C_{D_i} \quad \text{(Eq 4.73)} \quad 4.37$$

$$THP = K_o \frac{C_D}{C_L^{\frac{3}{2}}} \quad \text{(Eq 4.74)} \quad 4.38$$

$$V_T = \frac{V_e}{\sqrt{\sigma}} \quad \text{(Eq 4.75)} \quad 4.39$$

$$THP = \frac{THP_e}{\sqrt{\sigma}} \quad \text{(Eq 4.76)} \quad 4.39$$

$$\sigma = \frac{\rho_a}{\rho_{ssl}} \quad \text{(Eq 4.77)} \quad 4.40$$

$$THP_e V_e = \frac{C_{D_P} \rho_{ssl} V_e^4 S}{1100} + \frac{W^2}{275 \pi e AR S \rho_{ssl}} \quad \text{(Eq 4.78)} \quad 4.40$$

$$\eta_P = \frac{THP}{SHP} \quad \text{(Eq 4.79)} \quad 4.41$$

$$THP = \eta_P SHP \quad \text{(Eq 4.80)} \quad 4.41$$

$$THPSFC = \frac{\dot{W}_f}{THP} \quad \text{(Eq 4.81)} \quad 4.41$$

$$SHPSFC = \frac{\dot{W}_f}{SHP} \qquad \text{(Eq 4.82)} \qquad 4.42$$

$$\dot{W}_f = \frac{THP}{\eta_P}\ SHPSFC \qquad \text{(Eq 4.83)} \qquad 4.42$$

$$\left(\frac{W}{\delta}\right)_{Target} = \frac{W + W_f}{\delta} \qquad \text{(Eq 4.84)} \qquad 4.47$$

$$\left(\frac{W}{\delta}\right)_{Target} = \frac{W_{aircraft} + W_f}{\delta} \qquad \text{(Eq 4.85)} \qquad 4.48$$

$$\delta = \frac{W_{aircraft}}{\left(\frac{W}{\delta}\right)_{Target}} + \frac{1}{\left(\frac{W}{\delta}\right)_{Target}} W_f \qquad \text{(Eq 4.86)} \qquad 4.48$$

$$OAT = T_a\left(1 + \frac{\gamma - 1}{2} K_T M^2\right) \qquad \text{(Eq 4.87)} \qquad 4.48$$

$$H_{P_c} = H_{P_o} + \Delta H_{P_{ic}} + \Delta H_{pos} \qquad \text{(Eq 4.88)} \qquad 4.59$$

$$T_a = T_o + \Delta T_{ic} \qquad \text{(Eq 4.89)} \qquad 4.59$$

$$V_c = V_o + \Delta V_{ic} + \Delta V_{pos} \qquad \text{(Eq 4.90)} \qquad 4.59$$

$$V_T = \frac{V_c}{\sqrt{\sigma}} \qquad \text{(Eq 4.91)} \qquad 4.60$$

$$M = \frac{V_T}{a_{ssl}\sqrt{\theta}} \qquad \text{(Eq 4.92)} \qquad 4.60$$

$$\dot{W}_{f_{ref}} = \frac{\dot{W}_f}{\delta\sqrt{\theta}} \qquad \text{(Eq 4.93)} \qquad 4.60$$

$$W_{ref} = \frac{W}{\delta} \qquad \text{(Eq 4.94)} \qquad 4.60$$

$$R_{Test} = \sum_{j=1}^{n} V_j \Delta t_j \qquad \text{(Eq 4.95)} \qquad 4.63$$

$$R.F._{Test} = \frac{t_T}{\ln\left(\frac{W_1}{W_2}\right)} \qquad \text{(Eq 4.96)} \qquad 4.63$$

$$R_{Std} = R.F._{Test} \ln\left(\frac{W_{Std_1}}{W_{Std_2}}\right) \qquad \text{(Eq 4.97)} \qquad 4.63$$

$$M = f\left(V_c, H_{P_c}\right) \qquad \text{(Eq 4.98)} \qquad 4.66$$

$$\delta = f\left(H_{P_c}\right) \qquad \text{(Eq 4.99)} \qquad 4.67$$

$$\frac{W + W_f}{\delta} = \frac{W}{\delta} \qquad \text{(Eq 4.100)} \qquad 4.67$$

$$\frac{W}{\delta}(\text{error}) = \frac{100\left[\frac{W}{\delta}(\text{test}) - \frac{W}{\delta}(\text{target})\right]}{\frac{W}{\delta}(\text{target})} \qquad \text{(Eq 4.101)} \qquad 4.67$$

$$^{\circ}C = {}^{\circ}K - 273.15 \qquad \text{(Eq 4.102)} \qquad 4.67$$

$$OAT = f\left(T_a, M\right) \qquad \text{(Eq 4.103)} \qquad 4.67$$

$$T_a = f\left(OAT, M\right) \qquad \text{(Eq 4.104)} \qquad 4.67$$

$$S.R.\ \delta = \frac{661.483M}{\left(\frac{\dot{w}_f}{\delta\sqrt{\theta}}\right)} \qquad \text{(Eq 4.105)} \qquad 4.68$$

$$V_e = \sqrt{\frac{2q}{\rho_{ssl}}} = \sqrt{\frac{\sigma 2q}{\rho_a}} = \sqrt{\sigma}\ V_T \qquad \text{(Eq 4.106)} \qquad 4.73$$

$$SHP_e = SHP\sqrt{\sigma} \qquad \text{(Eq 4.107)} \qquad 4.73$$

$$T_a = T_{a_{Std}} + \Delta T_a \qquad \text{(Eq 4.108)} \qquad 4.78$$

$$S.R. = \frac{a_{ssl} M}{\left(\frac{\dot{W}_f}{\delta\sqrt{\theta}}\right)\delta} \qquad \text{(Eq 4.109)} \qquad 4.78$$

$$V_{T_{Hot\ day}} = 661.483\ M \sqrt{\theta_{Std}} \left(\frac{\sqrt{\theta_{Hot\ day}}}{\sqrt{\theta_{Std}}}\right) \qquad \text{(Eq 4.110)} \qquad 4.81$$

$$\dot{W}_{f_{Hot\ day}} = \dot{W}_{f_{Std}} \left(\frac{\sqrt{\theta_{Hot\ day}}}{\sqrt{\theta_{Std}}}\right) \qquad \text{(Eq 4.111)} \qquad 4.82$$

$$\frac{\dot{W}_f}{\sqrt{\theta}} = ¢ \qquad \text{(Eq 4.112)} \qquad 4.82$$

$$Range = \int_0^{W_{f_{Used}}} (S.R.)\, dW_f \qquad \text{(Eq 4.113)} \qquad 4.86$$

$$Range = \int_{W_1}^{W_2} (S.R.)\, dW \qquad \text{(Eq 4.114)} \qquad 4.87$$

$$Range = \int_{W_1}^{W_2} (S.R.\ \delta)\left(\frac{W}{\delta}\right)\frac{1}{W}\, dW \qquad \text{(Eq 4.115)} \qquad 4.87$$

$$Range = \int_{W_1}^{W_2} \left[\frac{661.483\ M}{\left(\frac{\dot{W}_f}{\delta\sqrt{\theta}}\right)}\frac{W}{\delta}\right]\frac{dW}{W} \qquad \text{(Eq 4.116)} \qquad 4.87$$

$$\frac{D}{\delta} = K_3 + K_4\left(\frac{W}{\delta}\right)^2 \qquad \text{(Eq 4.117)} \qquad 4.88$$

$$\text{R.F.} = \left[(\text{S.R. } \delta) \frac{W}{\delta} \right] \qquad \text{(Eq 4.118)} \qquad 4.90$$

$$\text{R.F.} = \left[\frac{661.483\ M}{\left(\frac{\dot{W}_f}{\delta \sqrt{\theta}} \right)} \left(\frac{W}{\delta} \right) \right] \qquad \text{(Eq 4.119)} \qquad 4.90$$

$$\text{Range} = \int_{W_1}^{W_2} (\text{R.F.}) \frac{dW}{W} \qquad \text{(Eq 4.120)} \qquad 4.90$$

$$C_L = \frac{2\ W}{\gamma\ P_a\ M^2\ S} = \frac{2 \frac{W}{\delta}}{\gamma\ M^2\ S\ P_{ssl}} \qquad \text{(Eq 4.121)} \qquad 4.101$$

$$C_L = f\left(\frac{W}{\delta}, M^2 \right) \qquad \text{(Eq 4.122)} \qquad 4.101$$

$$\frac{\frac{W}{\delta}}{\frac{D}{\delta}} = \frac{W}{D} = \text{Constant} \qquad \text{(Eq 4.123)} \qquad 4.101$$

$$\frac{661.483\ M}{\left(\frac{\dot{W}_f}{\delta \sqrt{\theta}} \right)} = \text{Constant} \qquad \text{(Eq 4.124)} \qquad 4.102$$

$$\frac{TSFC}{\sqrt{\theta}} = \text{Constant} \qquad \text{(Eq 4.125)} \qquad 4.102$$

$$\text{Range} = \text{R.F. ln} \frac{W_1}{W_2} \qquad \text{(Eq 4.126)} \qquad 4.105$$

CHAPTER 5

$TE = PE + KE$	(Eq 5.1)	5.2
$PE = \int_{o}^{h} W\, dh$	(Eq 5.2)	5.2
$PE = W \left(H_{P_c} + \Delta T \text{ correction} \right)$	(Eq 5.3)	5.2
$KE = \frac{1}{2} \frac{W}{g} V_T^2$	(Eq 5.4)	5.3
$TE = W\, h + \frac{1}{2} \frac{W}{g} V_T^2$	(Eq 5.5)	5.3
$\frac{TE}{W} = h + \frac{V_T^2}{2\, g}$	(Eq 5.6)	5.3
$E_h = h + \frac{V_T^2}{2\, g}$	(Eq 5.7)	5.3
$\frac{d}{dt} E_h = \frac{d}{dt} \left(h + \frac{V_T^2}{2\, g} \right)$	(Eq 5.8)	5.7
$\frac{d}{dt} E_h = \frac{dh}{dt} + \frac{V_T}{g} \frac{dV_T}{dt}$	(Eq 5.9)	5.7
$\sum F_x = \frac{W}{g} \frac{dV_T}{dt}$	(Eq 5.10)	5.8
$T_{N_x} = T_G \cos \alpha_j - T_R$	(Eq 5.11)	5.8
$T_{N_x} - D - W \sin \gamma = \frac{W}{g} \frac{dV_T}{dt}$	(Eq 5.12)	5.8
$\sin \gamma = \frac{V_T \text{ (vertical)}}{V_T \text{ (flight path)}} = \frac{\frac{dh}{dt}}{V_T}$	(Eq 5.13)	5.9

$$T_{N_x} - D - W \frac{dh}{dt} \frac{1}{V_T} = \frac{W}{g} \frac{dV_T}{dt}$$ (Eq 5.14) 5.9

$$\frac{V_T \left(T_{N_x} - D \right)}{W} - \frac{dh}{dt} = \frac{V_T}{g} \frac{dV_T}{dt}$$ (Eq 5.15) 5.9

$$\frac{V_T \left(T_{N_x} - D \right)}{W} = \frac{dE_h}{dt}$$ (Eq 5.16) 5.9

$$P_s = \frac{V_T \left(T_{N_x} - D \right)}{W}$$ (Eq 5.17) 5.9

$$P_s = \frac{dE_h}{dt}$$ (Eq 5.18) 5.10

$$P_s = \frac{dh}{dt} + \frac{V_T}{g} \frac{dV_T}{dt}$$ (Eq 5.19) 5.10

$$P_s = \frac{V_T \left(T_{N_x} - D - \Delta D_i \right)}{W}$$ (Eq 5.20) 5.13

$$P_s = \frac{V_T \left(T_{N_x} - D - \Delta D_i \right)}{W + \Delta W}$$ (Eq 5.21) 5.15

$$P_s = \frac{V_T \left(T_{N_x} - D - \Delta D_p \right)}{W}$$ (Eq 5.22) 5.16

$$P_s = \frac{V_T \left(T_{N_x} + \Delta T_{N_x} - D \right)}{W}$$ (Eq 5.23) 5.17

$$P_s = \frac{\left(P_A - \Delta P_A \right) - \left(P_{req} + \Delta P_{req} \right)}{W}$$ (Eq 5.24) 5.19

$$q_c = P_{ssl}\left\{\left[1 + 0.2\left(\frac{V_c}{a_{ssl}}\right)^2\right]^{3.5} - 1\right\}$$ (Eq 5.25) 5.28

$$P_a = P_{ssl}\left(1 - 6.8755856 \times 10^{-6} H_{P_c}\right)^{5.255863}$$ (Eq 5.26) 5.28

$$M = \sqrt{\frac{2}{\gamma - 1}\left[\left(\frac{q_c}{P_a} + 1\right)^{\frac{\gamma - 1}{\gamma}} - 1\right]}$$ (Eq 5.27) 5.28

$$T_a = \frac{OAT + 273.15}{1 + \frac{\gamma - 1}{2} K_T M^2}$$ (Eq 5.28) 5.28

$$h = H_{P_c}\frac{T_{a_{Test}}}{T_{a_{Std}}}$$ (Eq 5.29) 5.28

$$V_T = M\sqrt{\gamma g_c R T_a}$$ (Eq 5.30) 5.28

$$\frac{W_{Test}}{W_{Std}}$$ (Eq 5.31) 5.31

$$\frac{V_{T_{Std}}}{V_{T_{Test}}} = \frac{M_{Std}\sqrt{\theta_{Std}}}{M_{Test}\sqrt{\theta_{Test}}}$$ (Eq 5.32) 5.32

$$\frac{V_{T_{Std}}}{V_{T_{Test}}} = \sqrt{\frac{T_{a_{Std}}}{T_{a_{Test}}}}$$ (Eq 5.33) 5.32

$$\Delta T = f\left(T_a\right)$$ (Eq 5.34) 5.32

$$\Delta D = D_{Std} - D_{Test} = \frac{2\left(W_{Std}^2 - W_{Test}^2\right)}{\pi\, e\, AR\, S\, \gamma\, P_a\, M^2}$$ (Eq 5.35) 5.32

$$P_{s_{Std}} = P_{s_{Test}} \frac{W_{Test}}{W_{Std}} \sqrt{\frac{T_{a_{Std}}}{T_{a_{Test}}}} + \frac{V_{T_{Std}}}{W_{Std}} (\Delta T_{N_x} - \Delta D)$$ (Eq 5.36) 5.32

$$V_c = V_i + \Delta V_{pos}$$ (Eq 5.37) 5.36

$$H_{P_c} = H_{P_i} + \Delta H_{pos}$$ (Eq 5.38) 5.36

$$M = f\left(V_c , H_{P_c}\right)$$ (Eq 5.39) 5.37

$$W_{Test} = \text{Initial W} - \int \dot{W}_f \, dt$$ (Eq 5.40) 5.37

$$°C = °K - 273.15$$ (Eq 5.41) 5.37

$$OAT = f\left(T_a , M_T\right)$$ (Eq 5.42) 5.37

$$T_a = f\left(OAT, M\right)$$ (Eq 5.43) 5.37

$$V_{T_{Test}} = f\left(V_c , H_{P_c} , T_a\right)$$ (Eq 5.44) 5.37

$$V_{T_{Std}} = f\left(V_c, H_{p_c}, T_{Std}\right)$$ (Eq 5.45) 5.37

$$h = H_{P_{c_{ref}}} + \Delta H_{P_c} \left(\frac{T_a}{T_{Std}}\right)$$ (Eq 5.46) 5.37

$$E_h = h + \frac{V^2_{T_{Test}}}{2g}$$ (Eq 5.47) 5.38

$$P_{s_{Test}} = \frac{dE_h}{dt}$$ (Eq 5.48) 5.38

$$\gamma_{Test} = \sin^{-1}\left(\frac{dh/dt}{V_{T_{Test}}}\right)$$ (Eq 5.49) 5.38

$$CCF = 1 + \left(\frac{V_{T_{Std}}}{g} \frac{dV}{dh} \right)$$ (Eq 5.50) 5.38

$$P_{s_{Std}} = P_{s_{Test}} \left(\frac{W_{Test}}{W_{Std}} \right) \left(\frac{V_{T_{Std}}}{V_{T_{Test}}} \right) + \left(\frac{V_{T_{Std}}}{W_{Std}} \right) (\Delta T_{N_x} - \Delta D)$$ (Eq 5.51) 5.38

$$\left(\frac{dh}{dt} \right)_{Std} = \frac{P_{s_{Std}}}{CCF}$$ (Eq 5.52) 5.38

$$\gamma_{Std} = \sin^{-1} \left(\frac{\left(\frac{dh}{dt} \right)_{Std}}{V_{T_{Std}}} \right)$$ (Eq 5.53) 5.39

$$\left| \gamma_{Test} - \gamma_{Std} \right| < 0.1$$ (Eq 5.54) 5.39

CHAPTER 6

$$n_z = \frac{L}{W}$$ (Eq 6.1) 6.3

$$L^2 = W^2 + (W \tan \phi)^2$$ (Eq 6.2) 6.3

$$n_z^2 = 1 + \tan^2 \phi$$ (Eq 6.3) 6.3

$$\tan \phi = \sqrt{\left(n_z^2 - 1 \right)}$$ (Eq 6.4) 6.4

$$L \cos \phi = W$$ (Eq 6.5) 6.4

$$n_z = \frac{1}{\cos \phi}$$ (Eq 6.6) 6.4

$$W \tan \phi = \frac{W}{g} a_R$$ (Eq 6.7) 6.4

$$a_R = g \tan \phi$$ (Eq 6.8) 6.4

$$a_R = g\sqrt{\left(n_z^2 - 1\right)} \qquad \text{(Eq 6.9)} \qquad 6.4$$

$$R = \frac{V_T^2}{a_R} \qquad \text{(Eq 6.10)} \qquad 6.5$$

$$R = \frac{V_T^2}{g \tan \phi} \qquad \text{(Eq 6.11)} \qquad 6.5$$

$$R = \frac{V_T^2}{g\sqrt{\left(n_z^2 - 1\right)}} \qquad \text{(Eq 6.12)} \qquad 6.6$$

$$\omega = \frac{V_T}{R} \qquad \text{(Eq 6.13)} \qquad 6.6$$

$$\omega = \frac{g}{V_T} \tan \phi \qquad \text{(Eq 6.14)} \qquad 6.6$$

$$\omega = \frac{g}{V_T}\sqrt{\left(n_z^2 - 1\right)} \qquad \text{(Eq 6.15)} \qquad 6.6$$

$$\phi = \tan^{-1}\left(\frac{F_Y}{W}\right) \qquad \text{(Eq 6.16)} \qquad 6.8$$

$$L = \frac{W}{\cos \phi} \qquad \text{(Eq 6.17)} \qquad 6.8$$

$$\Delta L = F_Y \tan \phi \qquad \text{(Eq 6.18)} \qquad 6.9$$

$$F_R = W \tan \phi + \frac{F_Y}{\cos \phi} \qquad \text{(Eq 6.19)} \qquad 6.10$$

$$n_R = \tan \phi + \frac{n_Y}{\cos \phi} \qquad \text{(Eq 6.20)} \qquad 6.10$$

$$\phi_E = \tan^{-1}\left(\tan \phi + \frac{n_Y}{\cos \phi}\right) \qquad \text{(Eq 6.21)} \qquad 6.10$$

$$R = \frac{V_T^2}{g\left(\tan\phi + \frac{n_Y}{\cos\phi}\right)}$$ (Eq 6.22) 6.10

$$\omega = \frac{g\left(\tan\phi + \frac{n_Y}{\cos\phi}\right)}{V_T}$$ (Eq 6.23) 6.10

$$\Delta\omega = \frac{g\, n_Y}{V_T \cos\phi}$$ (Eq 6.24) 6.10

$$n_R = n_z - \cos\gamma$$ (Eq 6.25) 6.12

$$R_{(\text{wings level})} = \frac{V_T^2}{g\left(n_z - \cos\gamma\right)}$$ (Eq 6.26) 6.12

$$\omega_{(\text{wings level})} = \frac{g\left(n_z - \cos\gamma\right)}{V_T}$$ (Eq 6.27) 6.12

$$L = C_L q S + T_G \sin\alpha_j$$ (Eq 6.28) 6.16

$$n_z = \frac{C_L q}{W/S} + \frac{T_G}{W}\sin\alpha_j$$ (Eq 6.29) 6.16

$$n_{z_{max}} = \frac{C_{L_{max}} q}{(W/S)_{min}}$$ (Eq 6.30) 6.17

$$n_{z_{max}} = \frac{C_{L_{max}}}{(W/S)_{min}}\ 0.7\ P_a M^2$$ (Eq 6.31) 6.17

$$n_{z_{max}} = K M^2$$ (Eq 6.32) 6.17

$$K = \frac{0.7}{(W/S)}\ C_{L_{max}} P_a$$ (Eq 6.33) 6.17

$$\frac{1}{V_s^{\,2}\,(1g)} = \frac{n_L}{V_A^{\,2}} \qquad \text{(Eq 6.34)} \qquad 6.18$$

$$V_A = V_{s_{(1g)}}\sqrt{n_L} \qquad \text{(Eq 6.35)} \qquad 6.18$$

$$R = \frac{a^2\,M^2}{g\sqrt{K^2\,M^4 - 1}} \qquad \text{(Eq 6.36)} \qquad 6.20$$

$$\omega = \frac{g\sqrt{K^2\,M^4 - 1}}{a\,M} \qquad \text{(Eq 6.37)} \qquad 6.21$$

$$K = \frac{0.7}{(W/S)}\,C_{L_{max}}\,P_a \qquad \text{(Eq 6.38)} \qquad 6.21$$

$$R_{min_{V>V_A}} = \left(\frac{a^2}{g\sqrt{n_L^2 - 1}}\right) M^2 \qquad \text{(Eq 6.39)} \qquad 6.23$$

$$\omega_{max_{V>V_A}} = \left(\frac{g\sqrt{n_L^2 - 1}}{a}\right)\frac{1}{M} \qquad \text{(Eq 6.40)} \qquad 6.23$$

$$D = \frac{C_D}{C_L}\,L \qquad \text{(Eq 6.41)} \qquad 6.29$$

$$T = \frac{C_D}{C_L}\,n_z W \qquad \text{(Eq 6.42)} \qquad 6.29$$

$$n_z = \frac{T}{W}\,\frac{C_L}{C_D} \qquad \text{(Eq 6.43)} \qquad 6.29$$

$$n_{z_{sust_{max}}} = \frac{T}{W}\left(\frac{C_L}{C_D}\right)_{max} \quad (\text{Jet}) \qquad \text{(Eq 6.44)} \qquad 6.29$$

$$n_z = \frac{T\left(V_T\right)}{W} \quad \frac{L}{D\left(V_T\right)}$$

(Eq 6.45) 6.29

$$n_{z_{sust_{max}}} = \frac{THP_{avail}}{W} \quad \frac{L}{\left(THP_{req}\right)_{min}} \qquad \left(\text{Propeller}\right)$$

(Eq 6.46) 6.30

$$\omega_{sust} = \frac{57.3\ g}{V_T} \sqrt{n_{z_{sust}}^{2} - 1} \qquad \text{(deg/s)}$$

(Eq 6.47) 6.30

$$R_{sust} = \frac{V_T^{\ 2}}{g\sqrt{n_{z_{sust}}^{2} - 1}}$$

(Eq 6.48) 6.30

$$\frac{T}{\delta} = f\left(M, \frac{\dot{W}_f}{\delta_T \sqrt{\theta_T}}\right)$$

(Eq 6.49) 6.32

$$\frac{\Delta D}{\delta} = \frac{\Delta T}{\delta}$$

(Eq 6.50) 6.33

$$\Delta D_{Std\text{-}Test} = \frac{1}{\pi e AR\ S\ (0.7)\ P_{ssl}\ \delta_{Test}\ M^2} \left[\left(n_z W\right)^2_{Std} - \left(n_z W\right)^2_{Test} \right]$$

(Eq 6.51) 6.34

$$n_{z_{Std}} = \sqrt{\frac{1}{W^2_{Std}} \left[\left(n_z W\right)^2_{Test} + \Delta T\ \pi\ e\ AR\ (0.7)\ S\ P_{ssl}\ \delta_{Test}\ M^2 \right]}$$

(Eq 6.52) 6.34

$$n_{z_{Std}} = n_{z_{Test}} \left(\frac{W_{Test}}{W_{Std}} \right)$$

(Eq 6.53) 6.35

$$T_{ex} = T - D = \frac{W}{V_T} \frac{dh}{dt} + \frac{W}{g} \frac{dV_T}{dt}$$

(Eq 6.54) 6.38

$$\frac{dV_T}{dt} = \frac{11.3\ P_s}{V_T} \qquad \text{(Eq 6.55)} \qquad 6.48$$

$$n_z = n_{z_o} + \Delta n_{ic} + \Delta n_{z\ tare} \qquad \text{(Eq 6.56)} \qquad 6.57$$

$$V_i = V_o + \Delta V_{ic} \qquad \text{(Eq 6.57)} \qquad 6.63$$

$$V_c = V_i + \Delta V_{pos} \qquad \text{(Eq 6.58)} \qquad 6.63$$

$$H_{P_i} = H_{P_o} + \Delta H_{P_{ic}} \qquad \text{(Eq 6.59)} \qquad 6.63$$

$$H_{P_c} = H_{P_i} + \Delta H_{pos} \qquad \text{(Eq 6.60)} \qquad 6.63$$

$$n_{z_i} = n_{z_o} + \Delta n_{z_{ic}} \qquad \text{(Eq 6.61)} \qquad 6.63$$

$$n_{z_{Test}} = n_{z_i} + \Delta n_{z_{tare}} \qquad \text{(Eq 6.62)} \qquad 6.63$$

$$C_{L_{max_{Test}}} = \frac{n_{z\ Test}\ W_{Test}}{0.7\ P_{ssl}\ \delta_{Test}\ M^2\ S} \qquad \text{(Eq 6.63)} \qquad 6.63$$

$$V_T = a\ M \qquad \text{(Eq 6.64)} \qquad 6.64$$

$$\Delta T = T_{Std} - T \qquad \text{(Eq 6.65)} \qquad 6.66$$

$$n_{z_{sust}} = \sqrt{\frac{P_{s_{1g}}\ \pi\ e\ AR\ S\ \ 0.7\ P_{ssl}\delta\ M^2}{V_T W_{Std}}} + 1 \qquad \text{(Eq 6.66)} \qquad 6.68$$

$$T_{ex} = T - D = \frac{W_{Std}}{V_T}\ P_{s_{1g}} \qquad \text{(Eq 6.67)} \qquad 6.68$$

$$n_{z_{sust}} = \sqrt{\left(\frac{n_z W_{Std}}{\delta M}\right)^2\ \ \frac{\delta_h}{W_{Std}}\ M} \qquad \text{(Eq 6.68)} \qquad 6.68$$

$$n_z = \left(\frac{\delta}{W}\right)\left(0.7\ P_{ssl}\ S\right) C_L M^2 \qquad \text{(Eq 6.69)} \qquad 6.71$$

$$\left(n_z \frac{W}{\delta}\right)_{Test} = \left(0.7\ P_{ssl}\ S\right) C_L M^2 \qquad \text{(Eq 6.70)} \qquad 6.71$$

CHAPTER 7

$$E_h = h + \frac{V_T^2}{2g} \qquad \text{(Eq 7.1)} \qquad 7.2$$

$$P_s = \frac{dE}{dt}h = \frac{dh}{dt} + \frac{V_T}{g}\frac{dV_T}{dt} \qquad \text{(Eq 7.2)} \qquad 7.2$$

$$\frac{dV}{dt} = \frac{dV}{dh}\frac{dh}{dt} \qquad \text{(Eq 7.3)} \qquad 7.2$$

$$P_s = \frac{dh}{dt} + \frac{V}{g}\frac{dV}{dh}\frac{dh}{dt} \qquad \text{(Eq 7.4)} \qquad 7.3$$

$$P_s = \frac{dh}{dt}\left[1 + \frac{V}{g}\frac{dV}{dh}\right] \qquad \text{(Eq 7.5)} \qquad 7.3$$

$$\frac{dh}{dt} = P_s\left[\frac{1}{1 + \frac{V_T}{g}\frac{dV}{dh}}\right] \qquad \text{(Eq 7.6)} \qquad 7.3$$

$$CCF = \frac{1}{1 + \frac{V_T}{g}\frac{dV}{dh}} \qquad \text{(Eq 7.7)} \qquad 7.3$$

$$L - W\cos\gamma + T_G \sin\alpha_j = \frac{W}{g}\ a_z \qquad \text{(Eq 7.8)} \qquad 7.5$$

$$T_G \cos\alpha_j - T_R - D - W\sin\gamma = \frac{W}{g}\ a_x \qquad \text{(Eq 7.9)} \qquad 7.5$$

$$L = W\cos\gamma \qquad \text{(Eq 7.10)} \qquad 7.5$$

$$T_G \cos\alpha_j - T_R - D - W\sin\gamma = \frac{W}{g}\frac{dV_T}{dt} = 0 \qquad \text{(Eq 7.11)} \qquad 7.6$$

$$T_{N_x} = T_G \cos \alpha_j - T_R$$ (Eq 7.12) 7.6

$$T_{N_x} - D = W \sin \gamma$$ (Eq 7.13) 7.6

$$\gamma = \sin^{-1} \left[\frac{T_{N_x} - D}{W} \right]$$ (Eq 7.14) 7.6

$$V \sin \gamma = \frac{\left[T_{N_x} - D \right]}{W} \quad V = \frac{dh}{dt} = V_v$$ (Eq 7.15) 7.6

$$ROC = \frac{dh}{dt} = \frac{\left[T_{N_x} - D \right]}{W} V = \frac{T_{N_x} V - D V}{W} = \frac{P_A - P_{req}}{W}$$ (Eq 7.16) 7.10

$$t = \int_0^h \frac{1}{\frac{dh}{dt}} dh = \int_0^h \frac{1}{ROC} dh$$ (Eq 7.17) 7.12

$$V_v = V_T \sin \gamma$$ (Eq 7.18) 7.14

$$V_{hor} = V_T \cos \gamma$$ (Eq 7.19) 7.14

$$\text{Rate of Climb} = P_s \left(\frac{1}{1 + \frac{V}{g} \frac{dV_T}{dh}} \right)$$ (Eq 7.20) 7.20

$$\text{Time to Climb} = \int_{h_1}^{h_2} \frac{\left(1 + \frac{V}{g} \frac{dV_T}{dh} \right)}{P_s} dh$$ (Eq 7.21) 7.20

$$dt = \frac{dh + \frac{V}{g} dV_T}{P_s}$$ (Eq 7.22) 7.21

$$dE_h = dh + \frac{V}{g} dV$$ (Eq 7.23) 7.21

$$dt = \frac{dE_h}{P_s}$$ (Eq 7.24) 7.21

$$\text{Time to Climb} = \int_{E_{h_1}}^{E_{h_2}} \frac{1}{P_s} dE_h \qquad \text{(Eq 7.25)} \qquad 7.21$$

$$\frac{dE_h}{dW} = \frac{d}{dW}\left(h + \frac{V_T^2}{2g}\right) = \frac{dh}{dW} + \frac{V_T}{g}\frac{dV_T}{dW} \qquad \text{(Eq 7.26)} \qquad 7.25$$

$$\text{Fuel to Climb} = \int_{W_1}^{W_2} dW = -\int_{E_{h_1}}^{E_{h_2}} \frac{1}{\frac{dE_h}{dW}}\, dE_h \qquad \text{(Eq 7.27)} \qquad 7.25$$

$$-\frac{1}{\frac{dE_h}{dW}} = -\frac{dW}{dE_h} = -\frac{dW}{dt}\frac{dt}{dE_h} = \frac{\dot{W}_f}{P_s} \qquad \text{(Eq 7.28)} \qquad 7.25$$

$$\text{Fuel to Climb} = \int_{E_{h_1}}^{E_{h_2}} \frac{\dot{W}_f}{P_s}\, dE_h = \int_{E_{h_1}}^{E_{h_2}} \frac{1}{\frac{P_s}{\dot{W}_f}}\, dE_h \qquad \text{(Eq 7.29)} \qquad 7.26$$

$$E_{h_{Test}} = h_{Test} + \frac{V_{T_{Test}}^2}{2g} \qquad \text{(Eq 7.30)} \qquad 7.37$$

$$\left(\frac{dh}{dt}\right)_{Test} = P_{s_{Test}}\left(\frac{1}{1 + \frac{V_{T_{ref}}}{g}\frac{dV_T}{dh}}\right) \qquad \text{(Eq 7.31)} \qquad 7.38$$

$$P_{s_{Std}} = P_{s_{Test}} \frac{W_{Test}}{W_{Std}} \frac{V_{T_{Std}}}{V_{T_{Test}}} + \frac{V_{T_{Std}}}{W_{Std}} (\Delta T_{N_x} - \Delta D) \qquad \text{(Eq 7.32)} \qquad 7.38$$

$$\Delta D = D_{Std} - D_{Test} = \frac{2\left(W_{Std}^2 - W_{Test}^2\right)}{\pi\, e\, AR\, S\, \gamma\, P_a\, M^2} \qquad \text{(Eq 7.33)} \qquad 7.39$$

$$L = n_z W \qquad \text{(Eq 7.34)} \qquad 7.40$$

$$n_z = \cos \gamma \qquad \text{(Eq 7.35)} \qquad 7.40$$

$$\Delta D = \frac{2\left(W_{Std}^2 \cos^2\gamma_{Std} - W_{Test}^2 \cos^2\gamma_{Test}\right)}{\pi\, e\, AR\, \rho_{ssl}\, V_e^2\, S} \qquad \text{(Eq 7.36)} \qquad 7.40$$

$$\Delta D = \frac{2\left(W_{Std}^2 n_{z\,Std}^2 - W_{Test}^2 n_{z\,Test}^2\right)}{\pi\, e\, AR\, \rho_{ssl}\, V_e^2\, S} \qquad \text{(Eq 7.37)} \qquad 7.40$$

$$\left(\frac{dh}{dt}\right)_{Std} = P_{s_{Std}} \left(\frac{1}{1 + \frac{V_T}{g}\frac{dV_T}{dh}}\right) \qquad \text{(Eq 7.38)} \qquad 7.41$$

$$\gamma_{Std} = \sin^{-1}\left(\frac{\frac{dh}{dt}}{V_T}\right) \qquad \text{(Eq 7.39)} \qquad 7.41$$

$$L = W \cos\gamma - T_G \sin\alpha_j \qquad \text{(Eq 7.40)} \qquad 7.42$$

$$n_z = \frac{L}{W} \qquad \text{(Eq 7.41)} \qquad 7.42$$

$$n_z = \cos\gamma - \frac{T_G}{W}\sin\alpha_j \qquad \text{(Eq 7.42)} \qquad 7.42$$

$$\Delta T_N = f\left(\Delta H_P, \Delta T_a\right) \qquad \text{(Eq 7.43)} \qquad 7.44$$

$$\text{Distance} = \int_{t_1}^{t_2} V_T \cos\gamma\, dt \qquad \text{(Eq 7.44)} \qquad 7.46$$

$$\text{Fuel Used} = \int_{t_1}^{t_2} \dot{W}_f\, dt \qquad \text{(Eq 7.45)} \qquad 7.47$$

$$^{\circ}C = {}^{\circ}K - 273.15 \qquad \text{(Eq 7.46)} \qquad 7.52$$

$$OAT = f\left(T_a, M\right)$$ (Eq 7.47) 7.52

$$T_a = f\left(OAT, M\right)$$ (Eq 7.48) 7.52

$$V_T = f\left(OAT, M_T\right)$$ (Eq 7.49) 7.53

$$h = H_{P_{c\ ref}} + \Delta H_{P_c}\left(\frac{T_a}{T_{std}}\right)$$ (Eq 7.50) 7.53

CHAPTER 8

$$\sum F_z = L = W \cos\gamma$$ (Eq 8.1) 8.3

$$\sum F_x = D = W \sin\gamma$$ (Eq 8.2) 8.3

$$\frac{L}{D} = \frac{\cos\gamma}{\sin\gamma} = \cot\gamma$$ (Eq 8.3) 8.3

$$V_{hor} = V_T \cos\gamma$$ (Eq 8.4) 8.3

$$V_v = V_T \sin\gamma$$ (Eq 8.5) 8.3

$$\frac{V_{hor}}{V_v} = \frac{V_T \cos\gamma}{V_T \sin\gamma} = \cot\gamma = \frac{L}{D}$$ (Eq 8.6) 8.3

$$\sin\gamma = \frac{V_v}{V_T}$$ (Eq 8.7) 8.3

$$\gamma = \sin^{-1}\left(\frac{V_v}{V_T}\right)$$ (Eq 8.8) 8.4

$$\gamma = \sin^{-1}\left(\frac{dh/dt}{V_T}\right)$$ (Eq 8.9) 8.4

$$\frac{L}{D} = \cot\left[\sin^{-1}\left(\frac{dh/dt}{V_T}\right)\right]$$ (Eq 8.10) 8.4

$$\text{Glide Ratio} = \frac{L}{D} = \frac{V_T \cos\gamma}{V_v} \qquad \text{(Eq 8.11)} \qquad 8.4$$

$$GR = \frac{L}{D} \approx \frac{V_T}{V_v} \qquad \text{(Eq 8.12)} \qquad 8.4$$

$$V_T = \sqrt{V_T^2 \sin^2\gamma + V_T^2 \cos^2\gamma} = \sqrt{V_T^2\left(\sin^2\gamma + \cos^2\gamma\right)} \qquad \text{(Eq 8.13)} \qquad 8.5$$

$$\sum F_x = W \sin\gamma - D = \frac{W}{g}\frac{dV_T}{dt} \qquad \text{(Eq 8.14)} \qquad 8.10$$

$$\frac{D}{W} = \sin\gamma - \frac{1}{g}\frac{dV_T}{dt} \qquad \text{(Eq 8.15)} \qquad 8.10$$

$$\frac{dV_T}{dt} = \frac{dV_T}{dh}\frac{dh}{dt} \qquad \text{(Eq 8.16)} \qquad 8.10$$

$$\frac{D}{W} = \sin\gamma - \frac{1}{g}\frac{dV_T}{dh}\frac{dh}{dt} \qquad \text{(Eq 8.17)} \qquad 8.10$$

$$\frac{dh}{dt} = V_T \sin\gamma \qquad \text{(Eq 8.18)} \qquad 8.11$$

$$\frac{D}{W} = \sin\gamma - \frac{1}{g}\frac{dV_T}{dh} V_T \sin\gamma \qquad \text{(Eq 8.19)} \qquad 8.11$$

$$\frac{L}{W} = \cos\gamma \qquad \text{(Eq 8.20)} \qquad 8.11$$

$$\frac{L}{D} = \cot\gamma \left[\frac{1}{1 - \frac{V_T}{g}\frac{dV_T}{dh}}\right] \qquad \text{(Eq 8.21)} \qquad 8.11$$

$$\frac{L}{D} = \cot\left[\sin^{-1}\left(\frac{(dh/dt)}{V_T}\right)\right]\left[\frac{1}{1 - \frac{V_T}{g}\frac{dV_T}{dh}}\right] \qquad \text{(Eq 8.22)} \qquad 8.11$$

$$\frac{L}{D} = \left[\frac{GR}{1 - \frac{V_T}{g}\frac{dV_T}{dh}}\right] \qquad \text{(Eq 8.23)} \qquad 8.12$$

$$GR = \frac{L}{D}\left[1 - \frac{V_T}{g}\frac{dV_T}{dh}\right]$$ (Eq 8.24) 8.12

$$V_c = V_i + \Delta V_{pos}$$ (Eq 8.25) 8.29

$$H_{P_c} = H_{P_i} + \Delta H_{pos}$$ (Eq 8.26) 8.29

$$T_a(°C) = T_a(°K) - 273.15$$ (Eq 8.27) 8.29

$$OAT = f\left(T_a, M_T\right)$$ (Eq 8.28) 8.29

$$T_a = f\left(OAT, M_T\right)$$ (Eq 8.29) 8.29

$$V_{T_{Test}} = f\left(V_c, H_{P_c}, T_a\right)$$ (Eq 8.30) 8.29

$$V_{T_{Std}} = f\left(V_c, H_{P_c}, T_{Std}\right)$$ (Eq 8.31) 8.29

$$h = H_{P_{c\ ref}} + \Delta H_{P_c}\left(\frac{T_a}{T_{Std}}\right)$$ (Eq 8.32) 8.29

$$E_h = h + \frac{V^2_{T_{Test}}}{2g}$$ (Eq 8.33) 8.30

$$P_{s_{Test}} = \frac{dE_h}{dt}$$ (Eq 8.34) 8.30

$$P_{s_{Std}} = P_{s_{Test}}\left(\frac{W_{Test}}{W_{Std}}\right)\left(\frac{V_{T_{Std}}}{V_{T_{Test}}}\right) + \left(\frac{V_{T_{Std}}}{W_{Std}}\right)(\Delta T_{N_x} - \Delta D)$$ (Eq 8.35) 8.30

$$\gamma_{Test} = \sin^{-1}\left[\frac{dh/dt}{V_{T_{Test}}}\right]$$ (Eq 8.36) 8.30

$$DCF = 1 + \left(\frac{V_{T_{Std}}}{g} \frac{dV_T}{dh} \right)$$ (Eq 8.37) 8.30

$$\left(\frac{dh}{dt} \right)_{Std} = \frac{P_{s_{Std}}}{DCF}$$ (Eq 8.38) 8.30

$$\gamma_{Std} = \sin^{-1} \left[\frac{(dh/dt)_{Std}}{V_{T_{Std}}} \right]$$ (Eq 8.39) 8.30

$$V_i = V_o + \Delta V_{ic}$$ (Eq 8.40) 8.32

$$H_{P_i} = H_{P_o} + \Delta H_{P_{ic}}$$ (Eq 8.41) 8.32

$$T_i = T_o + \Delta T_{ic}$$ (Eq 8.42) 8.32

$$V_T = 39.0\ M \sqrt{T_a\ (°K)}$$ (Eq 8.43) 8.32

$$W_{f_{Used}} = W_{f_{Start}} - W_{f_{End}}$$ (Eq 8.44) 8.32

$$\Delta d = V_{T_{avg}} \frac{\Delta t}{60}$$ (Eq 8.45) 8.32

$$Range = \sum_{Sea\ Level}^{H_P} \Delta d$$ (Eq 8.46) 8.32

CHAPTER 9

$$R = \mu (W - L)$$ (Eq 9.1) 9.5

$$\int_0^{S_1} \left[T - D - \mu(W - L) \right] dS = \frac{1}{2} \frac{W}{g} \left(V_{TO}^2 \right)$$ (Eq 9.2) 9.6

$$\left[T - D - \mu(W - L) \right]_{Avg} S_1 = \frac{1}{2} \frac{W}{g} \left(V_{TO}^2 \right)$$ (Eq 9.3) 9.6

$$S_1 = \frac{W V_{TO}^2}{2g \left[T - D - \mu (W - L) \right]_{Avg}}$$ (Eq 9.4) 9.7

$$\text{Work} = \Delta T \, V \, \Delta t$$ (Eq 9.5) 9.9

$$T_{ex} = T - D - \mu(W - L)$$ (Eq 9.6) 9.9

$$q = \frac{1}{2} \rho V^2$$ (Eq 9.7) 9.9

$$D = C_D \, q \, S$$ (Eq 9.8) 9.9

$$L = C_L \, q \, S$$ (Eq 9.9) 9.9

$$C_D = C_{D_p} + C_{D_i}$$ (Eq 9.10) 9.9

$$C_{D_i} = \frac{C_L^2}{\pi \, e \, AR}$$ (Eq 9.11) 9.10

$$C_D = C_{D_p} + \frac{C_L^2}{\pi \, e \, AR}$$ (Eq 9.12) 9.10

$$D = \left(C_{D_p} + \frac{C_L^2}{\pi \, e \, AR} \right) q \, S$$ (Eq 9.13) 9.10

$$T_{ex} = T - \left(C_{D_p} + \frac{C_L^2}{\pi\, e\, AR} \right) q\, S - \mu\left(W - C_L\, q\, S \right)$$ (Eq 9.14) 9.10

$$\frac{dT_{ex}}{dC_L} = \left(\frac{2\, C_L}{\pi\, e\, AR} \right) q\, S + \mu\left(q\, S \right)$$ (Eq 9.15) 9.10

$$C_{L_{Opt}} = \frac{\mu\, \pi\, e\, AR}{2}$$ (Eq 9.16) 9.10

$$S_2 = \int_{\text{Lift off}}^{50\text{ ft}} (T - D)\, dS = \frac{W}{2g} \left(V_{50}^2 - V_{TO}^2 \right) + 50\, W$$ (Eq 9.17) 9.12

$$S_2 = \frac{W \left(\frac{V_{50}^2 - V_{TO}^2}{2g} + 50 \right)}{(T - D)_{Avg}}$$ (Eq 9.18) 9.12

$$V_{TO_w} = V_{TO} - V_w$$ (Eq 9.19) 9.13

$$S_{1_w} = \frac{W\, V_{TO_w}^2}{2\, g\, T_{ex_{Avg_w}}}$$ (Eq 9.20) 9.13

$$S_{1_{Std}} = \frac{W \left(V_{TO_w} + V_w \right)^2}{2\, g\, T_{ex_{Avg}}}$$ (Eq 9.21) 9.13

$$S_{1_{Std}} = S_{1_w} \frac{T_{ex_{Avg_w}}}{T_{ex_{Avg}}} \left(1 + \frac{V_w}{V_{TO_w}} \right)^2$$ (Eq 9.22) 9.13

$$S_{1_{Std}} = S_{1_w} \left(1 + \frac{V_w}{V_{TO_w}} \right)^{1.85}$$ (Eq 9.23) 9.14

$$S_{2_{Std}} = S_{2_w} + \Delta S_2 \qquad \text{(Eq 9.24)} \qquad 9.14$$

$$T_{ex_{Avg}} S_{1_{SL}} = \frac{1}{2} \frac{W}{g} V_{TO}^2 - W S_{1_{SL}} \sin\theta \qquad \text{(Eq 9.25)} \qquad 9.15$$

$$S_{1_{SL}} = \frac{W V_{TO}^2}{2 g \left(T_{ex_{Avg}} + W \sin\theta \right)} \qquad \text{(Eq 9.26)} \qquad 9.15$$

$$S_{1_{Std}} = \frac{S_{1_{SL}}}{\left(1 - \frac{2g S_{1_{SL}}}{V_{TO}^2} \sin\theta \right)} \qquad \text{(Eq 9.27)} \qquad 9.15$$

$$S_{1_{Std}} = S_{1_{Test}} \left(\frac{W_{Std}}{W_{Test}} \right)^{2.3} \left(\frac{\sigma_{Test}}{\sigma_{Std}} \right) \left(\frac{T_{N_{Test}}}{T_{N_{Std}}} \right)^{1.3} \qquad \text{(Eq 9.28)} \qquad 9.16$$

$$S_{2_{Std}} = S_{2_{Test}} \left(\frac{W_{Std}}{W_{Test}} \right)^{2.3} \left(\frac{\sigma_{Test}}{\sigma_{Std}} \right)^{0.7} \left(\frac{T_{N_{Test}}}{T_{N_{Std}}} \right)^{1.6} \qquad \text{(Eq 9.29)} \qquad 9.16$$

$$S_{1_{Std}} = S_{1_{Test}} \left(\frac{W_{Std}}{W_{Test}} \right)^{2.6} \left(\frac{\sigma_{Test}}{\sigma_{Std}} \right)^{1.9} \left(\frac{N_{Test}}{N_{Std}} \right)^{0.7} \left(\frac{P_{a_{Test}}}{P_{a_{Std}}} \right)^{0.5} \qquad \text{(Eq 9.30)} \qquad 9.17$$

$$S_{2_{Std}} = S_{2_{Test}} \left(\frac{W_{Std}}{W_{Test}} \right)^{2.6} \left(\frac{\sigma_{Test}}{\sigma_{Std}} \right)^{1.9} \left(\frac{N_{Test}}{N_{Std}} \right)^{0.8} \left(\frac{P_{a_{Test}}}{P_{a_{Std}}} \right)^{0.6} \qquad \text{(Eq 9.31)} \qquad 9.17$$

$$S_3 = \frac{W \left(\frac{V_{TD}^2 - V_{50}^2}{2g} - 50 \right)}{(T - D)_{Avg}} \qquad \text{(Eq 9.32)} \qquad 9.19$$

$$S_4 = \int_{\text{Touchdown}}^{\text{Stop}} \left[T\text{-}D\text{-}\mu(W - L) \right] dS = \frac{1}{2} \frac{W}{g} \left(0 - V_{TD}^2 \right)$$ (Eq 9.33) 9.19

$$S_4 = \frac{-W V_{TD}^2}{2g \left[T - D - \mu(W - L) \right]_{Avg}}$$ (Eq 9.34) 9.20

$$S_{3_{Std}} = S_{3_{Test}} \left(\frac{W_{Std}}{W_{Test}} \right)^{\left(2 + \frac{E_h}{E_h + 50} \right)} \left(\frac{\sigma_{Test}}{\sigma_{Std}} \right)^{\left(\frac{E_h}{E_h + 50} \right)}$$ (Eq 9.35) 9.23

$$E_h = \frac{V_{50}^2 - V_{TD}^2}{2g}$$ (Eq 9.36) 9.23

$$S_{4_{Std}} = S_{4_{Test}} \left(\frac{W_{Std}}{W_{Test}} \right)^2 \left(\frac{\sigma_{Test}}{\sigma_{Std}} \right)$$ (Eq 9.37) 9.23

V_w = Wind Velocity cos (Wind Direction Relative To Runway) (Eq 9.38) 9.28

$$\sigma = 9.625 \frac{P_a}{T_a}$$ (Eq 9.39) 9.29

$$V_{TD_w} = V_{TD} - V_w$$ (Eq 9.40) 9.30

$$S_{4_{Std}} = S_{4_w} \left(1 + \frac{V_w}{V_{TD}} \right)^{1.85}$$ (Eq 9.41) 9.30

$$S_{4_{Std}} = \frac{S_{4_{SL}}}{\left(1 - \frac{2 g S_{4_{SL}}}{V_{TD}^2} \sin \theta \right)}$$ (Eq 9.42) 9.31