3.10.7 - 3.10.11

$$T = \Upsilon\left(\rho/\rho_0\right)^a\left(T_0 + T_1 V + T_2 V^2\right) \qquad \text{(re-worked 3.10.7)}$$

Υ = throttle % a = experimentally determined power. Assume 1 if unknown

ρ = air density ρ_0 = air density @ S.S.L.

T_0, T_1, and T_2 are experimentally determined coefficents

V = airspeed

$$S_{i+1} - S_i = \frac{W}{g}\int_{V_i}^{V_{i+1}} \frac{(V - V_{hw})\,dV}{T - D - F_r} \qquad (3.10.4)$$

$T = \Upsilon(\rho/\rho_0)^a(T_0 + T_1 V + T_2 V^2)$

$D = \tfrac{1}{2}\rho V^2 S_w C_D \qquad (3.10.5)$

$F_r = \mu_r(W - \tfrac{1}{2}\rho V^2 S_w C_L) \qquad (3.10.6)$

$$= \frac{W}{g}\int_{V_i}^{V_{i+1}} \frac{(V - V_{hw})\,dV}{\Upsilon(\rho/\rho_0)^a T_0 + \Upsilon(\rho/\rho_0)^a T_1 V + \Upsilon(\rho/\rho_0)^a T_2 V^2 - \tfrac{1}{2}\rho V^2 S_w C_D - \mu_r W + \tfrac{1}{2}\rho V^2 S_w C_L \mu_r}$$

$$= \frac{W}{g}\int_{V_i}^{V_{i+1}} \frac{(V - V_{hw})\,dV}{\Upsilon(\rho/\rho_0)^a T_0 - \mu_r W + \left[\Upsilon(\rho/\rho_0)^a T_1\right]V + \left[\Upsilon(\rho/\rho_0)^a T_2 + \tfrac{1}{2}\rho S_w(C_L \mu_r - C_D)\right]V^2}$$

$$= \frac{1}{g}\int_{V_i}^{V_{i+1}} \frac{(V - V_{hw})\,dV}{\underbrace{\frac{\Upsilon(\rho/\rho_0)^a T_0}{W} - \mu_r}_{(K_0)_i} + \underbrace{\frac{\Upsilon(\rho/\rho_0)^a T_1}{W}}_{(K_1)_i} V + \underbrace{\left[\frac{\Upsilon(\rho/\rho_0)^a T_2}{W} + \frac{\rho S_w}{2W}(C_L \mu_r - C_D)\right]}_{(K_2)_i} V^2}$$

$$(K_0)_i = \frac{\Upsilon(\rho/\rho_0)^a T_0}{W} - \mu_r$$

$$(K_1)_i = \frac{\Upsilon(\rho/\rho_0)^a T_1}{W}$$

$$(K_2)_i = \frac{\Upsilon(\rho/\rho_0)^a T_2}{W} + \frac{\rho S_w}{2W}\left(C_L \mu_r - C_D\right)$$

* Now Eqs. (3.10.12) - Eqs. (3.10.19) can follow as shown in "Mechanics of Flight" by Phillips

3.10.21 – 3.10.24

$$T = \Upsilon\left(\rho/\rho_0\right)^a\left(T_0 + T_1 V + T_2 V^2\right) \qquad \text{(re-worked 3.10.7)}$$

Υ = throttle % $\quad$ a = experimentally determined power. Assume 1 if unknown

ρ = air density $\quad$ ρ_0 = air density @ S.S.L.

T_0, T_1, and T_2 are experimentally determined coefficents

V = airspeed

$$T_0\Upsilon\left(\rho/\rho_0\right)^a = T_s\Upsilon\left(\rho/\rho_0\right)^a \qquad (3.10.21)$$

$$T_1\Upsilon\left(\rho/\rho_0\right)^a = \Upsilon\left(\rho/\rho_0\right)^a \frac{6\bar{T} - 4T_s - 2T_{LO}}{V_{LO}} \qquad (3.10.22)$$

$$T_2\Upsilon\left(\rho/\rho_0\right)^a = \Upsilon\left(\rho/\rho_0\right)^a \frac{3T_s + 3T_{LO} - 6\bar{T}}{V_{LO}^2} \qquad (3.10.23)$$

T_s = static thrust

T_{LO} = thrust at liftoff

$$\bar{T} = \text{avg. thrust} = \Upsilon\left(\rho/\rho_0\right)^a \frac{1}{V_{LO}}\int_0^{V_{LO}} T\,dV \qquad (3.10.24)$$

$$\boxed{\begin{aligned} K_0 &= \frac{T_s\Upsilon\left(\rho/\rho_0\right)^a}{W} - \mu_r \quad \text{-------} \quad (3.10.32) \\ K_1 &= \Upsilon\left(\rho/\rho_0\right)^a \frac{6\bar{T} - 4T_s - 2T_{LO}}{W V_{LO}} \quad \text{------} \quad (3.10.33) \\ K_2 &= \Upsilon\left(\rho/\rho_0\right)^a \frac{3T_s + 3T_{LO} - 6\bar{T}}{W V_{LO}^2} + \frac{\rho S_w}{2W}\left(C_L\mu_r - C_D\right) \quad (3.10.34) \end{aligned}}$$

* Now Eqs. (3.10.25) – Eqs. (3.10.31) and Eq. (3.10.35) can be followed as shown in "Mechanics of Flight" by Warren Phillips.