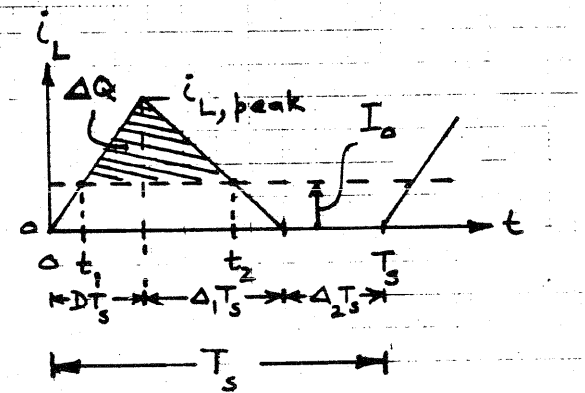
Problem 7–4

Derive an expression for ΔV_o in the discontinuous mode.



Solution: $\frac{di}{dt} = \frac{V}{L}$; $[\frac{V_d - V_o}{L}]t_1 = I_o$; $t_1 = \frac{LI_o}{V_d - V_o}$ where t_1 is defined in the figure

$$i_{L,peak} = \frac{DT_s}{L}[V_d - V_o]$$

$$t_2 = DT_s + \frac{L(i_{L,peak}-I_o)}{V_o}; \quad t_2 - t_1 = \frac{-LI_o}{V_d - V_o} + DT_s + \frac{L(i_{L,peak}-I_o)}{V_o}$$

$$t_2 - t_1 = \frac{DT_s(V_d-V_o)V_o - LI_oV_o + L(V_d-V_o)[\frac{DT_s}{L}(V_d-V_o) - I_o]}{V_o(V_d-V_o)}$$

$$\Delta V_o = \frac{\Delta Q}{C} = \frac{1}{C} \cdot \frac{1}{2}(i_{L,peak}-I_o)(t_2-t_1)$$

$$= \frac{1}{2C}[\frac{DT_s}{L}(V_d-V_o) - I_o](t_2-t_1)$$

$$\therefore \boxed{\Delta V_o = \frac{[DT_s(V_d-V_o)-LI_o][DT_s(V_d-V_o)V_o-LI_oV_o+(V_d-V_o)(DT_s(V_d-V_o)-LI_o)]}{2LC\,V_o(V_d-V_o)}}$$