H&H 5.8

CAP CHARGES THROUGH R_A AND/OR R_B.
SAME FOR DISCHARGE.

PERIOD $\equiv T = T_U + T_D$

T_U CHARGE UP T_D CHARGE DOWN

CHARGE UP: $V_{CAP} = \frac{1}{3}V_{CC} \rightarrow \frac{2}{3}V_{CC}$

Q1 OFF (DISCHARGE PIN DISABLED)
CHARGING THROUGH R_A & R_B.

$V_{CAP}(t)$ FOLLOWS GENERAL FORMULA.

$$V_c = V_{MAX}\left(1 - e^{-t_U/R'C}\right) + V_{OFFSET}$$

@ $t=0$

$$V_c = \frac{1}{3}V_{CC} \Rightarrow V_{OFFSET} = \frac{1}{3}V_{CC}$$

@ $t=\infty$ $\quad V_c = V_{CC} \Rightarrow V_{MAX} = \frac{2}{3}V_{CC}$

CHARGE UP TIME t_U FOR $V_c = \frac{1}{3}V_{CC} \rightarrow \frac{2}{3}V_{CC}$

$$\frac{2}{3}V_{CC} = \frac{2}{3}V_{CC}\left(1 - e^{-t_U/R'C}\right) + \frac{1}{3}V_{CC}$$

$$\frac{1}{2} = \left(1 - e^{-t_U/R'C}\right)$$

$$\frac{1}{2} = e^{-t_U/R'C}$$

$$\ln 2 = t_U/R'C$$

$$\boxed{t_U = (\ln 2)(R_A + R_B)\,C}$$

CHARGE DOWN:

$$V_C = V_{MAX}\, e^{-t_D/R'C} + V_{OFFSET}$$

@ $t=0$, $V_C = \frac{2}{3}V_{CC} \Rightarrow V_{MAX} = \frac{2}{3}V_{CC}$

@ $t = \delta$, $V_C = 0$, $\Rightarrow V_{OFFSET} = 0$

So,

$$\frac{1}{3}V_{CC} = \frac{2}{3}V_{CC}\, e^{-t_D/R'C}$$

$$\frac{1}{2} = e^{-t_D/R'C}$$

$$\Rightarrow \boxed{t_D = (\ln 2) R_B\, C}$$

$$T = t_U + t_D = \ln 2\,(R_A + 2R_B)\,C$$

$$\boxed{T = 0.693\,(R_A + 2R_B)\,C}$$