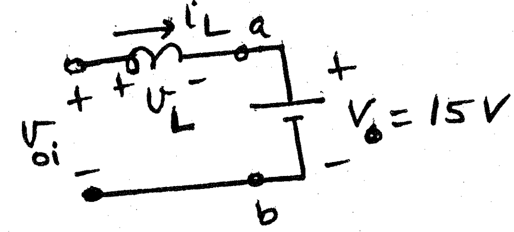
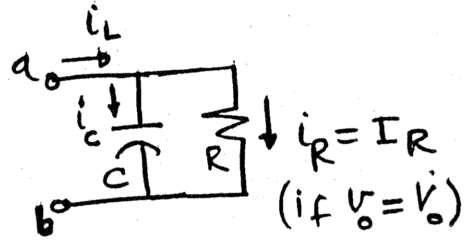
Problem 1-5





$T_s = \frac{1}{f_s} = 3.33\,\mu s$

$DT_s = 0.75 \times T_s = 2.5\,\mu s$

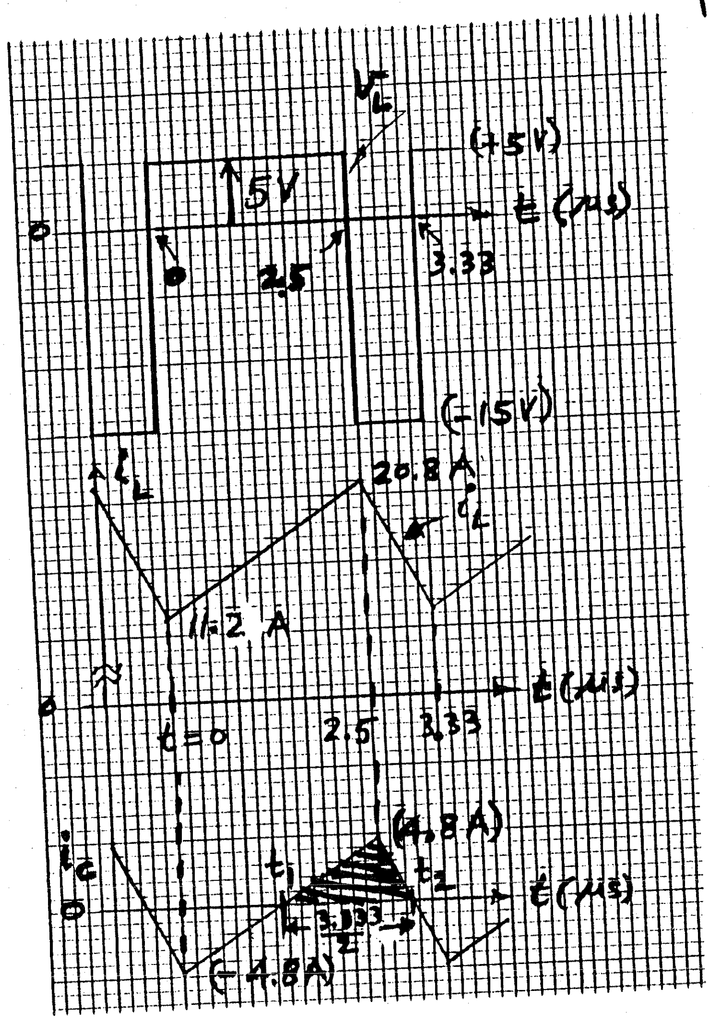
$I_R = \frac{240\,W}{15\,V} = 16\,A$

$i_L = i_c + i_R$

$\therefore\ I_L = I_R$ (Since $I_c = 0$) average

$= 16\,A$

During $0 < t < 2.5\,\mu s$ when the switch is ON, $v_L = V_d - V_o = 20 - 15 = 5V$. The waveforms are shown below. The peak-to-peak ripple $(\Delta i_L)_{pp}$ in the inductor current i_L can be calculated during this interval.



$$(\Delta i_L)_{pp} = \frac{1}{L}\int_0^{2.5\,\mu s} v_L\, dt$$

$$= \frac{5 \times 2.5}{1.3}$$

$$\simeq 9.6\,A$$

$\&\ \frac{(\Delta i_L)_{pp}}{2} = 4.8\,A$

$\therefore\ I_{L,min} = I_L - 4.8$

$= 11.2\,A$

and

$I_{L,max} = I_L + 4.8$

$= 20.8\,A$

$$i_c(t) = i_L(t) - I_R \quad [\text{assuming } i_R \simeq I_R]$$

The i_c waveform is shown. Due to i_c, the capacitor voltage v_c will be at its minimum at t_1 and its maximum at t_2, where $(t_2 - t_1) = \frac{T_s}{2} = \frac{3.33}{2}\ \mu s$.

$$\therefore\ (\Delta V_c)_{pp} = \frac{1}{C}\int_{t_1}^{t_2} i_c \cdot dt = \frac{1}{C}\left[\begin{array}{l}\text{Area shown}\\ \text{under } i_c\\ \text{waveform}\end{array}\right]$$

$$= \frac{1}{50}\cdot\left[\frac{4.8 \times \frac{3.33}{2}}{2}\right]$$

$$\simeq 80\ \text{mV}$$