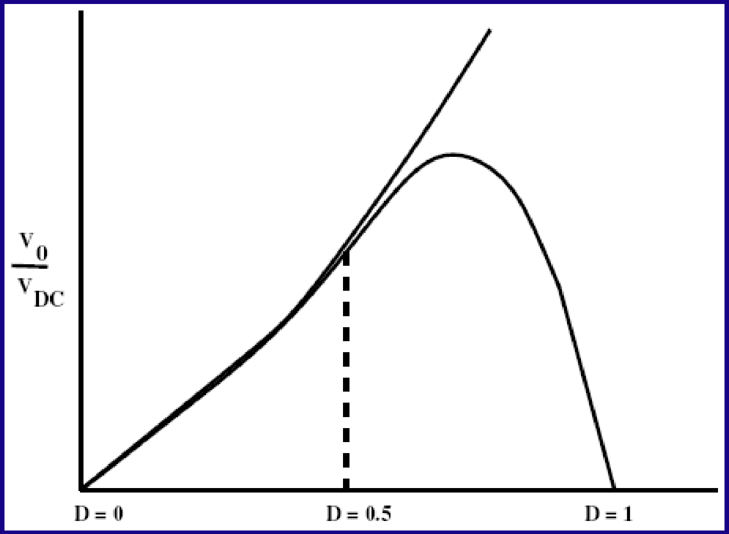
Review :

1. Buck – Boost : $\dfrac{DV_{DC}}{1-D}$

$$\therefore \ I_0 = \frac{1-D}{D} I_s$$



2. Cuk ' Converter : $\dfrac{DV_{DC}}{1-D}$

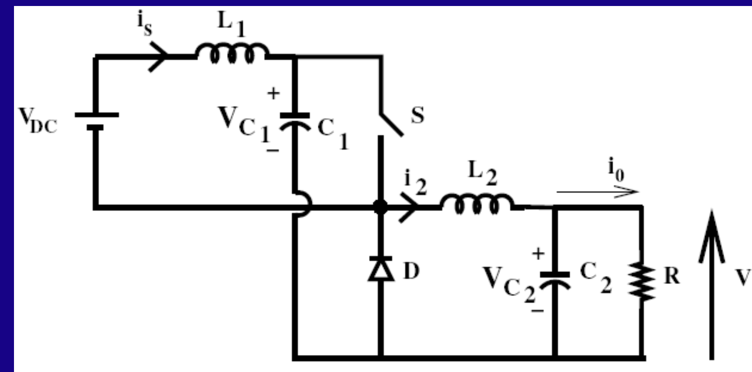
$$\therefore \ I_0 = \frac{1-D}{D} I_s$$

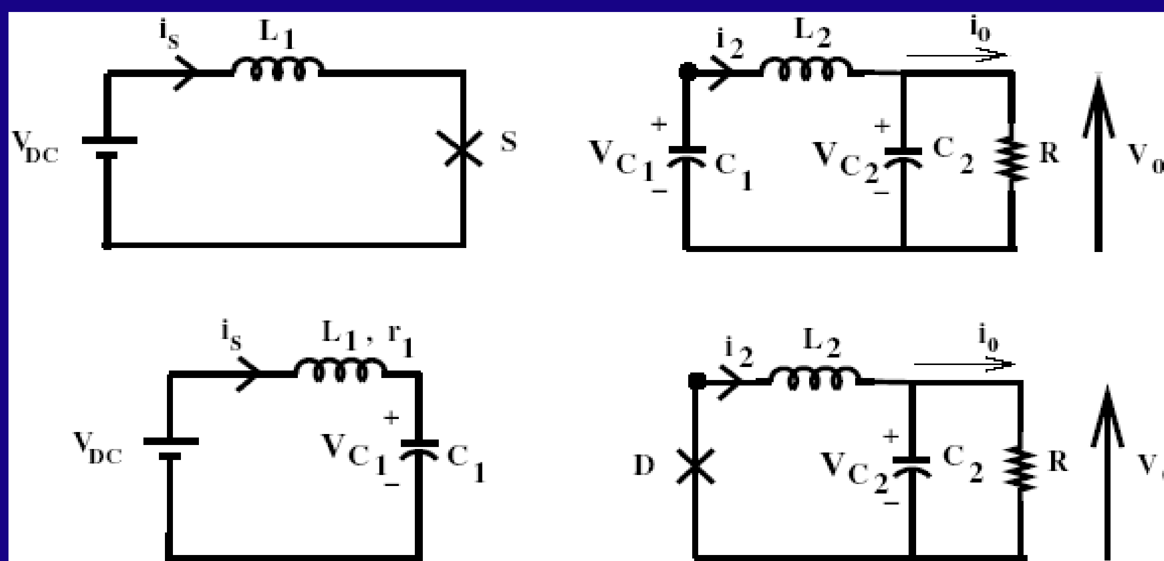
$$I_2DT = I_s(1-D)T$$

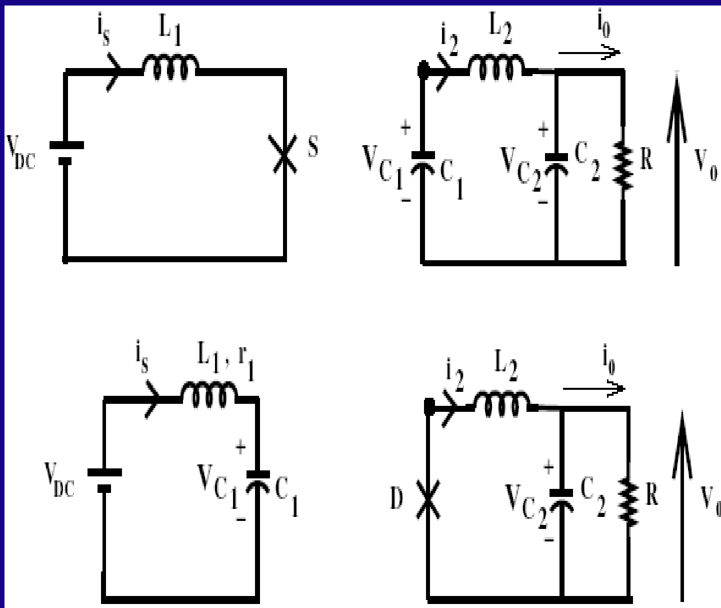
$$\text{Av. } I_2 = I_0$$

$$\therefore I_0DT = I_s(1-D)T$$

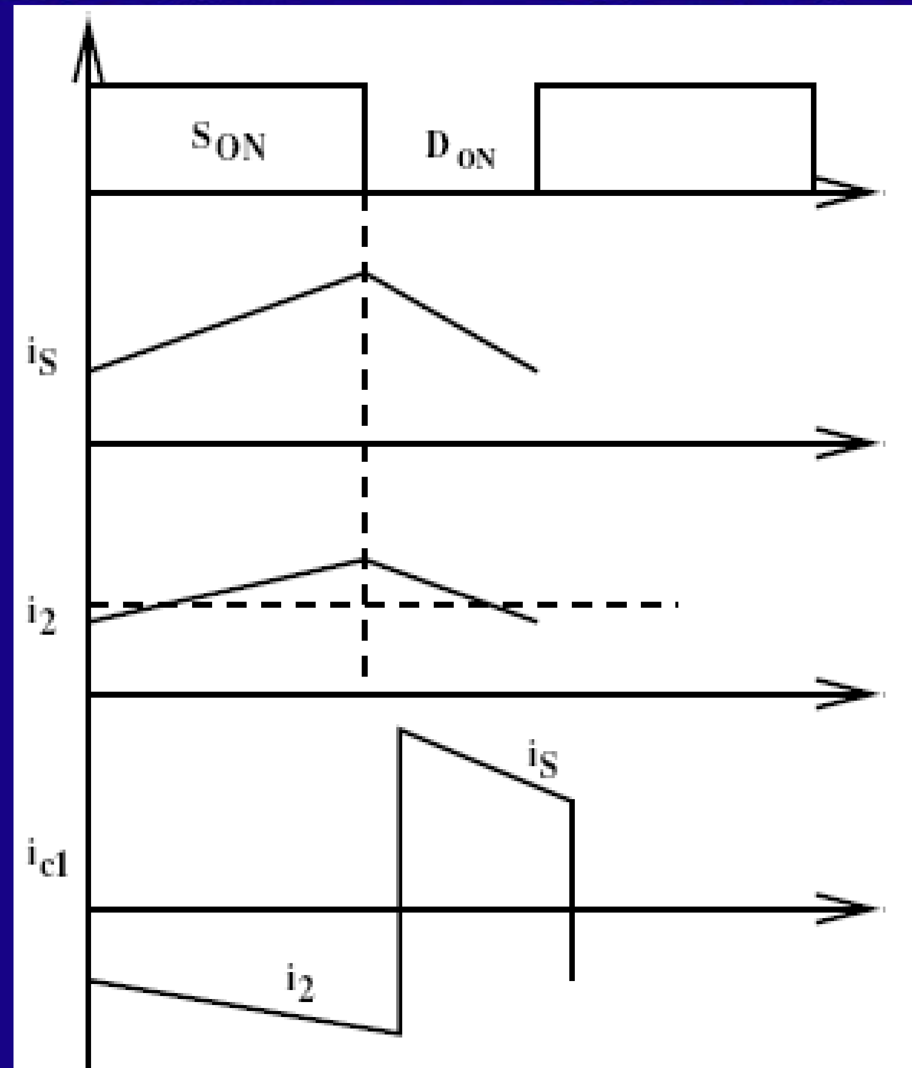
$$\Rightarrow I_0 = \frac{I_s(1-D)}{D}$$



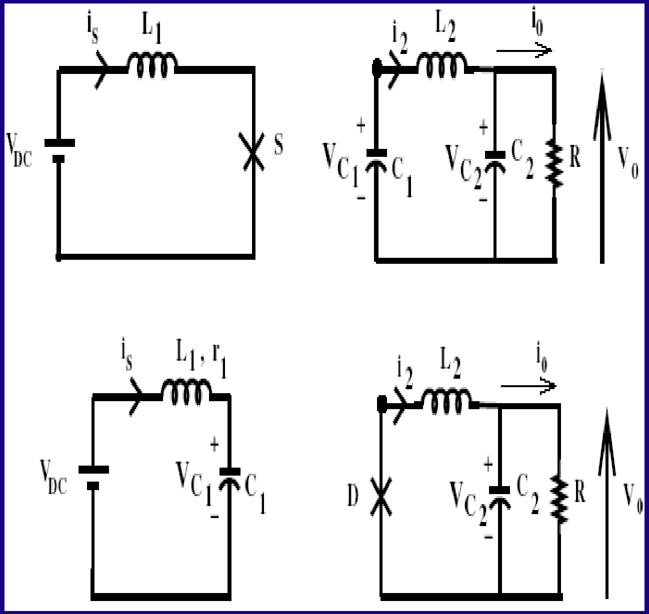




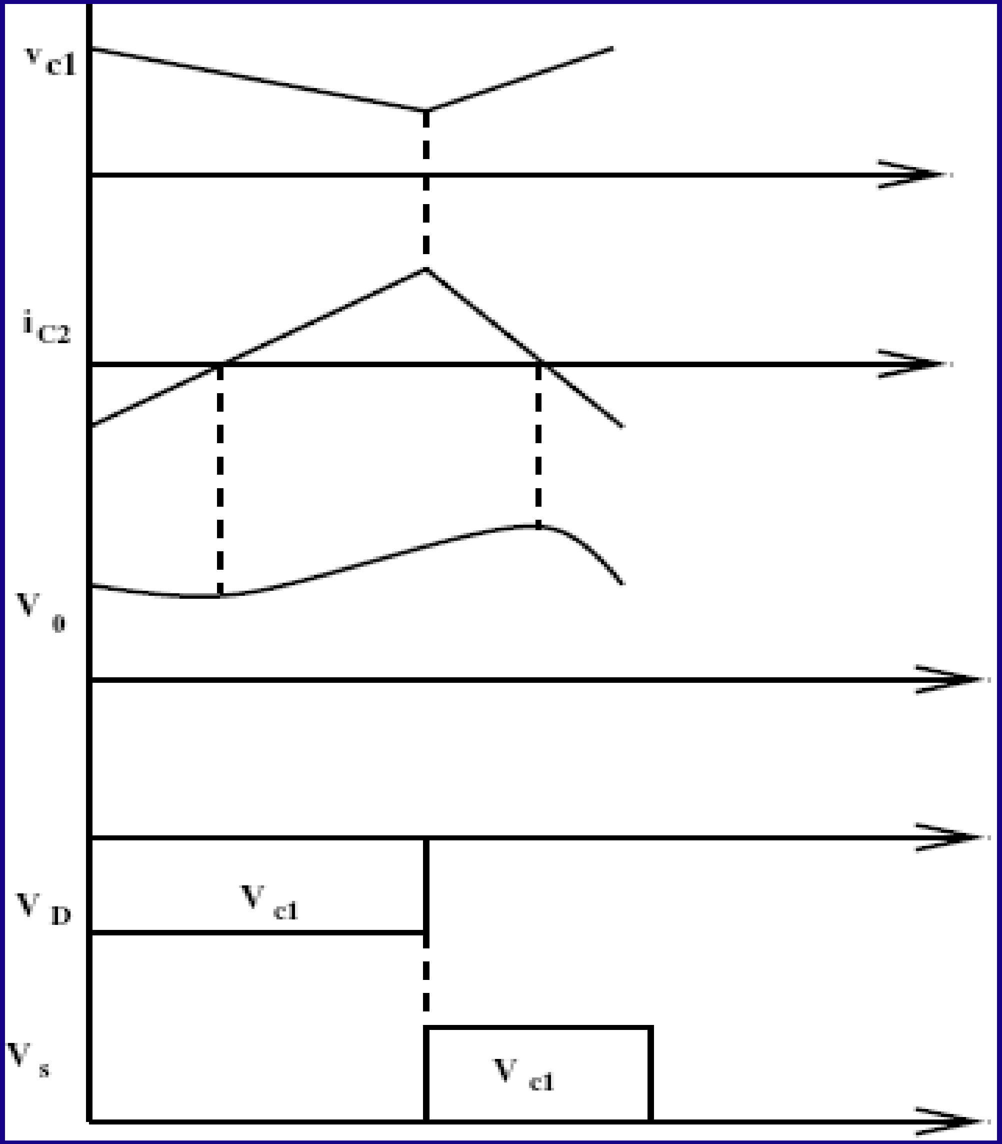
i_s
L_1
V_DC
S
i_2
L_2
i_0
V_C1
C_1
V_C2
C_2
R
V_0
L_1, r_1
D



S_ON
D_ON
i_S
i_2
i_c1
i_S
i_2



i_s
L_1
V_{DC}
S
i_2
L_2
i_0
V_{C_1}
C_1
V_{C_2}
C_2
R
V_0
L_1, r_1
D



v_{c1}
i_{C2}
V_0
V_D
V_{c1}
V_s
V_{c1}

Problem 1 :

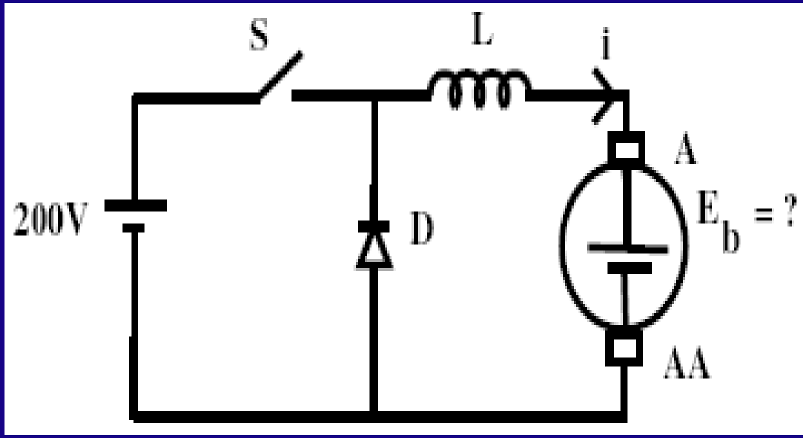
$r_a \approx 0$, Total 'L' in circuit = 50 mH.

Switching frequency = 500 Hz and d = 0.5

Av. current drawn by the motor = 10A.

Assume that i_L is continuous.

Determine I_{max} and I_{min}.



Sol :

$E_b = V_{DC} * D = 100V$

$$200 = L\left(\frac{di}{dt}\right)_I + E_b \qquad 0 < t < DT \text{ ---(1)}$$

$$-E_b = L\left(\frac{di}{dt}\right)_D \qquad DT < t < T \text{ ---(2)}$$

$$\left(\frac{di}{dt}\right)_I - \left(\frac{di}{dt}\right)_D = \frac{200}{L} = 4000 \text{ A/s}$$

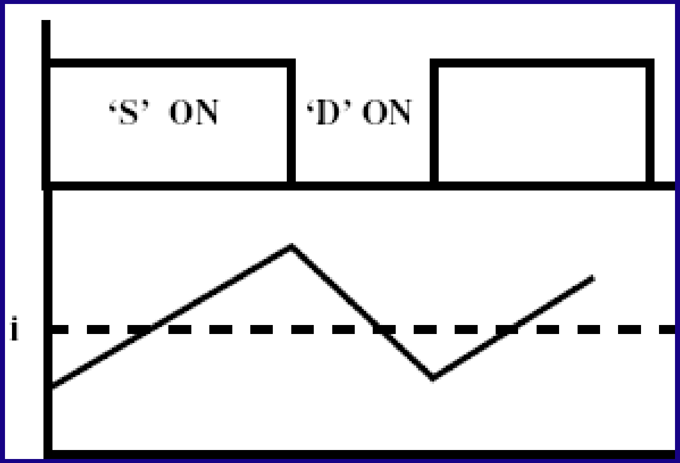
$$\therefore \; L\frac{di}{dt} = 100$$

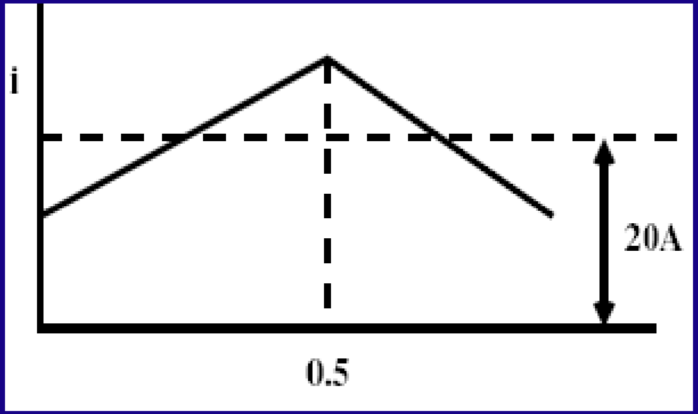
$$-L\frac{di}{dt} = 100$$

$$\therefore \; \left(\frac{di}{dt}\right)_I = -\left(\frac{di}{dt}\right)_D = 2000 \text{ A/s}$$

$$I_{avg} = 20 \text{ A}$$

$$\therefore \; I_{min} = 19\text{A} \;\&\; I_{max} = 21\text{A}$$





Problem 2 :

F_S = 20 kHz, D = 0.5

Calculate power transferred from 100V source to 300V source.

Assume that the circuit has attained a steady state.

Sol:

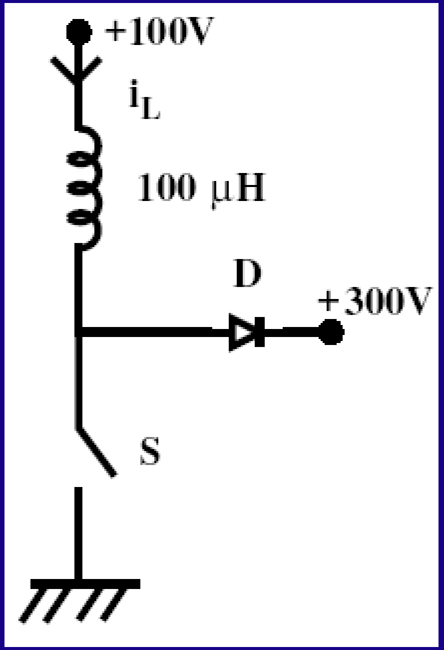
When 'S' is ON

$$L\frac{di}{dt} = 100V \quad 0 < t < DT$$

$$L\frac{di}{dt} = -200V \text{ when 'S' if OFF and 'i' is finite.}$$

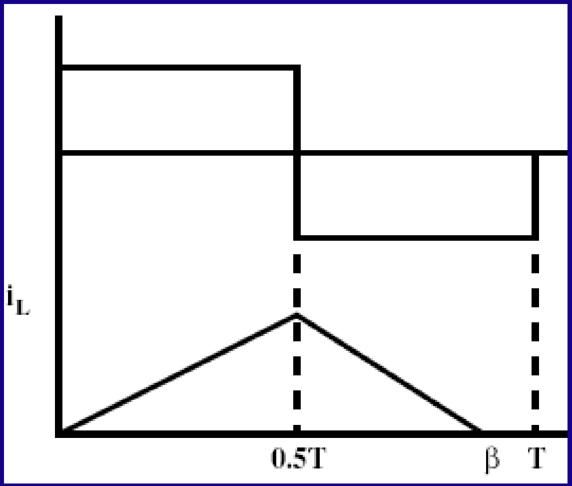
i_L is DISCONTINUOUS.

$$\therefore\ I_{peak} = \frac{100}{L} * 25 * 10^{-6} = 25A$$



Let 'β' be the instant 'I' becomes zero.

'V' across it during this period = -200V

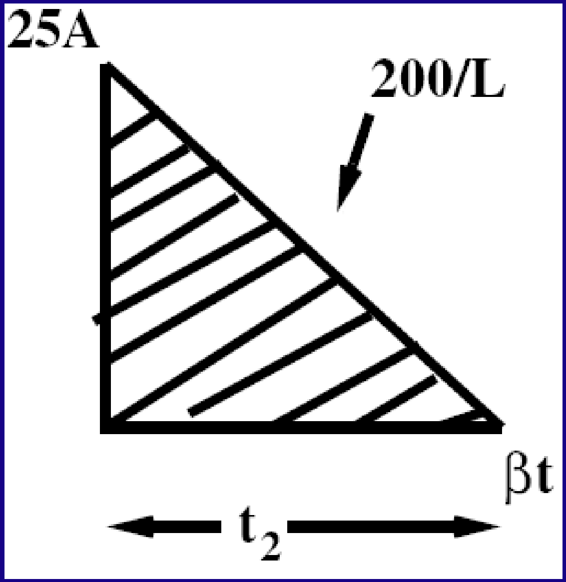


$\therefore\ 25 = \frac{200}{L} * t_2$

$\therefore t_2 = 12.5\ \mu sec.$

Energy transferred to 300V source in one cycle

= the area shaded as shown in the fig.



$= V * \frac{1}{2} * I_{peak} * t_2 = 0.047J$

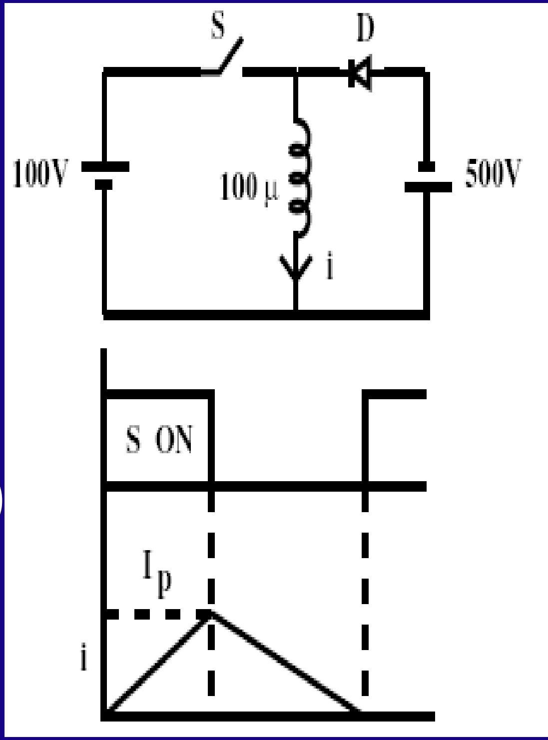
$\therefore$ Power transferred

$= 20 * 10^3 * E = 938W$

Problem 3.

Switching frequency = 10kHz

'i' is just continuous. T_{ON} = ? & i_P = ?



Sol:

$$T = \frac{1}{10 * 10^3} = 100\ \mu\ sec.$$

$$\text{Peak 'i'} = i_P = \frac{100}{100 * 10^{-6}} * DT$$

$$= \frac{500}{100 * 10^{-6}} (T - DT)$$

$$\therefore\ DT = 5\left(100 * 10^{-6} - DT\right)$$

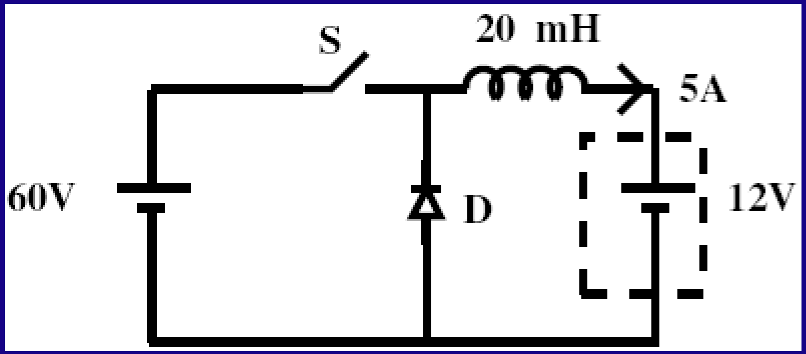
$$\therefore\ DT = t_{ON} = 83.3\ \mu sec$$

$$\therefore\ I_P = \frac{100 * 83.3 * 10^{-6}}{100 * 10^{-6}} = 83.3A$$

Problem 4.

F_s = 1 kHz, D = 0.2

L = 20 mH, I_{av} = 5A



What is the peak to peak current ripple flowing through the load ?

Sol :

$$L\frac{di}{dt} = 60 - 12 = 48$$

DT = 0.2 msec

$$\therefore \; di = \frac{60 - 12}{20 * 10^{-3}} * 0.20 * 10^{-3}$$

$$= \; 0.48A$$

Problem 5 :

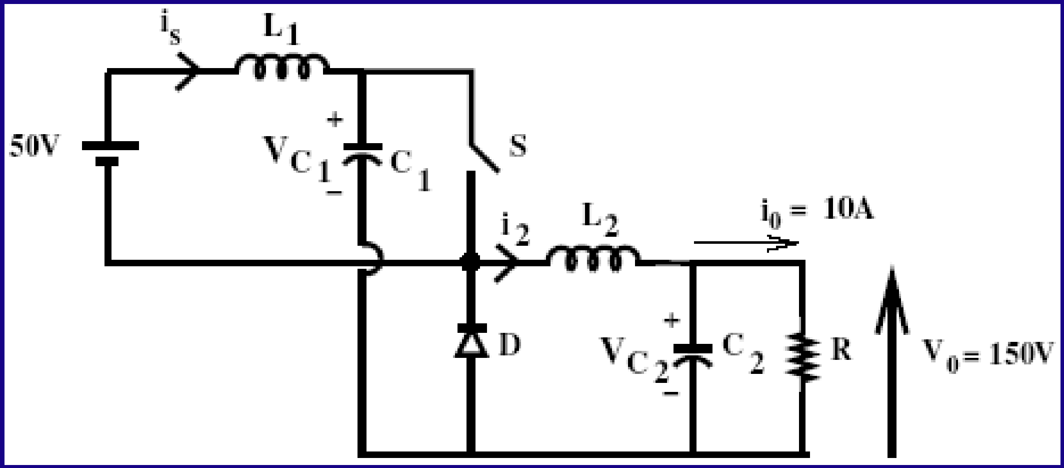
Peak to peak ripple in current flowing through L_1 and L_2 is 1A & Peak to peak voltage ripple in V_{C1} is 10V and that in V_{C2} = 1V and F_S = 25kHz. Neglect internal resistance of L_1 and L_2.

Sol:

$$V_0 = V_{DC} \frac{D}{(1-D)}$$

(i/p and o/p are current sources)

$\therefore$ D = 0.75



$T = 40\ \mu sec.$ $\therefore T_{ON} = 30\ \mu sec$ and $T_{OFF} = 10\ \mu sec.$

Avg. load current = Avg. current through L_2 = 10A

$V_{C1} = ?$

avg. $V_{L1} = 0$

$$(V_{C1} - V_{DC}) = 50 * \frac{30}{10}$$

$\therefore V_{C1} = 200V$

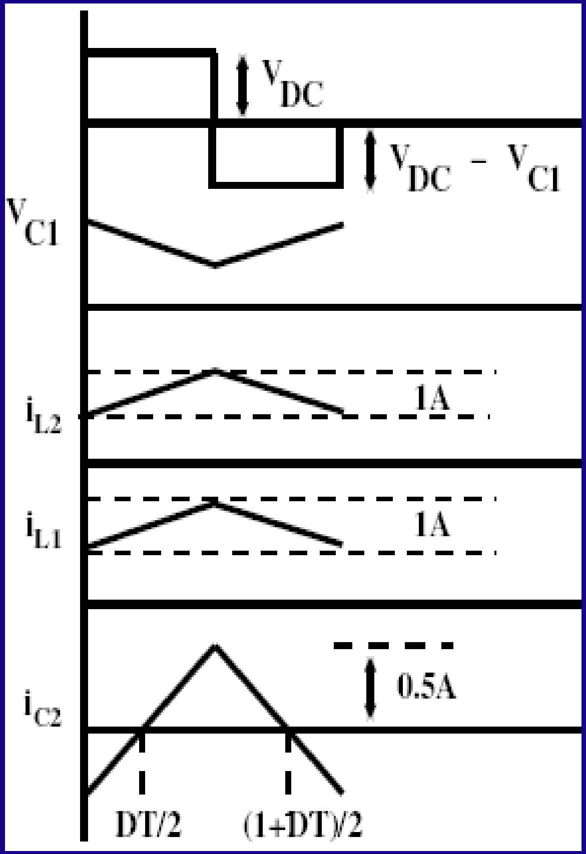
C_1 is being charged by i_{L1} for 10 μsec (t_{OFF})

& discharged by current (i_{L2}) for 30 μsec.

Neglect ripple.

$I_{L1} * 10 = I_{L2} * 30$ (where I_{L2} = 10A)

$\therefore I_{L1} = 30A$



Ripple in i_{L1} = 1A

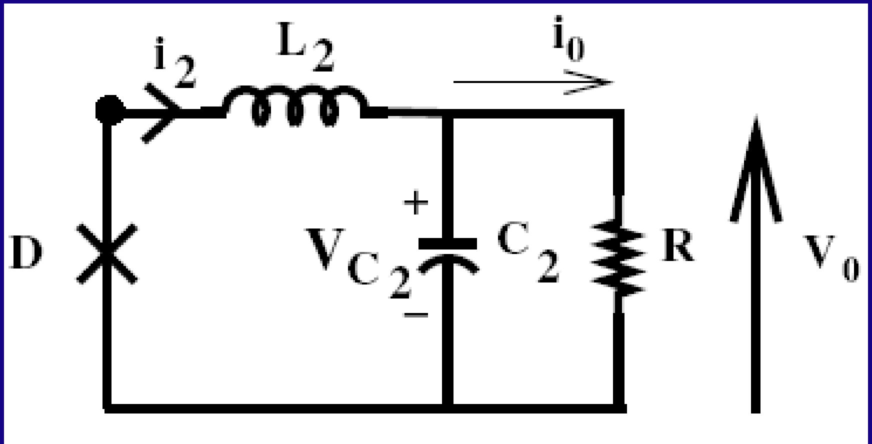
$$\therefore\ L\frac{di}{dt} = V_{DC} \Rightarrow \frac{50}{L_1} = \frac{1}{30\ \mu sec.} \qquad \therefore\ L_1 = 1.5\ mH$$

Similarly, ripple in i_{L2} = 1A.

$$\therefore\ \frac{V_{C1} - V_0}{L_2} = \frac{di}{dt}$$

dt = 30 μsec, V_{C1} = 200V, V_0 = 150V, di = 1A.

$\therefore\ L_2 = 1.5$ mH.



C_1 = ? & C_2 = ?

C_2 charges when $i_{L2} > I_0$

i.e. from $\frac{DT}{2}$ to $\left(\frac{1+D}{2}\right)T$

$$\therefore \ \Delta q_2 = \frac{1}{2} * 0.5 * 20*10^{-6} = 5\ \mu C$$

$$\therefore \ C_2 = \frac{\Delta q}{\Delta V} = 5\ \mu F$$

Similarly, C_1 is discharged by an average current of 10A for 30 μsec.

$$\therefore \ \Delta V \text{ for } V_{C1} = 10V$$

$$\therefore \ C = \frac{10 * 30}{10\ V} = 30\ \mu F$$