Problem 1:

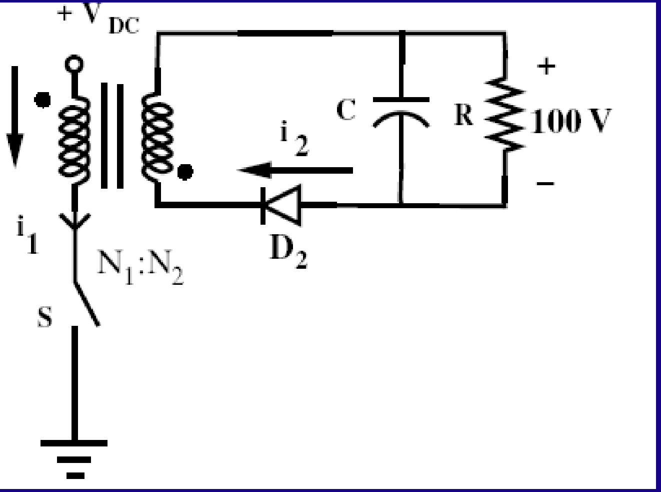
Find the turns ratio such that o/p V required is 100V at 0.5 for nominal i/p V = 12V

a. Compute min & max value of D, if i/p varies from 10 – 14V. Keep V_0 constant

b. Compute the value of L_s on sec. side so that i_2 is just continuous at the min. value of D.

c. Find the value of 'C' for o/p voltage ripple of 1% at $D = D_{max}$

Take $V_s = 0.8V$, $V_D = 0.8V$, $f_s = 2KHz$



Solution :

a. $\text{Volt.sec / turn}\left(d\phi = \frac{V.DT}{N} \right)$

Balance is a must

$$\frac{1}{N_1}\left(V_{DC} - V_s\right)T_{ON} = \frac{1}{N_2}\left(V_0 + V_d\right)T_{off}$$

At nominal i/p V, $V_0 = 100V$ at $D = 0.5$

$$\therefore \frac{N_2}{N_1} = \frac{100 + 0.8}{12 - 0.8} = \underline{\underline{9}}$$

Variation in D :

$$\frac{D}{(1-D)} = \frac{V_0 + V_d}{V_{DC} - V_s} \times \frac{N_1}{N_2}$$

$$\therefore D = \frac{V_0 + V_d}{\left(V_{DC} - V_s\right)\frac{N_2}{N_1} + \left(V_0 + V_d\right)}$$

If V_{DC} varies from the nominal value

so will $\underline{\underline{D}}$

$\therefore$ At $V_{DC} = 12V \quad D = 0.5$

$= 10V \quad D = 0.55$

$= 14V \quad D = 0.46$

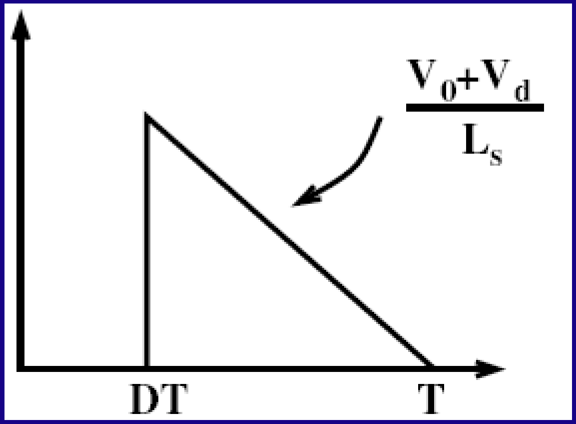
$\Rightarrow$ Controller should do this function

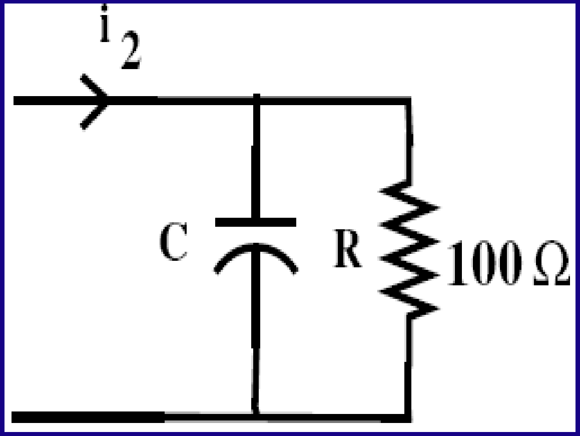
b. Value of L_s

$\Rightarrow$ Av I_2 = Av I_0

neglecting ΔV_0,

$$I_2\Big|_{av} = \frac{V_0}{R}$$





$$\frac{1}{2} I_p \frac{(1-D)T}{T} = \frac{V_0}{R}$$

$$\therefore I_p = \frac{2V_0}{R(1-D)}$$

$$\Rightarrow I_p = \frac{V_0 + V_d}{L_s}(1-D)T$$

$$\therefore L_s = \frac{V_0 + V_d}{2V_0}(1-D)^2 T\, R$$

'V_0' is held constant. I_2 should be just continuous

at $D = D_{min} = 0.46$

$$\therefore L_s = 612\mu H$$

c. Duration for which 'C' is charging $(i_2 > I_0)$

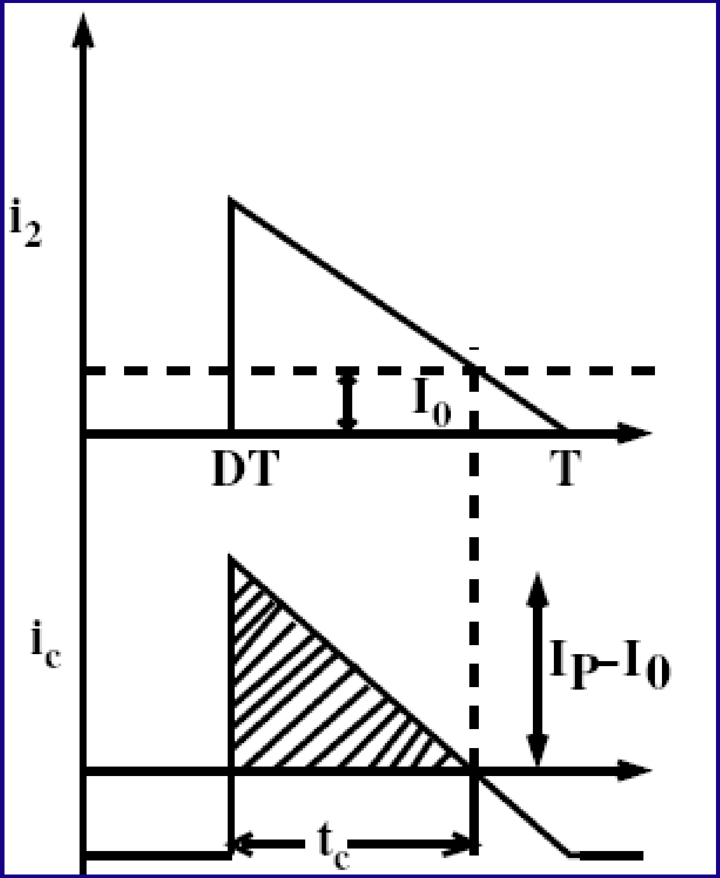
Peak value of $i_2 = I_p$

$i_2 \downarrow$ at the rate of $\dfrac{V_0 + V_d}{L_s}$

$\therefore$ Peak value of $i_C = I_p - I_0$

$$\therefore t_c = \frac{I_p - I_0}{\left(\dfrac{V_0 + V_d}{L_s}\right)}$$

$$\Delta q = C\,\Delta V_0 = \frac{1}{2}\left\{I_p - I_0\right\} t_c$$



$$\Rightarrow \Delta q = \frac{1}{2}\left\{I_p - I_0\right\}\frac{I_p - I_0}{\left(V_0 + V_d\right)}.L_s$$

$$\text{we know, } I_0 = \frac{V_0}{R}, \quad I_p = \frac{2V_0}{R\left(1-D\right)}$$

$$\Rightarrow \Delta q = \frac{1}{2}\left[\frac{2V_0}{R\left(1-D\right)} - \frac{V_0}{R}\right]^2 \frac{L_s}{V_0 + V_d}$$

$$\Rightarrow C\Delta V_0 = \frac{1}{2}\left[\frac{V_0}{R}\right]^2 \frac{1}{V_0 + V_d} L_s \left(\frac{1+D}{1-D}\right)^2$$

$$\therefore \frac{\Delta V_0}{V_0} = \frac{L_s V_0}{2R^2 C\left(V_0 + V_d\right)} \text{x} \left(\frac{1+D}{1-D}\right)^2 = 0.01$$

$$\Rightarrow C \quad = 36\mu F$$

Problem 2 :

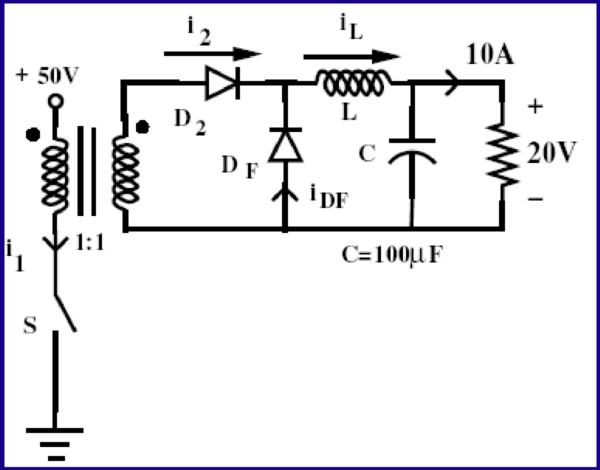
A Forward converter is operating at the boundary of continuous / discontinuous conduction. Switching frequency is 100 kHz.

Assume $\mu \to \infty$ so that energy recovery winding is ignored

A load of 10A at 20V is being supplied

a. Determine the value of 'L' &

b. Determine peak to peak ripple in output voltage



Solution:

a. $V_0 = V_{DC}\left(\frac{N_2}{N_1}\right)D$

$\therefore D = 0.4$

$\therefore T_{on} = 4\,\mu\,\text{sec}\,,\ T_{0ff} = 6\,\mu\,\text{sec}$

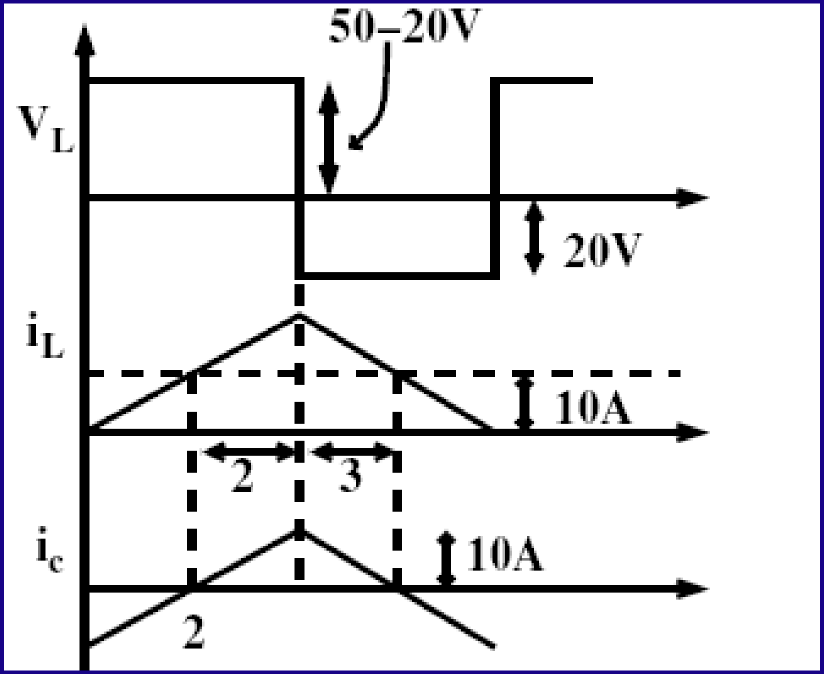
av. $i_L = I_0 = 10\,A$

$\therefore I_p = 20\,A$

$L = ?$

$$\frac{di}{dt} = 5\,A/\mu\,\text{sec}$$

$$\therefore L = \frac{V}{\left(di/dt\right)} = \frac{30}{5} = 6\,\mu\,H$$



$$\text{b. } CdV_0 = dq = \frac{1}{2} \times 10 \times 5 = 25\mu C$$

$$\therefore \Delta V = \frac{25\mu C}{100\mu F} = 0.25\,V$$

$$\therefore \frac{\Delta V}{V_0} = \frac{0.25}{20} = 1.25\%$$

Flyback, Forward converter $\rightarrow$

Operation in I[st] quadrant only

$\Rightarrow$ Current through transformer is DC

$\Rightarrow$ Use 2 forward converters working in anti – phase

$\Rightarrow$ Bi – directional core excitation

$\Rightarrow$ AC current through transformer

$\Rightarrow$ Both converters deliver power to the load in each half cycle

$\Rightarrow$ Both of them $\underline{\text{pushing}}$ power to the load

$\Rightarrow$ Push – Push converter

$\Rightarrow$ Push – Pull converter has prevailed