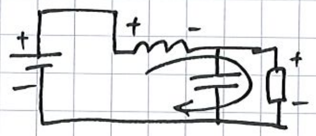
Q#1. Check your lecture handouts

Q#2. (a) Assume CCM.

$0 < t < DT$



$v_L = V_d - V_o$

$DT < t < T$

$v_L = -V_o$

$$V_L = \frac{1}{T}\int_0^T v_L \cdot dt$$

$$= D \cdot (V_d - V_o) + (-V_o) \cdot (1-D) = 0$$

$$D = \frac{V_o}{V_d} = \frac{10V}{20V} = 0.5$$ 0.5p

$$\Delta i_L = \frac{1}{L} \cdot (V_d - V_o) \cdot DT = \frac{1}{100\mu H} \times (20V - 10V) \times 0.5 \times \frac{1}{20kHz}$$

$$= 2.5\,A$$ 0.5p

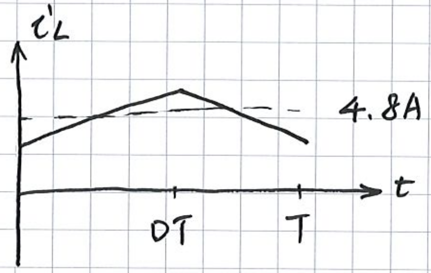
$$I_L = I_o = \frac{P_o}{V_o} = \frac{48W}{10V} = 4.8A > \frac{1}{2}\Delta i_L$$ $\therefore$ CCM

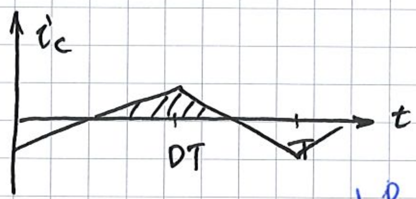
0.5p 0.5p $D = 0.5$.

(b) $I_o = \frac{P_o}{V_o} = \frac{48W}{10V} = 4.8\,A$ 1p

$I_d = \frac{P_o}{V_d} = \frac{48W}{20V} = 2.4\,A$ 1p

Q#2. (c)





1p

$$\Delta V = \frac{1}{C}\int i_c \cdot dt = \frac{Q}{C} = \frac{1}{C}\cdot\frac{1}{2}\cdot\frac{\Delta i_L}{2}\cdot\frac{T}{2}$$

$$= \frac{\Delta i_L \cdot T}{8C} = \frac{2.5A}{8\times 450\mu F\times 20kHz} = 34.7\ mV$$ 1p

(d) $P_o' = 8W$. Assume CCM, $D=0.5$, $\Delta i_L = 2.5A$.

$$I_L' = I_o' = \frac{P_o'}{V_o} = \frac{8W}{10V} = 0.8A < \frac{1}{2}\Delta i_L.\quad DCM.$$

1p 1p

(e) The corner frequency should be much smaller than the switching frequency. 1p

$$f_{corner} = \frac{1}{2\pi\sqrt{LC}} = 750.26Hz \ll 20kHz$$

1p.

So the chosen values of L and C satisfy the requirment.

2

Q#3.

CCM:

$0<t<DT,\quad v_{Lm} = V_d$ 0.5p

$DT<t<T\quad v_{Lm} = v_1 = \frac{N_1}{N_3}\cdot v_3 = -\frac{N_1}{N_3}\cdot V_o$ 0.5p

$$V_{Lm} = \frac{1}{T}\int_0^T v_{Lm}$$

$$= D\cdot V_d + \left(-\frac{N_1}{N_3}V_o\right)\cdot(1-D) = 0$$

$$\frac{V_o}{V_d} = \frac{N_3}{N_1}\cdot\frac{D}{1-D}$$ 1p

DCM:

$0<t<DT,\quad v_{Lm} = V_d$

$$\Delta i_{Lm} = \frac{1}{L_m}\cdot V_d\cdot DT = \frac{V_d\cdot D}{L_m f_{sw}}$$ 0.5p

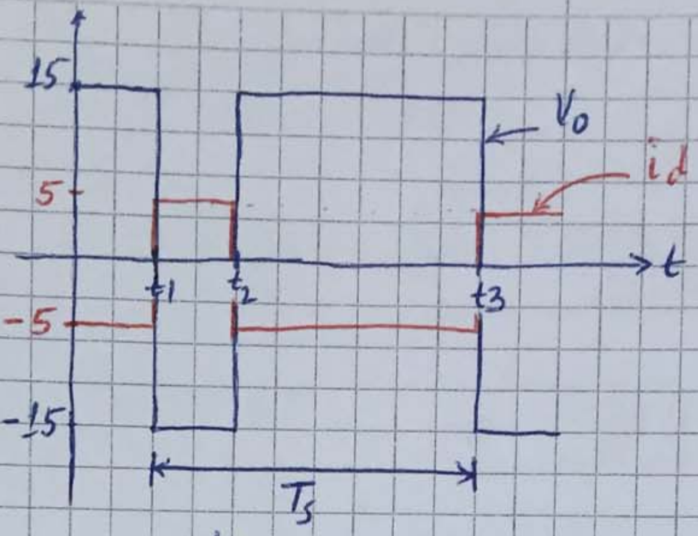
$$W_{Lm} = P_{load}\cdot T$$ 0.5p

$$\frac{1}{2}\cdot L_m\cdot\Delta i_{Lm}^2 = \frac{V_o^2}{R_{load}}\cdot\frac{1}{f_{sw}}$$

$$\frac{1}{2}\cdot L_m\cdot\left(\frac{V_d\cdot D}{L_m\cdot f_{sw}}\right)^2 = \frac{V_o^2}{R_{load}}\cdot\frac{1}{f_{sw}}.$$

$$\frac{V_o}{V_d} = D\cdot\sqrt{\frac{R_{load}}{2L_m\cdot f_{sw}}}$$ 1p.

Q#4. a)



(2)

b) $V_o = \frac{1}{T_s}\int_{t_1}^{t_3} v_o dt = V_{control} = \underline{\underline{7.5V}}$

from current direction & assuming ideal converter (2)

$P_{ac\text{-}side} = P_{dc\text{-}side}$

$\Rightarrow V_o I_o = -V_d I_d \Rightarrow I_d = -\frac{V_o I_o}{V_d} = \frac{-7.5(5)}{15} A = \underline{\underline{-2.5A}}$

c) $t_1 \leq t \leq t_2$, S_2 and S_4 (1)

$t_2 \leq t \leq t_3$, D_1 and D_3