CHALMERS

Civil registration no. / Person nr: Midterm 2018	Points for question (to be filled in by teacher)	Consecutive page no. / Löpande sid nr 1
Print name / Textat namn: Mebtu	Poäng på uppgiften (ifylles av lärare)	Question no. / Uppgift nr 1

$$V_{avg} = \frac{1}{2\pi}\int_0^{2\pi} v(\theta)d\theta = \frac{1}{2\pi}\left[\pi \cdot A + \pi\cdot(-A)\right] = \underline{\underline{0}}$$ (1)

$$V_{RMS} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} v(\theta)^2 d\theta} = \sqrt{\frac{1}{2\pi}\left[A^2 \cdot 2\pi\right]} = \underline{\underline{A}}$$ (1)

odd symmetry in the signal
half-wave symmetry in the signal } ⇒ odd-quarter wave

∴ the fourier coefficients are:

$a_h = 0$ for all h , $b_h = 0$ for even h

$$b_h = \frac{4}{\pi}\int_0^{\pi/2} v(\theta)\sin(h\theta)d\theta = \frac{4}{\pi}\int_0^{\pi/2} A\sin(h\theta)\,d\theta = \frac{4A}{\pi h} \text{ for } h = \text{odd}$$ (2)

$$\Rightarrow b_1 = \frac{4}{\pi} \Rightarrow V_1^{rms} = \frac{\sqrt{a_1^2+b_1^2}}{\sqrt{2}} = \frac{b_1}{\sqrt{2}} = \underline{\underline{\frac{2\sqrt{2}}{\pi}A}}$$

$$THD = \frac{\sqrt{V_{RMS}^2 - V_1^{rms\,2}}}{V_1^{rms}} \cdot 100\% = \frac{\sqrt{A^2 - (2\sqrt{2}/\pi)^2 A^2}}{\frac{2\sqrt{2}}{\pi}A} \cdot 100\% = \frac{\sqrt{\pi^2 - 8}}{2\sqrt{2}}(100\%)$$

$$= \underline{\underline{48.34\%}}$$ (1)

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CHALMERS	Civil registration no. Person nr: Midterm 2018	Points for question (to be filled in by teacher)	Consecutive page no. Löpande sid nr 2
	Print name Textat namn: Mebtu Beza	Poäng på uppgiften (ifylles av lärare)	Question no. Uppgift nr 2

1

CCM

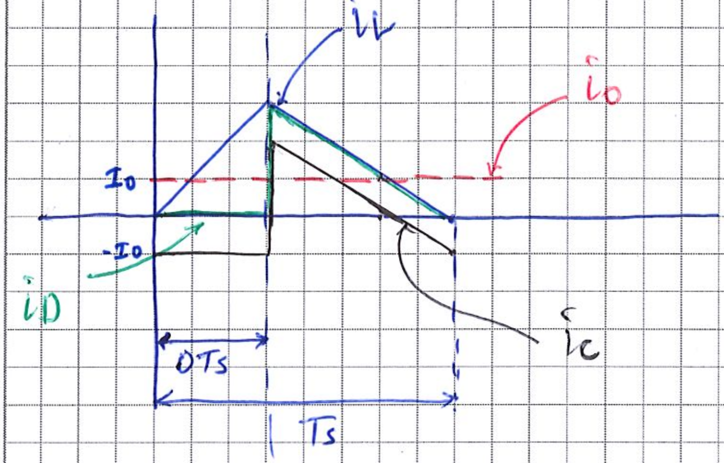
switch on ⇒ $V_L = V_d$, diode off as it is reverse biased.

switch off ⇒ $V_L = V_d - V_o$, diode must conduct to let the inductor current flow

⇒ $V_L = 0 = V_d \cdot D T_s + (V_d - V_o)(1-D) T_s = 0$. T_s: switching cycle, D: duty cycle

(2)

⇒ $\frac{V_o}{V_d} = \frac{1}{1-D} > 0$ boost/stepup DC/DC converter



$i_c = i_D - i_o$

(3)

1

CHALMERS	Civil registration no. Person nr: Midterm 2018	Points for question (to be filled in by teacher)	Consecutive page no. Löpande sid nr 3
	Print name Textat namn: Mebtu Beza	Poäng på uppgiften (ifylles av lärare)	Question no. Uppgift nr 3

CCM:- S on $\Rightarrow V_1 = V_d$

S off $\Rightarrow V_1 = -\frac{N_1}{N_3} V_0$

$\Rightarrow V_1^{avg} = 0 \Rightarrow V_d \cdot DT_s - \frac{N_1}{N_3} V_0 (1-D) T_s = 0$

$$\Rightarrow \frac{V_0}{V_d} = \frac{N_3}{N_1} \cdot \frac{D}{1-D}$$ (1)

DCM:- Energy stored during on period = energy dissipated to load in off period.

$$\Rightarrow \frac{1}{2} L_m \Delta i_m^2 = \frac{V_0^2}{R} \cdot \frac{1}{f_{sw}}$$

during on period $V_1 = V_d = L_m \frac{\Delta i_m}{DT_s} = L_m \frac{\Delta i_m}{D} \cdot f_{sw}$

$$\Rightarrow \Delta i_m = \frac{DV_d}{L_m f_{sw}}$$

$$\Rightarrow \frac{1}{2} L_m \left[\frac{DV_d}{L_m f_{sw}}\right]^2 = \frac{V_0^2}{R_{load} f_{sw}} \Rightarrow \frac{V_0^2}{V_d^2} = \frac{1}{2} \cdot \frac{D^2 R_{load}}{L_m f_{sw}}$$

$$\Rightarrow \frac{V_0}{V_d} = D \sqrt{\frac{R_{load}}{2 L_m f_{sw}}}$$ (2)

winding N_2 means that diode D_2 conducts if $V_{D_2} > 0$

this happens if $-V_d - V_2 \geq 0 \Rightarrow V_2 \leq -V_d$

during off period, this happens when $V_2 = \frac{N_2}{N_3} V_3 = -\frac{N_2}{N_3} V_0 \leq -V_d$

$\Rightarrow D_2$ conducts when $V_0 \geq \frac{N_3}{N_2} V_d$ which then makes D to stop conducting and the V_0 is limited to the maximum value.

$\Rightarrow V_0 \leq \frac{N_3}{N_2} V_d$.

$R_{load} = \infty \Longrightarrow V_0 = V_{0,max} = \frac{N_3}{N_2} V_d$ (2)

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1

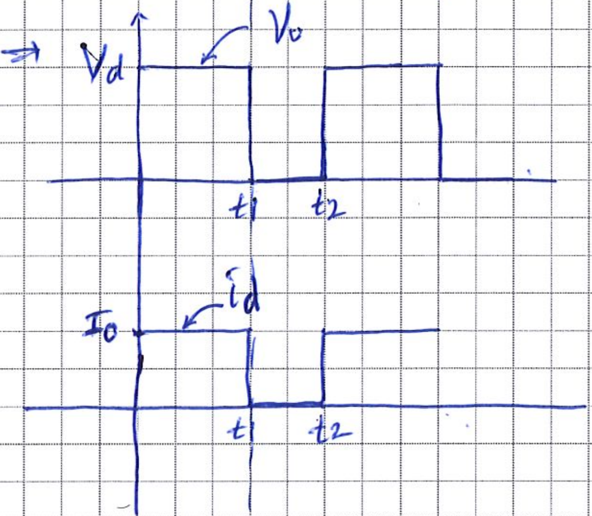
CHALMERS	Civil registration no. / Person nr: Midterm 2018	Points for question (to be filled in by teacher)	Consecutive page no. / Löpande sid nr: 4
	Print name / Textat namn: Mebtu Beze	Poäng på uppgiften (ifylles av lärare)	Question no. / Uppgift nr: 4

(a) $0 \le t \le t_1$. S_1 on, S_2 off, $\Rightarrow v_o = V_d$. $i_o > 0 \Rightarrow S_1$ is conducting

$t_1 \le t \le t_2$, S_1 off S_2 on, $\Rightarrow v_o = 0$, $i_o > 0 \Rightarrow D_2$ conducting (1)

(b) $\to i_d = i_o$ during this interval

$\to i_d = 0$ during this interval as S_1 and D_1 are not conducting



$V_d = 15\,V$

(2)

$I_o = 5A$

(c) $V_o = \frac{1}{t_2}\int_0^{t_2} V_d\,dt = V_d \cdot t_1/t_2$ but $\frac{t_1}{t_2} = \frac{V_{control}}{V_d}$

$= V_d \cdot \frac{V_{control}}{V_d}$

$= V_{control} = \underline{9V}$

$I_d = \frac{1}{t_2}\int_0^{t_2} i_o\,dt = I_o \cdot t_1/t_2$

$= I_o \cdot \frac{V_{control}}{V_d}$ (2)

$= \frac{I_o \cdot V_o}{V_d}$ $(P_{out} = P_{in})$

$= \frac{5 \cdot 9}{15} A$

$= \underline{3\,A}$

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