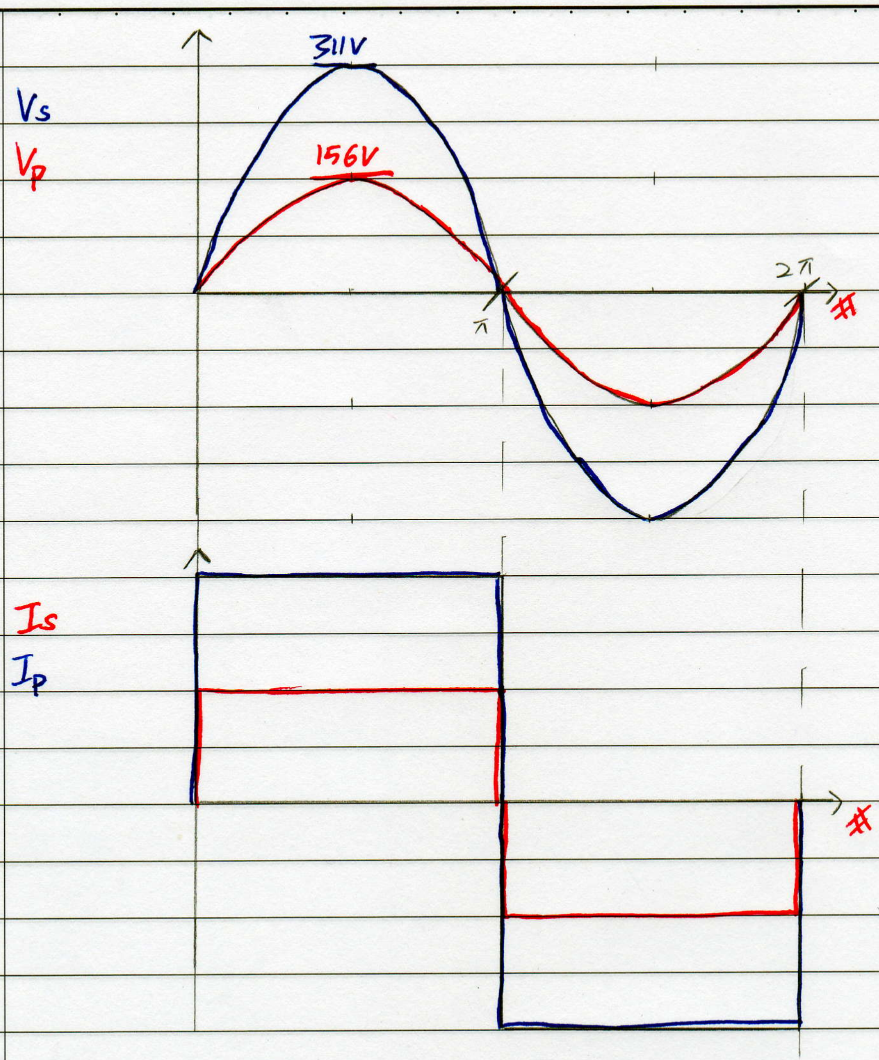
PYP #EE4532 NOV/DEC 15 Megarine Tee

1a)



$V_m = 220 \times \sqrt{2} = 311V$

$V_{pm} = V_m/2 = 156V$

Since $I_{Dpeak} = 10A \therefore I_{speak} = 10A$.

Transformer Rating $= V_s I_s = (220)(10/\sqrt{2}) = 1.556\ kVA$ #

$PIV = V_m = 311V$ #

$I_{Dpeak} = 10A$ #

$I_{Drms} = I_{orms}/\sqrt{2} = (10/\sqrt{2})/\sqrt{2} = 5A$ #

$I_{Davg} = \frac{1}{2\pi}\int_0^{\pi} 10 \sin \omega t \, d\omega t = \frac{10}{2\pi}[-\cos \omega t]_0^{\pi} = \frac{10}{\pi} = 3.18A$ #

b) $I_{o\,avg} = 2 \times I_{D\,avg} = 2 \times 3.18 = 6.36A$

Under highly inductive,

$I_{o\,rms} = I_{o\,peak} = I_{o\,avg} = 6.36A$

$\Rightarrow I_{in\,peak} = 6.36A$

$a_n = a_0 = 0$

$$b_n = \frac{1}{\pi}\int_0^{2\pi} I_{in}(\omega t)\,\sin(n\omega t)\,d\omega t = \frac{2}{\pi}\int_0^{\pi} 6.36\,\sin(n\omega t)\,d\omega t$$

$$= \frac{12.72}{\pi n}\Big[-\cos(n\omega t)\Big]_0^{\pi} = \frac{4.049}{n}\left[1-(-1)^n\right]$$

$$\therefore I_{in} = \sum_{n=1}^{\infty} \frac{4.049}{n}\left[1-(-1)^n\right]\sin(n\omega t) \quad \#$$

$I_{in\,1\,rms} = \left[\frac{4.049}{1}(2)\right]/\sqrt{2} = 5.726A$

$I_{in\,rms} = 6.36A$

$$THD = \left[\left(\frac{I_{in\,rms}}{I_{in\,1\,rms}}\right)^2 - 1\right]^{1/2} = 48.34\% \ \# \quad , \quad PF = \frac{I_{in\,1\,rms}}{I_{in\,rms}}\cos(\phi) = 0.9 \ \#$$

For purely resistive $THD = 0\%$, $PF = 1$ $\#$

2a)

i) $V_{o\,avg} = \frac{1}{2\pi}\int_0^{2\pi} V_o(\omega t)\, d\omega t = \frac{2}{2\pi}\int_\alpha^{\pi+\alpha} V_m \sin\omega t\, d\omega t$

$= \frac{V_m}{\pi}\left[-\cos\omega t\right]_\alpha^{\pi+\alpha} = \frac{2V_m}{\pi}\cos\alpha$

$\therefore \frac{2V_m}{\pi}\cos\alpha = 80V \Rightarrow \alpha = \cos^{-1}\left(\frac{80\pi}{2V_m}\right)$

$= 66.2^\circ$ #

ii) $V_{o\,avg} = 80V$ #

$V_{o\,rms} = V_m/\sqrt{2} = 219.9V$ #

$I_{o\,avg} = V_{o\,avg}/R = 16A$ #

$I_{o\,rms} = I_{o\,avg} = 16A$ #

iii) $PIV = V_m = 311V$ #

$I_{T\,peak} = 16A$ #

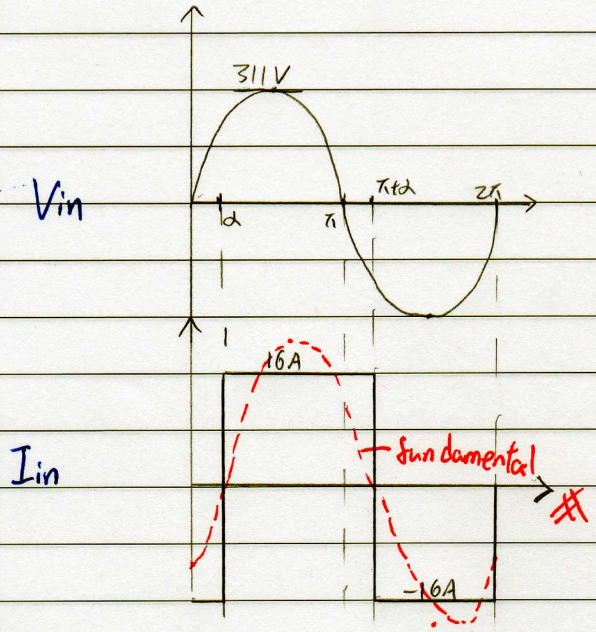
$I_{T\,rms} = I_{o\,rms}/\sqrt{2} = 11.3A$ #

$I_{T\,avg} = I_{o\,avg}/2 = 8A$ #

iv) Transformer Rating $= V_s I_s = (311/\sqrt{2}) \times (I_{o\,rms}) = 3.519\ kVA$ #

~~b)~~

b)



Phase shift: $I_{in(1)}$ lag by α

Find $I_{in(1)}$ peak:

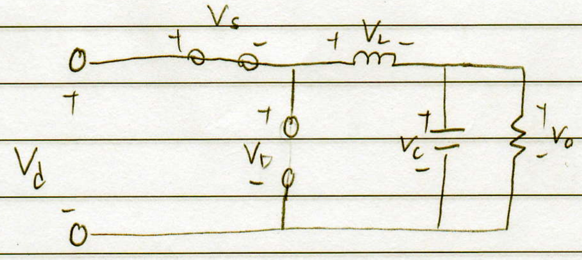
$$I_{in(1)peak} = \cancel{\frac{1}{\pi}}\ \frac{2}{\pi}\int_0^{\pi} 16\sin(\omega t)\,d\omega t = \frac{32}{\pi}\left[-\cos\omega t\right]_0^{\pi} = \frac{64}{\pi}A$$

$$I_{in(1)rms} = I_{in(1)peak}/\sqrt{2} = 14.405A$$

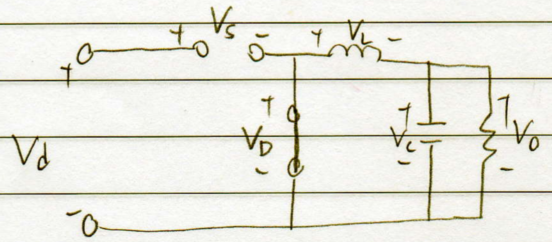
$$PF = \frac{I_{in(1)rms}}{16}\cos(\alpha) = 0.363$$

3)

a)



"On State" #



"Off State" #

Under CCM:

$\frac{V_o}{V_d} = D$ #

b) $D = 0.6$

$\frac{V_o}{V_d} = 0.6 \Rightarrow V_o = 50 \times 0.6$

$= 30V$ #

$I_{o\,avg} = V_{o\,avg} / R = 30/25$

$= 1.2A$ #

$I_{D\,avg} = I_{o\,avg} \times \frac{t_{off}}{T_s} = I_{L\,avg} \times \frac{t_{off}}{T_s} = 1.2 \times (1-0.6)$

$= 0.48A$ #

$I_{s\,avg} = I_{o\,avg} \times \frac{t_{on}}{T_s} = I_{L\,avg} \times \frac{t_{on}}{T_s} = 1.2 \times (0.6)$

$= 0.72A$ #

c) Under BCM:

$I_{oB} = \frac{1}{2}\Delta I_L$, $\Delta I_L = \frac{V_o}{L} t_{off} = \frac{V_o}{L}(1-D)T_s$

$I_{oB} = \frac{V_o}{R} = \frac{V_o}{2L}(1-D)T_s \Rightarrow D = 1 - \frac{2L}{RT_s} = 0.2$ #

$\Delta V_o = \frac{\Delta Q}{C}$, $\Delta Q = \frac{1}{2} \times \frac{T_s}{2} \times \frac{\Delta I_L}{2}$, $D = 0.2$, $V_o = 10V$

$\Delta V_o = \frac{T_s^2 V_o (1-D)}{8CL} = 0.1V$ #

4)

a:) $f = f_s / m_f = 5000/100 = 50\,Hz$ #

$V_{o1} = m_a \frac{V_d}{2} \sin(100\pi t)$

$V_{o1\,rms} = (m_a \frac{V_d}{2})/\sqrt{2} = 229.8V$ #

ii) for $m_a < 1$, the $V_{o1\,rms}$ is in linear region hence is easy to control the voltage. When $m_a > 1$, it is in non linear region hence not easy to control. #

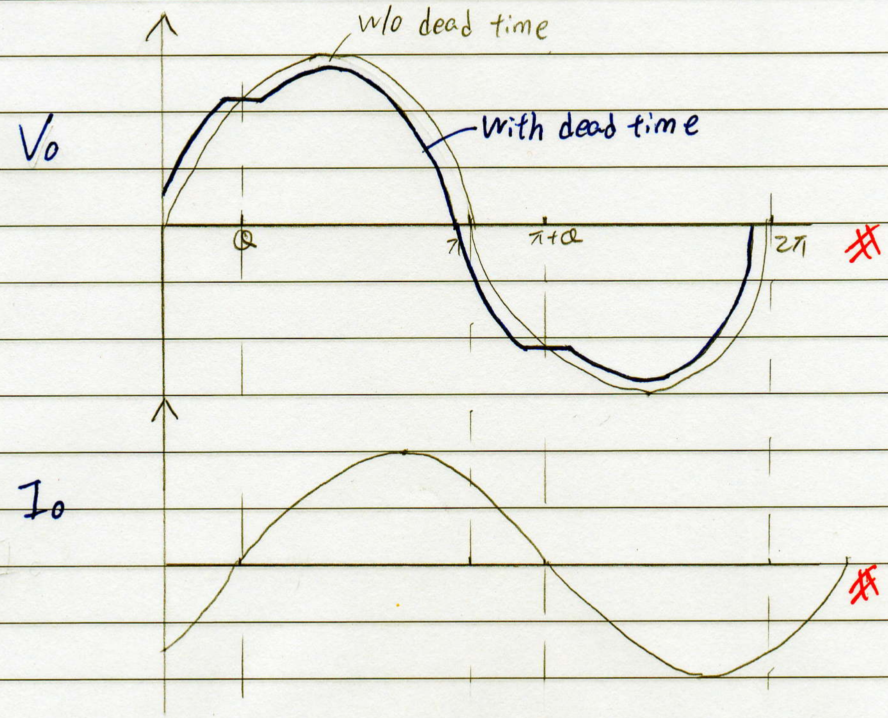
bi) $Z_1 = \sqrt{R^2 + (2\pi f_1 L)^2} = \sqrt{(40)^2 + (100\pi \times 95.5 \times 10^{-3})^2} = 50\Omega$

$I_{o1\,rms} = V_{o1\,rms}/Z_1 = 4.596A$ #

$\Theta = \tan^{-1}\left(\frac{2\pi f_1 L}{R}\right) = 36.87°$

$PF = \cos(\Theta) = 0.8$ lag #

ii)

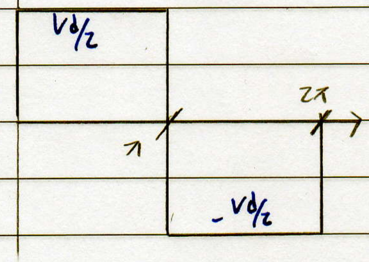


#

#

C i)

V_o



$a_n = a_0 = 0$

$$b_n = \frac{1}{\pi}\int_0^{2\pi} V_{o(\omega t)} \sin(n\omega t)\, d\omega t = \frac{2}{\pi}\int_0^{\pi} \frac{V_d}{2} \sin(n\omega t)\, d\omega t$$

$$= \frac{V_d}{\pi n}\Big[-\cos(n\omega t)\Big]_0^{\pi} = \frac{V_d}{n\pi}\left[1-(-1)^n\right]$$

$$\therefore V_o = \sum_{n=1}^{\infty} \frac{V_d}{n\pi}\left[1-(-1)^n\right] \sin(n\omega t) \quad \#$$

ii) $$V_{o3} = \frac{V_d}{3\pi}\left[1-(-1)^3\right] = 169.8V$$

$$V_{o3\,rms} = V_{o3}/\sqrt{2} = 120V \quad \#$$