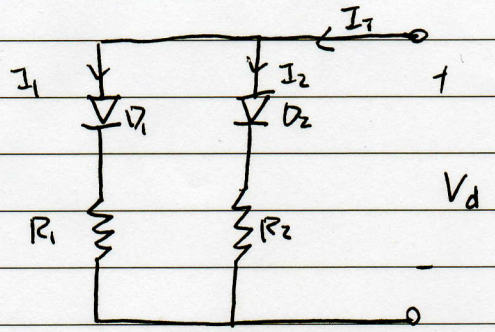
PYP EE4532 NOV/DEC 12 Megarine Tee

1)



$I_T = 100A$

a i) ~~I_1~~ $= 52A$, $I_2 = 48A$

$V_{D1} = 1.5V$, $V_{D2} = 2V$

$V_{D1} + R_1 I_1 = V_{D2} + R_2 I_2$

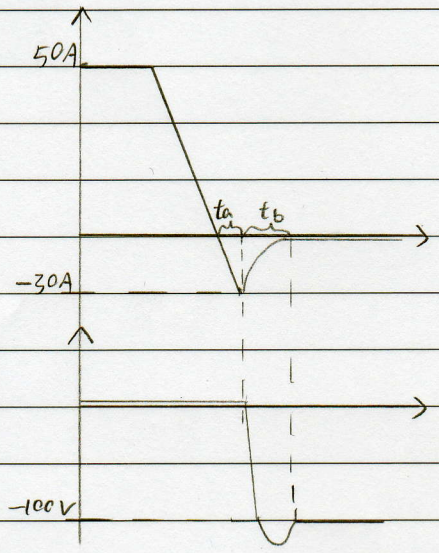
~~$\Rightarrow R_1 =$~~ Let $R_1 = R_2 = R$,

$1.5 + R(52) = 2 + R(48)$

$\Rightarrow R = 0.125\Omega$ #

ii) $P_{loss} = I_1^2 R + I_2^2 R = 626W$ #

b i)



$\frac{di}{dt} = 10A/\mu s$

$SF = 0.7 = t_b/t_a$

$t_b + t_a = t_{rr}$

$t_a = I_{rr} / \frac{di}{dt} = 3\mu s$

$t_b = t_a \times SF = 2.1\mu s$

$t_{rr} = t_a + t_b = 5.1\mu s$ #

2) Highly inductive, $V_{o\,avg} = 120\,V$, $V_m = 311\,V$, $R = 10\,\Omega$

a) i) $$V_{o\,avg} = \frac{1\times 2}{2\pi}\int_{\alpha}^{\pi+\alpha} V_m \sin\omega t\, d\omega t = \frac{V_m}{\pi}\left[-\cos\omega t\right]_{\alpha}^{\pi+\alpha}$$

$$= \frac{2V_m}{\pi}\cos\alpha$$

$$\Rightarrow \frac{2V_m}{\pi}\cos\alpha = 120\,V \quad \Rightarrow \alpha = 52.69^\circ \#$$

ii) $I_{o\,avg} = I_{o\,rms} = V_{o\,avg}/R = 12\,A$ #

iii) ~~$I_{in\,rms} = 12\,A$~~

Current distortion $\Rightarrow$ discontinuous current. $\Rightarrow$ Resistive load

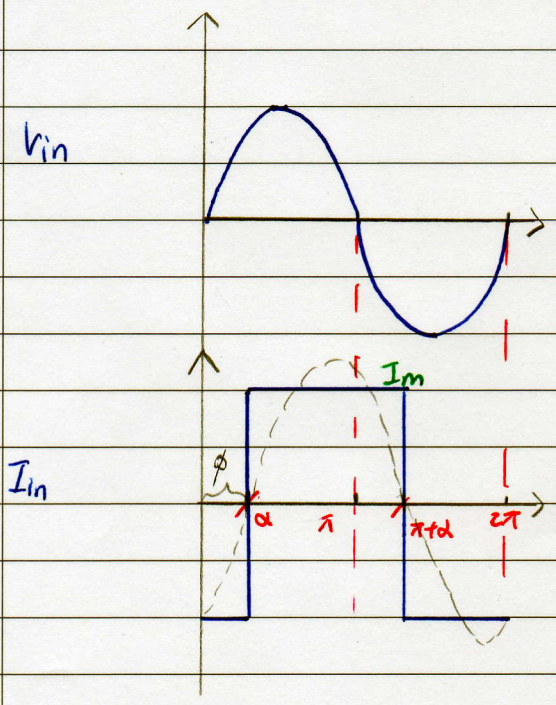
$$I_{in\,rms} = \left[\frac{1\times 2}{2\pi}\int_{\alpha}^{\pi} \frac{V_m^2}{R^2}\sin^2\omega t\, d\omega t\right]^{1/2} = \left[\frac{V_m^2}{R^2\pi 2}\int_{\alpha}^{\pi}(1-\cos 2\omega t)\, d\omega t\right]^{1/2}$$

$$= \left[\frac{V_m^2}{R^2\pi 2}\left[\omega t - \tfrac{1}{2}\sin 2\omega t\right]_{\alpha}^{\pi}\right]^{1/2} = \left[\frac{V_m^2}{R^2 2\pi}\left[\pi - \alpha - \tfrac{1}{2}\sin 2\pi + \tfrac{1}{2}\sin 2\alpha\right]\right]^{1/2}$$

$$= 20.40\,A$$

Transformer $kVA = I_{in\,rms} \times V_{in\,rms} = 4.4867\,kVA$ #

b)



Find $I_{in(1)peak}$: $I_m = 12\,A$

$$I_{in(1)peak} = \frac{1}{\pi}\times 2\times I_m \int_0^{\pi} \sin\omega t\, d\omega t$$

$$= \frac{2I_m}{\pi}\left[-\cos\omega t\right]_0^{\pi}$$

$$= \frac{4}{\pi}I_m$$

$$= 15.2789\,A$$

Phase shift $\phi = \alpha = 52.69^\circ$ lag

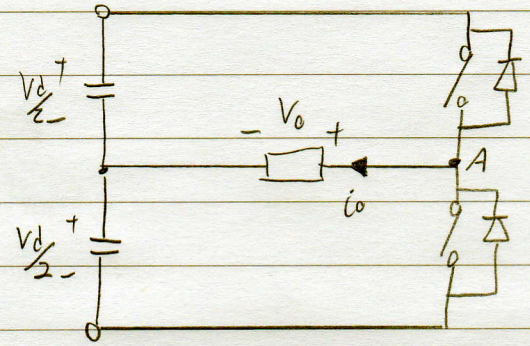
$I_{in\,rms} = I_m = 12\,A$

$I_{in(1)\,rms} = I_{in(1)peak}/\sqrt{2} = 10.804\,A$

$\therefore PF = (I_{in(1)\,rms}/I_{in\,rms})\cos\phi$

$= 0.5457$ #

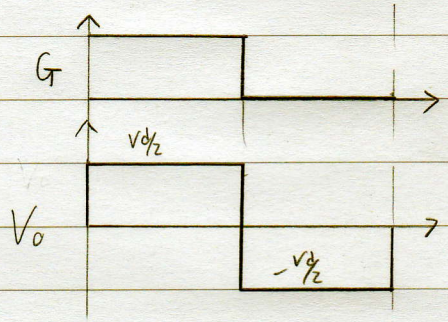
3)



$V_d = 200V$

assume $f = 50Hz$

a i)



$V_{orms} = \frac{V_d}{2} = 100V$ #

ii) Since finding fundamental, set $n=1$.

$$b_1 = \frac{1}{\pi}\int_0^{2\pi} V_o \sin(\omega t)\, d\omega t = \frac{2}{\pi}\int_0^{\pi} \frac{V_d}{2}\sin(\omega t)\, d\omega t$$

$$= \frac{V_d}{\pi}\left[-\cos(\omega t)\right]_0^{\pi} = \frac{2}{\pi}V_d$$

$$\therefore V_{o(1)} = \frac{2}{\pi}V_d \sin(\omega t) \Rightarrow V_{o(1)\,peak} = \frac{2}{\pi}V_d = 127.32V$$ #

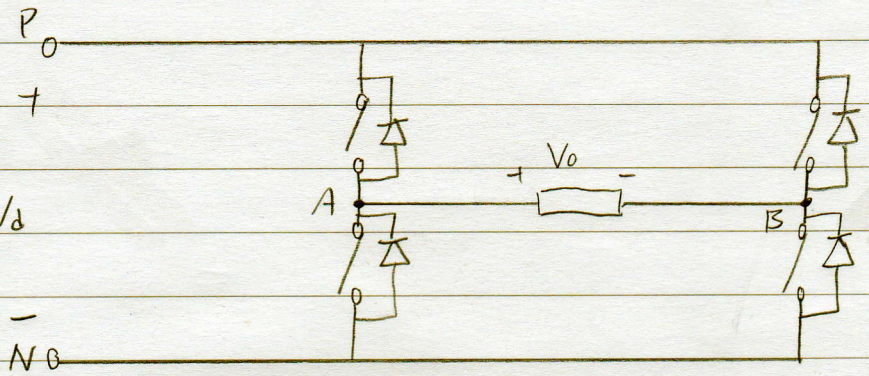
iii) $V_{o(1)\,rms} = V_{o(1)\,peak}/\sqrt{2} = 90.03V$ #

b) $Z = \left[(2\pi \times 50 \times 2)^2 + (R)^2\right]^{1/2} = 10.482\,\Omega$

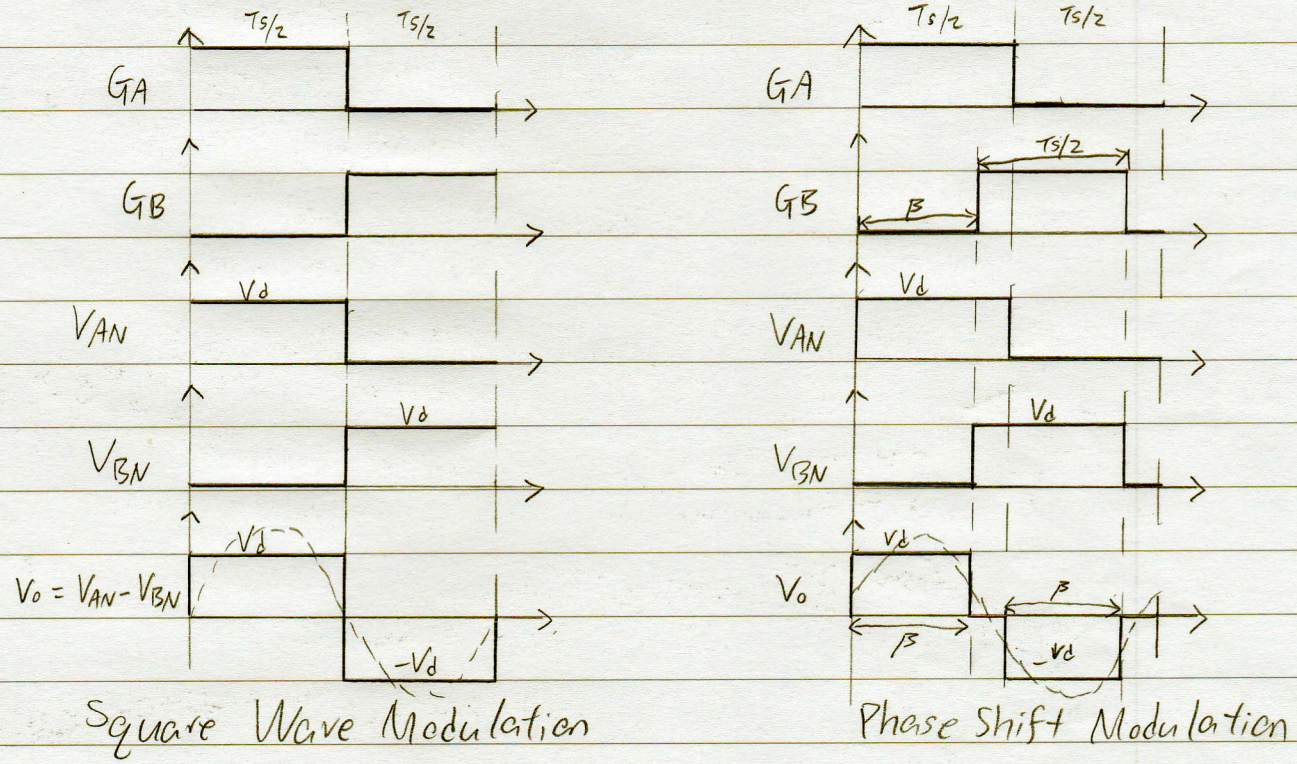
i) $I_{o(1)\,peak} = V_{o(1)\,peak}/Z = 12.147A$ #

ii) $I_{o(1)\,rms} = V_{o(1)\,rms}/Z = 8.589A$ #

4)



a)



$$Vo_{rms} = \left[\frac{1}{2\pi}\int_0^{2\pi} Vo^2\, d\omega t\right]^{1/2} = \left[\frac{1}{2\pi} \times V_d^2 \times 2\beta\right]^{1/2} = V_d\sqrt{\frac{\beta}{\pi}}$$

β vary of 0 to π therefore by controlling β, Vorms can be controlled. #

By using SPWM, the dominant harmonic is located at higher order. In addition, by using a low pass filter ~~wt~~ with corner frequency ~~the~~ of the fundamental frequency, high frequencies can be eliminated. #

b) $V_d = 350V$, square wave modulation, max V_o

i) $V_{orms} = V_d = 350\,V$ #

ii) For fundamental, set $n = 1$,

$$b_1 = \frac{1}{\pi}\int_0^{2\pi} V_o \sin \omega t \, d\omega t = \frac{2}{\pi}\int_0^{\pi} V_d \sin \omega t \, d\omega t$$

$$= \frac{2}{\pi} V_d [-\cos \omega t]_0^{\pi} = \frac{4}{\pi} V_d$$

$$\therefore V_{o(1)} = \frac{4}{\pi} V_d \sin \omega t$$

$$V_{o(1)peak} = \frac{4}{\pi} V_d = 445.634\,V \#$$

$$V_{o(1)rms} = V_{o(1)peak} / \sqrt{2} = 315.111\,V \#$$

iii) $$THD = \sqrt{\left[\left(\frac{V_{orms}}{V_{o(1)rms}}\right)^2 - 1\right]^{1/2}} = \left[\left(\frac{350}{315.111}\right)^2 - 1\right]^{1/2} = 0.4834$$

$$= 48.34\% \#$$