

Mid - Term Examination - I

Sub - Advanced Power Electronics

Qus. 1

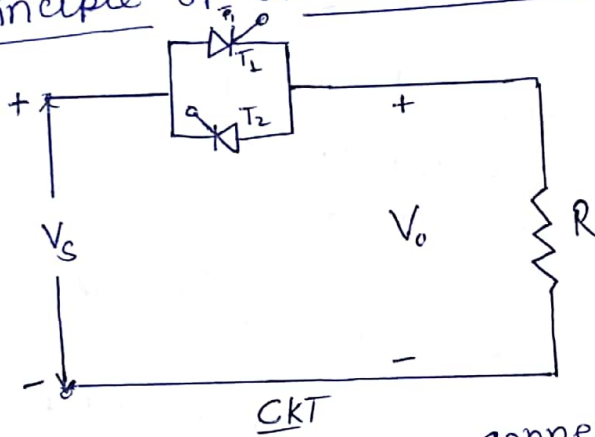
(a) Explain the principle of ON-OFF control for single phase full wave controller.

(b) For a single phase AC voltage controller feeding a resistive load, show that power factor is given by

$$P.F. = \left[\frac{1}{\pi} \left\{ (\pi - \alpha) + \frac{1}{2} \sin 2\alpha \right\} \right]^{1/2}$$

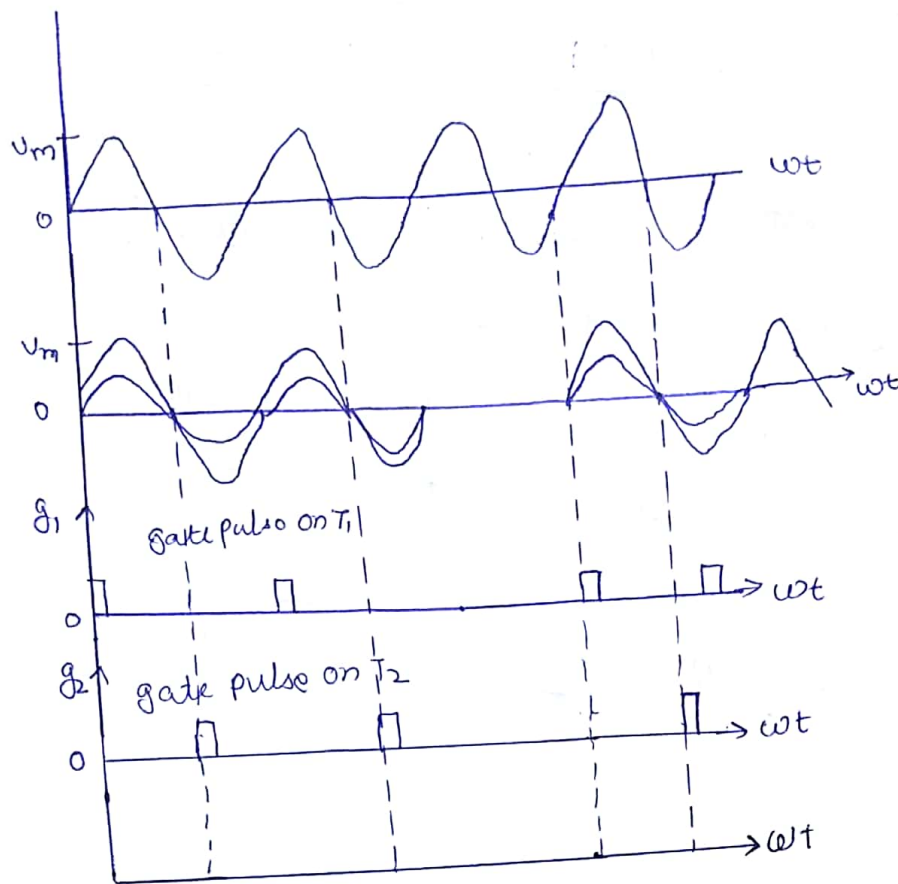
Solⁿ

(a) Principle of ON-OFF control →



(a) The thyristor switch connects the ac supply to load for a time t_n ; the switch is turned off by a gate pulse inhibiting for time t_n . The on-time t_n usually consists of an integral number of cycles.

(b) The thyristors are turned on at the zero-voltage crossing of ac input voltage. The gate pulses for thyristors T_1 & T_2 and the waveforms for i/p & o/p v/t.



→ This type of control is applied in applications that have a high mechanical inertia + high thermal time constant. Due to zero voltage + zero current switching of thyristors, the harmonics generated by switching actions are reduced.

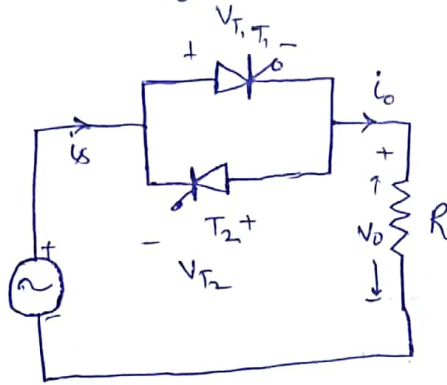
→ The rms output voltage can be found from

$$V_o = \left[\frac{n}{2\pi(n+m)} \int_0^{2\pi} 2V_s^2 \sin^2 \omega t d(\omega t) \right]^{1/2}$$

$$= V_s \sqrt{\frac{n}{m+n}} = V_s \sqrt{k}$$

where k is called the duty cycle.

1- ϕ Ac voltage Controller with R load and voltage + current waveform are shown in fig



Now, from fig. rms value V_{or} of the o/p is -

$$V_{or} = \left[\frac{1}{\pi} \int_{\alpha}^{\pi} V_m^2 \sin^2 \omega t d(\omega t) \right]^{1/2}$$

$$= \frac{V_m}{\sqrt{2}} \left[\frac{1}{\pi} \left\{ (\pi - \alpha) + \frac{1}{2} \sin 2\alpha \right\} \right]^{1/2}$$

$$I_{or} = \frac{V_{or}}{R} = \text{rms value of load or source current}$$

Now,

$$\text{p.f.} = \frac{\text{Real Power}}{\text{Apparant power}} = \frac{V_s I_1 \cos \phi}{V_s \cdot I_{rms}} = \frac{I_1 \cos \phi}{I_{rms}}$$

Where,

$$I_1 = \frac{I_{1m}}{\sqrt{2}} = \text{r.m.s. value of fundamental Component}$$

of source current.

$$\text{Real power delivered to load} = \frac{V_{or}^2}{R}$$

$$\text{Apparent power delivered to load} = V_s I_{or} = V_s \cdot \frac{V_{or}}{R}$$

$$P.F. = \frac{V_{or}^2 / R}{V_s \cdot V_{or} / R} = \frac{V_{or}}{V_s}$$

$$P.F. = \frac{V_{or}}{V_s} = \left[\frac{1}{\pi} \left\{ (\pi - \alpha) + \frac{1}{2} \sin 2\alpha \right\} \right]^{1/2}$$

Qus. 2.

(Q) A three phase cyclo converter has output voltage of 250V to feed a 1- ϕ load at 50A. If the load power factor is unity, find the input power per phase and power factor.

Ans The fundamental RMS of per phase output voltage of a cyclo converter is

$$E_{or} = E_{ph} \sin\left(\frac{m}{\pi}\right) \cdot \sin\left(\frac{\pi}{m}\right)$$

$$250 = \left(\frac{3}{\pi}\right) E_{ph} \sin\left(\frac{\pi}{3}\right)$$

$$E_{ph} = 250 \times \frac{\pi}{3} \times \frac{2}{\sqrt{3}}$$

$$E_{ph} = 302.29 \text{ V/phase}$$

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The max^m Value of the CycloConverter load = $50\sqrt{2}$
 $\Rightarrow 70.7106 A$

Thyristor rms Current I_{rms}

$$I_{rms} = \frac{50\sqrt{2}}{\sqrt{3}} = 40.82 A$$

Input power per phase
 $= \frac{1}{3} \times \text{load power} = \frac{1}{3} \times 50 \times 250 \times 1$
 $= ~~4166~~ 4166.67 W$

$$\text{Power Factor} = \frac{\text{Power}}{E_{rms} \cdot I_{rms}}$$

$$I_{rms} = \sqrt{\frac{(50)^2}{3}} = 28.86 A$$

$$\text{Power factor} = \frac{4166.67}{302.21 \times 28.86}$$

$$= 0.477 \text{ Ans.}$$

(b) Explain the Converters difference b/w cycloconverters and dc link inverters. Give the applications of cyclo converter.

Solⁿ cycloconverters

- (i) In a cyclo converter a.c. Power at one frequency is converted to lower frequency at a 1- conversion state.
- 2) For reasonable power o/p & Efficiency, the o/p frequency is limited to $1/3$ i/p frequency.
- 3) Require Large no. of thyristors & its control circuitry is more complex.
- 4) Has very low power factor particularly at reduced o/p voltage.
- 5) Extremely attractive for large power low speed reversibly drives.

→ Applications of cyclo converter are as follows.

- (i) Induction heating
- (ii) Static VAR generation
- (iii) speed control of high power ac drives
- ~~(iv)~~

DC Link Converters.

- (i) DC Link Converters has two power controls and the full o/p power is converted into two stages.
- 2) DC Link Converters, On the other hand requires forced commutation for the inverter though the rectifiers operated on phase control principle.
- 3) The d.c. link converter require only 12 Thyristors
- 4) DC Link has high I/P Power factor if diode rectifier is used.
- 5) Extremely suitable for high frequency.