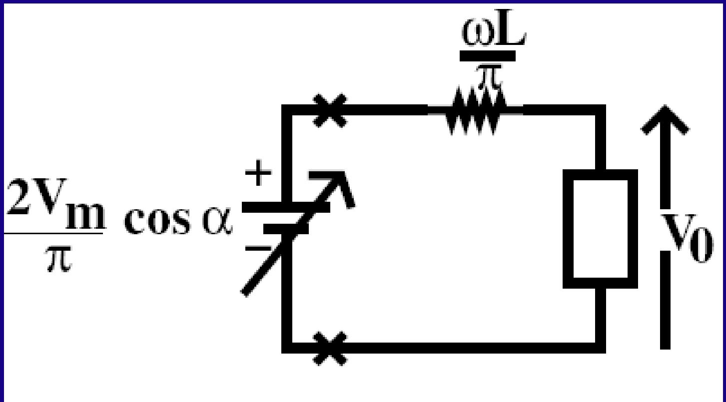
<u>Review</u> :

1. All four quadrant operation is possible with Dual Converter.
2. If source 'L' is finite ,

   Avg. Value of $V_0 \downarrow$



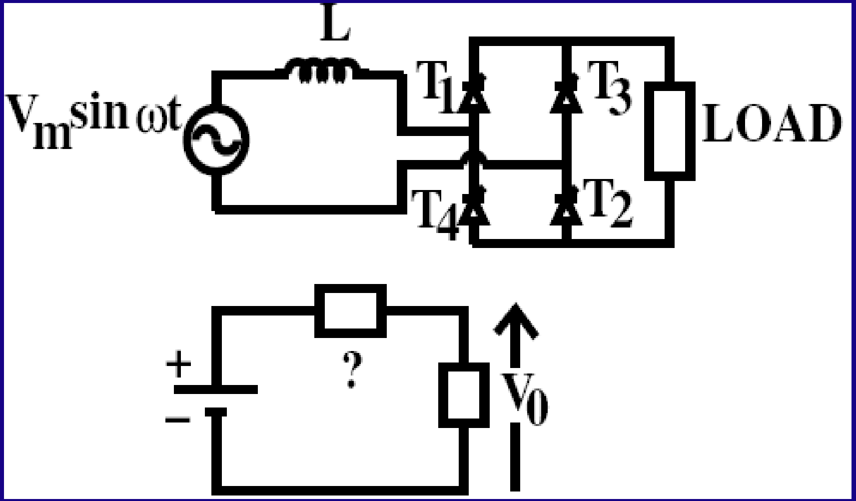
$$V_0 = \frac{V_m}{\pi}[\cos\alpha + \cos(\alpha+\mu)]$$

$$= 0\ , \text{ for } \mu = \pi \rightarrow \text{Ideal current source}$$

$$= \pi - 2\alpha \rightarrow \text{Ideal 'L'}$$

$$I_0 = \frac{V_m}{\omega L}[\cos\alpha - \cos(\alpha+\mu)]$$

Problem 2 : A single phase fully controlled bridge has a 'μ' with a load current of 10A. Determine 'μ' when α is increased to 45^0 ? Load current remains the same.



Sol.

$$I_0 = \frac{V_m}{\omega L}[\cos\alpha - \cos(\alpha+\mu)]$$

$$\Rightarrow \cos\alpha - \cos(\alpha+\mu) = \frac{I_0 \omega L}{V_m}$$

$$\therefore 1 - \cos 30^0 = \cos 45^0 - \cos(45^0 + \mu_1)$$

$\Rightarrow \mu_1 = 10^0 \Rightarrow$ depends on α if I_0 is held constant.

'V' drop due to source 'L' at $\alpha = 45^0$

$$= \frac{V_m}{\pi}[\cos\alpha - \cos(\alpha+\mu)] = 14 \text{ V}$$

given when alpha=00 overlap angle=30

1φ Half Wave Rectification - One pulse/cycle

1φ Full Wave Rectification - Two pulse/cycle

3φ Half Wave Rectification - Three pulse converter

$V_{an} = V\angle 0$

$V_{bn} = V\angle -120$

$V_{cn} = V\angle -240$

Common Cathode Configuration

At $\omega t = X^+$

Anode pot. of $D_1 > D_3 > D_2$

$\Rightarrow D_1$ Conducts

$\Rightarrow V_0 = V_{an}$

At $\omega t = Y^+$

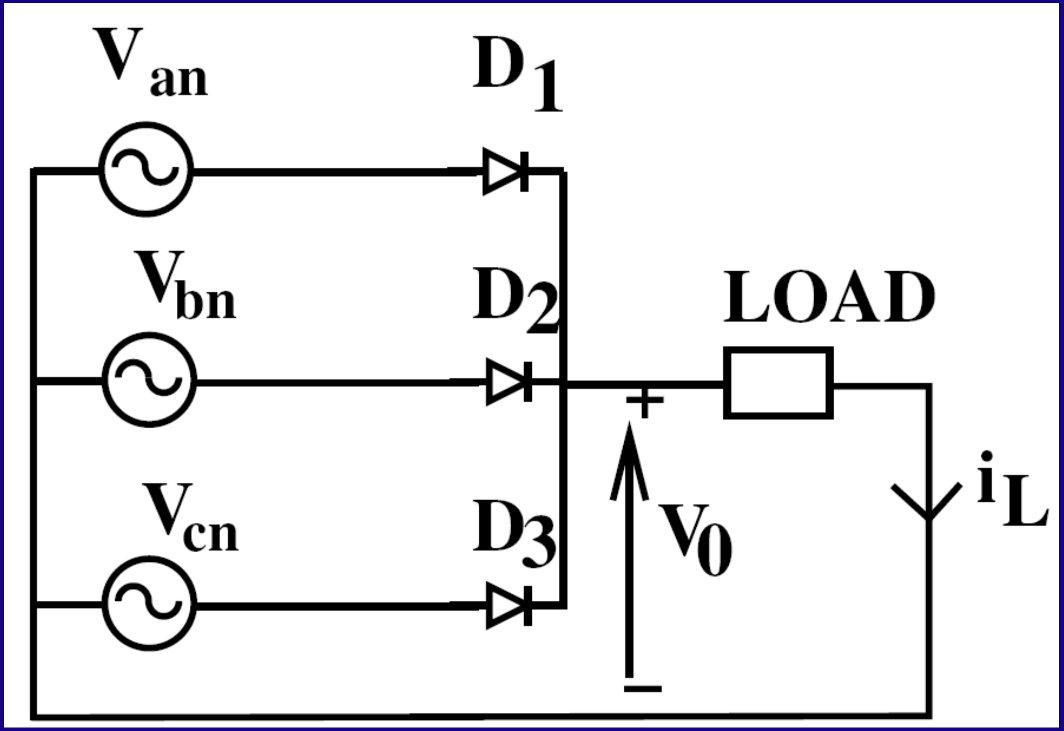
$\Rightarrow D_2$ Conducts

$\Rightarrow V_0 = V_{bn}$

At $\omega t = Z^+$

$\Rightarrow D_3$ Conducts

$\Rightarrow V_0 = V_{cn}$



X, Y, Z are known as points of natural commutation

Each Diode conducts for $\frac{2\pi}{3}$ radians

V rating of diode:

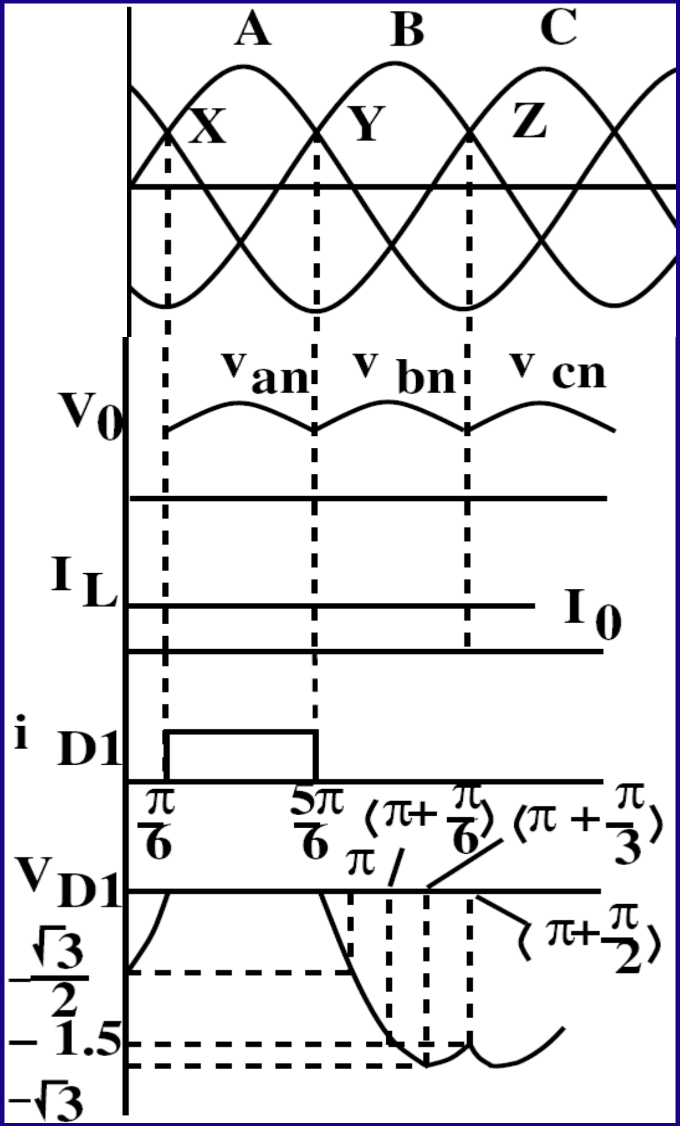
When 'D' is ON, $V_D = 0$

For $0 < \omega t < 30°$ D_3 is ON

'K' pot. of D_1 is V_{cn}

'A' pot. of D_1 is V_{an}

$\therefore V_{AK} = V_{an} - V_{cn}$



At ωt=0

$$V_{cn} \propto \sin 120^\circ = \frac{\sqrt{3}}{2}\ \text{p.u}$$

$$V_{an} = 0 \quad \therefore\ V_{AK} = -\frac{\sqrt{3}}{2}$$

At ωt = 30°, $V_{AK} = 0$

$$\because V_{an} \propto \sin 30^\circ = 0.5\ \text{p.u}$$

$$V_{cn} \propto \sin 150^\circ = 0.5\ \text{p.u}$$

From $\omega t = \frac{\pi}{6}^{+}$ to $\frac{5\pi}{6}$, $V_{AK}=0$

From $\omega t = \frac{5\pi}{6}^{+}$ till $\left(\frac{5\pi}{6}+\frac{2\pi}{3}\right)$, D_2 conducts

'K' pot. of $D_1 = V_{bn}$

'A' pot. of $D_1 = V_{an}$

$\Rightarrow V_{D1}=V_{an}-V_{bn}$

At $\omega t = \pi$

$$V_{an} = 0, V_{bn} = \text{Sin}60^\circ = \frac{\sqrt{3}}{2} \quad \therefore V_{D1} = -\frac{\sqrt{3}}{2}$$

At $\omega t = \left(\pi + \frac{\pi}{6}\right)$

$$V_{an} = -\frac{1}{2}, V_{bn} = \text{Sin}90^\circ \quad \therefore V_{D1} = -\frac{1}{2} - 1 = -1.5$$

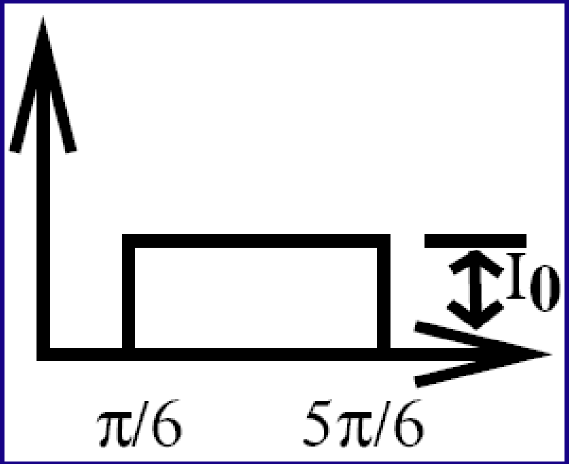
At $\omega t = \left(\pi + \frac{\pi}{3}\right)$

$$V_{an} = -\frac{\sqrt{3}}{2}, V_{bn} = \frac{\sqrt{3}}{2} \quad \therefore V_{D1} = -\sqrt{3}$$

$\underline{\text{At } \omega t = \left(\pi + \frac{\pi}{2}\right)^{-}}$ $V_{an} = -1, V_{bn} = \frac{1}{2} \quad \therefore V_{D1} = -\frac{3}{2}$

$\underline{\text{At } \omega t = \left(\pi + \frac{\pi}{2}\right)^{+}}$ D_3 starts conducting

$V_{D1} = V_{an} - V_{cn}, V_{an} = -1, V_{cn} = \frac{1}{2} \quad \therefore V_{D1} = -\frac{3}{2}$



$$V_{av} = \frac{3}{2\pi} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} V_m \, \text{Sin}\omega t = \frac{3\sqrt{3}}{2\pi} V_m$$

Peak value of voltage across diode = $\sqrt{3} V_m$

r.m.s value of the current $= \frac{I_0}{\sqrt{3}}$

3 phase half wave controlled bridge

x, y, z

Points of natural commutation

$\Rightarrow \alpha$ is measured w.r.t. these points.

$\Rightarrow$ Assume i_L is continuous

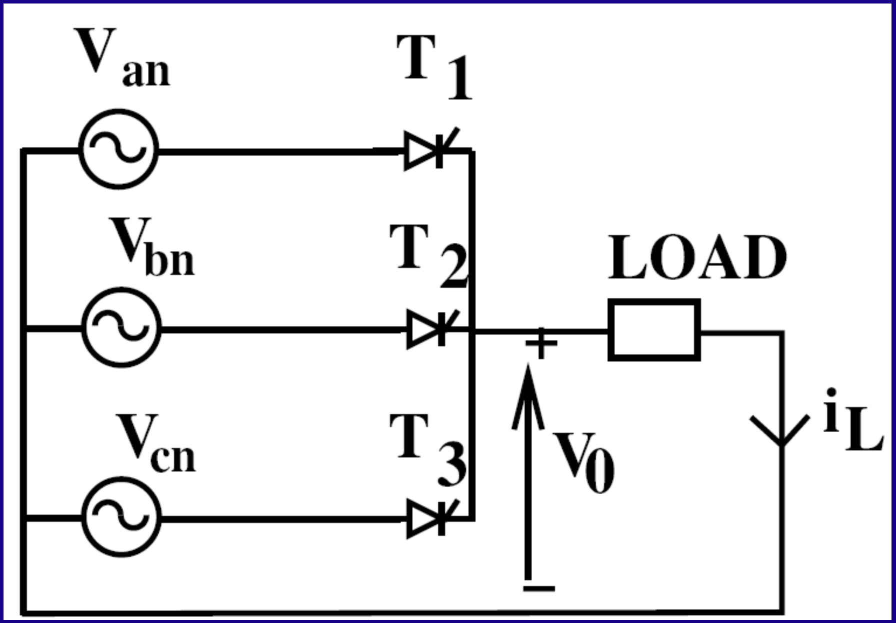
$\Rightarrow T_1$ will continue to conduct till T_2 is triggered.

$\Rightarrow$ Just prior to triggering T_1 T_3 was conducting.

$V_0 = V_{cn}$

As soon as T_1 is triggered T_3 turns off. $V_0 = V_{an}$

$$\therefore V_0 = \frac{3\sqrt{3}}{2\pi} V_m \text{Cos}\,\alpha$$



<u>Observations</u>

For $0<\alpha<30°$

Load is passive

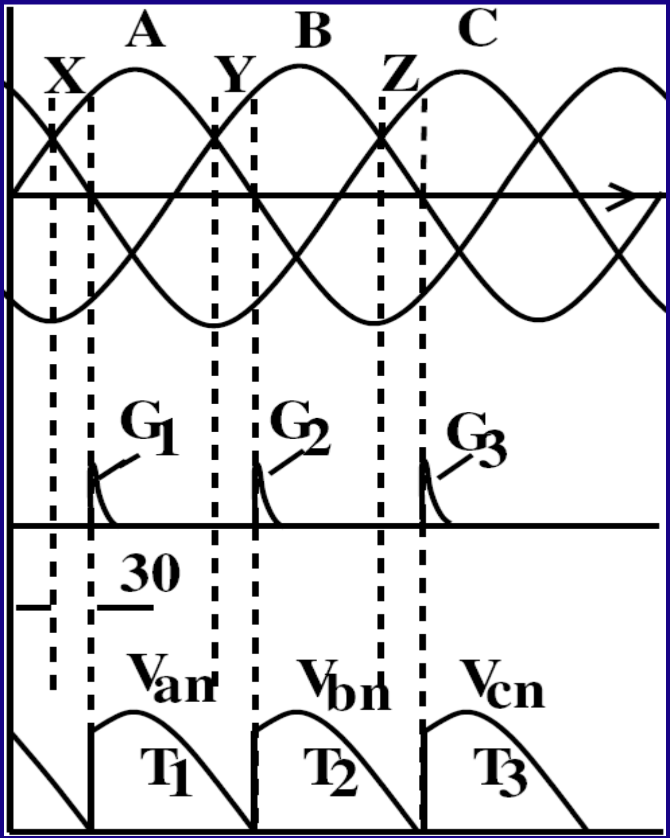
i_L will be continuous

$\alpha>30°$

i_L will be discontinuous

For Load $=$ R

$\Rightarrow$ If i_L is continuous each device conducts for 120°



$\Rightarrow$ Each phase is supplying power for 120° [It can supply for 360°]

$\Rightarrow$ Source i has a DC component (av. value of i_s is finite)

3-Phase Full wave rectification

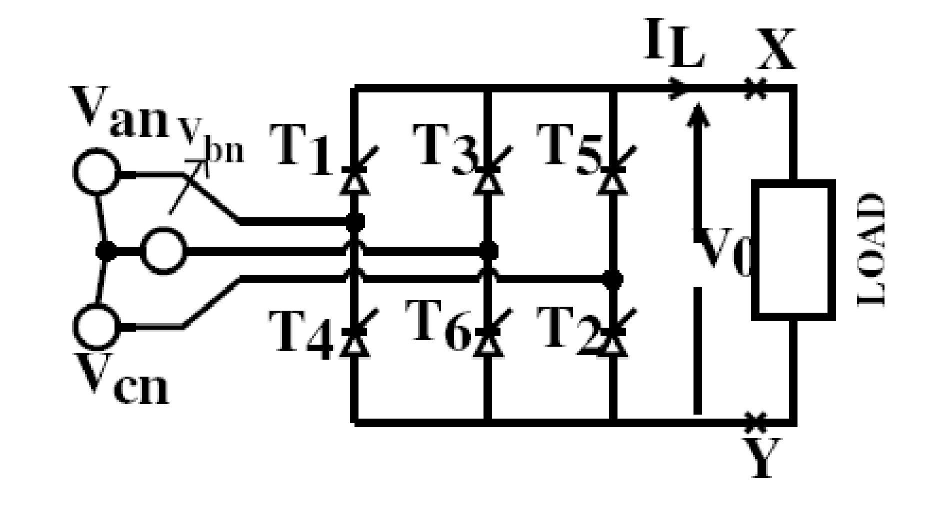
$T_1, T_3, T_5 \rightarrow$ Form common cathode configuration

$T_2, T_4, T_6 \rightarrow$ Form common anode configuration

If all are diodes ($\alpha = 0$)

$T_5 \rightarrow T_1$ takes at X^+,

$T_6 \rightarrow T_2$ takes at P^+



$\underline{\alpha = 0}$

(Equivalent to uncontrolled bridge)

T_1 starts conducting at X &

T_3 starts conducting at Y

at P T_2 starts conducting

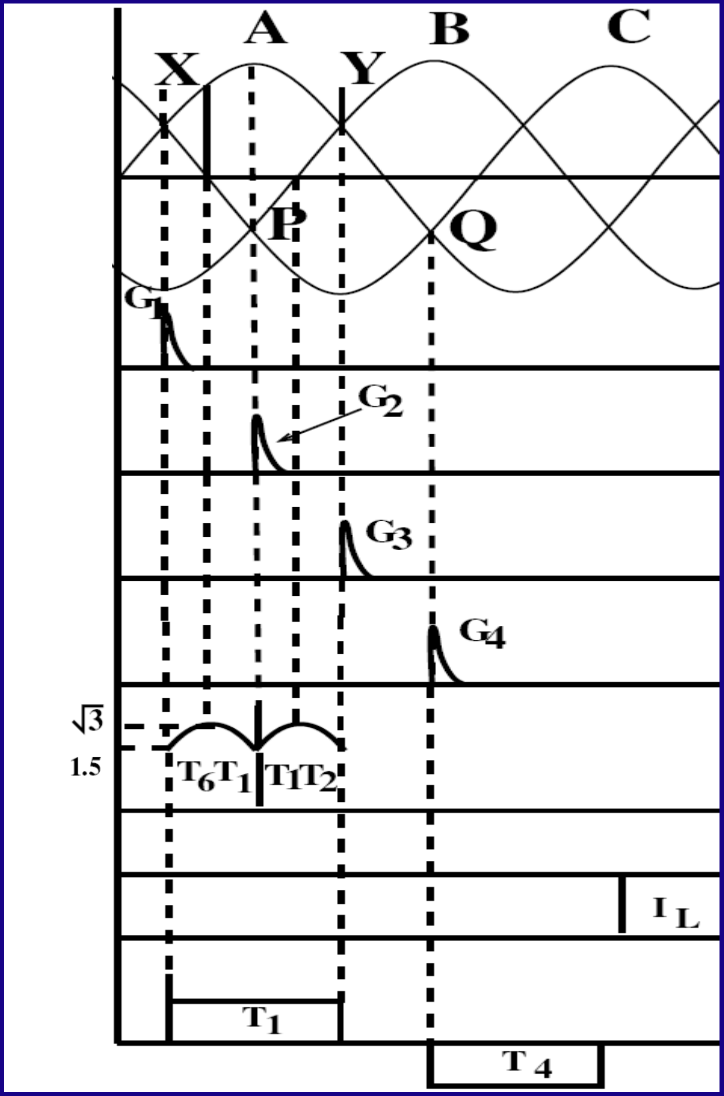
Prior to P, T_6 was conducting

$\underline{\text{At point } X^+ :}$

$$V_{an} = \text{Sin}30^\circ = \frac{1}{2}$$

$$V_{bn} = \text{Sin}270^\circ = -1$$

$$V_0 = V_{an} - V_{bn} = \frac{1}{2} + 1 = 1.5$$



at $\omega t=60°$

(w.r.t. +ve zero crossing of phase A)

$V_{an}=\sin 60°=\frac{\sqrt{3}}{2}$

$V_{bn}=\sin 300°=-\frac{\sqrt{3}}{2}$

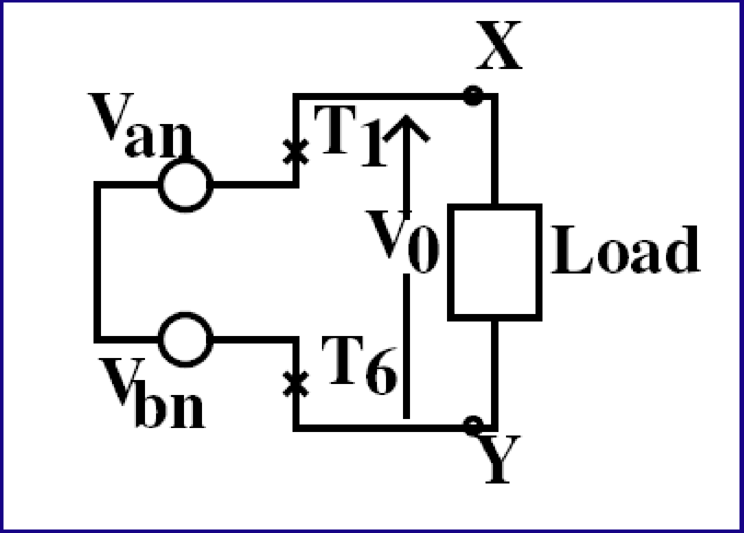
$\therefore V_0=\sqrt{3}$

at $\omega t=90^-$ (Just prior to point P)

$V_{an}=\sin 90°=1$

$V_{bn}=\sin 330°=-\frac{1}{2}$

$\therefore V_0=1.5$



At point P, T_2 is triggered and it starts conducting

at $\omega t=120°$

$$V_{an}=\text{Sin}120°=\frac{\sqrt{3}}{2}$$

$$V_{cn}=\text{Sin}240°=-\frac{\sqrt{3}}{2}$$

$$V_0=V_{an}-V_{cn}$$

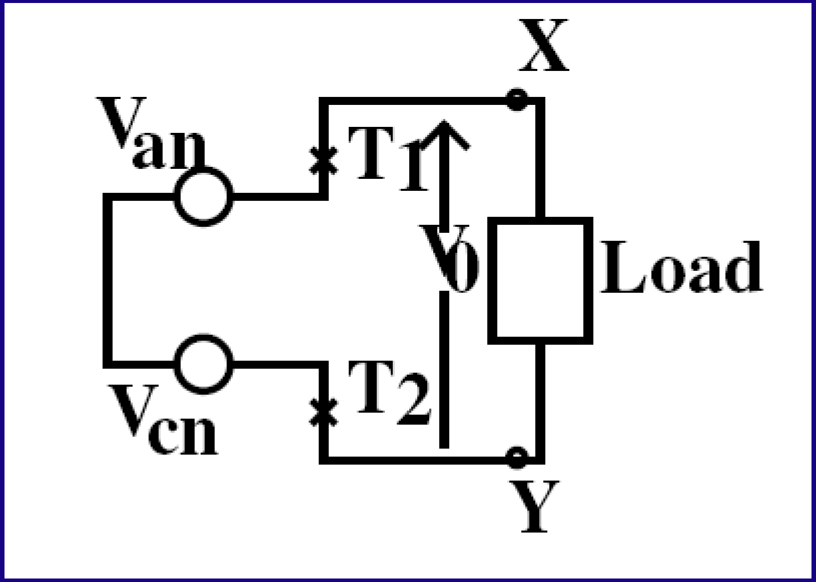
$$\therefore V_0=\sqrt{3}$$

at $\omega t=150°$

$$V_{an}=\text{Sin}150°=\frac{1}{2}$$

$$V_{cn}=\text{Sin}290°=-1$$

$$\therefore V_0=1.5$$



at $\omega t=150^{\circ+}$, corresponding point Y

$\Rightarrow T_3$ is triggered T_1 turns off

$\Rightarrow T_2\, T_3$ continue to carry the load I

at point Q $\rightarrow T_4$ is triggered

This point corresponds to $\omega t=210°$

T_1 (Phase A) start conducting at $\omega t=30°$

$\Rightarrow$ It is turned off at $\omega t=150°$

$\Rightarrow$ From 150° to 210° Phase A

does not supply power

(corresponds $\alpha=0°$)