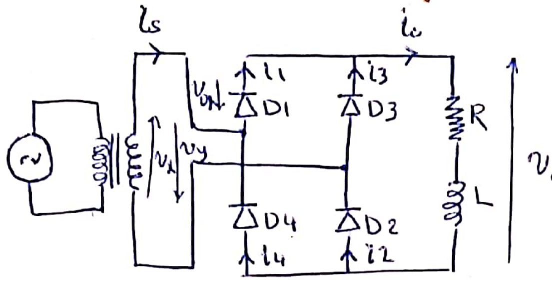
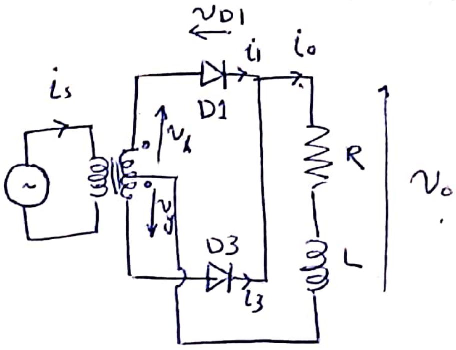
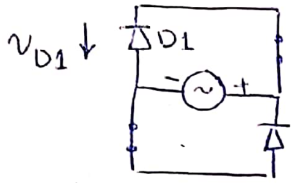
## 2.3 Uncontrolled full-wave ~~bridge~~




(a)

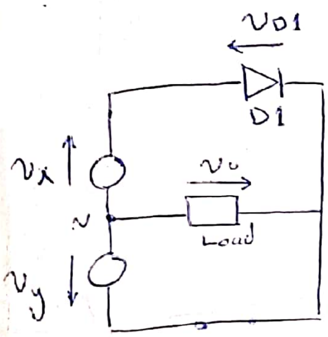



(b)




$\Rightarrow v_{D1} = -V_{max}$

$\therefore$ P.R.V $= V_{max}$




$v_o = v_y = V_{max}$

$-v_x + v_{D1} + v_o = 0$

$v_{D1} = v_x - v_o = v_x - v_y$

$= -V_{max} - V_{max}$

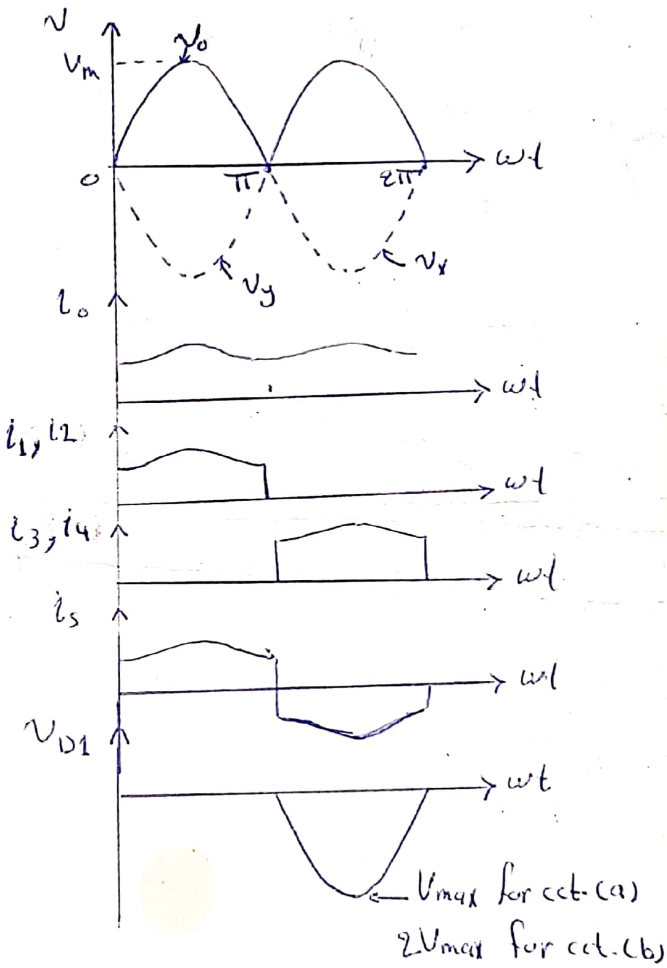
$= -2V_{max}$

$\therefore$ P.R.V $= 2V_{max}$

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

$$= \frac{V_m}{\pi}\left(-\cos\omega t\right)_0^{\pi}$$

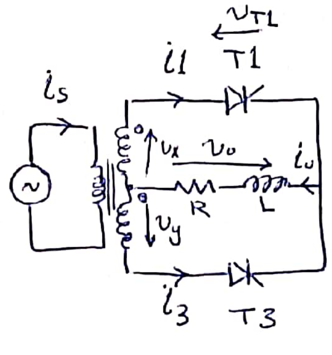
$$= \frac{2V_m}{\pi}$$



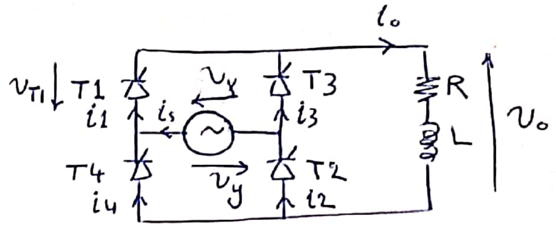

(a)

Fig. (2-8)

## 2-4 Full-wave fully Controlled converter




(a)




(b)

$$\theta = \tan^{-1}\frac{\omega L}{R}$$

case 1 $\alpha < \theta$

In this case the load current is continuous (always greater than zero)

$$V_o = \frac{1}{\pi}\int_{\alpha}^{\pi+\alpha} V_m \sin\omega t \, d\omega t$$

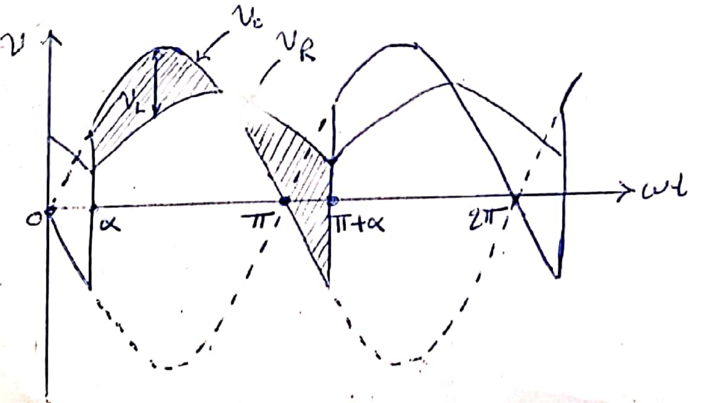
$$= \frac{V_m}{\pi}\left(-\cos\omega t\right)_{\alpha}^{\pi+\alpha}$$

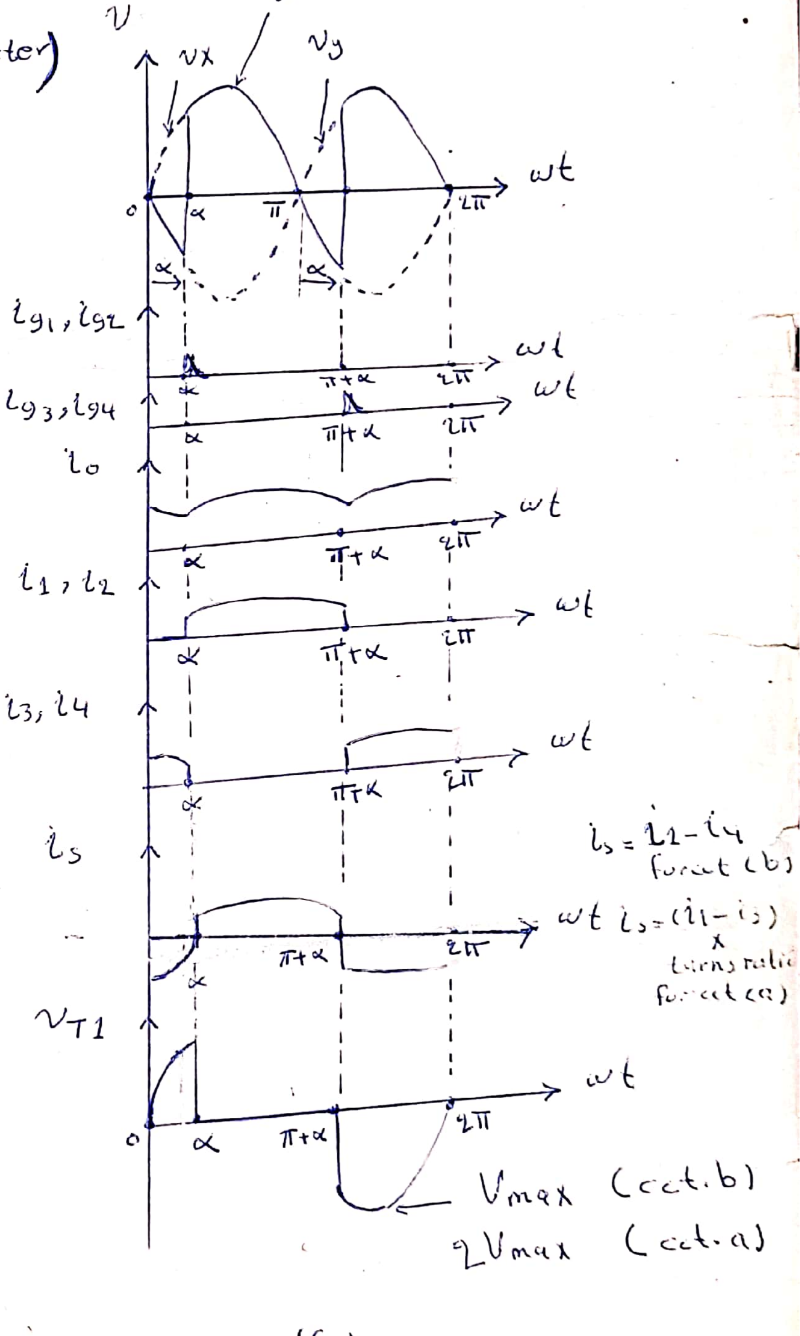
$$= \frac{V_m}{\pi}\left[\cos\alpha - \cos(\pi+\alpha)\right]$$

$$= \frac{V_m}{\pi}\left[\cos\alpha - \cos\pi\cos\alpha - \sin\pi\sin\alpha\right]$$

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

$$I_o = \frac{V_o}{R}$$




(c)

Fig. (2-9)

case 2 $\alpha = \theta$

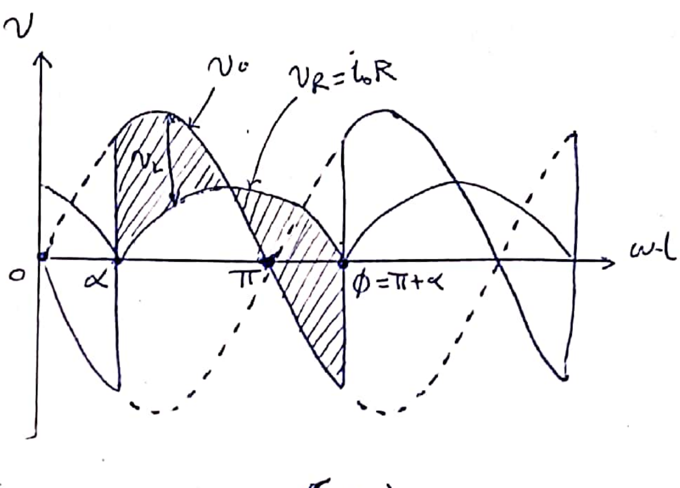
The load current is continous & $\phi = \pi + \alpha$

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

$$i = \frac{V_m}{Z}\sin(\omega t - \theta)$$

$$I_o = \frac{V_o}{R}$$

بما ان θ هي ال power factor لذلك فان التيار سيتخلف عن الفولتية بمقدار θ وان α = θ لذلك فان لحظة ال trigger تتطابق مع التيار




(a)

Case 3 $\alpha > \theta$

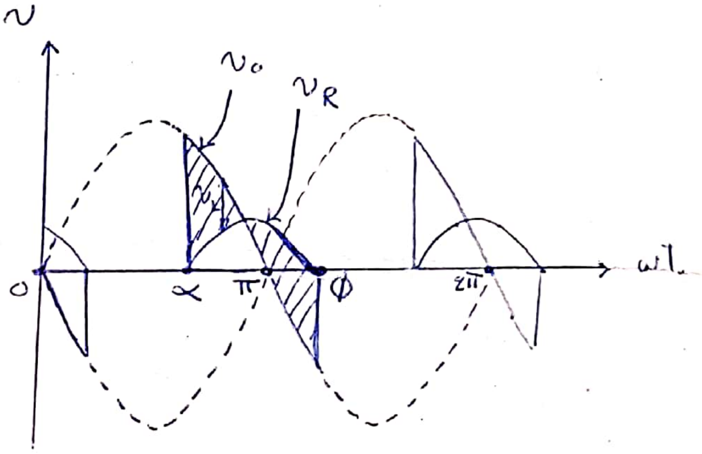
The load current is discontuous.

$$V_o = \frac{1}{\pi}\int_{\alpha}^{\phi} V_m \sin\omega t \, d\omega t$$

$$= \frac{V_m}{\pi}\left(-\cos\omega t\right)_{\alpha}^{\phi}$$

$$= \frac{V_m}{\pi}(\cos\alpha - \cos\phi)$$

$$I_o = \frac{V_o}{R}$$

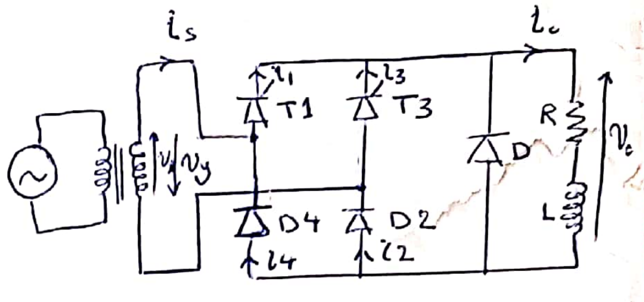



(b)

Fig. (2-10)

## 2-5 Full-wave half controlled converter

When a converter contains both diodes and thyristors, the converter is termed half controlled. The circuit diodes prevent the load voltage from going negative.
The half controlled circuit is cheaper than the fully controlled circuit but the a.c supply current is more distorted due its zero periods. The half controlled converter cannot be used in inversion mode.



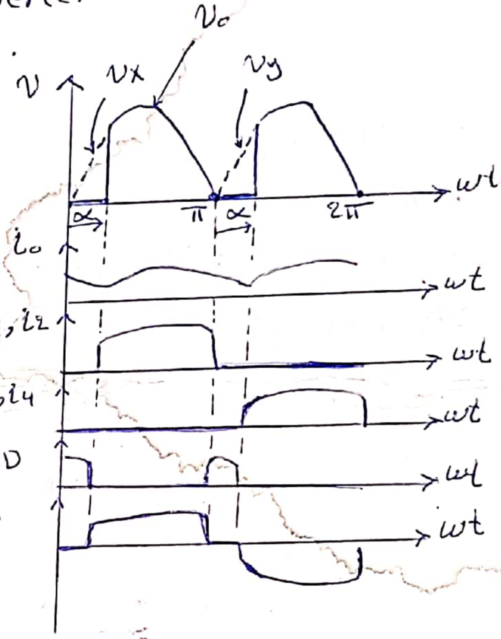
(a)

$$V_o = \frac{1}{\pi}\int_{\alpha}^{\pi} V_m \sin\omega t \, d\omega t$$

$$= \frac{V_m}{\pi}\left(-\cos\omega t\right)_{\alpha}^{\pi}$$

$$= \frac{V_m}{\pi}\left(\cos\alpha - \cos\pi\right)$$

$$= \frac{V_m}{\pi}\left(1+\cos\alpha\right)$$



(b)

Fig. (2-11)

The load voltage of a fully controlled converter can reverse, allowing power flow into the supply, a process called inversion. Thus a fully controlled converter can be described as a bidirectional converter as it facilitates power flow in either direction.
The half-controlled converter, and also the uncontrolled converter, contain diodes which prevents the output voltage from going negative. Such converters only allow power flow from the supply to the load, termed rectification, and can therfore be described as unidirectional converters.

Homework: For the circuit of fig (2-11a) Draw all the waveforms if:
(a) D is removed.
(b) D2 & D4 are replaced with thyristors.
(c) T3 & D4 are interchanged with eachother & D is removed.

## 2.6 Three-phase half-wave rectifier

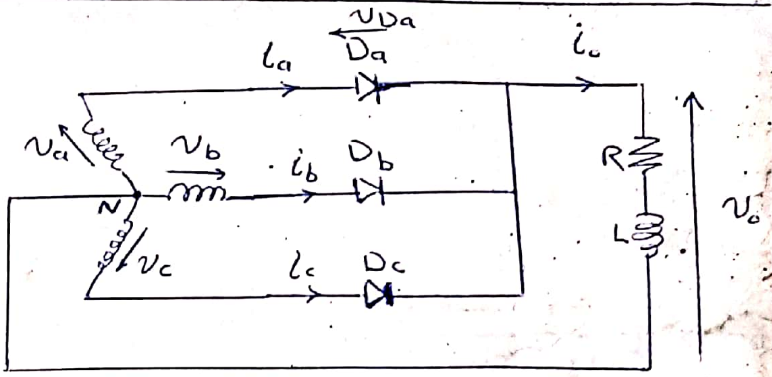
$$V_o = \frac{1}{2\pi/3}\int_{\pi/6}^{5\pi/6} V_m \sin\omega t \, d\omega t$$

$$= \frac{3V_m}{2\pi}\left(-\cos\omega t\right)_{\pi/6}^{5\pi/6}$$

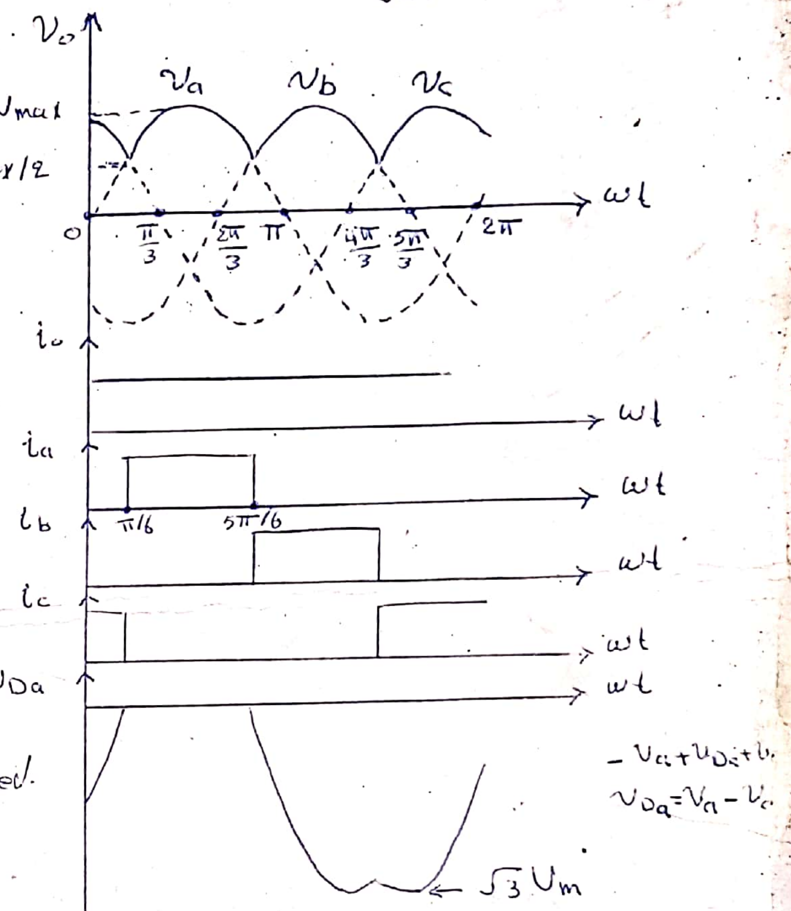
$$= \frac{3V_m}{2\pi}\left[\cos\frac{\pi}{6} - \cos\frac{5\pi}{6}\right]$$

$$= \frac{3V_m}{2\pi}\left[\frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{2}\right]$$

$$= \frac{3\sqrt{3}\,V_m}{2\pi}$$




(a)




(b)

Fig. (2.12)

The diode with the highest potential with respect to the neutral conducts a rectangular current pulse. As the potential of another diode becomes the highest, the current is transferred to that device, and the previously conducting device is reversed-biased and naturally commutated. As the load current is constant, the mean current in diode is

$I_D = I_o / n$ , n = number of pulses

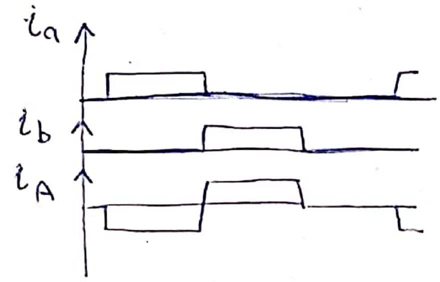
$= I_o/3$

rms current in diode $= I_o/\sqrt{n} = I_o/\sqrt{3}$.

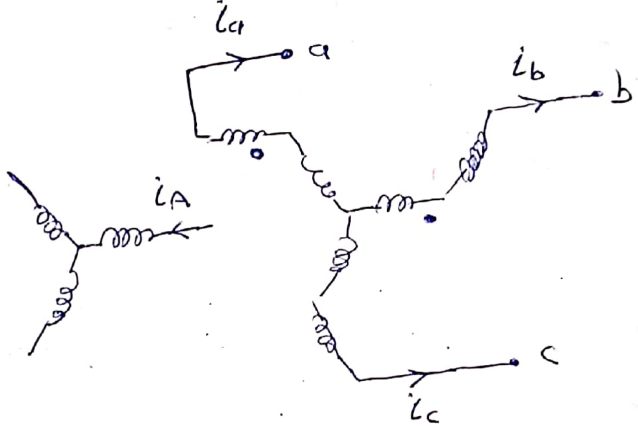
diode current form factor = rms current / mean current

$$= \frac{I_o/\sqrt{n}}{I_o/n} = \sqrt{n} = \sqrt{3}$$

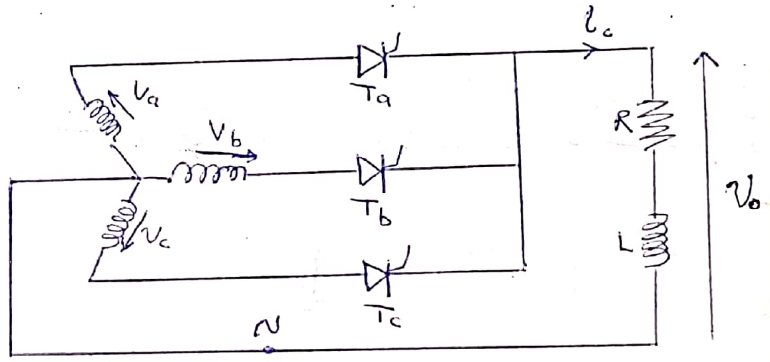
If the neutral is available, the transformer is not necessary. The full load current is returned via the neutral supply. This neutral supply current is generally not acceptable other than at low power levels. The using the simple «conventional Y» transformer connection leads to dc magnetization of the transformer core because of unidirectional current in each phase. To avoid this problem zig-zag «interconnected-star» is used as shown below



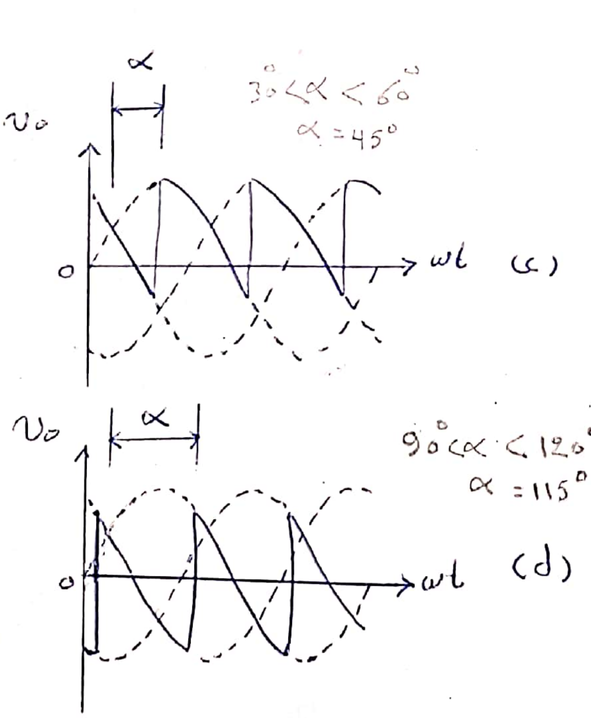

$i_A = i_b - i_a$

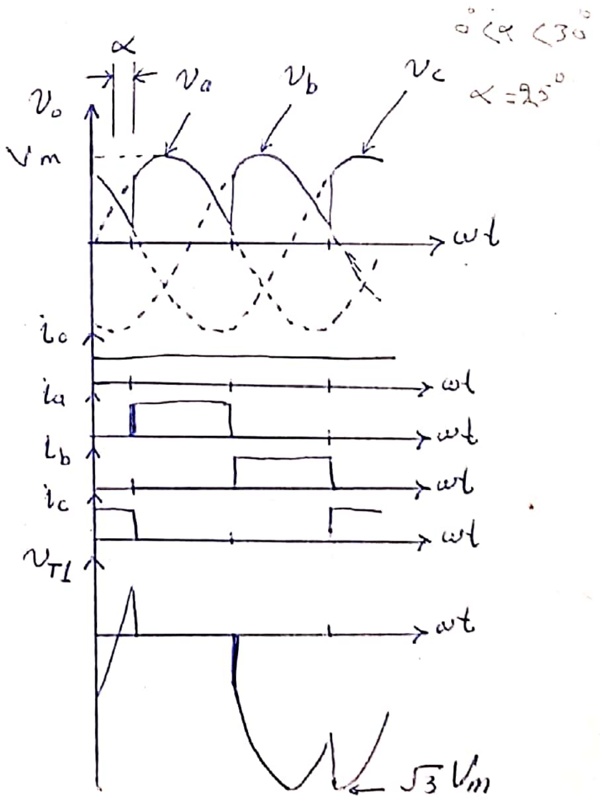



2.7 Three-phase half-wave controlled converter




(a)



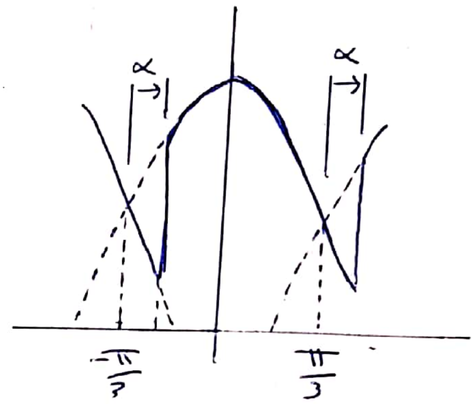




(b)

Fig. (2.13)

as in example 2-22

$$V_o = \frac{1}{2\pi/3}\int_{-\frac{\pi}{3}+\alpha}^{\frac{\pi}{3}+\alpha} V_m \cos\omega t \, d\omega t$$




$$= \frac{V_m}{2\pi/3}\left(\sin\omega t\right)_{-\frac{\pi}{3}+\alpha}^{\frac{\pi}{3}+\alpha}$$

$$= \frac{V_m}{2\pi/3}\left[\sin\left(\frac{\pi}{3}+\alpha\right) - \sin\left(-\frac{\pi}{3}+\alpha\right)\right]$$

$$= \frac{V_m}{2\pi/3}\left[\sin\frac{\pi}{3}\cos\alpha + \cos\frac{\pi}{3}\sin\alpha - \sin\left(-\frac{\pi}{3}\right)\cos\alpha - \cos\left(-\frac{\pi}{3}\right)\sin\alpha\right]$$

$$= \frac{V_m}{2\pi/3}\left[\sin\frac{\pi}{3}\cos\alpha + \cos\frac{\pi}{3}\sin\alpha + \sin\frac{\pi}{3}\cos\alpha - \cos\frac{\pi}{3}\sin\alpha\right]$$

$$= \frac{V_m}{2\pi/3}\left[2\sin\frac{\pi}{3}\cos\alpha\right]$$

$$= \frac{V_m}{2\pi/3}\left[2\cdot\frac{\sqrt{3}}{2}\cos\alpha\right]$$

$$= \frac{3\sqrt{3}\,V_m}{2\pi}\cos\alpha$$