If the diodes in figure (2.16) are replaced by thyristors the output voltage waveforms will be as shown below

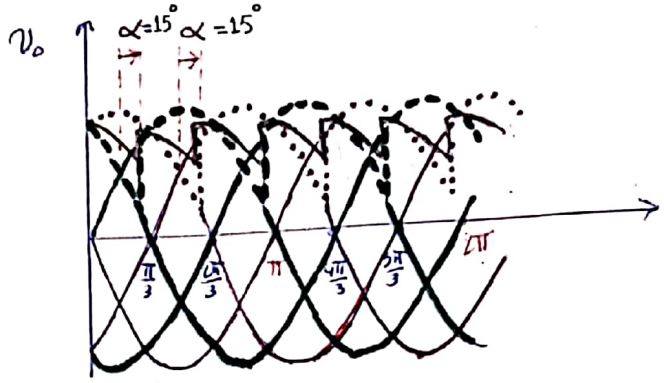
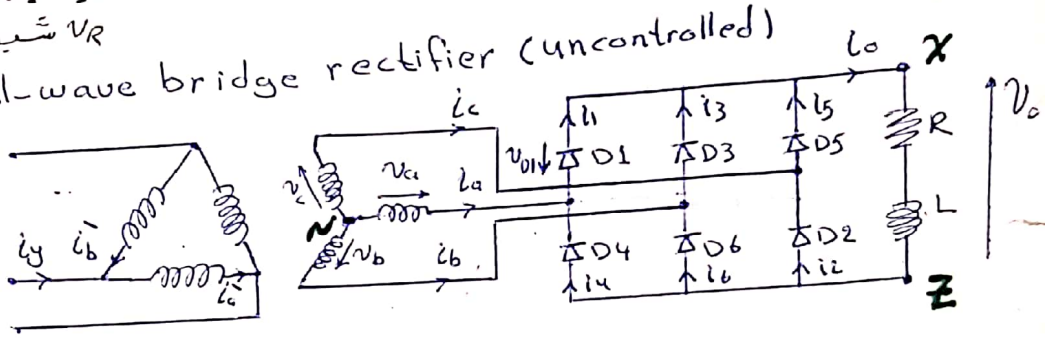


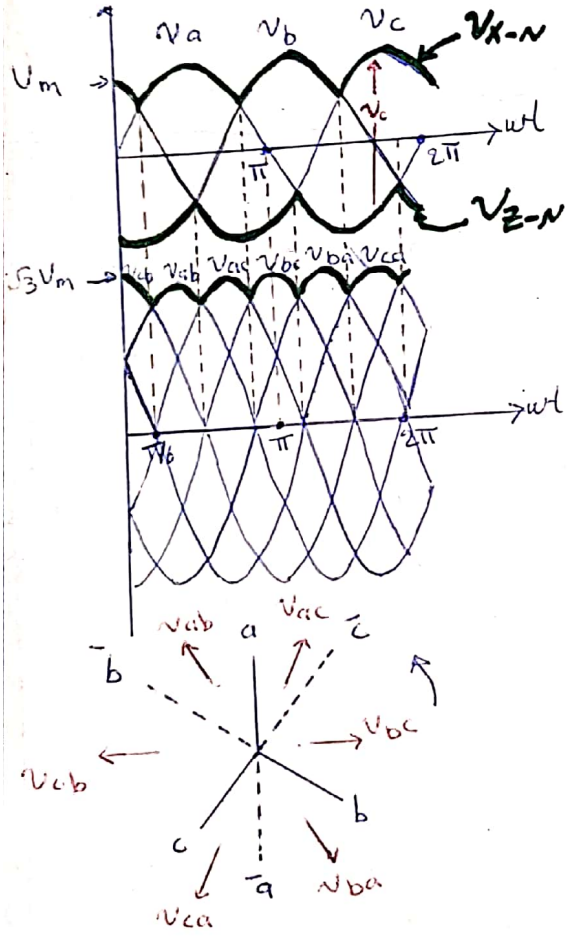

Fig.(2.17)

برامج الكتاب ووجد عندما تكون $\alpha=90^\circ$ حيث يكون عندها $V_o=0$ وبشكل موجة شبه مستطيلة $v_R$

## 2.9 Three-phase full-wave bridge rectifier (uncontrolled)




(a)




(b)

Fig.(2-18)

Figure (2-18) shows a 3$\phi$- full wave rectifier where no neutral is necessary and it will be seen that two series diodes are always conducting. One diode can be considered as being in the fed circuit, while the other is in the return circuit. As such the line-line voltage is impressed across the load. Figure (2-18b) shows the output voltage and also show how the line-line voltages can be drawn from phase voltages.

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

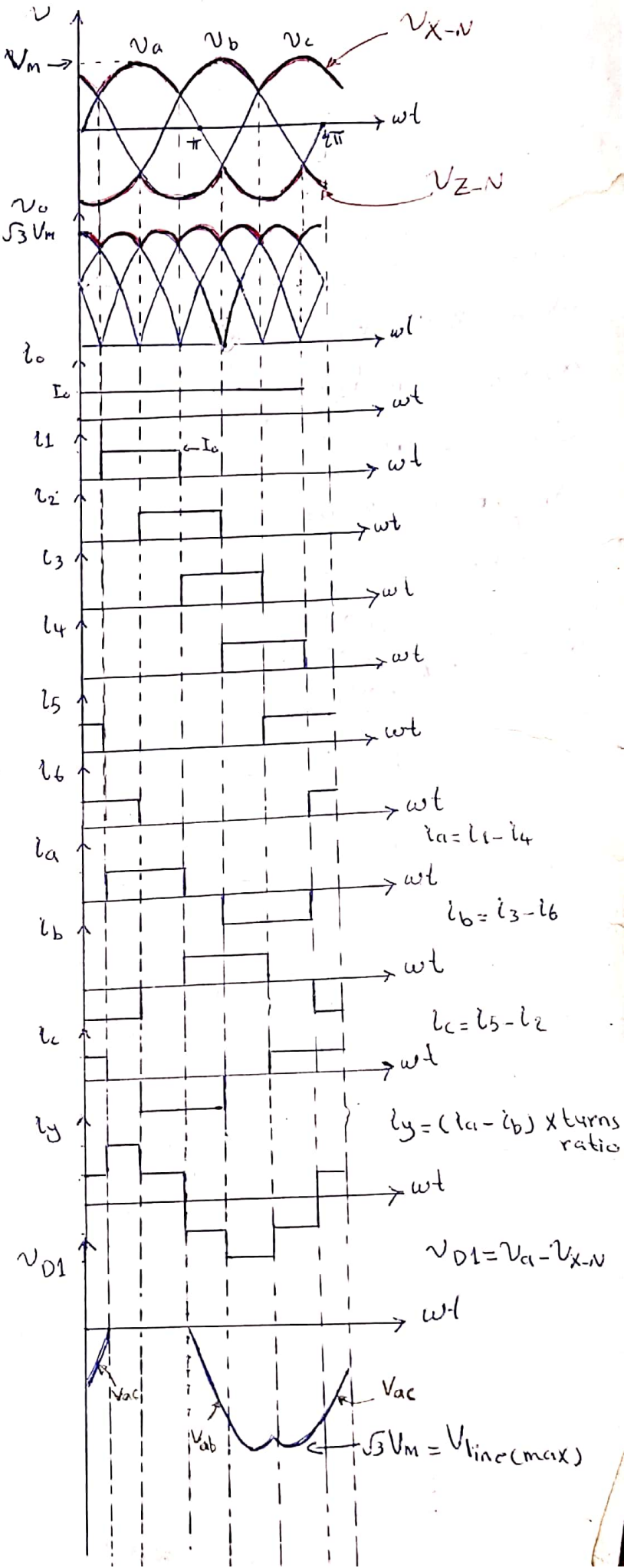
$$= \frac{3\sqrt{3}}{\pi} V_m$$

$$= \frac{3 V_{line(max)}}{\pi}$$

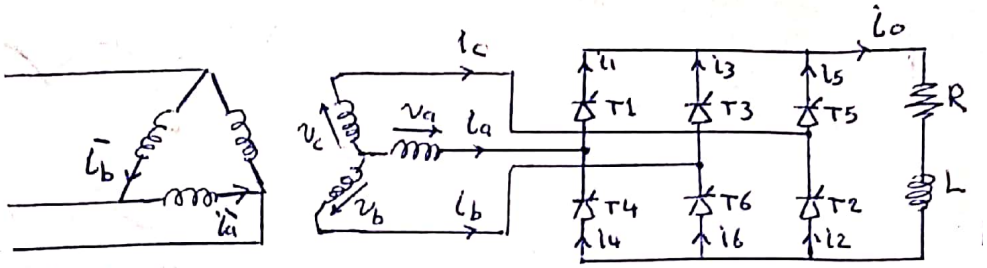
Fig. (2-19)

Fig (2.19) shows that each diode conducts the full load current for one third of a cycle, the order of commutation determining the numbering of the diodes in the circuit.

The a.c supply current is symmetrical, but of quasisquare shape. However the current waveforms are closer to a sinusoidal shape than those in single phase bridge connection.



## 2-10 Controlled three-phase full-wave bridge rectifier




A three-phase bridge if fully controlled when all six bridge devices are thyristors as shown in figure (2-20a).

Circuit waveforms are shown in figure (2-20b) the output mean voltage is given by

$$V_o = \frac{1}{2\pi/6}\int_{-\frac{\pi}{6}+\alpha}^{\frac{\pi}{6}+\alpha} \sqrt{3}V_m \cos\omega t\, d\omega t$$

$$= \frac{3\sqrt{3}V_m}{\pi}\left[\sin\omega t\right]_{-\frac{\pi}{6}+\alpha}^{\frac{\pi}{6}+\alpha}$$

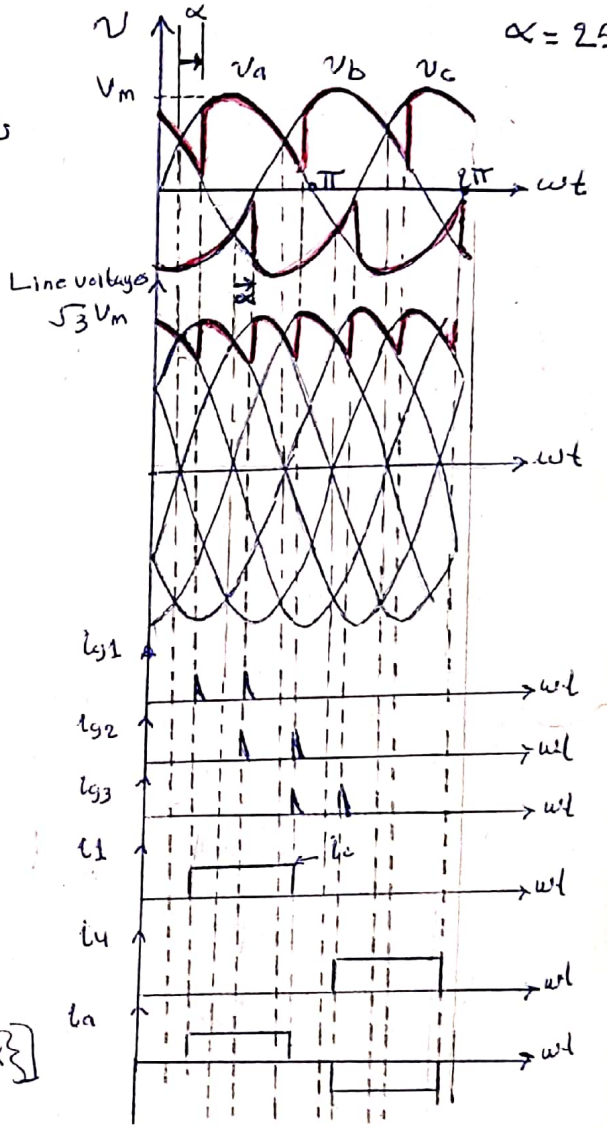
$$= \frac{3\sqrt{3}V_m}{\pi}\left[\sin\left(\frac{\pi}{6}+\alpha\right) - \sin\left(-\frac{\pi}{6}+\alpha\right)\right]$$

$$= \frac{3\sqrt{3}V_m}{\pi}\left[\sin\frac{\pi}{6}\cos\alpha + \cos\frac{\pi}{6}\sin\alpha - \left\{\sin\left(-\frac{\pi}{6}\right)\cos\alpha + \cos\left(-\frac{\pi}{6}\right)\sin\alpha\right\}\right]$$

$$= \frac{3\sqrt{3}V_m}{\pi}\left[\sin\frac{\pi}{6}\cos\alpha + \cos\frac{\pi}{6}\sin\alpha + \sin\frac{\pi}{6}\cos\alpha - \cos\frac{\pi}{6}\sin\alpha\right]$$

$$= \frac{3\sqrt{3}V_m}{\pi}\left[2\sin\frac{\pi}{6}\cos\alpha\right]$$

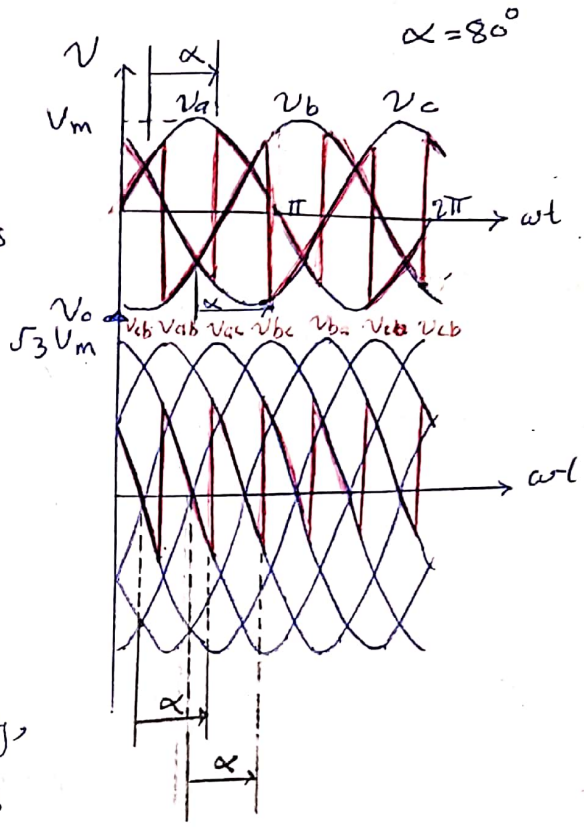
$$= \frac{3\sqrt{3}V_m}{\pi}\cos\alpha$$



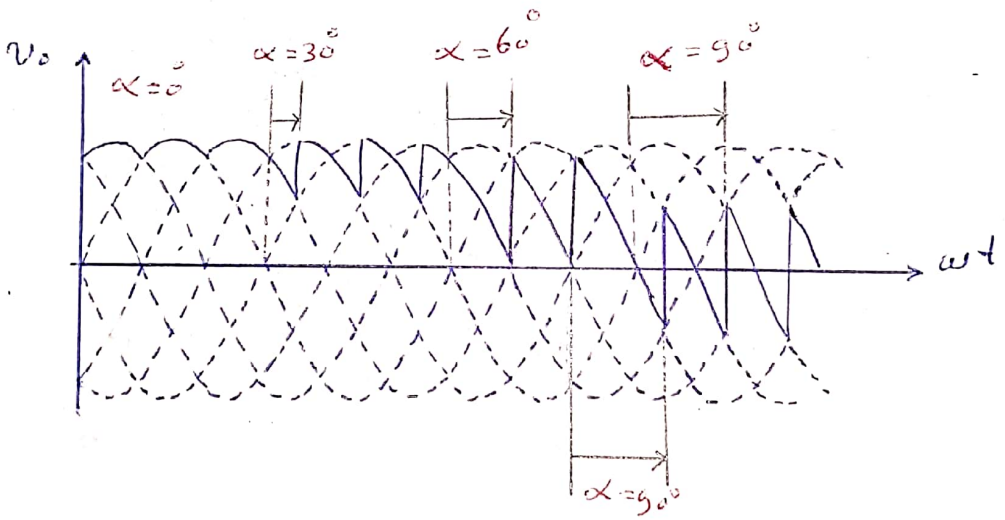

(b)

Fig.(2-20)

A problem does arise with the bridge circuit that is one of starting. If only a single firing gate pulse is used, no current will flow, as the other thyristors in the current path will be in the off-state, hence two thyristors must be fired at the same time. Hence for starting purpose, the firing circuit must produce a firing pulse 60° after its first pulse. Once the circuit is running normally, the second pulse will have no effect, as the thyristor will already be in the on-state.




(a)




(b)

من شكل (2-21b) لاحظ ان $v_o$ موجبة طالما $\alpha$ اصغر من 60° وتبدأ بالانحناس اي تصبح سالبة عندما تكون $\alpha$ اكبر من 60°

Fig.(2-21)

Figure(2-21a) shows the output voltage when $\alpha$ is 80°. Figure(2-21b) shows the output voltage for different values of firing angle $\alpha$.

Three phase bridge half controlled

$$V_o = \frac{1}{2\pi/3} \int_{\alpha}^{\pi} \sqrt{3} V_m \sin \omega t$$

{ by choosing the line voltage Vac

$$= \frac{3\sqrt{3} V_m}{2\pi} \int_{\alpha}^{\pi} \sin \omega t \, d\omega t$$

$$= \frac{3\sqrt{3} V_m}{2\pi} (-\cos \omega t)_{\alpha}^{\pi}$$

$$= \frac{3\sqrt{3} V_m}{2\pi} (\cos \alpha - \cos \pi)$$

$$= \frac{3\sqrt{3} V_m}{2\pi} (1 + \cos \alpha)$$