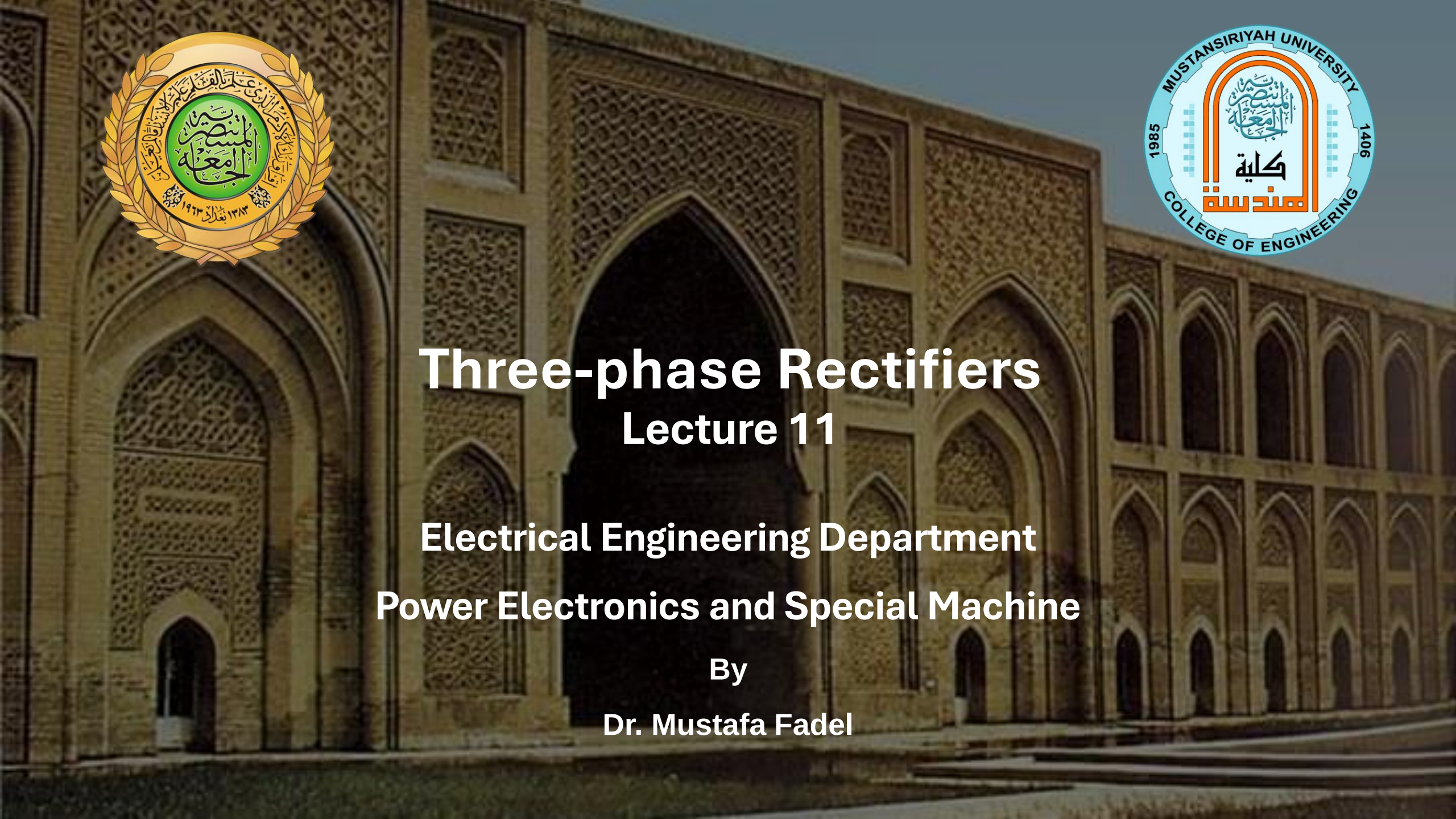


Three-phase Rectifiers

Lecture 11

Electrical Engineering Department

Power Electronics and Special Machine

By

Dr. Mustafa Fadel

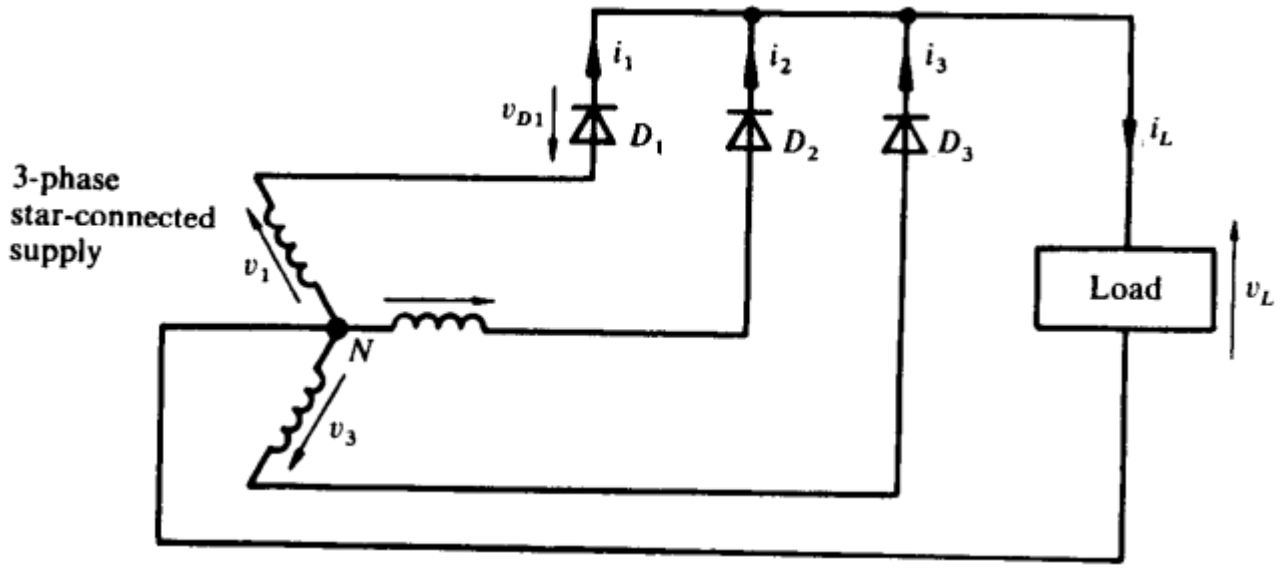
Important Notice

Note to Students:

These lecture materials are provided as supplementary support to help clarify and reinforce the concepts discussed in the main course lectures. They are not a substitute for the official course materials or the primary references assigned. Students are encouraged to refer to the original sources and attend the main lectures to ensure full understanding of the subject.

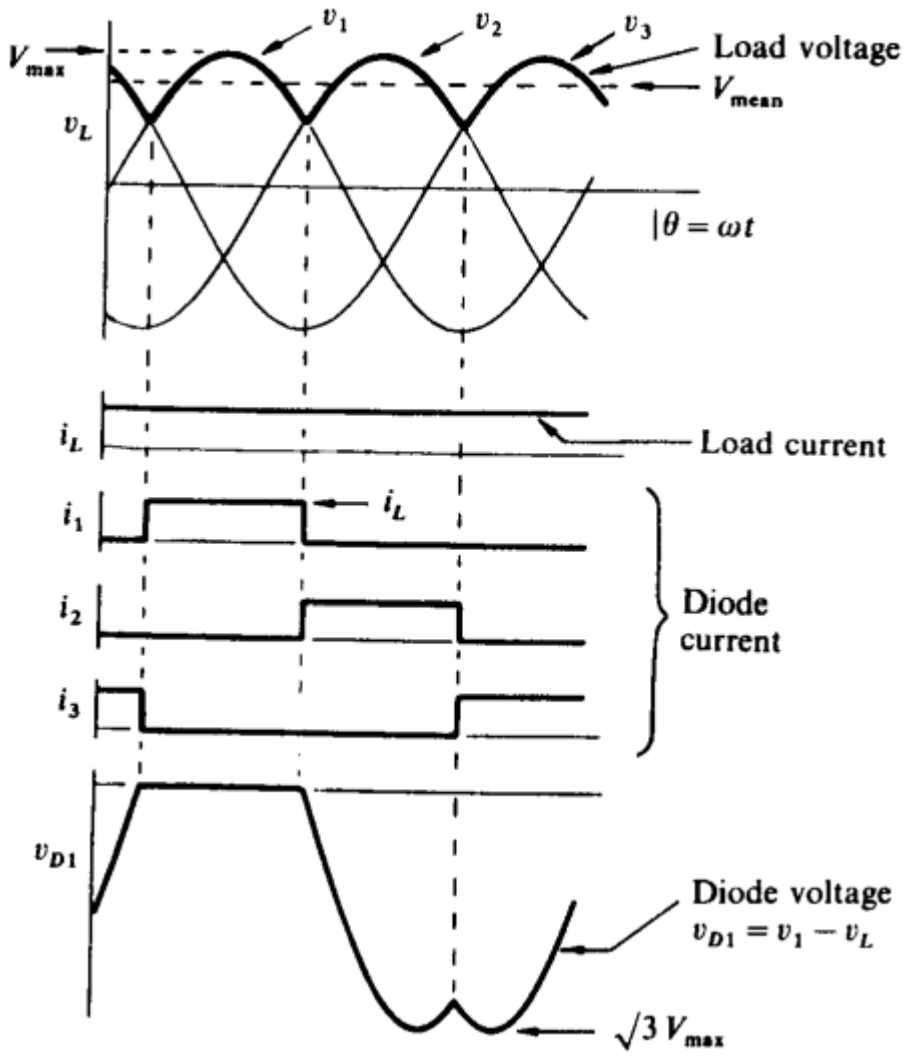
Uncontrolled Three-phase Half-wave Rectifier (or Single-way)

The circuit of three-phase half-wave rectifier feeding load is shown below



Uncontrolled Three-phase Half-wave Rectifier (or Single-way)

The waveforms of three-phase half-wave rectifier feeding load is shown:



The mean load voltage is

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

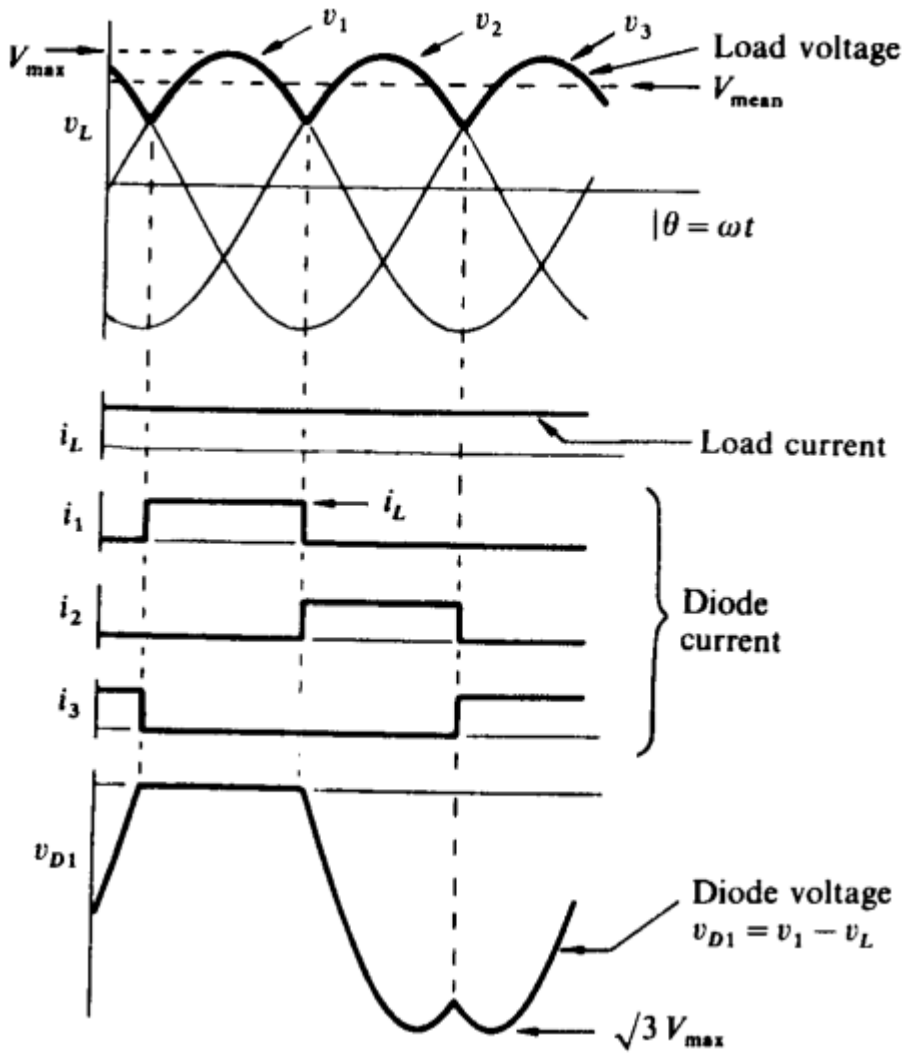
$$V_{mean} = \frac{3\sqrt{3}\, V_m}{2\pi}$$

Uncontrolled Three-phase Half-wave Rectifier (or Single-way)

The RMS value of the diode current rating is as follows:

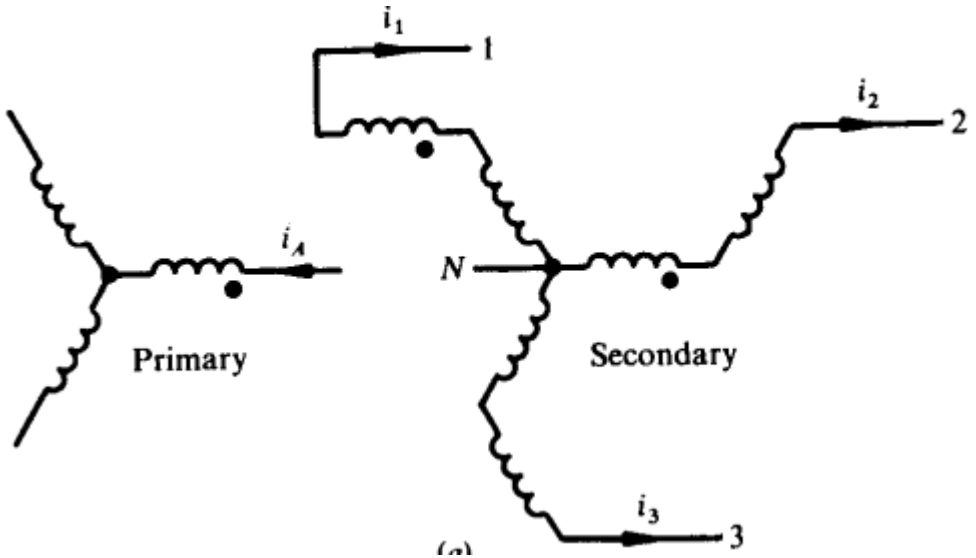
$$I_{rms} = \sqrt{\left(\frac{I_L^2 + 0^2 + 0^2}{3}\right)} = \frac{I_L}{\sqrt{3}}$$

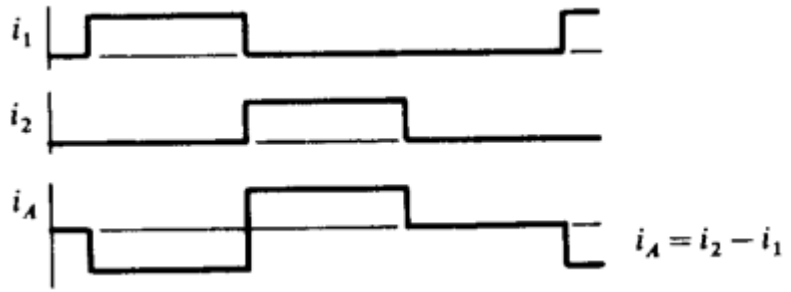
While the peak reverse voltage of each diode is equal to $\sqrt{3}\, V_m$



Uncontrolled Three-phase Half-wave Rectifier (or Single-way)

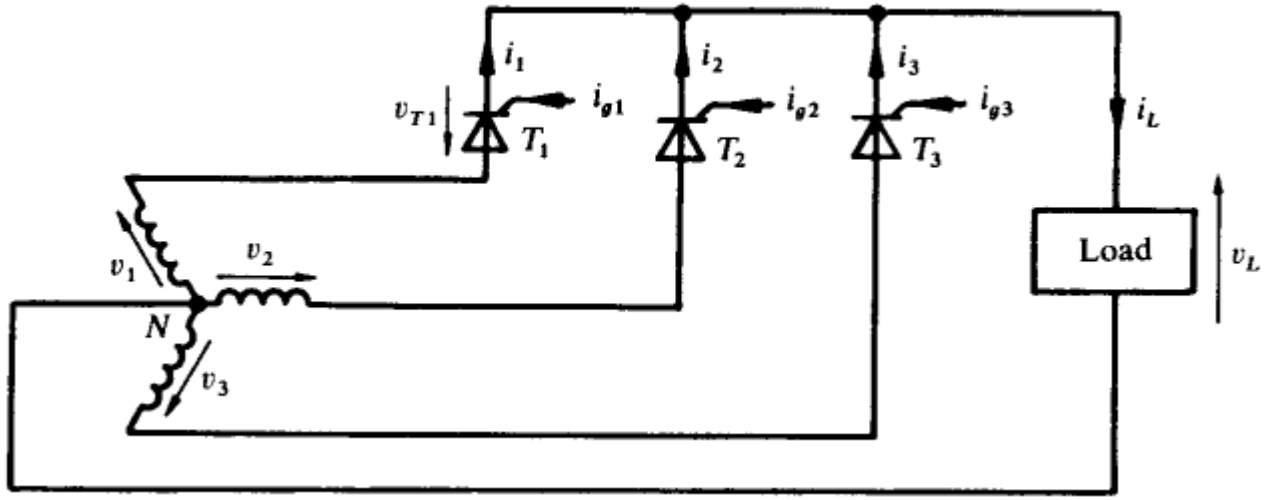
The unidirectional current in the star connection will cause DC magnetization to the transformer core and increases the iron losses. To avoid this, an interconnection-star (Zig-Zag) is used to remove any DC component MMF in the core





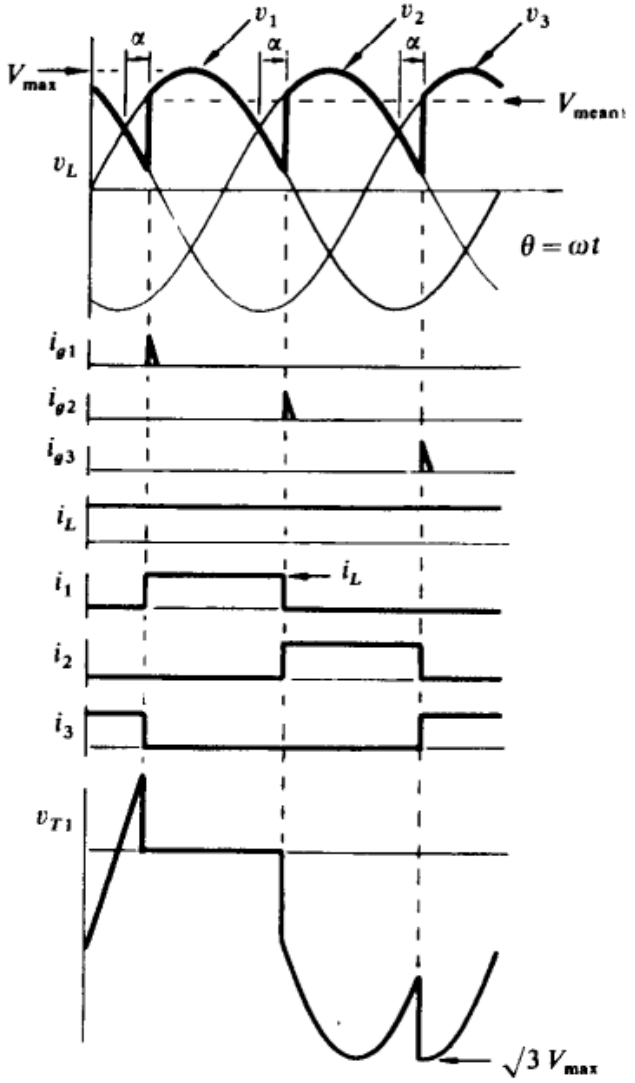
Controlled Three-phase Half-wave Rectifier

The circuit of controlled three-phase half-wave rectifier feeding load is shown below



Controlled Three-phase Half-wave Rectifier

The waveforms of three-phase half-wave rectifier feeding load is shown:



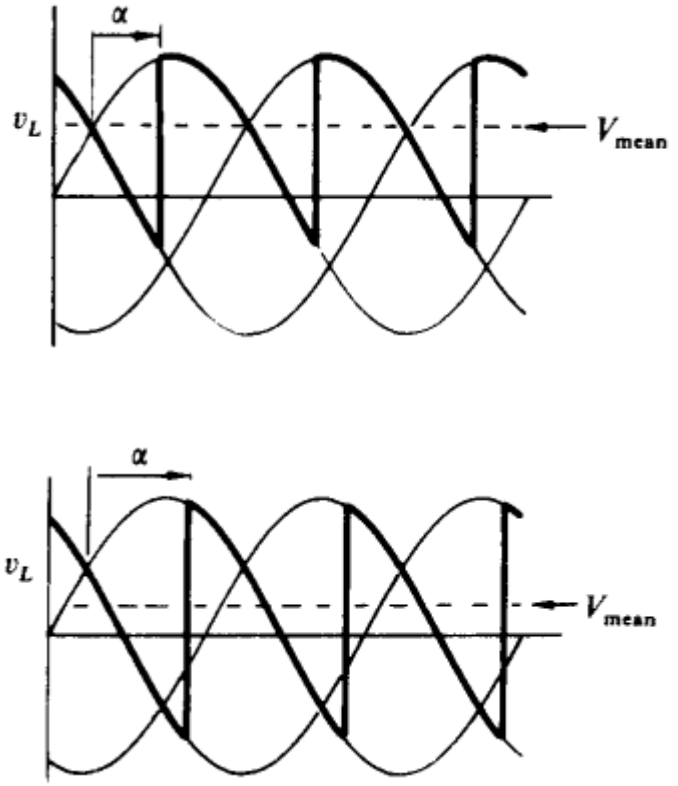
The mean load voltage is

$$V_{mean} = \frac{1}{2\pi/3} \int_{\frac{\pi}{6}+\alpha}^{\frac{5\pi}{6}+\alpha} V_m \sin(\omega t)\, d\omega t$$

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

Controlled Three-phase Half-wave Rectifier

The waveforms of three-phase half-wave rectifier feeding load is shown:



The mean load voltage is

$$V_{mean} = \frac{1}{2\pi/3} \int_{\frac{\pi}{6}+\alpha}^{\frac{5\pi}{6}+\alpha} V_m \sin(\omega t)\, d\omega t$$

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

Controlled Three-phase Half-wave Rectifier

Example: A three-phase half-wave controlled rectifier is supplied from a 150 V/phase, 50 Hz AC source. Determine the mean load voltage for firing delay angles of 0°, 30°, 60°, and 90° assuming each thyristor to have voltage drop of 1.5 V and continuous load current.

Controlled Three-phase Half-wave Rectifier

Solution:

$$V_{mean} = \frac{3\sqrt{3}\,V_m}{2\pi}\cos\alpha - 1.5$$

α	0°	30°	60°	90°
V_{mean}	173.9 V	150.4 V	86.2 V	0 V


Thanks for listening!