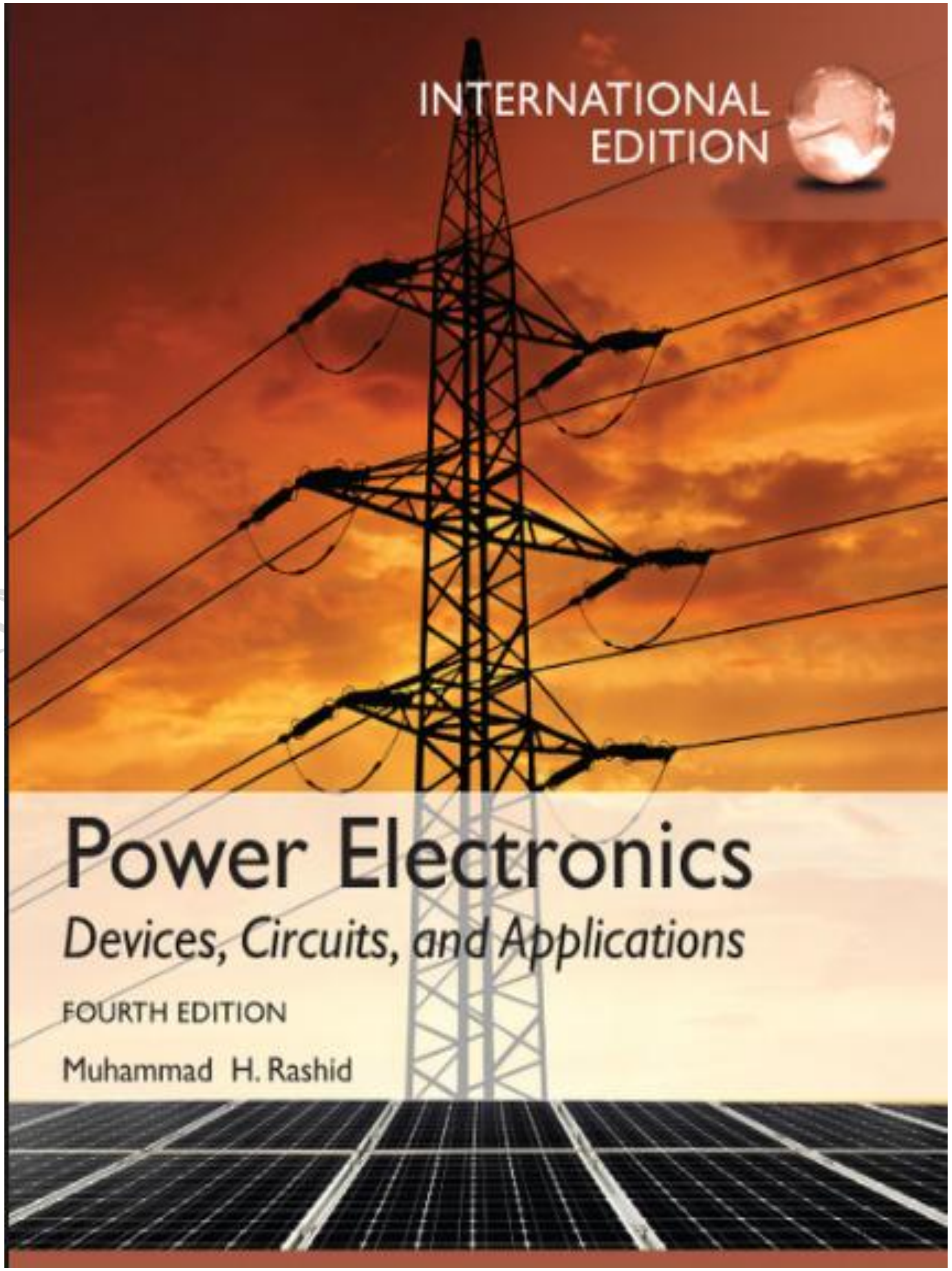
University of Technology
Laser and Optoelectronic Engineering Department
Power Electronics/2018-2019)
For the third years (Laser Engineering)



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Ref: Power Electronics 4th edition/ Muhammed H. Rashid

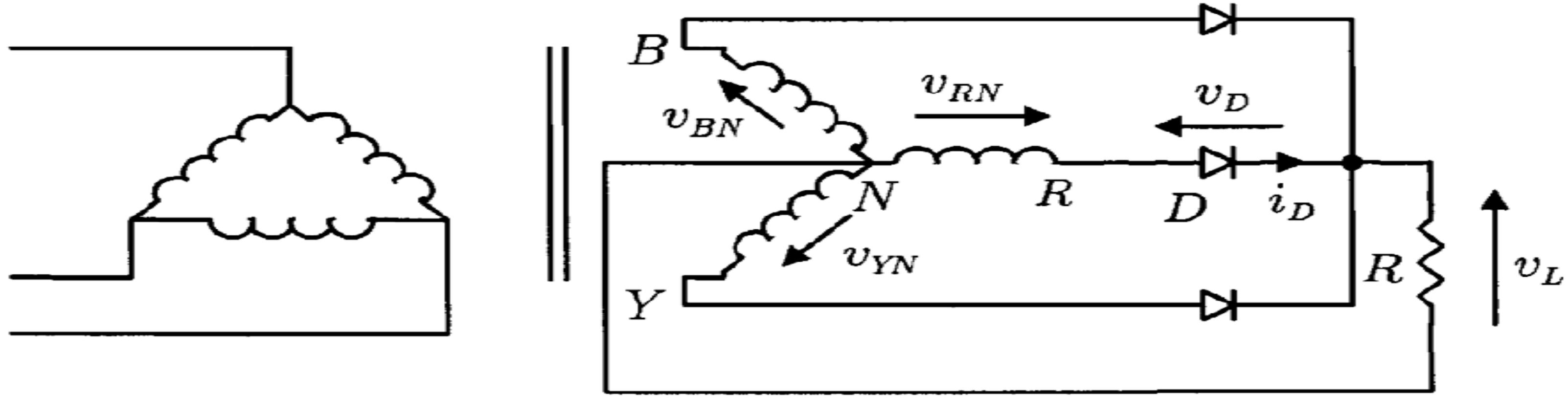
Lecture No.8

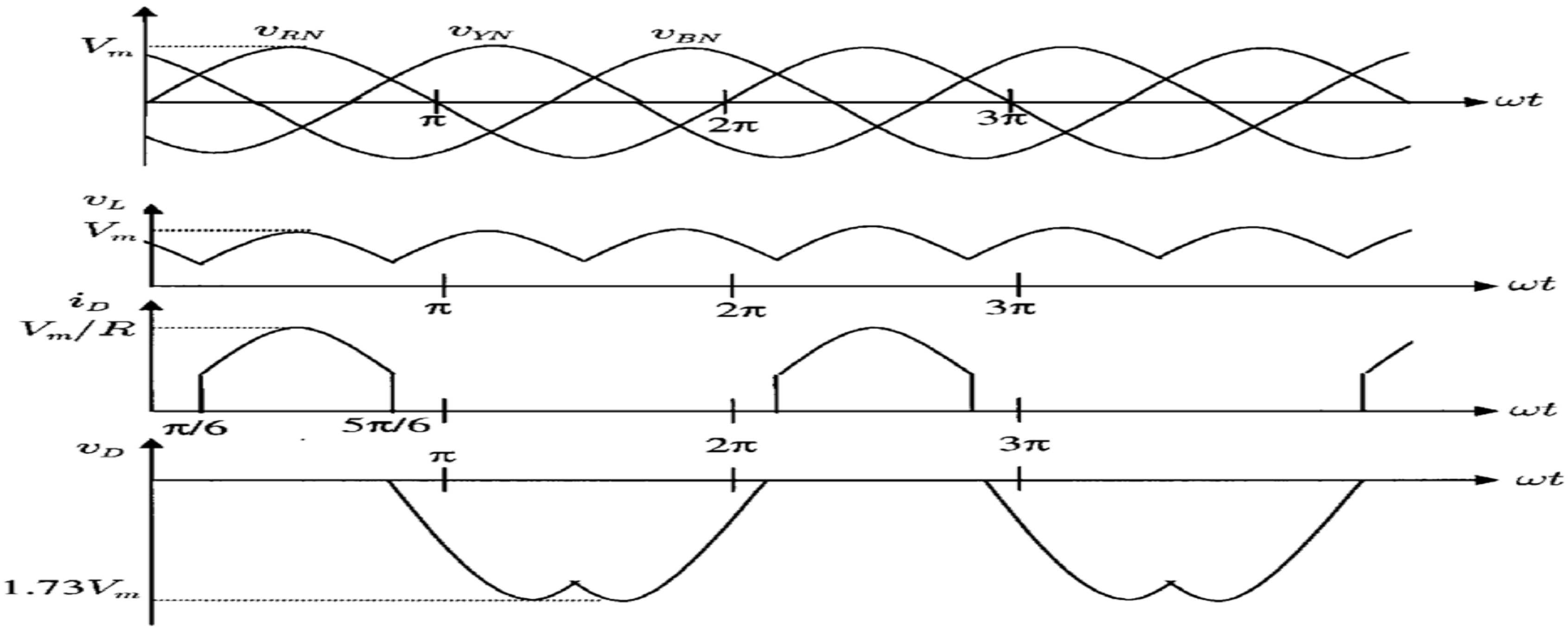
Three-Phase Diode Rectifiers

There are two types of three-phase diode rectifier, star rectifiers and bridge rectifiers.

Three-Phase Star Rectifiers

A basic three-phase star rectifier circuit is shown in Figure below. This circuit can be considered as three single-phase half-wave rectifiers combined together. Therefore, it sometimes referred to as a three-phase half-wave rectifier. The diode in a particular phase conducts during the period when the voltage on that phase is higher than that on the other two phases.





→ It is clear that, unlike the single-phase rectifier circuit, the conduction angle of each diode is **2π=3**, instead of **π**.

→Taking phase R as an example, diode D conducts from **π=6 to 5π=6.** Therefore, the average value of the output can be found as:

$$V_{dc} = \frac{3}{2\pi}\int_{\pi/6}^{5\pi/6} V_m \sin\theta \, d\theta$$

Or,

$$V_{dc} = V_m \frac{3}{\pi} \frac{\sqrt{3}}{2} = 0.827 \; V_m$$

Similarly, the rms value of the output voltage can be found as:

$$V_L = \sqrt{\frac{3}{2\pi}\int_{\pi/6}^{5\pi/6} (V_m \sin\theta)^2\, d\theta}$$

Or,

$$V_L = V_m\sqrt{\frac{3}{2\pi}\left(\frac{\pi}{3}+\frac{\sqrt{3}}{4}\right)} = 0.84\ V_m$$

The rms current in each transformer secondary winding can also be found as:

$$I_s = I_m\sqrt{\frac{1}{2\pi}\left(\frac{\pi}{3}+\frac{\sqrt{3}}{4}\right)} = 0.485\ I_m$$

→It is clear that the peak inverse voltage (PIV) of the diodes is equal to **$1.73V_m$** during their blocking state. Hence, the Peak Repetitive Reverse Voltage (V_{RRM}) rating of the diodes must be chose to be higher than **$1.73V_m$** to avoid reverse breakdown.

→During its conducting state, each diode has a forward current that is equal to the load current and, therefore, the Peak Repetitive Forward Current (**I_{FRM}**) rating of these diodes must be chosen to be higher than the peak load current **$I_m = V_m \times R$** in practice.

→ Form factor of diode current **$I_s / I_{dc} = 1.76$**

→ The rectification ratio is:

$$\frac{P_{dc}}{P_L} = \frac{V_{dc}I_{dc}}{V_L I_L}$$

$$FF = \frac{V_L}{V_{dc}} \quad \text{or} \quad \frac{I_L}{I_{dc}}$$

→ Form factor of three-phase half-wave rectifier

$$FF = \frac{0.84V_m}{0.827V_m} = 1.0165$$

→ Ripple factor of three-phase half-wave rectifier

$$\mathbf{RF} = \sqrt{\left(\frac{V_L}{V_{dc}}\right)^2 - 1} = \sqrt{\mathbf{FF}^2 - 1}$$

$$= \mathbf{0.182}$$