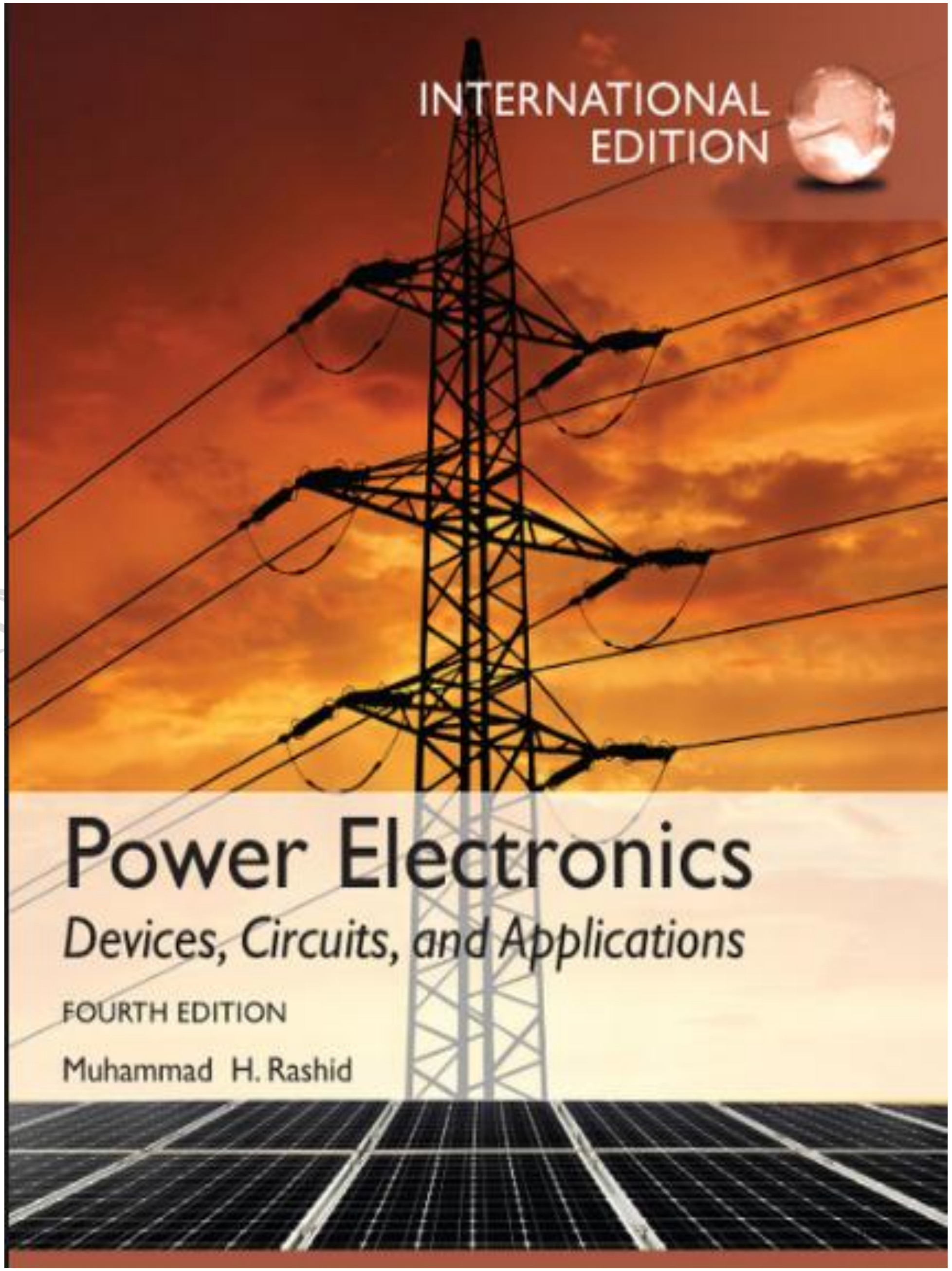
University of Technology
Laser and Optoelectronic Engineering Department
Power Electronics/2018-2019)
For the third years (Laser Engineering)



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

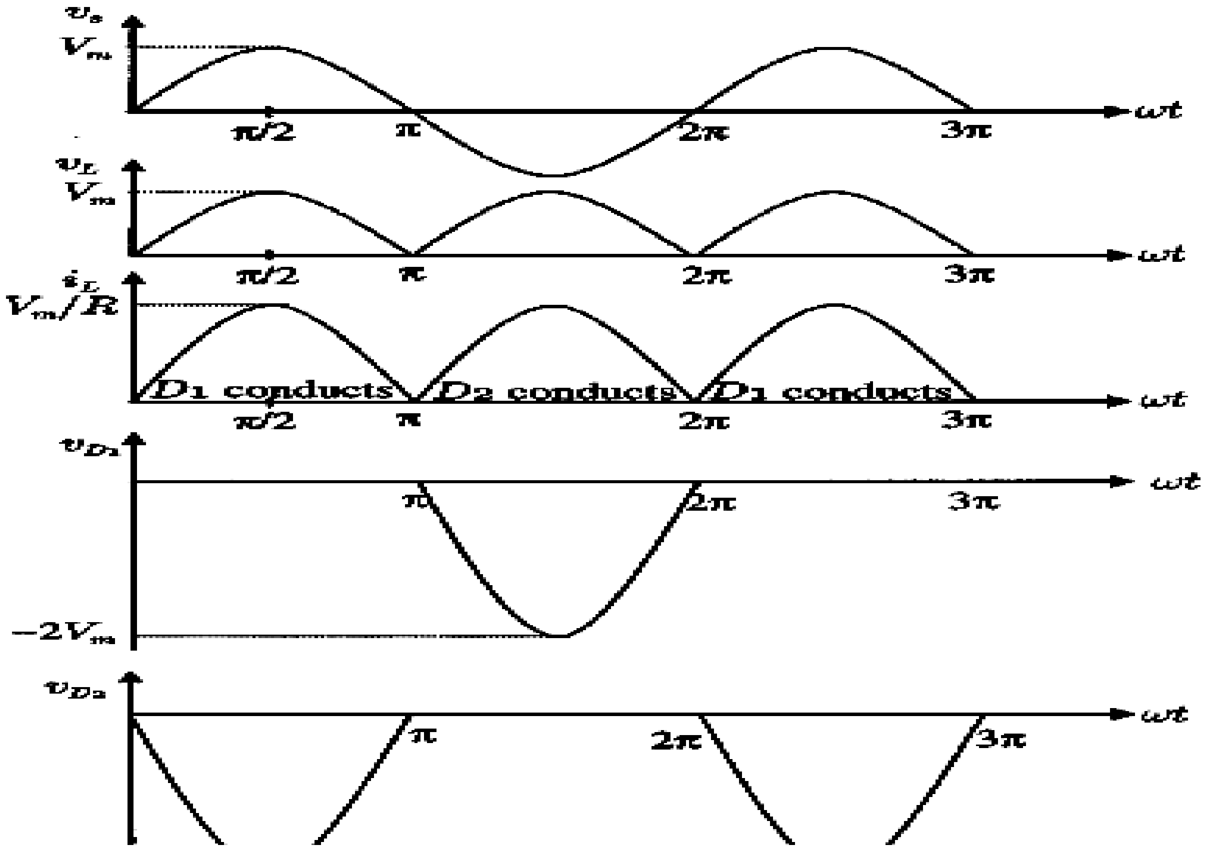
Lecture No.7

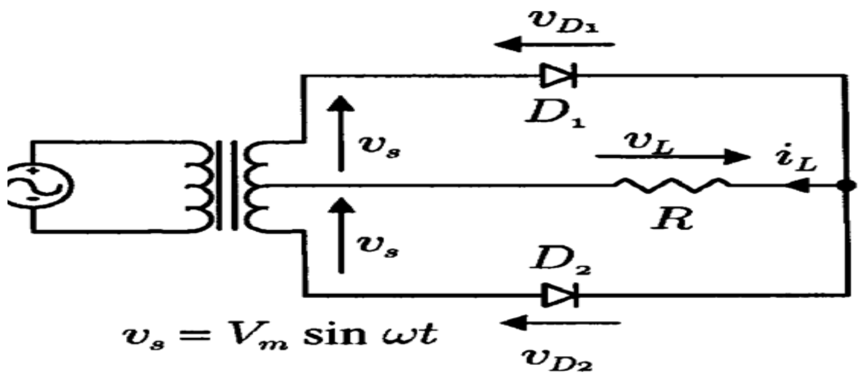
Single-Phase Full-Wave Rectifiers

There are two types of single-phase full-wave rectifier, namely, full-wave rectifiers with center-tapped transformer and bridge rectifiers.

I. full-wave rectifier with a center-tapped transformer:

It is clear that each diode, together with the associated half of the transformer, acts as a half-wave rectifier. The outputs of the two half- wave rectifiers are combining to produce full-wave rectification in the load.

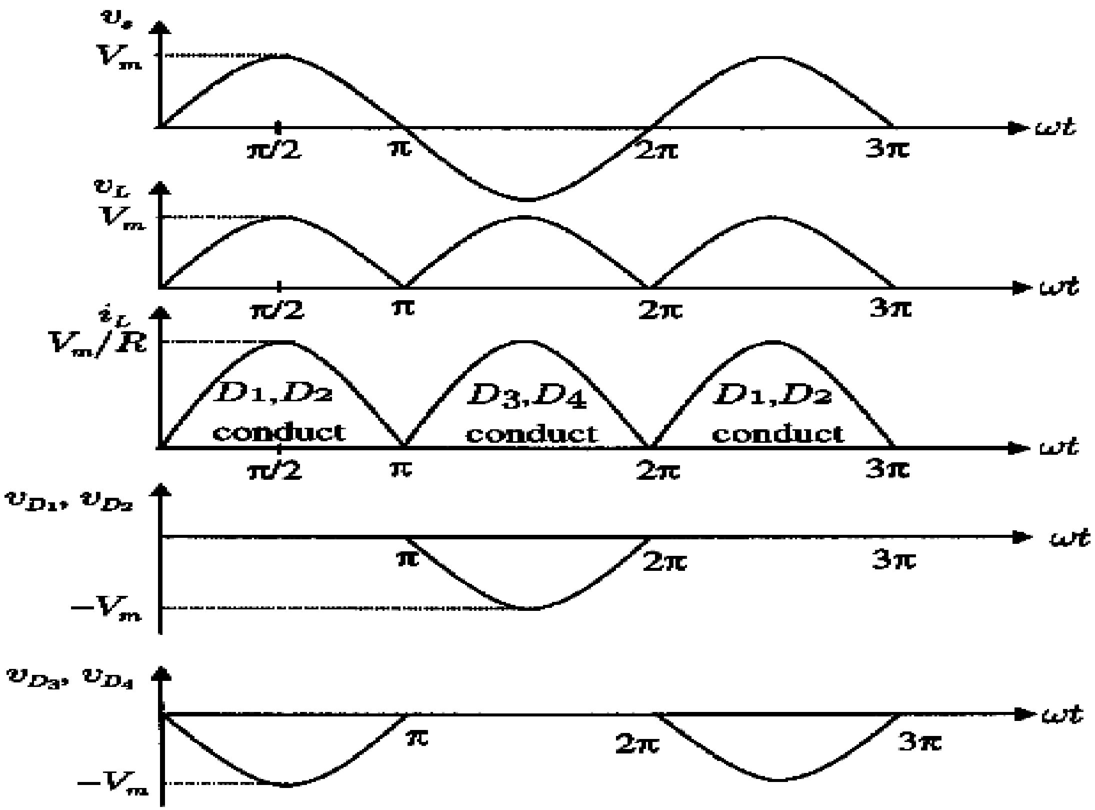


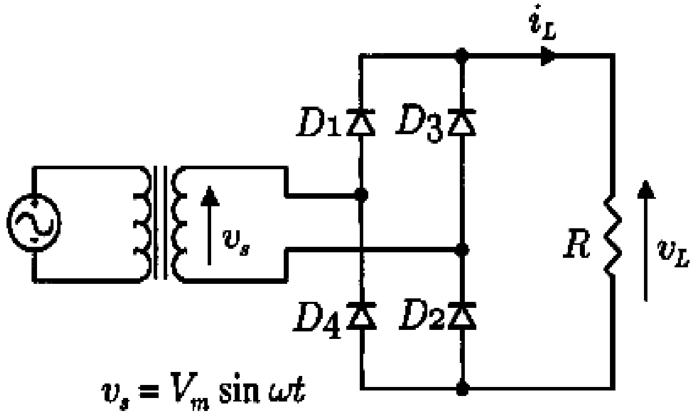


→It is clear that the peak inverse voltage (PIV) of the diodes is equal to $2V_m$ during their blocking state. Hence, the Peak Repetitive Reverse Voltage (V_{RRM}) rating of the diodes must be chose to be higher than $2V_m$ to avoid reverse breakdown.

→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 V_m=R in practice.

Bridge rectifier: It can provide full-wave rectification without using a center-tapped transformer. During the positive half cycle of the transformer secondary voltage, the current flows to the load through diodes D_1 and D_2. During the negative half cycle, D_3 and D_4 conduct.





→As with the full-wave rectifier with center-tapped transformer, the Peak Repetitive Forward Current (I_{FRM}) rating of the employed diodes must be chosen to be higher than the peak load current $V_m = I_m \times R$

→ However, the peak inverse voltage (PIV) of the diodes is reduced from $2V_m$ to V_m during their blocking state.

$V_{dc} = \frac{1}{\pi}\int_0^{\pi} V_m \sin\omega t \, d(\omega t)$)=$V_m |\sin\omega t|$ for both the positive and negative half-cycles. Hence;

Therefore;

$$\text{Full-wave } V_{dc} = \frac{2V_m}{\pi} = 0.636\ V_m$$

The root-mean-square (rms) value of load voltage v_L is V_L, which is defined as:

$$V_L = \left[\frac{1}{T}\int_0^T v_L^2(t)dt\right]^{1/2}$$

Hence, the equation can be rewritten as:

$$V_L = \sqrt{\frac{1}{\pi}\int_0^{\pi}(V_m \sin\omega t)^2 d(\omega t)}$$

OR

$$\text{Full-wave } V_L = \frac{V_m}{\sqrt{2}} = 0.707\ V_m$$

Therefore; the average and the rms value load current is:

$$I_{dc} = \frac{0.636\ V_m}{R}$$

$$I_L = \frac{0.707\ V_m}{R}$$

The rectification ratio is:

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

$$= \frac{(0.636\ V_m)^2}{(0.707\ V_m)^2} = 81\%$$

The FF can be found by:

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

$$\mathbf{FF} = \frac{0.707\ V_m}{0.636\ V_m} = 1.11$$

The ripple factor (RF), which is a measure of the ripple content, is defined as:

$$\mathbf{RF} = \frac{V_{ac}}{V_{dc}}$$

$$V_{ac} = \sqrt{V_L^2 - V_{dc}^2}$$

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

$$\mathbf{RF} = \sqrt{1.11^2 - 1} = 0.482$$