University of Technology
Laser and Optoelectronic Engineering Department
Power Electronics/2018-2019)
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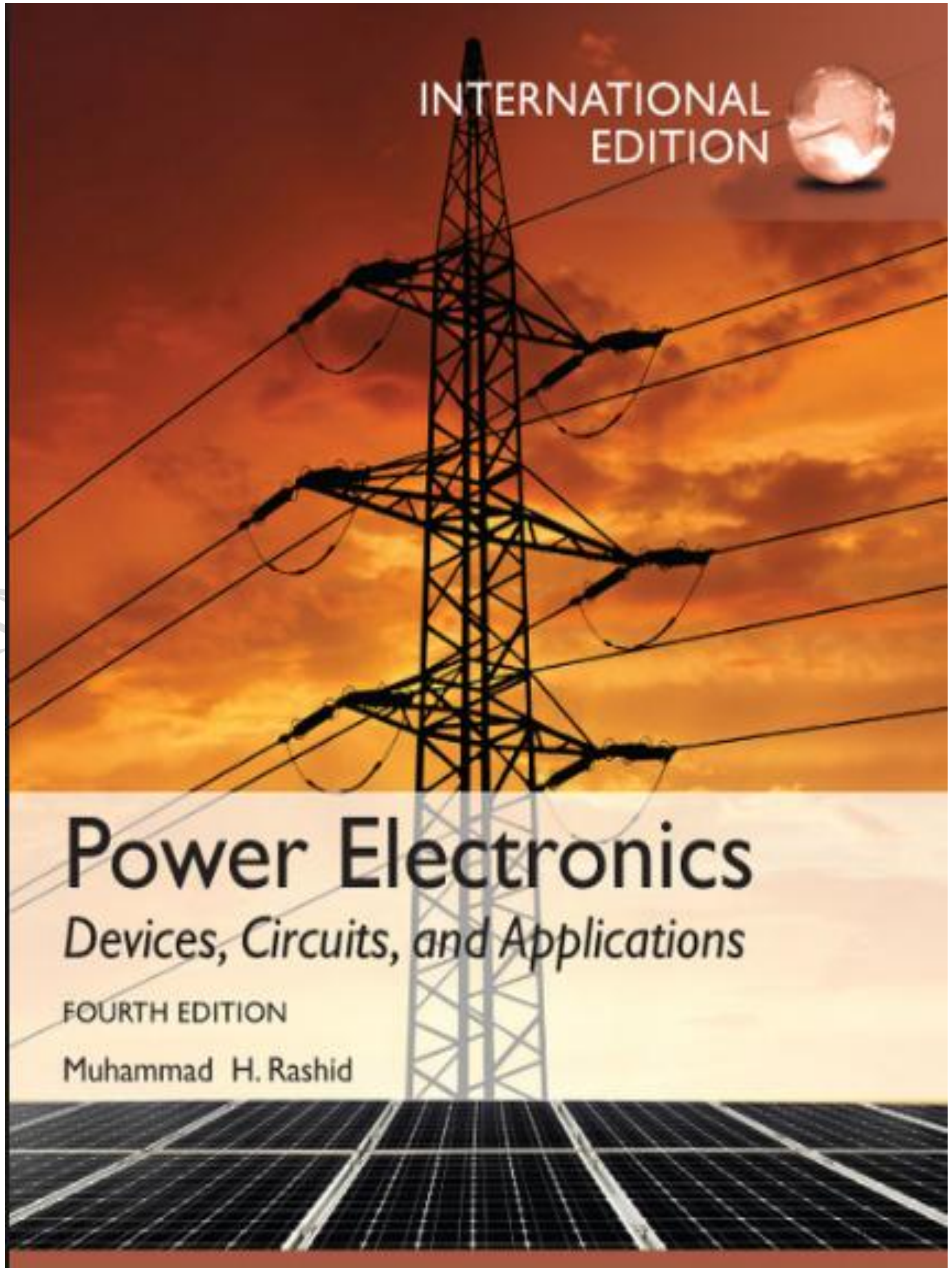
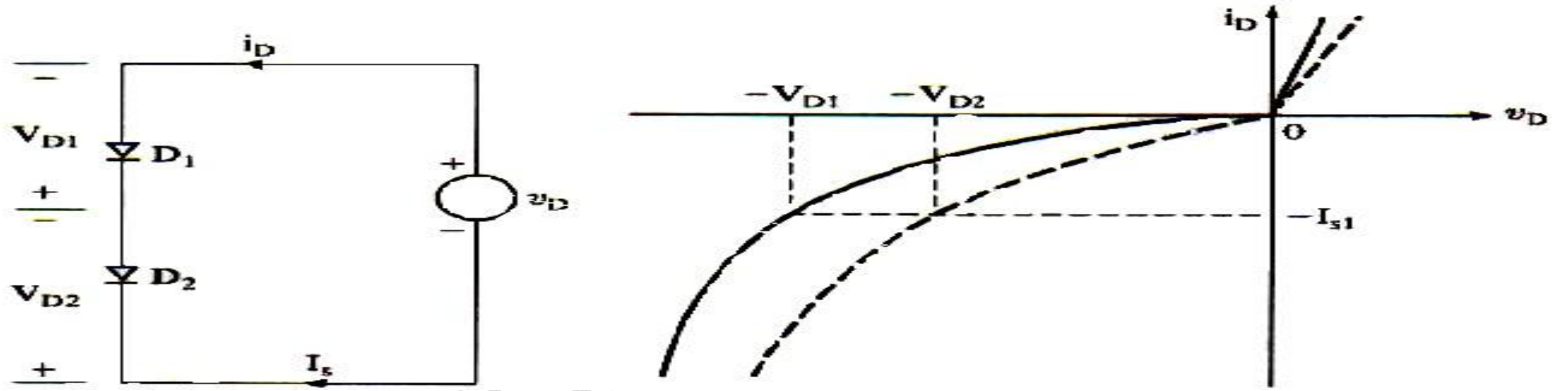


Ref: Power Electronics 4th edition/ Muhammed H. Rashid

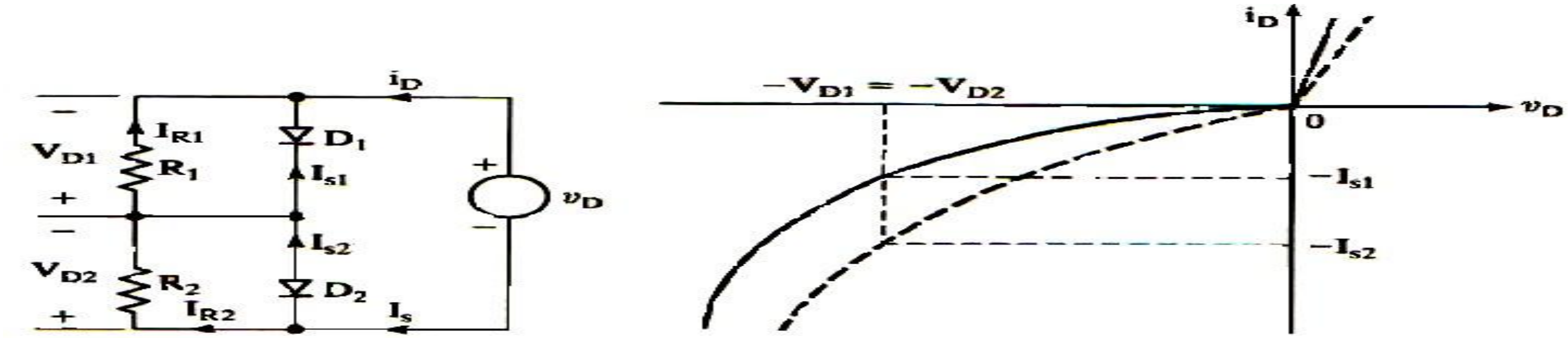
Lecture No.5

High Voltage Series Connected Diodes

- In many high voltage applications, one commercially diode cannot meat the required voltage rating
- Because of this reason, diodes are connected in series to increase the reverse blocking capabilities.



- VD1 and VD2 are the sharing reverse voltages of diodes D1 and D2.
- In practice, the *v*-*i* characteristics for the same type of diodes differ due to tolerances in their production process.
- Refer to the figure above, for reverse blocking conditions, each diode has to carry the same leakage current. And as a result, the blocking voltage will be different.
- The solution is to force equal voltage sharing by connecting a resistor across each diode as shown in figure below.
- This will make the leakage current of each diode would be different because the total leakage current must be shared by a diode and its resistor.



(a) Circuit diagram (b) $v - i$ characteristics

$$V_{D1} + V_{D2} = V_S$$

$$I_S = I_{S1} + I_{R1} = I_{S2} + I_{R2}$$

$$I_{R1} = \frac{V_{D1}}{R_1} \text{ and } I_{R2} = \frac{V_{D2}}{R_2}$$

$$I_{S1} + \frac{V_{D1}}{R_1} = I_{S2} + \frac{V_{D2}}{R_2}$$

Howe work:

Two diodes are connected in series, shown in figure above to share a total dc reverse voltage of VD = 5kV. The reverse leakage currents of the two diodes are I_{S1}=30mA and I_{S2}=35mA.

a) Find the diode voltages if the voltage sharing resistance are equal, $R_1=R_2=R=100k\Omega$.

b) Find the voltage sharing resistances R1 and R2 if the diode voltages are equal, $V_{D1}=V_{D2}=0.5V_D$

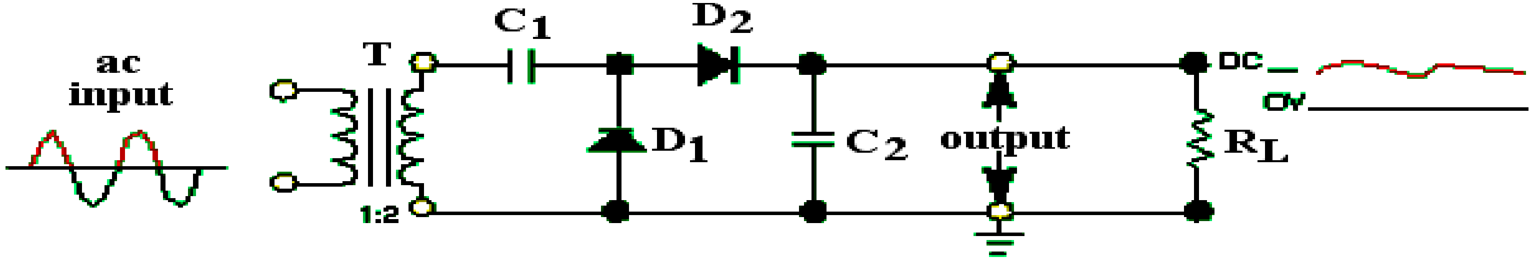
Voltage Multiplier

Voltage multipliers may also be used as primary power supplies where a 177 volt-ac input is rectified to pulsating dc. This dc output voltage may be increased (through use of a voltage multiplier) to as much as 1000 volts dc. This voltage is generally used as the plate or screen grid voltage for electron tubes.

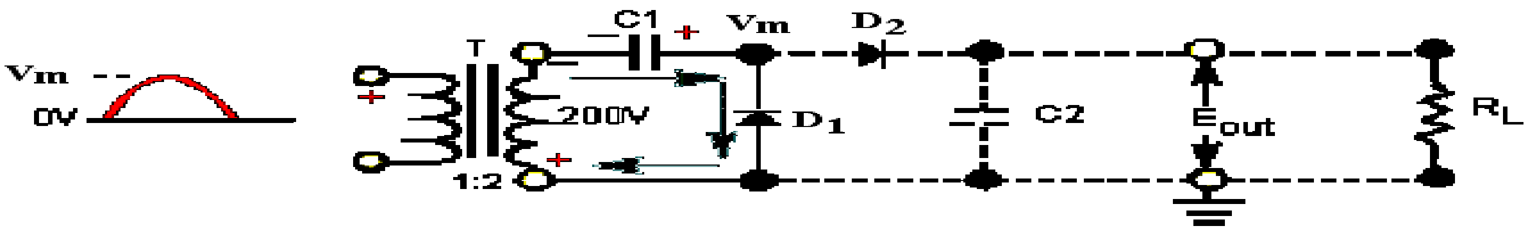
Voltage multipliers may be classified as voltage doublers, triplers, or quadruplers. The classification depends on the ratio of the output voltage to the input voltage. For example, a voltage multiplier that increases the peak input voltage twice is called a voltage doubler. Voltage multipliers increase voltages through the use of series-aiding voltage sources.

Half wave voltage multiplier

Figure below shows the schematic for a half-wave voltage doubler. Notice the similarities between this schematic and those of half-wave voltage rectifiers. In fact, the doubler shown is made up of two half-wave voltage rectifiers. C_1 and D_1 make up one half-wave rectifier, and C_2 and D_2 make up the other. The schematic of the first half-wave rectifier is indicated by the dark lines in figure below. The dotted lines and associated components represent the other half-wave rectifier and load resistor.



Notice that C_1 and D_1 work exactly like a half-wave rectifier. During the positive alternation of the input cycle, the polarity across the secondary winding of the transformer is make the top of the secondary is negative. At this time D_1 is forward biased (cathode negative in respect to the anode). This forward bias causes D_1 to function like a closed switch and allows current to follow the path indicated by the arrows. At this time, C_1 charges to the peak value of the input voltage.



During the period when the input cycle is negative, the polarity across the secondary of the transformer is reversed. Note specifically that the top of the secondary winding is now positive. This condition now forward biases D_2 and reverse biases D_1. A series circuit now exists consisting of

C_1, D_2, C_2, and the secondary of the transformer. The secondary voltage of the transformer now aids the voltage on C_1. This results in a pulsating dc voltage with $2V_m$, as shown by the waveform. The effect of series aiding is comparable to the connection of two batteries in series. As shown in figure C_2 charges to the sum of these voltages.