UNIVERSITY OF ENGINEERING AND TECHNOLOGY TAXILA
ELECTRICAL ENGINEERING DEPARTMENT

Lab Manual No. 02
For the Course of
<u>Power Electronics</u>

For
Eighth Semester
Electrical Engineering Department
(**B.Sc. Electrical Engineering**)

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Section – A 2k17

Title:

Comparative Analysis of Rectifier Diode and Schottky Diode

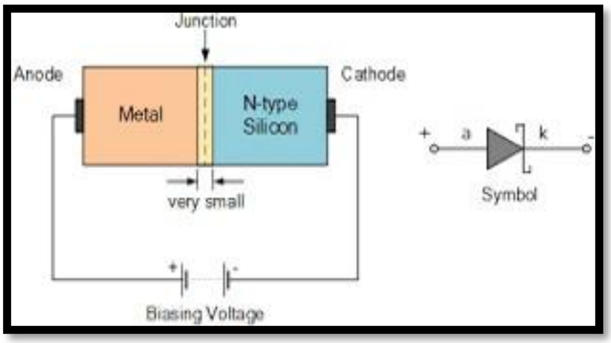
Objectives:

- To compare rectifier diode and Schottky diode.
- To observe characteristics of rectifier diode and Schottky diode, like:
    a. Characteristic Curve
    b. Reverse Leakage Current
    c. Power Loss
    d. Switching Speed

Theoretical Background

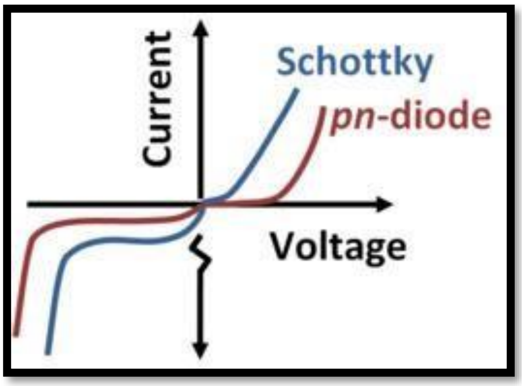
Schottky Diode:

A Schottky Diode is a metal-semiconductor diode with a low forward voltage drop and a very fast switching speed.



V-I Characteristics of Schottky Barrier Diode:

The V-I characteristics of a Schottky barrier diode are below:



- The forward voltage drop of the Schottky barrier diode is very low compared to a normal PN junction diode.
- The forward voltage drops ranges from 0.3 volts to 0.5 volts.
- The forward voltage drop of Schottky barrier is made up of silicon.
- The forward voltage drops increase at the same time increasing the doping concentration of N type semiconductor.
- The V-I characteristics of a Schottky barrier diode are very steeper compared to the V-I characteristics of normal PN junction diode due to the high concentration of current carriers.

Current Components in Schottky Diode:

The current condition in this diode is through electrons (majority carriers) in N-type semiconductor.

$$I_T = I_{Diffusion} + I_{Tunneling} + I_{Thermonic\ emission}$$

I$_{Diffusion}$ is diffusion current due to concentration gradient and diffusion current density.

$$J_n = D_n * q * dn/dx$$

for electrons, where D_n is the diffusion constant of electrons, q is electronic charge.
= $1.6*10^{19}$coulombs, dn/dx is a concentration gradient for electrons.

I$_{Tunneling}$ is the tunneling current due to quantum mechanical tunneling through the barrier. The probability of tunneling increases with the decrease in the barrier or built-in potential and decrease in depletion layer width. This current is directly proportional to the probability of tunneling.

I$_{Thermionic\ emission}$ is a current due to thermionic emission current. Due to thermal agitation, some carriers have equal energy to or larger than the conduction band energy to the metal-semiconductor interface, and to the current flow. This is known as thermionic emission current.

Advantages of Schottky Diode:

Advantages of Schottky diode are showing below-

- It has fast recovery time due to very low quantity of stored charge. So, this diode is used for high speed switching application.
- It has low turn on voltage.
- It has low junction capacitance.
- Voltage drop is low.

Disadvantages of Schottky Diode:

Disadvantages of Schottky diode are showing below-

- Reverse leakage current.
- Low reverse voltage rating.

Application of Schottky Diode:

- Used in Switched-mode power supplies.
- Used in reverse current protection.
- Used in discharge protection.
- Used in voltage clamping application.
- Used in RF mixer and Detector diode.

- Used in solar cell application.

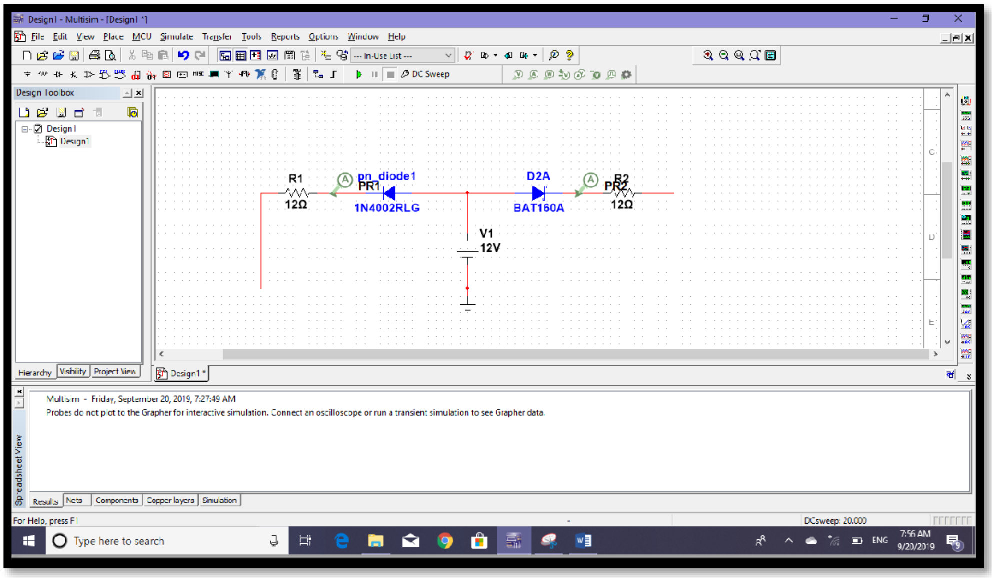
Difference between Schottky and Rectifier Diode:

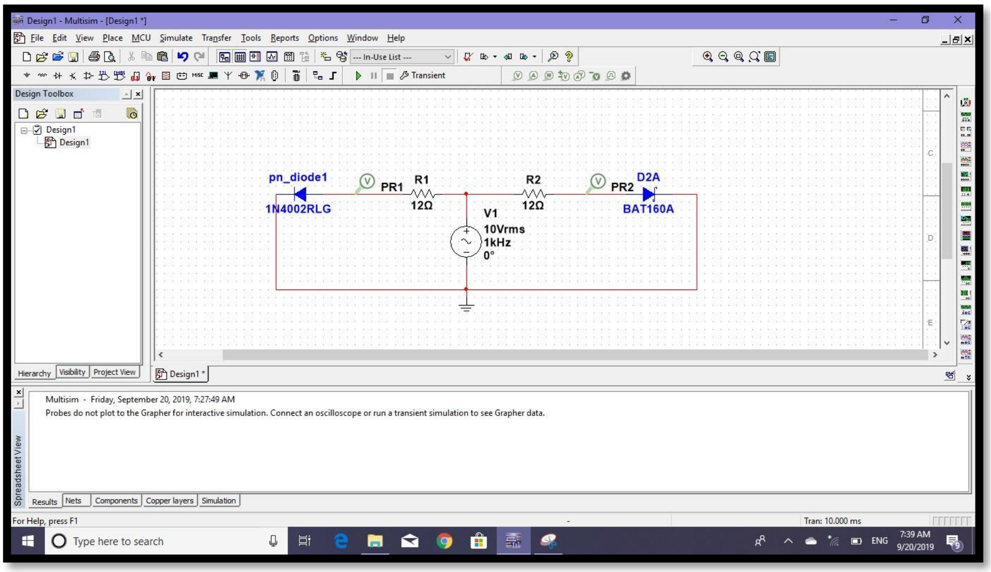
Features	Schottky diode	P-N diode
Forward current	It occurs due to thermionic emission. (majority carrier transport)	It occurs due to diffusion currents. (minority carrier transport)
Reverse current	It is generated only due to majority carriers which overcome the barrier. (It depends less on temperature.)	It is generated due to minority carriers diffusing to the depletion layer and drifting to the other side. (It depends more on temperature.)
Cut-in voltage	It is small about 0.3V.	It is large about 0.7V.
Speed	It has high switching speed due to majority carrier transport. No recombination time needed.	It is limited by recombination time of injected minority carriers.
Ideality Factor	It is about 1 due to no recombination in depletion layer.	It is about 1.2 to 2.0 due to recombination in depletion layer.

Procedure:

1. Make circuit in Multisim using resistors, rectifier diode, Schottky diode and DC power source.
2. Set values of components according to calculation.
3. Then select DC sweep analysis and draw V-I curves if both diodes.
4. Then observe which diode has more reverse leakage current.
5. Then select interactive mode and find power loss of each diode and observe which diode has more power loss.
6. Then replace DC source with AC source and exchange positions of resistors and diode in the circuit.
7. Then select Transient analysis and draw waveforms of current of both diodes and observe which diode has more switching speed.

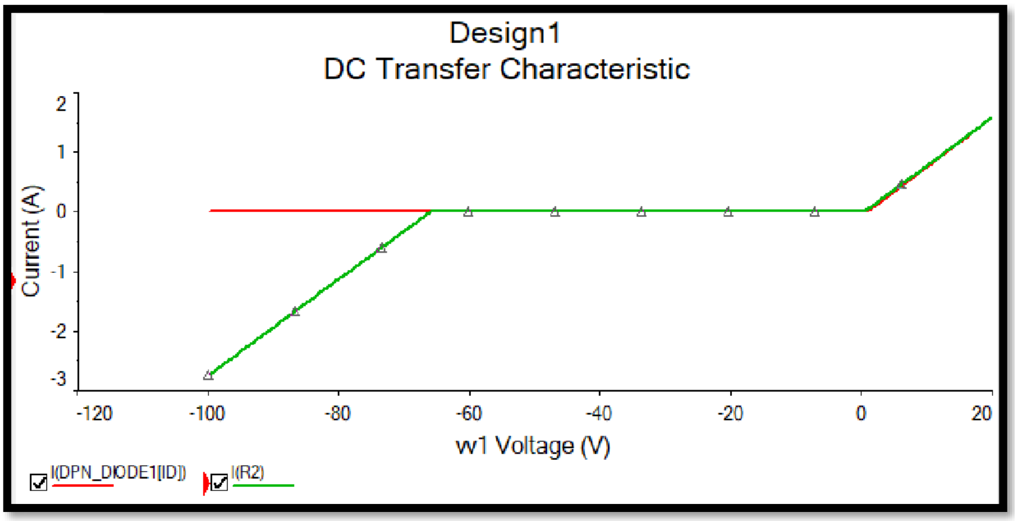
Circuit Diagrams:



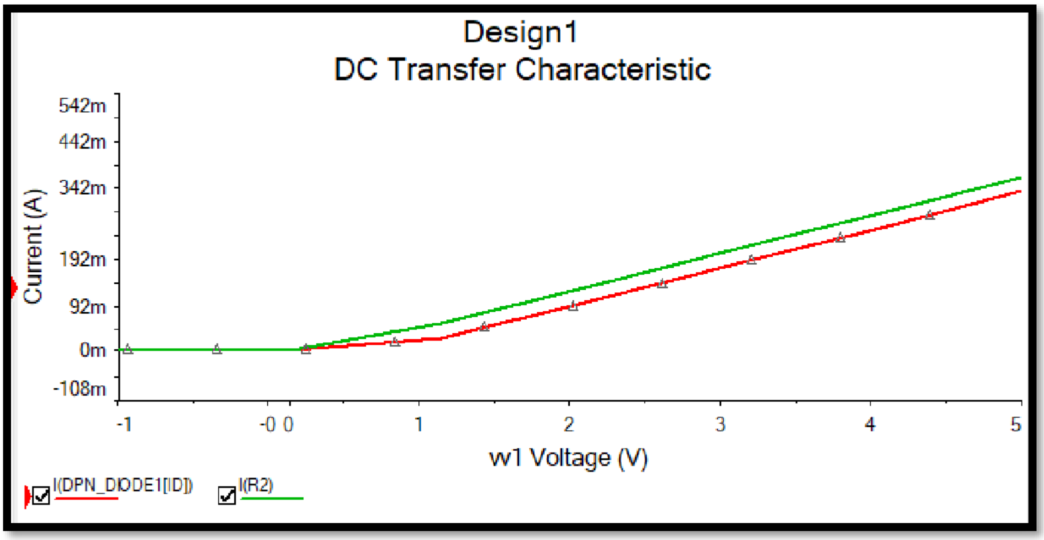


Results:

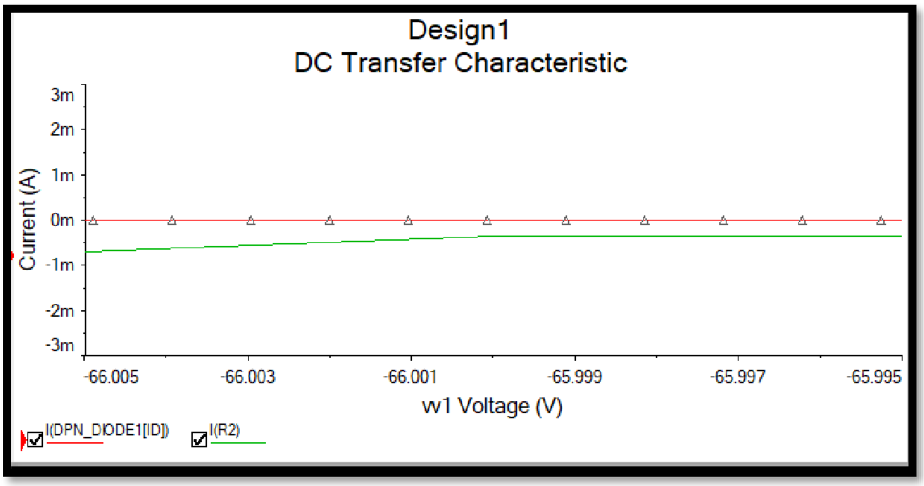
Characteristic Curve:



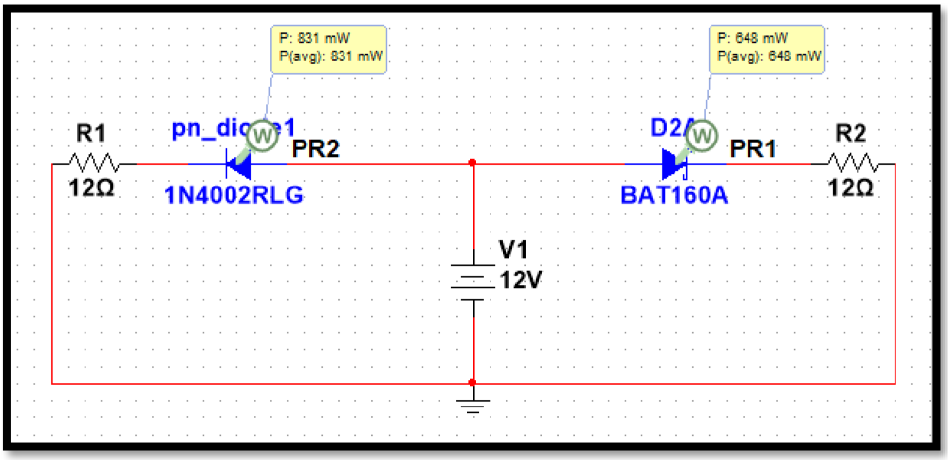
Forward Voltage:



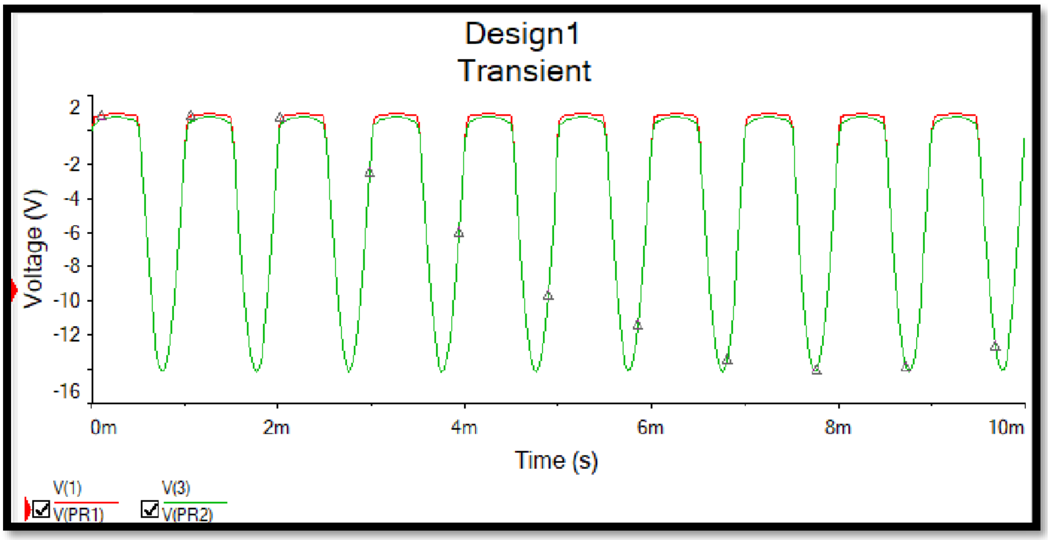
Reverse Leakage Current:

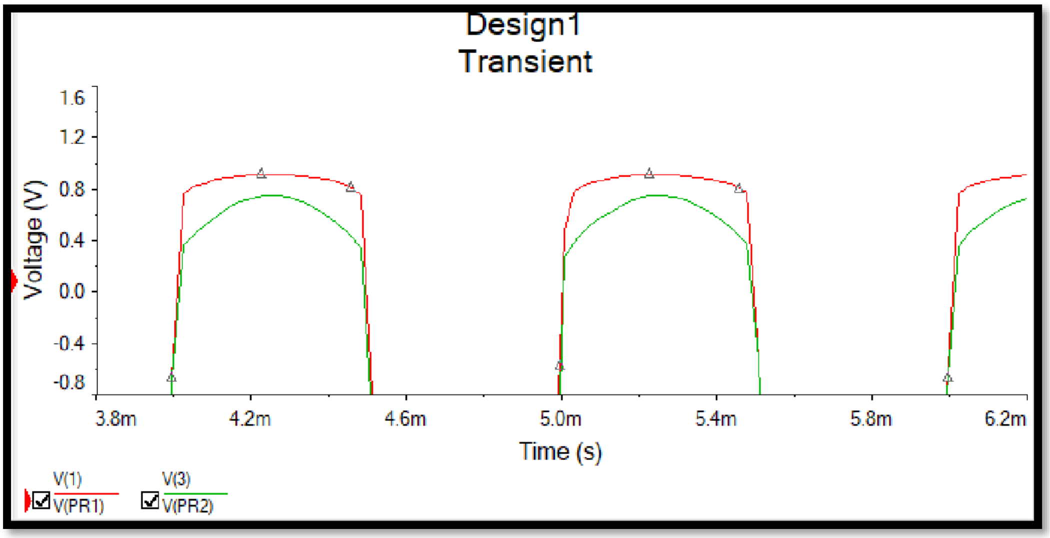


Power Loss:



Switching Speed:





Conclusion:

By using comparative analysis of rectifier diode and Schottky diode, I concluded that Schottky diode has less forward voltage, less reverse leakage current, less power loss and more switching speed than rectifier diode.