Experiment-1
PN JUNCTION DIODE AND ITS APPLICATIONS

V P SHIVASANKARAN 19110104
Computer science

Aim:

- Understanding the characteristics of the PN junction diode.
- Making clipper and clamper circuits using PN junction diode.
- Use of junction diode in voltage regulator.

Materials Required:

- PN junction diode
- Capacitors
- AC Voltage source
- Function generator
- Transformer 230V-12V
- CRO
- Wires
- Zener diodes
- Resistors
- Breadboard

Experiments:

Forward Characteristics of the junction diode:

1. The circuit is made as shown in the figure below.
2. The voltage from the source is increased slowly till the ammeter detects current in the circuit. This voltage is called the cutoff voltage.
3. Readings are taken by varying the voltage and plotted as a graph.

Reverse Characteristic of the junction diode:

1. The circuit is made as shown in the figure below.
2. The voltage is increased slowly to 30V (max).
3. No current was detected by the ammeter which means that the diode does not allow current to flow in reverse bias till the voltage reaches breakdown voltage.

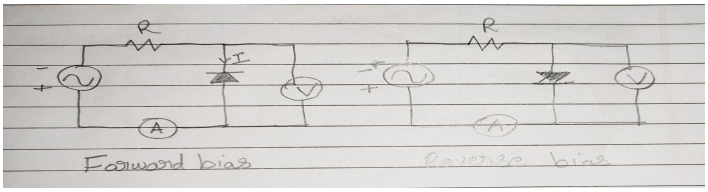
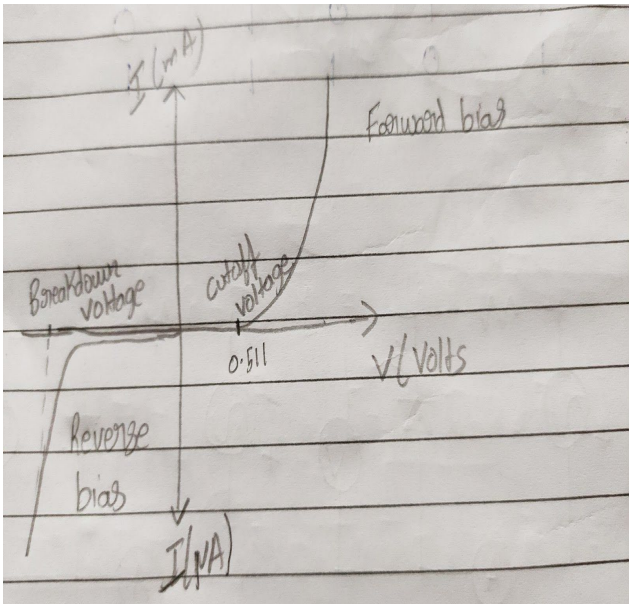


Table for the forward bias characteristics:

V (in V)	I (in mA)
0.511	0.13
0.723	21.97
0.775	82.0
0.783	100.1
0.798	142.9
0.80	161.6
0.805	181.8
0.811	201.9
0.812	252.6
0.825	261.2

Graph of the characteristics of PN junction diode:



Clipper Circuits:

Clipper circuits are used to remove either the positive or negative or a part of the input signal.

1. The circuit is made as shown in the figure below.
2. The input and output voltages are monitored by CRO.

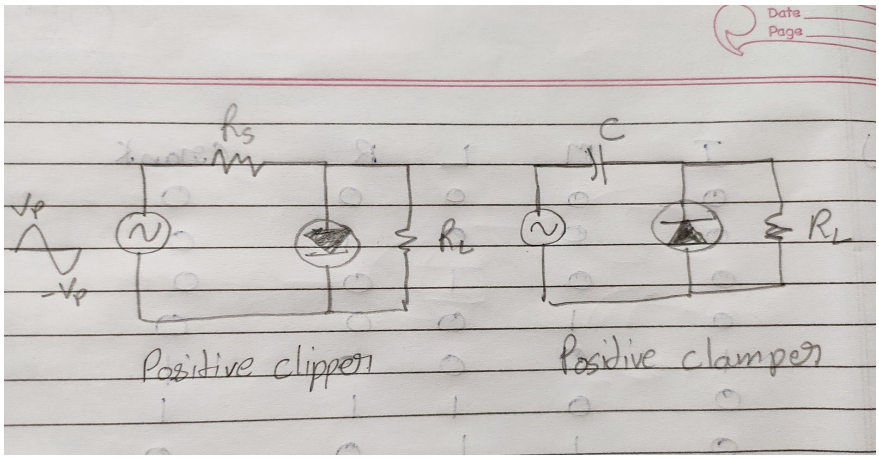
When the input voltage is negative the diode is reverse biased so Vin = Vout. But, when the input voltage is positive the diode is forward biased and acts like short circuit so Vout = 0. So, any positive input voltage gets clipped.

NOTE: Diodes present in labs are not ideal so they would have some voltage during the forward bias so, Vout = Vin - Vd. Similar deviations from ideal behaviour are also present during reverse bias.

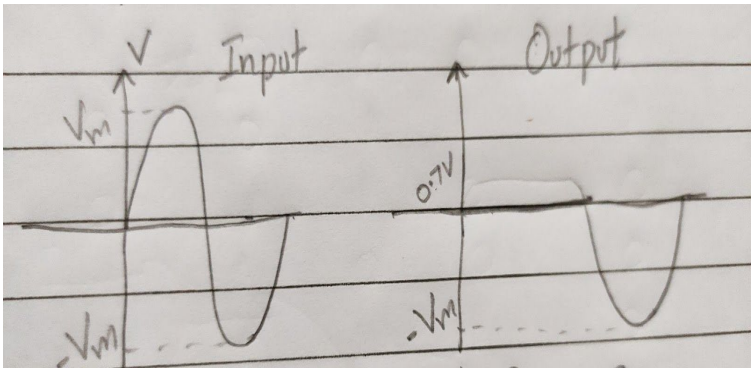
Clamper circuits:

1. The circuit is made as shown in the figure below.
2. The input and output voltages are monitored by CRO.

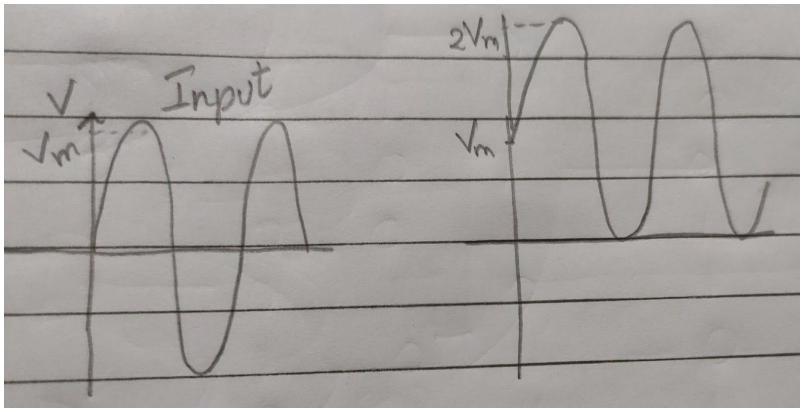
During the first negative cycle, the capacitor charges maximum to Vm and the diode is forward biased.
During the next half of the negative cycle, the diode is reverse biased and the time constant is kept much higher than the time period so the capacitor acts as an additional voltage source of Vp.



Clipper output



Clamper output



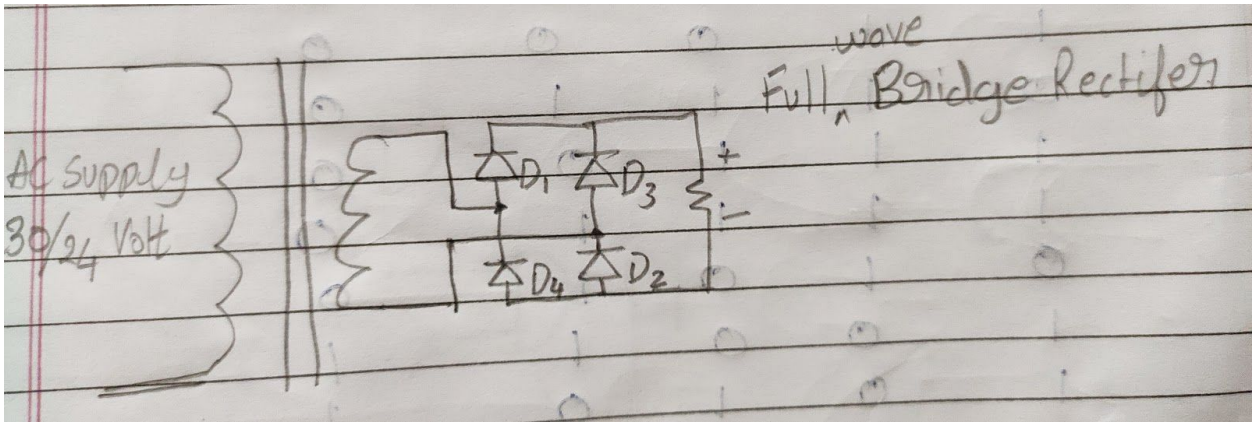
NOTE: When there is a DC source (Vs) in series with the diode then in the clipper circuit positive cycle saturates to Vs instead of 0. Similarly, When there is a DC source in series with the diode then in the clamper circuit the minimum voltage becomes Vs instead of 0.

<u>Bridge rectifier and voltage regulation.</u>

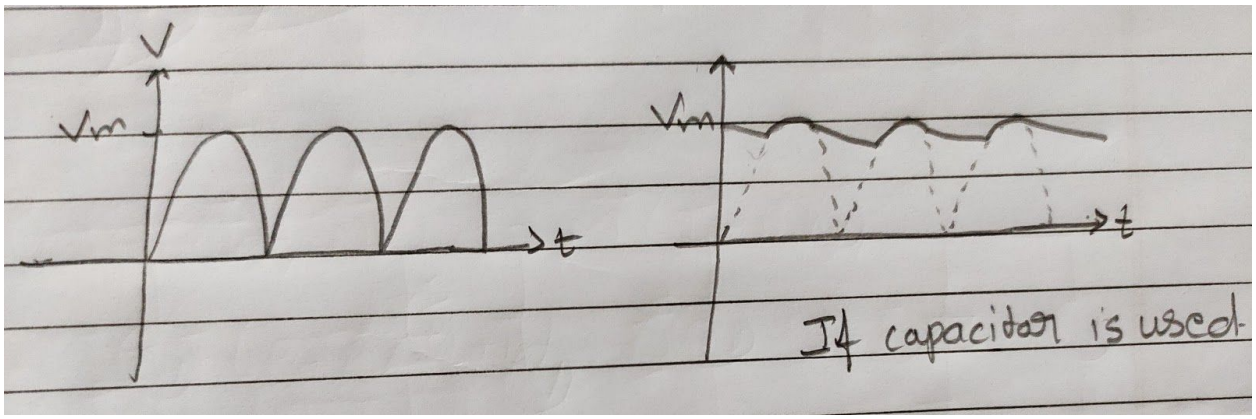
1. The circuit is shown in the figure below.
2. The input is given from the function generator.
3. The output is taken across the Zener diode.

During the positive half-cycle D1, D2 are forward biased and D3, D4 are reverse biased. During the negative half-cycle D3, D4 are forward biased and D1, D2 are reverse biased. So when the negative input voltage is translated as positive to the capacitor.
The capacitor is used to convert the AC signal from the diodes to a DC signal by choosing a high time constant for the circuit.

The Zener diode is used to maintain a stable output voltage in spite of variations in input voltage or load current.



Full-wave rectifier output



Reverse recovery time:

When a reverse bias voltage is applied to currently forward-biased diode. The charge carriers have to be pulled back by the reverse bias voltage for the diode to get into reverse bias and this process takes time. So voltage sources of high frequencies will cause problems when used with diodes which have higher recovery time

Observations and Conclusion:

1. During forward bias, an ideal PN junction diode acts as a short circuit and allows the flow of current freely. A real PN junction diode when forward biased resists the flow of current slightly and a voltage around 0.5V-0.9V is required to make current flow through the diode.

2. During reverse bias, an ideal PN junction diode acts as an open circuit until the input voltage reaches the breakdown voltage. Once the input voltage exceeds breakdown voltage the current spikes to infinity. A real PN junction diode during reverse bias allows a very small current to flow until the input voltage reaches the breakdown voltage.

3. The forward bias current is in mA and reverses bias current is in μA

4. While choosing a diode for the experiment the reverse recovery time of the diode should be taken care based on the source's frequency.

5. PN junction diode is widely used in electronics especially when it is combined with other passive elements like a capacitor, Zener diodes, resistors. The main advantage of PN junction diode is that it allows the flow of current in one direction and does not allow the flow of current in the other direction. This has property has been used extensively to regulate voltage in the form of clipper, clamper, rectifier circuits.

References:

- Lab manual
- https://www.electronics-tutorials.ws/diode/diode-clipping-circuits.html
- https://www.tutorialspoint.com/electronic_circuits/electronic_clamper_circuits.htm
- Electronic Principles 7th Edition by Malvino and Bates