EXPERIMENT NO 1[A]

P-N JUNCTION DIODE CHARACTERISTICS

Objective:

To observe and draw the Forward and Reverse bias V-I Characteristics of a P-N Junction diode.

Apparatus:

S.NO	Apparatus	Specification	Quantities
1	P-N Diode	IN4007	
2	Resistor	1K, 10K	
3	Ammeter	(0-20 mA)	
4	Ammeter	(0-200µA)	
5	Regulated Power supply	(0-30V)	
6	Voltmeter	(0-20V)	
7	Bread board		
8	Connecting wires		

THEORY:

A P-N junction diode conducts only in one direction. The V-I characteristics of the diode are curve between voltage across the diode and current flowing through the diode. When external voltage is zero, circuit is open and the potential barrier does not allow the current to flow. Therefore, the circuit current is zero. When P-type (Anode) is connected to +ve terminal and n- type (cathode) is connected to –ve terminal of the supply voltage is known as forward bias. The potential barrier is reduced when diode is in the forward biased condition. At some forward voltage, the potential barrier altogether eliminated and current starts flowing through the diode and also in the circuit. Then diode is said to be in ON state. The current increases with increasing forward voltage.

When N-type (cathode) is connected to +ve terminal and P-type (Anode) is connected –ve terminal of the supply voltage is known as reverse bias and the potential barrier across the junction increases. Therefore, the junction resistance becomes very high and a very small current (reverse saturation current) flows in the circuit. Then diode is said to be in OFF state. The reverse bias current is due to minority charge carriers.

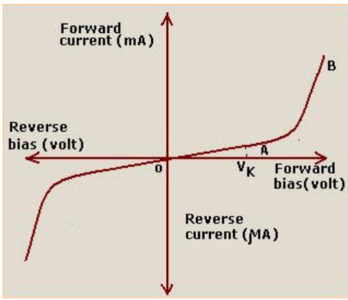


Figure: V-I Characteristics of a P-N Junction diode

$$I = I_O(e^{(v/(\eta v_T))} - 1) \tag{1}$$

Where, I: Diode current
V=Applied voltage to the diode
V_T: voltage equivalent to temperature (KT/e)
η: constant (Ge=1 , Si=2)

In forward bias When $V_F = +V$, then $e^{(v/(\eta v_T))} > 1$ thus eq.(1) becomes as

$$I = I_O(e^{(v/(\eta v_T))}) \tag{2}$$

Hence the theoretical analysis indicates that forward current increases exponentially with voltage. But practically it is not found becausee PN junction diode has a certain barrier/threshold/knee potential. Initially the applied forward potential to diode is used to neutralize this barrier potential. Therefore the current is approximately zero. The current increases appreciably after the barrier potential.

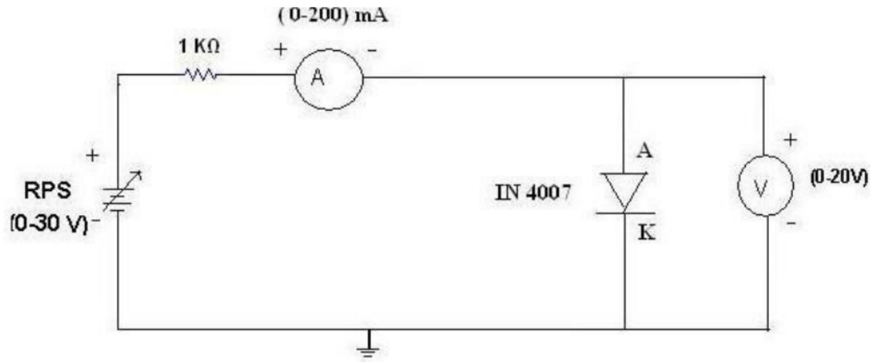
In reverse bias When $V_R = -V$, then $e^{(v/(\eta v_T))} < 1$ thus eq.(1) becomes as

$$I_R = I_0 \tag{3}$$

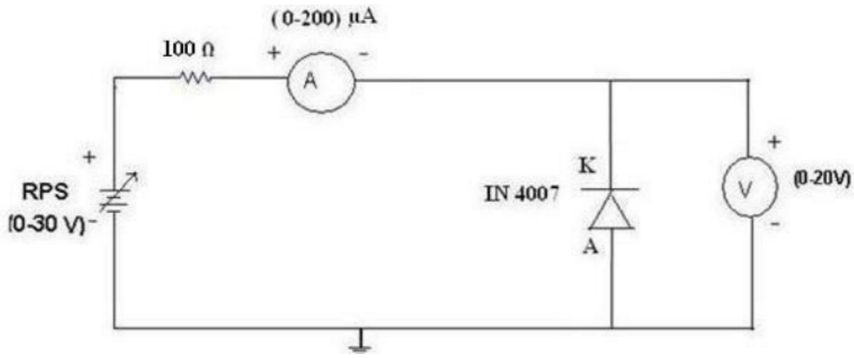
Thus in reverse bias of diode, a constant current flows through the diode whose direction is opposite to forward bias current. This current is known as reverse saturation current and it is independent of voltage. At large reverse bias voltage, the reverse bias current increases gradually to maximum due to breakdown.

CIRCUIT DIAGRAM:

A) Forward bias:



B) Reverse bias:



PROCEDURE:

A) Forward bias:

1. Connections are made as per the circuit diagram.
2. for forward bias, the RPS +ve is connected to the anode of the diode and RPS –ve is connected to the cathode of the diode.
3. Switch on the power supply and increases the input voltage (supply voltage) in Steps of 0.1V.
4. Note down the corresponding current flowing through the diode and voltage across the diode for each and every step of the input voltage.
5. The reading of voltage and current are tabulated.

6. Graph is plotted between voltage (V_f) on X-axis and current (I_f) on Y-axis.

B) Reverse bias:

1. Connections are made as per the circuit diagram.
2. For reverse bias, the RPS + ve is connected to the cathode of the diode and RPS–ve is connected to the anode of the diode.
3. Switch on the power supply and increase the input voltage (supply voltage) in Steps of 1V.
4. Note down the corresponding current flowing through the diode voltage across the diode for each and every step of the input voltage.
5. The readings of voltage and current are tabulated
6. Graph is plotted between voltage (V$_R$)$onX-axisandcurrent(I_R)onY-axis$.

OBSERVATIONS AND CALCULATIONS:

A) FORWARD BIAS:

S.NO.	Applied Voltage(V)	Forward Voltage(V$_F$)	Forward current(I$_F mA$)
1.			
2			
3			
4			
5			
6			
7			
8			
9			
10			

B) REVERSE BIAS:

S.NO.	Applied Voltage(V)	Reverse Voltage(V_R)	Reverse current(I_R, uA)
1.			
2			
3			
4			
5			
6			
7			
8			
9			
10			

CALCULATIONS:

Calculation of Static and Dynamic Resistance for a given diode

In forward bias condition:

Static Resistance$R_s = V_f/I_f =$

In Reverse bias condition:

Static Resistance, $R_s = V_R/I_R =$

PRECAUTIONS:

1. The connection should be tight otherwise fluctuation in voltage and current will happen.
2. At the turning point of curve, more reading should be taken.

3. For the plot of Graph, current should be taken mA for forward and µA for reverse biased diode.
4. The reading should be in multiple of least count.

RESULT:

The V-I Characteristics of a P-N Junction diode has been observed and also calculated Static Resistance in both Forward bias and Reverse bias condition

EXPERIMENT NO 1[B]

HALF -WAVE RECTIFIER WITH FILTER

Objective:

To examine the input and output waveforms of half wave Rectifier with filter and also Calculate its ripple factor.

Apparatus:

S.NO	Apparatus	Specification	Quantities
1	P-N Diode	IN4007	
2	Resistor	1KΩ, 10KΩ	
3	Digital Multimeter		
4	Transformer	(6V-0-6V)	
5	Capacitor	100 μf/4.7 μf	
6	CRO and CRO probes		
7	Bread board		
8	Connecting wires		
9	Function Generator		

THEORY:

In Half Wave Rectification, When AC supply is applied at the input, only Positive Half Cycle appears across the load whereas, the negative Half Cycle is suppressed.
During positive half-cycle of the input voltage, the diode D1 is in forward bias and conducts through the load resistor RL. Hence the current produces an output voltage across the load resistor RL, which has the same shape as the +ve half cycle of the input voltage.
During the negative half-cycle of the input voltage, the diode is reverse biased and there is no current through the circuit. i.e., the voltage across RL is zero. The net result is that only the +ve half cycle of the input voltage appears across the load. The average value of the half wave rectified o/p voltage is the value measured on dc voltmeter. The efficiency of the Half Wave Rectifier is 40.6

Rectifiers with Filter: All rectifier outputs contain considerable amount of ripple in addition to the DC component. In order to avoid AC components, a filter is connected at the output of the rectifier.

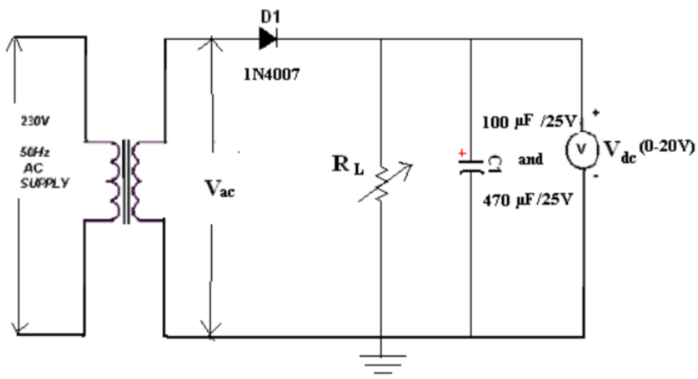
Capacitor input filter, choke input filter, RC, CRC, LC, and CLC filters are the usually used filters. Capacitor input filter is the simplest and cheapest. A high value capacitor C is connected in shunt with the load resistor RL. Capacitor charges to peak voltage Vm when the half cycle appears at the output. After the peak value is passed, the capacitor discharges through the load resistor slowly since the diode is reverse biased by the capacitor voltage. Before the capacitor voltage drops substantially, next output cycle arrives and the capacitor recharges to peak.

The rms value of the filtered output is calculated assuming that the wave as a triangular wave and it is
Vr, rms = Vrpp $/2\sqrt{3}$, where Vrpp is the peak to peak value of the ripple voltage.
$V_{dc} = Vm - (Vrpp/2)$, Ripple factor $r = Vr, rms/V_{dc}$

For a half wave rectifier the ripple factor is also expressed as a function of capacitance and load resistance, r = $1/2\sqrt{3}$f$R_L C$.

CIRCUIT DIAGRAM:

Half Wave Rectifier With Filter:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.
3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the filter.
4. Find the theoretical value of dc voltage by using the formula, Vdc=Vm/π Where, Vm=2Vrms, (Vrms=output ac voltage.)
5. The Ripple factor is calculated by using the formula r = ac output voltage/dc output voltage

OBSERVATIONS AND CALCULATIONS:

Half wave rectifier (with filter)

Vp-p (input voltage) (V)	Vrp-p (peak to peak ripple voltage) (V)	Vm (Peak voltage) =Vp-p/2 (V)	Vdc= Vm- Vrp-p/2 (V)	Vrms = Vrpp/2$\sqrt{3}$ (V)	Ripple factor	
					Theoretical	Experimental

Theoretical calculation (with filter) :

$$\text{Ripplefactor} = 1/(2\sqrt{3}fR_LC) =$$

Experimental calculation (with filter) :

$$\text{Ripplefactor} = Vrms/Vdc =$$

MODEL WAVEFORMS

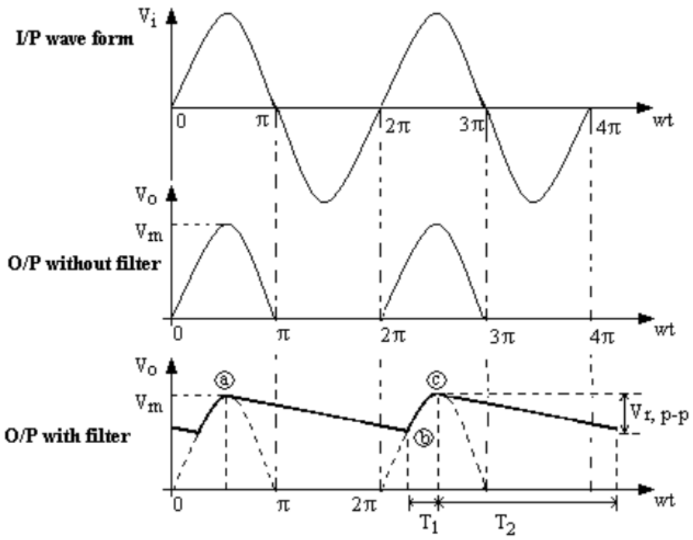


Figure:Half-Wave Rectifier with capacitor filter waveform

PRECAUTIONS:

1. The primary and secondary side of the transformer should be carefully identified.
2. The polarities of all the diodes should be carefully identified.

Results:

We have observed the Input and Output waveform of half wave rectifier with and without filter in DSO and also calculated experimental value of ripple factor of half wave rectifier with filter which is ____