Experiment no. 2

Basic electronics circuits lab, IIIT Chittoor

Characteristics and applications of PN junction diode

Part A. Forward & Reverse Bias characteristics of PN junction Diode

In this section the characteristics of PN junction Diode under forward and reverse bias conditions are studied. A PN junction diode (IN4007) is a two terminal semiconductor junction device with a metallurgical junction formed between a p-type and n-type semiconductor materials. When the positive terminal of the battery is connected to the p-region of the diode and the negative terminal of the battery is connected to the n-region of the diode, then the diode is said to be forward biased. On **forward biasing,** initially no current flows due to barrier potential. As the applied potential exceeds the barrier potential the charge carriers gain sufficient energy to cross the potential barrier and hence enter the other region. The holes, which are majority carriers in the p-region, become minority carriers on entering the n-region, and electrons, which are the majority carriers in the n-region, become minority carriers on entering the p-region. This injection of minority carriers results in the current flow, opposite to the direction of electron movement.

To obtain **Forward Bias Characteristics**, Connect the circuit as shown in **Fig 2.1** vary the applied voltage **V** in steps of 0.2 V. Tabulate the Ammeter readings **I_f**. With corresponding Voltmeter Reading **V_f** in the table shown in **Table 2.1.** Plot a graph between **V_f** & **I_f.**

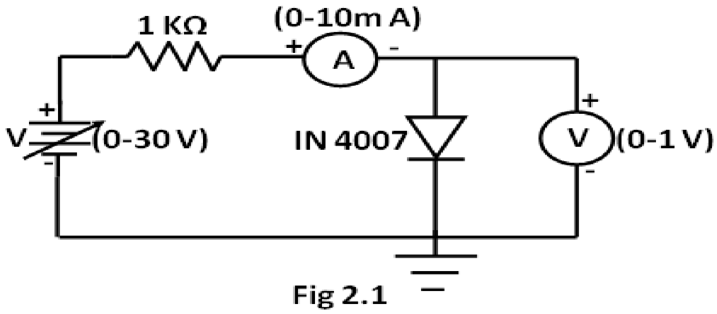

Fig 2.1

Forward biased PN junction diode

s.no.	Voltage V_f (in Volts)	Current I_f (in mA)
1		
2		
3		
4		
5		

6		
7		
8		
9		
10		

Table 2.1 tabular columns for forward voltage and current for PN junction diode

(a) Static resistance = $\frac{V_f}{I_f} =$ ____________________________

(b) Dynamic resistance = $\frac{V_2 - V_1}{I_2 - I_1} =$ ________________________

(c) Forward voltage drop = ____________________________

When the positive terminal of the battery is connected to the n-region of the diode and the negative terminal of the battery is connected to the p-region of the diode, then the diode is said to be reverse biased. On **reverse biasing**, the majority charge carriers are attracted towards the terminals of the applied potential resulting in the widening of the depletion region. Since the charge carriers are pushed towards the terminals no current flows in the device due to majority charge carriers. There will be some current in the device due to the thermally generated minority carriers. The generation of such carriers is independent of the applied potential and hence the current is constant for all increasing reverse potential. This current is referred to as **reverse saturation current (I_o)** and increases with temperature. When the applied reverse voltage is increased beyond a certain limit, it results in breakdown. When diode breaks down the diode current increases rapidly.

To obtain **reverse bias characteristics**, connect the circuit as shown in **Fig 2.2** vary the applied reverse voltage V_r in steps of 0.5 V and tabulate the ammeter readings I_r as shown in **Table 2.2.** Plot a graph between V_r & I_r.

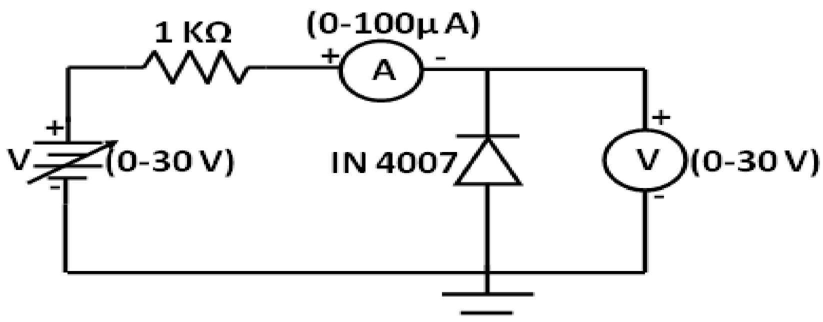

Fig 2.2

Reverse biased PN junction diode

S.no.	Voltage V_r (in Volts)	Current I_r (in mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Table 2.2

The model graph for both forward and reverse biased conditions of a PN junction diode is shown in Fig. 2.3.

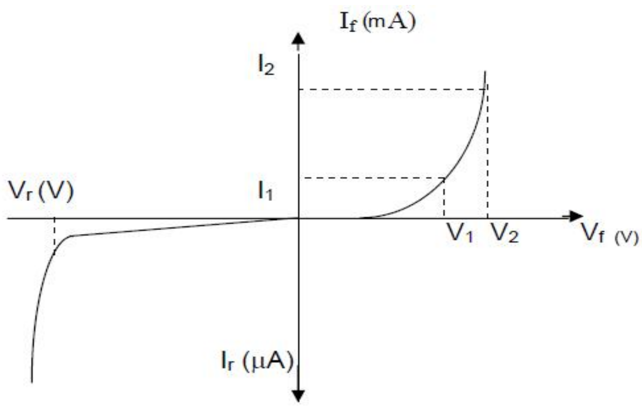

Fig. 2.3: Model graph for VI characteristics of a PN junction diode

Part B. Rectifiers

The conversion of AC into DC is called as rectification. A PN junction diode can convert AC power into DC power. The rectifiers are classified into two types, half Wave rectifier and full wave rectifier.

Half Wave Rectifier

Connect the circuit as shown in **Fig 2.4.** Using a CRO, measure the maximum voltage **V_m** at the output of the rectifier. Using a DC voltmeter, measure the DC voltage **V_{dc}** at the load resistance **R**. Plot the graph for CRO output.

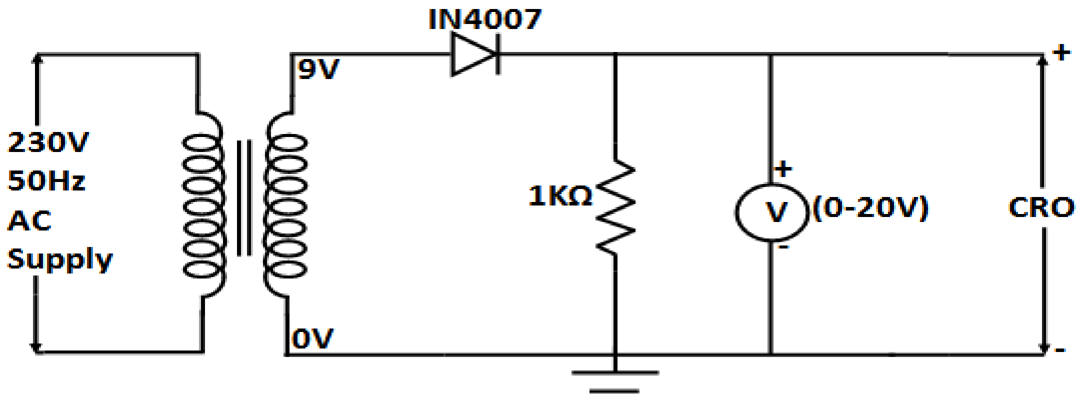

Fig 2.4

Half wave rectifier

RMS value of voltage $V_{rms} = \frac{V_m}{2}$ =______________________________

Average value $V_{dc} = \frac{V_m}{\pi}$ =______________________________________

Ripple factor = $\sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}$ = _________________________________

Rectifier efficiency = $\frac{P_{dc}}{P_{ac}}$ =______________________________________

where, $P_{ac} = \frac{V_{rms}^2}{R}; P_{dc} = \frac{V_{dc}^2}{R}$

Full Wave Rectifier

Connect the circuit as shown in **Fig 2.5.** Using a CRO, measure the maximum voltage **V_m** at the output of the rectifier. Using a DC voltmeter, measure the DC voltage **V_{dc}** at the load resistance **R**. Plot the graph for CRO output.

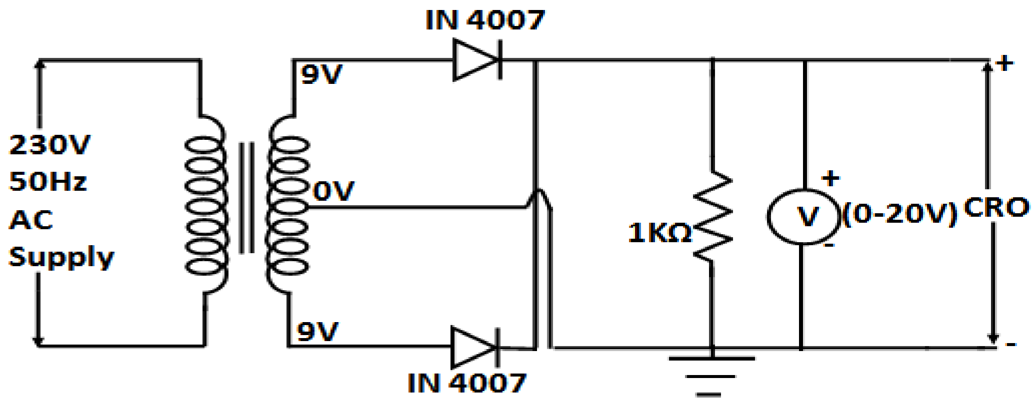

Fig. 2.5: Full wave rectifier

RMS value of voltage $V_{rms} = \frac{V_m}{\sqrt{2}}$ =_______________________________

Average value $V_{dc} = \frac{2V_m}{\pi}$ =____

Ripple factor = $\sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}$ _____________________________________

Rectifier efficiency = $\frac{P_{dc}}{P_{ac}}$ =____

where, $P_{ac} = \frac{V_{rms}^2}{R}; P_{dc} = \frac{V_{dc}^2}{R}$

The theoretical and experimental values of ripple factor and efficiency for full-wave and half-wave rectifier are tabulated as shown in table 2.3

Type of rectifier	**Ripple Factor**		**Efficiency**
	Theoretical	**Experimental**	
Half wave rectifier			
Full wave rectifier			

Table 2.3