Experiment #: 17

Experiment Title: What does the UI characteristic of an LED look like?

Objectives:

i) To investigate the general properties of a diode and types of diode

ii) To determine the turn on voltage for different type of diodes

iii) To measure I-V characteristics of type of diodes, red and blue light emitting diodes (LEDs).

Theory:

The emission intensity as a function of the diode current will be determined as well as photodetector. Then, comparing the real diode and ideal diode

A light emitting diode (LED) is a semiconductor component which has a characteristic curve. A component can be characterized by the relationship between the applied voltage and the measured current. In this experiment you will learn to record a characteristic and to interpret it.

Sourcemeter measures current-voltage (I-V) characteristics of LED, solar cells, Schottky diode, p-n junction, photosensors, biosensor, gas sensors under various external effects

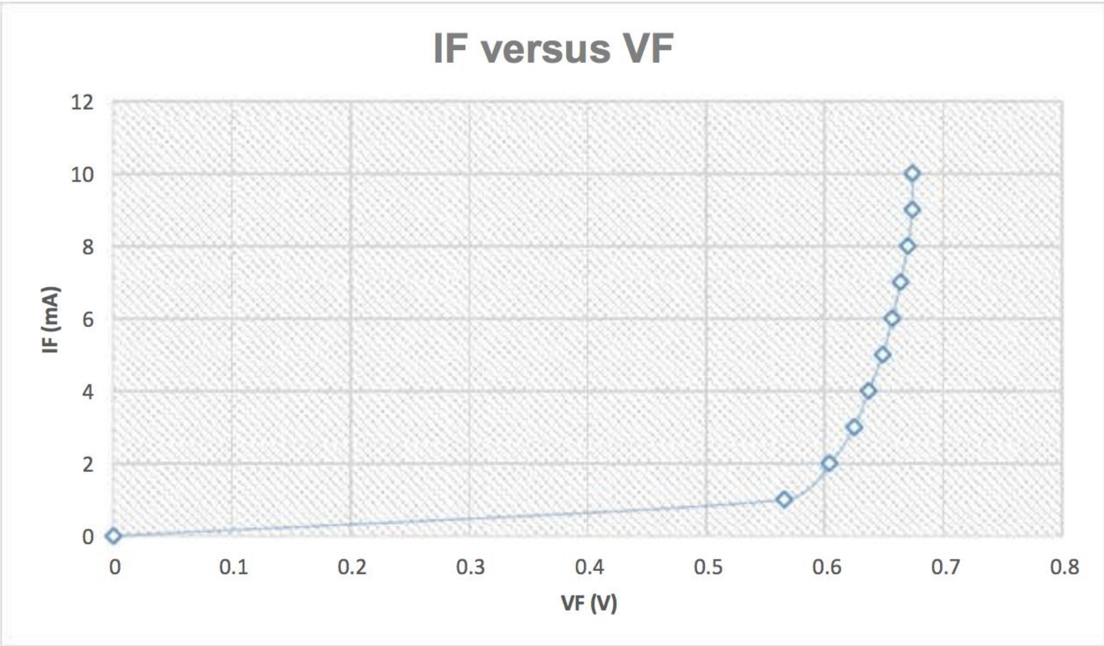
TEST 1: THE JUNCTION DIODE

Testing on a circuit consisting of a silicon diode connected in
forward bias, a 1 kΩ resistor and power supply, by varying the current, below is the tabulated record for this handled experiment

I_F (mA)	V_F (V)
0	0.000
1	0.566
2	0.604
3	0.625
4	0.637
5	0.649
6	0.657
7	0.664
8	0.670
9	0.674
10	0.674

Table 1

Tabulation value of forward potential differences with respect to applied currents in the diode circuit. From the above records, we found that the forward voltage is increases as the currents increase. Theoretically, diode allows only one directional current flow which it will provide small resistance in forward bias. The resistance (small impedance inside the diode) also varies with the variation of potential difference and current. In the tabulation of forward current $I_F$and V_F above, the pattern of increment for both variables slightly can be observed. From the table, we can see that V_F increases with the increment of I_F, however the increments of V_F are not linear due to changeable resistance inside the diode with applied voltage



Graph 1 Graph I_F against V_F.

current I_F and V_F above, the pattern of increment for both variables slightly can be observed. From the table, we can see that V_F increases with the increment of I_F , however the increments of VF are not linear due to changeable resistance inside the diode with applied voltage. Graph 1 shows a graph plotted for I_F versus VF for forward bias diode circuit. As compared to the theoretical graph, the curve fits the theorem, even the value might be varied. From thisgraph, we found that the knee voltage will be ≈ 0.6 V which nearly correct for a silicon diode.

The rate of the potential drop between 0 mA to 1 mA is relatively small. During this time, the current applied or the voltage is dealing with the depletion region (barrier potential) of the diode. When we apply voltage to the terminals of diode, the width of depletion region slowly starts decreasing. The reason for this is, in forward bias we apply voltage in a direction opposite to that of barrier potential. We know the p-side of diode is connected to positive terminal and n-side of diode is connected to negative terminal of battery. So the electrons in n-side gets pushed towards the junction (by force of repulsion) and the holes in p-side gets pushed towards the junction. As the applied voltage increases from 0 volts to 0.6 volts (for this case), the depletion region width reduces to zero. This means depletion region vanishes at 0.6 volts of applied voltage. This results in increased diffusion of electrons from n-side to p-sideregion and the increased diffusion of holes from p-side to n-side region. In other words,
minority carrier injection happens on both p-side (in a normal diode (without bias) electrons are a minority on p-side) and n-side (holes are a minority on n-side) of the diode.

Next test is by conducting the diode circuit in reverse bias

. The table below shows the value obtained for a reverse bias circuit

Theory explained that once the diode circuit is operated in reverse bias, the impedance in diode will become so high which sometimes being assumed to be infinity. This will then lead to the assumption that the circuit is open, which results V = 0 V, means, diode does not conduct in reverse bias. Suppose, theoretically, there will be reverse current which will appear in record (in the range of micro ampere) representing the current produced by leakage current and saturation current happen in the PN junction.

The reverse saturation current is the negligibly small current (in the range of micro amperes), from 0 volts to break down voltage. It remains almost constant (negligible increase do exist) in the range of 0 volts to reverse breakdown voltage. We know, as electrons and holes are pulled away from junction, they dont get diffused each other across the junction. So the net diffusion current" is zero. What remains is the drift due to electric field. This reversesaturation current is the result of drifting of charge carriers from the junction region to terminal region. This drift is caused by the electric field generated by depletion region. However, we couldn't detect the current due to the scale applied and should not worried because that kind of current is negligible.

Another part of attention, we know that suppose there will be a part in graph (theoretically) in reverse bias where the diode conduct extremely, named as breakdown voltage where here the diode is damaged. The voltage necessary to cause breakdown of the diode was not possible to reach with the lab power supply and was not practical due to probable damage to the diode. If the power supply was capable of causing breakdown, the diode would begin conducting heavily in the negative region until the diode burned up or disintegrated. The readings that were taken proved that current is restricted from flowing in the reverse bias region.

V_R (V)	V_{Rexact} (V)	I_R (A)
1	1.02	0
3	3.10	0
8	8.09	0
15	14.99	0

Table 2 Tabulation value of reverse current with respect of reverse potential differences.

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List of Equipment:

Apparatus

Circuit Diagram:

Procedure:

Data Collection:

Calculation:

Result: