# Experiment-1

# Light Emitting Diode and Photodiode Characterizations

## Simulation Exercise

1. Write ngpice netlist to measure I/V characteristics of RED, GREEN and BLUE
2. The NGSpice models of the LEDs are as follows:

   .model red D(Vj=.75 Cjo=175p Rs=.25 Eg=3.2 M=.5516 Nbv=1.6989 N=2.4 Bv=1.7 Fc=.5 Ikf=0 Ibv=20.245m Is=880.5E-18 Xti=3)

   .model green D(Is=1e-19 Rs=1.5 N=1.5 Cjo=50p Iave=30m Vpk=5)

   .model blue D(IS=93.1P RS=42M N=7.47 BV=5 IBV=30U CJO=2.97P VJ=.75 M=.333 TT=4.32U)

3. Run the simulation and plot all the characteristics on the same plot. Call this Plot 1.
4. Now plot a graph of ln $I_D$ v/s $V_D$ for all the diodes. Call this Plot 2. The slope of the graph is given by

$$\frac{\ln I_{D2} - \ln I_{D1}}{V_{D2} - V_{D1}} = \frac{1}{\eta V_T} \qquad (1)$$

Calculate the ideality factor η of each diode from the slope. Also calculate the saturation current $I_S$ from the y-intercept.

5. Calculate the bandgap $E_g$ for each LED using the emission wavelengths as:

$$E_g = \frac{1240}{\lambda} \qquad (2)$$

6. From Plot 1, choose a constant value of $I_D$, say 1 mA. For each diode, find out the value of $V_D$ corresponding to $I_D$ = 1 mA.
7. Now plot a graph of $V_D$ v/s $E_g$ for all the diodes. For the chosen value of $I_D$, you should get one point ($V_D$, $E_g$) on the graph for each diode and hence you can plot all five points (for the different diodes) on a single graph.

## Hardware Exercise Objectives:

1. To identify that the band gap of LEDs
2. To determine the bandwidth a given LED

## Equipment/Components Required:

1. LEDs – Red, Green, Blue,
2. Resistor – 1kΩ
3. Variable power supply
4. Multimeters – one ammeter and a voltmeter

## Steps:

1. Make the circuit connections as shown in Figure 1.

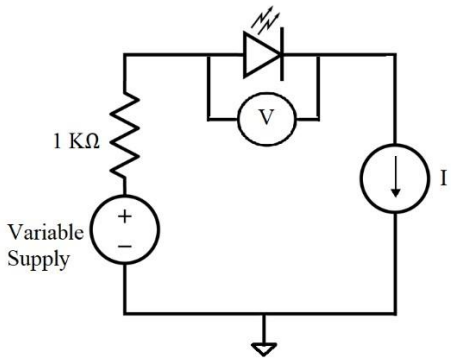


Figure 1

2. Vary the supply voltage from 0 – 5V in steps of 0.2 V and measure the $V_D$ and $I_D$.
3. Tabulate your observations and plot $I_D$ Vs $V_D$. Name this plot 3.
4. Now plot a graph of log $I_D$ Vs $V_D$. Call this plot as plot 4. Calculate the ideality factor η from the slope and the saturation current Is from the y - intercept for the given diode.
5. Repeat steps 2 to 4 for all the three LEDs.
6. Are the hardware observations same as simulation results?
7. Plot the cut-off voltage Vs $E_g$ for all the five diodes.
8. Calculate the reverse saturation current of each LED using equation given below:

$$I_D = I_{00} e^{-\frac{E_g}{kT}} \left( e^{\frac{qV_D}{kT}} - 1 \right)$$

9. No connect one of the LEDs in series with 1 kΩ resistor and power the LED using a square wave signal of frequency 1 Hz. Set the amplitude of the square wave a little higher than the cut-off voltage of the LED. The voltmeter and the ammeter need not be connected for this circuit. What do you see?