$$I_{Lmax} = \frac{V_L}{R_{Lmin}} = \frac{V_Z}{R_{Lmin}} \qquad Since, V_L = V_Z$$

V_S is the voltage drop across R_S

$$V_S = V_{Imin} - V_Z$$

$$I_S = \frac{V_{Imin} - V_Z}{R_S}$$

For $R_L < R_{Lmin}$

$$V_O = V_I$$

For $R_L > R_{Lmin}$

$$V_O = V_I - I_S \times R_S$$

Procedure

Zener Diode - Line Regulation

1. Set the Zener Voltage(V_Z)
2. Set the Series Resistance (R_S) value.
3. Set the Load Resistance (R_L) value.
4. Vary DC voltage.
5. Voltmeter is placed parallel to load resistor and ammeter series with the series resistor.
6. Choose appropriate DC voltage such that zener diode is 'on'.
7. Now note the Voltmeter and Ammeter reading for various DC voltage.
8. Note the Load current(I_L), zener current(I_Z), Output voltage(V_O)
9. Calculate the voltage regulation.

Zener Diode - Load Regulation

1. Set DC voltage.
2. Set the Series Resistance (R_S) value.
3. 1W D0-41 Glass Zener Diode 1N4740A, Zener voltage is 10 V.
4. Vary the Load Resistance (R_L).
5. Voltmeter is placed parallel to load resistor and ammeter series with the series resistor.
6. Choose Load Resistance in such a manner, such that the Zener diode is 'on'.
7. Now note the Voltmeter and Ammeter reading for various Load Resistance.
8. Increase the load resistance (R_L).
9. Note the Load current (I_L), zener current (I_Z), Output voltage(V_O)
10. Calculate the voltage regulation.

EXPERIMENT-3

Objective: To verify the V-I characteristics of the LED.

Apparatus required

Power supply

Lab trainer kit

Jumper wires

Oscilloscope

Waveform generator

Multimeter

Theory

Light Emitting Diode (LED)

A Light Emitting Diode (LED) is a semiconductor diode that emits light when an electric current is applied in forward direction of the device as in simple LED circuit. The effect is a form of electroluminescence where incoherent and narrow-spectrum light is emitted from the p-n junction.

For optical communication systems requiring bit rates less than approximately 100-200 Mb/s together with multimode fiber-coupled optical power in tens of microwatts, semiconductor light-emitting diodes (LEDs) are usually the best light source choice. LEDs require less complex drive circuitry than laser diodes since no thermal or optical stabilization circuits are needed and they can be fabricated less expensively with higher yields.

To be useful in fiber transmission applications and LED must have a high radiance output, a fast emission response time and high quantum efficiency. To achieve a high radiance and a high quantum efficiency, the LED structure must provide a means of confining the charge carriers and the stimulated optical emission to the active region of the pn junction where radiative recombination takes place.

The two basic LED configurations being used for fiber optics are surface emitters and edge emitters.

Internal Quantum Efficiency

The internal quantum efficiency ηint is an important parameter of an LED. It is defined as the fraction of the electron-hole pairs that recombine radiatively. If the radiative recombination rate is Rr and the non-radiative recombination rate isRnr, then the internal quantum efficiency is the ratio is the ratio of the radaitiverecombination rate to the total recombination rate. ηint is typically 50% in homojunction LEDs, but ranges from 60 to 80% in double-heterostructure LEDs.

Optical Power

If the current injected into the LED is I, then the total number of recombinations per second is I/q, where q is the electron charge. Total number of radaiativerecombinations is equal to (ηint I/q). Since each photon has an energy hν, the optical power generated internally by the LED is: Pint = (ηint I/q)(hν).

External Quantum Efficiency

The external quantum efficiency (ηext)of a LED is defined as the ratio of the photons emitted from the LED to the number of internally generated photons. Due to reflection effects at the surface of the LED typical values of ηout are < 10%.

LED Characteristics

Two important characteristics of a LED are its Light intensity vs. Current and Junction Voltage vs. Current characteristics. These are described briefly below.

i) Light Intensity (Optical Power) vs. Current

This is a very important characteristic of an LED. It was shown earlier that the optical power generated by an LED is directly proportional to the injected current I (current through the LED). However, in practice the characteristic is generally non-linear, especially at higher currents. The near-linear light output characteristic of an LED is exploited in small length fiber optic analog communication links, such as fiber optic closed-circuit TV.

ii) Junction Voltage vs. Current

The junction voltage vs. current characteristic of an LED is similar to the V-I characteristics of diodes. However, there is one major difference. The knee voltage of a diode is related to the barrier potential of the material used in the device. Silicon diodes and bipolar junction transistors are very commonly used whose knee voltage or junction voltage is about 0.7 V. Very often it is wrongly assumed that other diodes also have the same junction voltage. In an LED, depending on the material used its junction voltage can be anywhere between 1.5 to 2.2 Volts.