Aim-To study Characteristics of Light Emitting Diode & calculate Plank's Constant.

Introduction:-

Light Emitting Diode

It is a heavily doped p-n junction which under forward bias emits spontaneous radiation. The diode is encapsulated with a transparent cover so that emitted light can come out. When the diode is forward biased, electrons are sent from n → p (where they are minority carriers) and holes are sent from p → n (where they are minority carriers). At the junction boundary the concentration of minority carriers increases compared to the equilibrium concentration (i.e., when there is no bias). Thus at the junction boundary on either side of the junction, excess minority carriers are there which recombine with majority carriers near the junction. On recombination, the energy is released in the form of photons. Photons with energy equal to or slightly less than the band gap are emitted. When the forward current of the diode is small, the intensity of light emitted is small. As the forward current increases, intensity of light increases and reaches a maximum. Further increase in the forward current results in decrease of light intensity. LEDs are biased such that the light emitting efficiency is maximum.

The V-I characteristics of a LED is similar to that of a Si junction diode. But the threshold voltages are much higher and slightly different for each colour. The reverse breakdown voltages of LEDs are very low, typically around 5V. So care should be taken that high reverse voltages do not appear across them.

LEDs that can emit red, yellow, orange, green and blue light are commercially available. The semiconductor used for fabrication of visibleLEDs must at least have a band gap of 1.8 eV (spectral range of visible light is from about 0.4 μm to 0.7 μm, i.e., from about 3 eV to 1.8 eV). The compound semiconductor Gallium Arsenide – Phosphide ($GaAs_{1-x}P_x$) is used for making LEDs of different colours. $GaAs_{0.4}P_{0.4}$(E_g~ 1.9 eV) is used for red LED. GaAs (E_g~ 1.4 eV) is used for making infrared LED.

These LEDs find extensive use in remote controls, burglar alarm systems, optical communication, etc. Extensive research is being done for developing white LEDs which can replace incandescent lamps.LEDs have the following advantages over conventional incandescent low power lamps:

(i) Low operational voltage and less power.

(ii)Fast action and no warm-up time required.

(iii)The bandwidth of emitted light is 100 Å to 500 Å or in other words it is nearly (but not exactly) monochromatic.

(iv)Long life and ruggedness.

(v)Fast on-off switching capability.

The energy of a photon is given by the equation:

$$E = h\upsilon \qquad \ldots\ldots..(1)$$

Where E is the energy of photon,υ is its frequency, and h is a constant. In the case of the photoelectric effect, an electron is emitted from a metal if the energy of the photon is greater than the work function of the metal. If the energy of said photon is greater than the work function of a given material then the electron emitted possesses a voltage, which equals the difference in these energies. In the case of an

LED's the opposite is true. If an electron of sufficient voltage is passed across a material then a photon is emitted whose energy is equivalent to the work function of that material. The voltage at which this effect observed is the 'turn on voltage'.

This effect is not normally observed in metals and other typical substances because the photons emitted are usually outside the range of visible light, usually somewhere in the infrared. The energy of the photons emitted should then be the same as the energy of a given electron. Since:

$$P = IV \qquad \ldots\ldots\ (2)$$

Where P is power, I is current and V is the voltage of a system. The energy of one electron is the charge of an electron (i.e. the current flow of one electron per second in amps) times the voltage. Using this knowledge we then from the equation:

$$E = eV \qquad \ldots\ldots\ldots\ (3)$$

Where, $e = 1.6 \times 10^{-19}$ C (electron charge)

We then solve equation (1) for hand replace the E term with the equivalent of E in equation (3), as well as replace υ with:

$$\upsilon = \frac{c}{\lambda} \qquad \ldots\ldots\ldots..(4)$$

Where $c = 3\times10^{8}$ m/sec (speed of light)

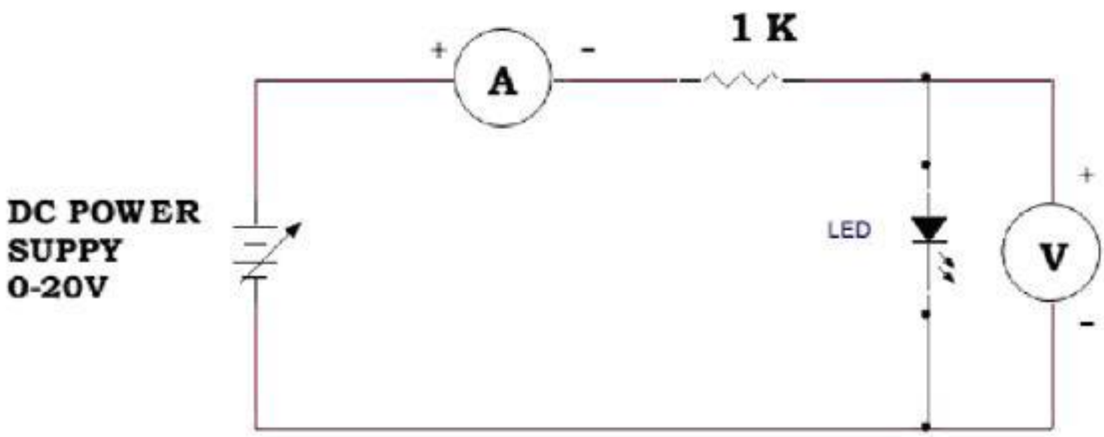
We than get,

$$h = \frac{eV\lambda}{c} \qquad \ldots\ldots\ldots\ldots..(5)$$

Procedure:-

1. Connected the L.E.D. to the jack provided on the front panel and switch ON the Unit.
2. Take the different voltage and current measurement of LED (as tabulated below) for V-I characteristic of LED.:
3. Take different LEDs and follow step 2.
4. Plot the curve on the graph paper between Voltage on X axis and current on Y axis

Circuit diagram (forward bias):



Colour Of LED 1		
Turn on Voltage for LED 1		
Plank's Constant using Turn on Voltage		
Sr.No	**Supply Voltage(V)**	**Current(mA)**
1		
2		
3		
4		
5		
6		

7		
8		
9		
10		

Colour Of LED 2		
Turn on Voltage for LED 2		
Plank's Constant using Turn on Voltage		
Sr.No	**Supply Voltage(V)**	**Current(mA)**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Conclusion:

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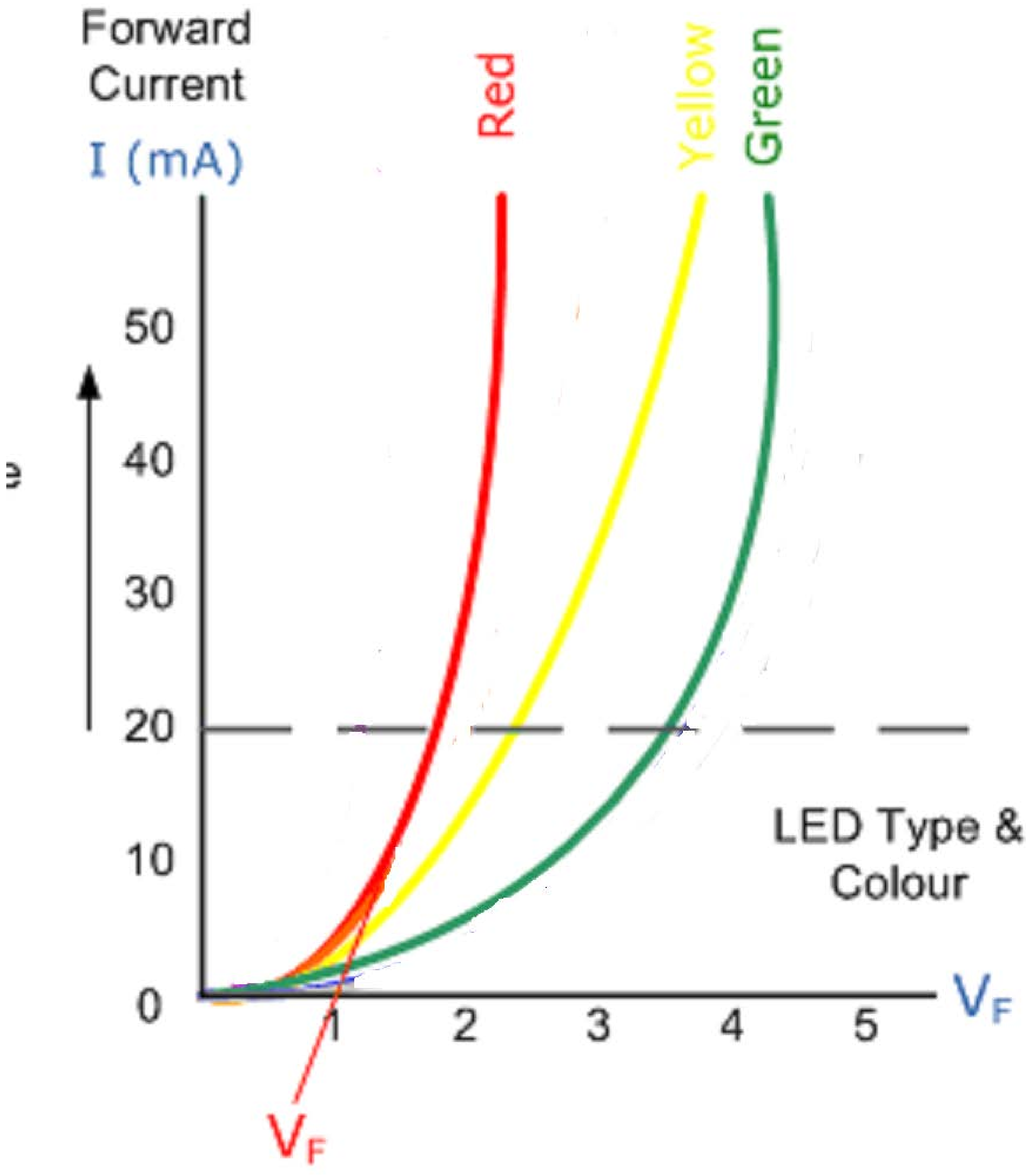
Forward
Current
I (mA)
Red
Yellow
Green
50
40
30
20
10
0
1
2
3
4
5
V_F
LED Type &
Colour
V_F