DEVICES AND CIRCUITS LABORATORY
EXPERIMENT-1
LED And Photodiode Characterizations

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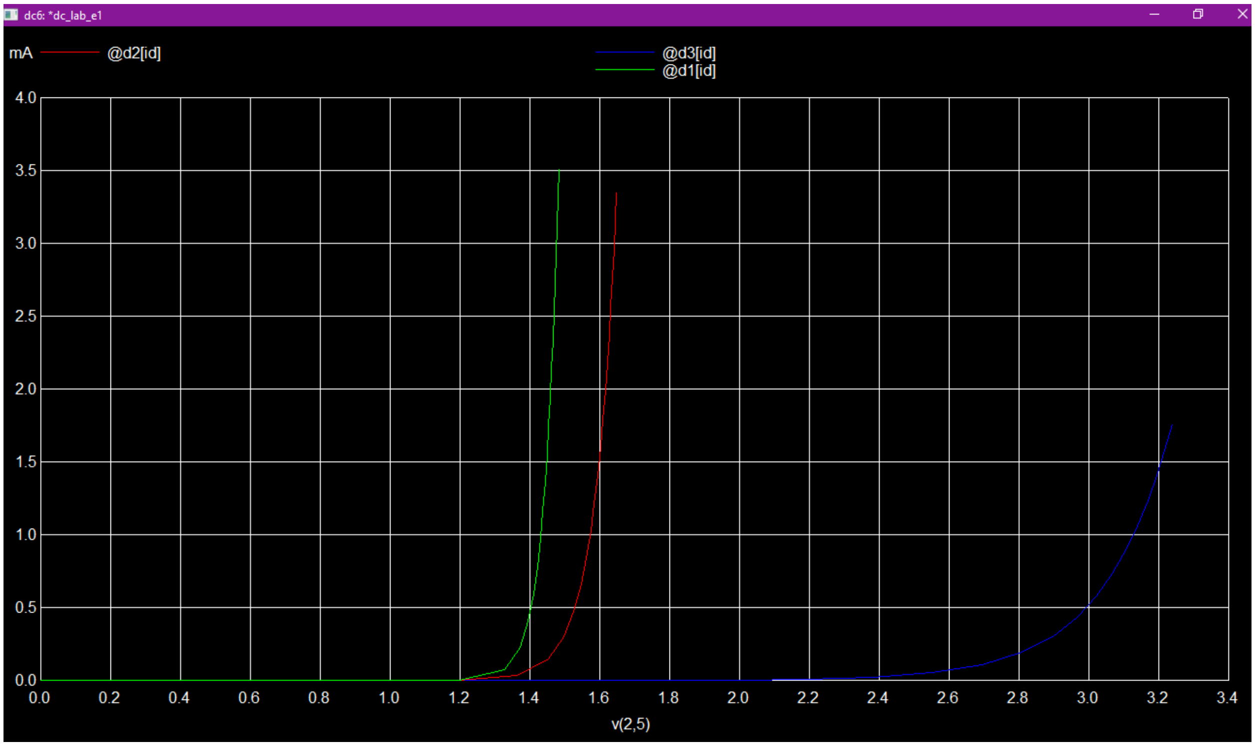
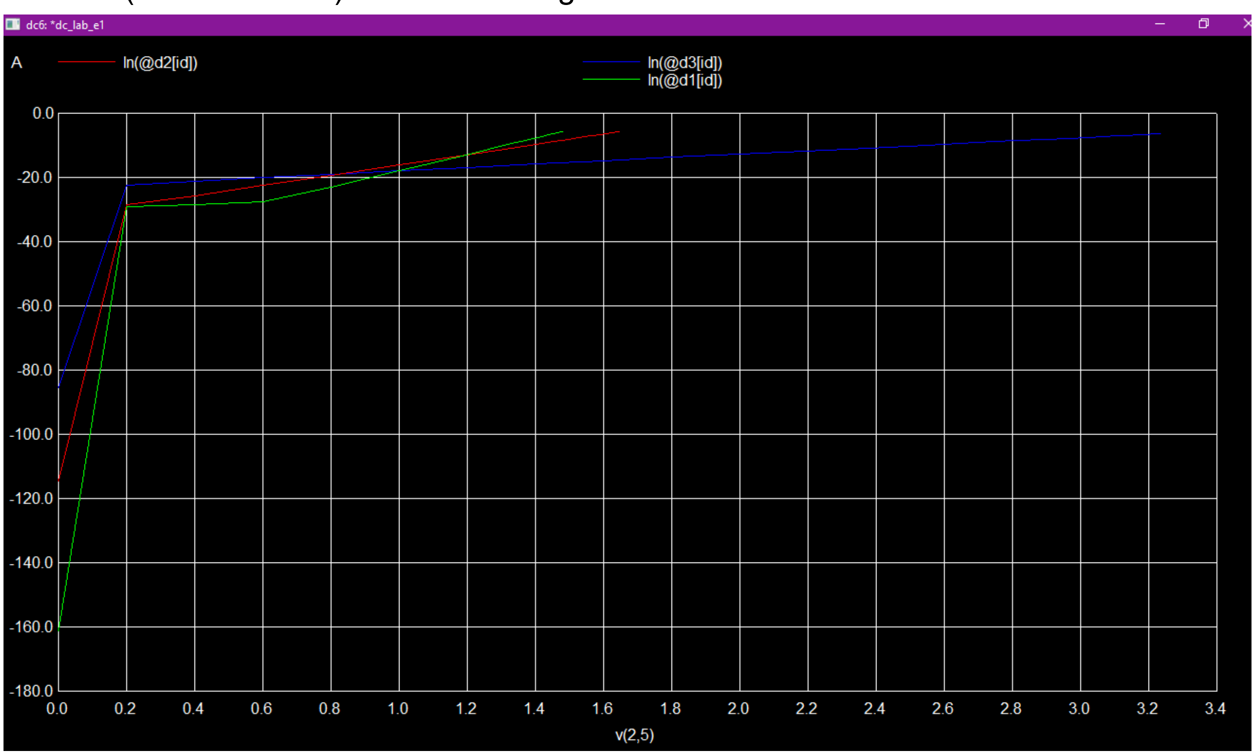
NGSPICE Code:

```
*DC_Lab_E1
Vin 1 0 dc=0
.dc Vin 0 5 0.2
R1 1 2 1k
R2 1 3 1k
R3 1 4 1k
d1 2 5 green
d2 3 6 red
d3 4 7 blue
vdummy1 5 0 0
vdummy2 6 0 0
vdummy3 7 0 0

.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)
.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)
.save all @d1[id]
.save all @d2[id]
.save all @d3[id]

.control
run
plot @d1[id] vs v(2,5),@d2[id] vs v(3,6),@d3[id] vs v(4,7)
plot ln(@d1[id]) vs v(2,5),ln(@d2[id]) vs v(3,6),ln(@d3[id]) vs v(4,7)



.endc
.end
```

Plot 1: Diode Current vs Diode Voltage



Plot 2: ln(Diode Current) vs Diode Voltage



Observations:

14/12/21

LAB - 1 SIMULATION REPORT

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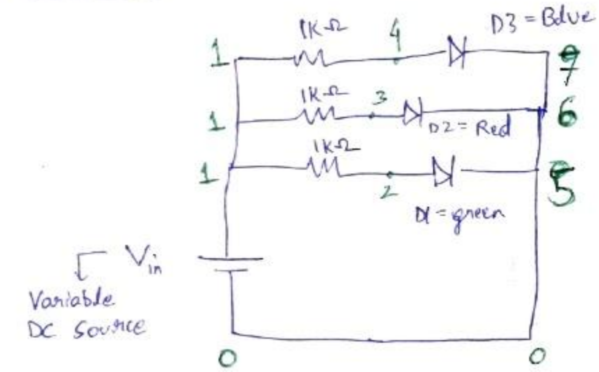
CIRCUIT :-



OBSERVATIONS :-

SATURATION CURRENTS :- (Approximate)

BLUE :- + 80 μA

RED :- + 20 μA

GREEN :- + 80 μA

SLOPES of PLOT 2 :-

GREEN :- 650

RED :- 410

BLUE :- 325

Taking $V_T = 25.85 mV$

The respective Ideality factors :-

RED :- 0.9435

BLUE :- 1.1903

GREEN :- 0.5951

Bandgap (E_g):-

BLUE:- $\frac{1240}{450} = 2.75\,eV$

RED:- $\frac{1240}{700} = 1.77\,eV$

GREEN:- $\frac{1240}{550} = 2.25\,eV$

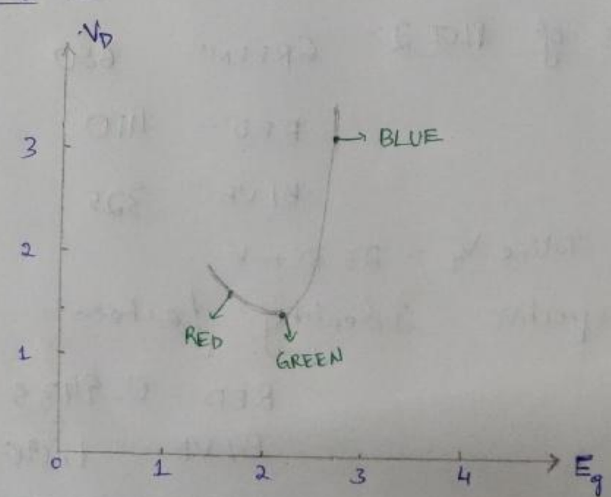
for $I_D = 1mA$:-

V_D :- BLUE:- 3.125 V

RED:- 1.572 V

GREEN:- 1.431 V

V_D vs E_g graph :-



Discussion:

DISCUSSION :-

The saturation currents of the LED lights are very small, in the order of μA and goes in the order of red < blue < green

The ideality factors of the given photodiodes indicate how close the behavior of the given diodes are, wrt to the ideal diode [Ideality factor ≈ 1] indicates that the given diode almost behaves like an ideal diode.

The Band-gap energy of each diode is indirectly proportional to the wavelength of light emitted by it.; Since wavelength follows the order:- Blue < Green < Red; Band-gap energy follows the order Blue > Green > Red. Thus, the Red LED requires lesser energy to get excited compared to the blue & green LED.

Regarding V_D, V_D (for $I_D = 1mA$) for Blue is quite higher, compared to Red & green (almost double). The trend in V_D vs E_g graph indicates that, generally, with increase in E_g, V_D tends to increase. i.e, more voltage is to be applied across the photodiode, to obtain the same diode current, if the band-gap energy of the diode is higher.

SCOPE FOR TECHNICAL IMPROVEMENT :-

- Since the saturation currents of the diodes are very low, they need to be measured with better accuracy
- The slopes need to be calculated efficiently from the plots obtained from NG Spice. The points on the graph should be chosen with better accuracy, and it is tough to obtain, using just a mouse-pointer. Thus, the ideality factors obtained may not be as accurate as we expect it to be.