7. Unscrew the self locking cap in the LED without removing it completely and insert the 1.25m plastic fiber into the cap. Now tighten the cap. Remove the ST adaptor from the power meter PD and mount the Bare fiber adaptor – plastic on to the PD. Insert the other end of the plastic fiber to this adaptor. Repeat above experiment but the optical measurement with a plastic fiber and plastic fiber adaptor in Power meter, instead of measuring it was explained in step 3.

Plot the optical power values and what do you see in the plots and what happens to the E-O conversion efficiency?

8.1.5.2 TABULATION

Wavelength of the LED: 850 **nm**

S. No.	V_1 V	If mA	V_{LED} V	P dBm	P_0 mW
1	0.232	3.41	1.22	-34.3	3.71×10^{-4}
2	0.27	3.97	1.23	-33.7	4.26×10^{-4}
3	0.32	4.7	1.24	-31.6	6.91×10^{-4}
4	0.36	5.294	1.248	-30.1	9.77×10^{-4}
5	0.42	6.176	1.25	-29.4	1.14×10^{-3}
6	0.53	7.79	1.26	-28.6	1.35×10^{-3}
7	0.82	10.2	1.28	-26.8	2.08×10^{-3}
8	1.23	18	1.3	-25.2	3.01×10^{-3}
9	1.6	23	1.32	-24	3.98
10	1.93	28	1.33	-23	5.01
11	2.35	34	1.34	-21.8	6.6
12	2.42	35	1.34	-20	0.01
13	3.04	44	1.36	-19.4	0.011
14	3.9	57	1.38	-18.3	0.014

O/P @ RLB

8.2.5.1 TABULATION

S.No.	V_1 Volts	I_{LD} mA	V_{ID} Volts	P dBm	P_0 mW
1	0.568	8.2	2.339	-35.6	2.75×10^{-4}
2	0.574	8.4	2.348	-35.4	2.88×10^{-4}
3	0.60	8.8	2.38	-35.0	3.16×10^{-4}
4	0.636	9.35	2.39	-34.5	3.54×10^{-4}
5	0.75	10	2.46	-33.3	4.67×10^{-4}
6	0.81	12	2.56	-32	6.3×10^{-4}
7	0.96	14	2.63	-31	7.9×10^{-4}
8	1.06	15	2.71	-30	10×10^{-4}
9	1.14	16	2.74	-29	1.25×10^{-3}
10	1.22	17	2.78	-29	1.58×10^{-3}
11	1.29	18	2.83	-27	1.97×10^{-3}
12	1.32	20	2.85	-26	2.51×10^{-3}
13	1.36	21	2.88	-25	3.16×10^{-3}
14	1.38	22	2.90	-23.3	4.67×10^{-3}
15	1.41	23	2.91	-21.2	7.58×10^{-3}

8.2.6 EXPERIMENT

8.2.6.1 PROCEDURE

1. Setup the LD module as shown in the figure.
2. Keep the potentiometer at the minimum position. Turn ON the power to the module.
3. Measure the voltage V_1 between ground and the point. Calculate the current through the LD I_{LD} which is given is $I_{LD} = V_1/R_1$

   Note: Scientech module R_1= 100, Benchmark module R_1 = 24
4. Now without changing any voltage or the multi-turn post position, measure the optical power output P of the LD. Calculate the power in mW which is given as $P_0(mW) = 10^{P(dBm)/10}$

Microwave and optical Communication Lab

Experiment - 8.1

I Pre-Lab Questions

1 How to change the Color of LED?

Soln LEDs produce different colors by using various materials which produce lights of different wavelength. These individual wavelengths appear as different colors.

2 What are the two different types of LED structure?

Soln (i) Planar LED
(ii) Dome LED

3 Compare LED, Incandescent bulb, and CFL lamp power for 450, 800 and 1100 Lumens of light.

Soln:

	LED	Incandescent Bulb	CFL Lamp
450	4-5	40	9-13
800	6-8	60	13-15
1100	9-13	75	18-25

4 What do you know about the spectral width of LED?

Soln Spectral width of LEDs are of the order of 20 nm to 50nm whereas lasers are of the order of 1-2 nms. Ideally, all the light is emitted in a range of wavelength centered at the peak wavelength their range is calculated spectral width.

5 Give the expression that relates bandgap and wavelength

Soln The expression is $E = h\nu = \frac{hc}{\lambda}$

6 How does LED differ from a normal PN junction diode?

Soln An LED consists of a PN junction just like an ordinary semiconductor diode, the only difference is that the PN junction of an LED is covered with a transparent material to direct the emitted light from the junction to the outer surface.

II Post-Lab Question

1. List the specifications of good LED materials.

Soln. The specifications are (i) long life (ii) No flicker (iii) Should be insensitive to heat and cold (iv) Should not have breakable glass

2. What is Lambertan pattern?

Soln The Lambertan pattern depends on the angle θ incline to the normal that is perpendicular to the surface of the source.

3. Discuss about fiber LED coupling.

Soln. Fiber LED coupling is used to take light from one LED and focus it with a small spot, typically a few millimeters in diameter, onto the end of a fiber optic bundle.

4. On what factor does the speed of LED depend on?

Soln. It depends on the energy gap of the semiconductor and reverse bias.

5. What is OLED?

Soln. OLED stands for Organic Light Emitting Diode is an LED in which the emissive electroluminescent layer is a film of organic compound that emits light in response to electric current.

6. Given,

$V = 3V$, $I = 1mA$, and 6 LEDs connected in series.

What is the power generated in this setup?

$V = IR$

$P = IV$

$P = 3mW$ for 1 bulb.

$\therefore$ for 6 bulbs, $6 \times 3mW = 18mW$.

7. Given $V_{drop} = 2.0$

$I = 20mA$

Find the value of series resistor?

$V = IR$

$R = \frac{V}{I} = \frac{V - V_{drop}}{I} = \frac{10-2}{20 \times 10^{-3}} = 400\Omega$

I Pre-Lab Questions - 8.2

1. What are multi quantum well lasers?

Soln Quantum well lasers with multiple quantum wells is a laser diode in which the active region of the device is so narrow that quantum confinement occurs in multiple regions.

2. What are the different types of laser modes

Soln (i) wavelength (ii) Waveguide (iii) pulsed layer (iv) Accumulator (v) Photon

3 Expand (Nd: YAG) LASER:

Soln neodymium doped yttrium aluminium garnet ($Nd:Y_3Al_5O_{12}$)

4. Mention the important transition process demonstrated by Einstein for Laser Action.

Soln Einstein postulated that in an excited level an atom make a radioactive transition to a lower energy either through spontaneous emission a through stimulated emission

5. In Comparision to LED, Laser has 2nm spectral width.

II Post-Lab Questions -S2

1. When light amplification occurs in LASER?

Soln. The source photons cause stimulated emission in excited state. Increasing another coherent photon, this results in light.

2. ~~What is preferred over~~ laser is preferred over LED in optic fiber.

3. State the threshold conditions for laser oscillations.

Soln. Laser oscillation is possible for the pair of pair (2,3) at an electron density and temperature higher than for the other pair (3,4) and (4,5) when the self absorption is negligible.

4. List some of the major advantages of LASER over LEDs.

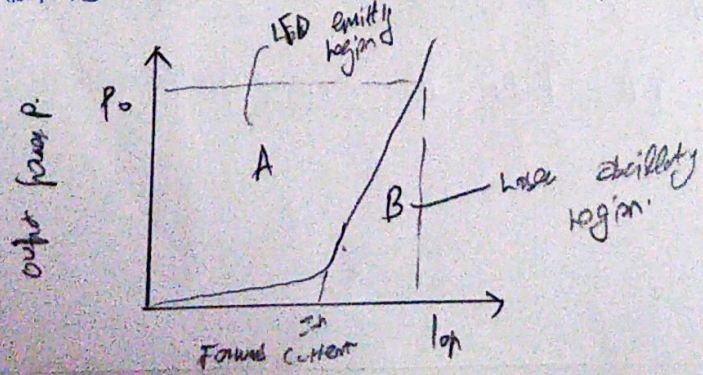
Soln. Lasers are specified on their optical output power, a 1 watt laser produces 1 watt of light output. In LED, LEDs are specified by their electrical power consumption. Thus a 1 watt LED consume 1 watt of electrical power.

5. What are the sources of noise in LASER?

Soln. The spontaneous emission in the gain medium, technical noise, from excess noise of the pump source, from vibration of laser resonators.

6. Identify LED and laser region of operation with respect to threshold in drive current vs optical power curve.

Soln.



7

$E_{avg} = E_{peak}$

$P_{width} = 1$ nano

$T = 1/f = 1$ msec

width $= E/T$

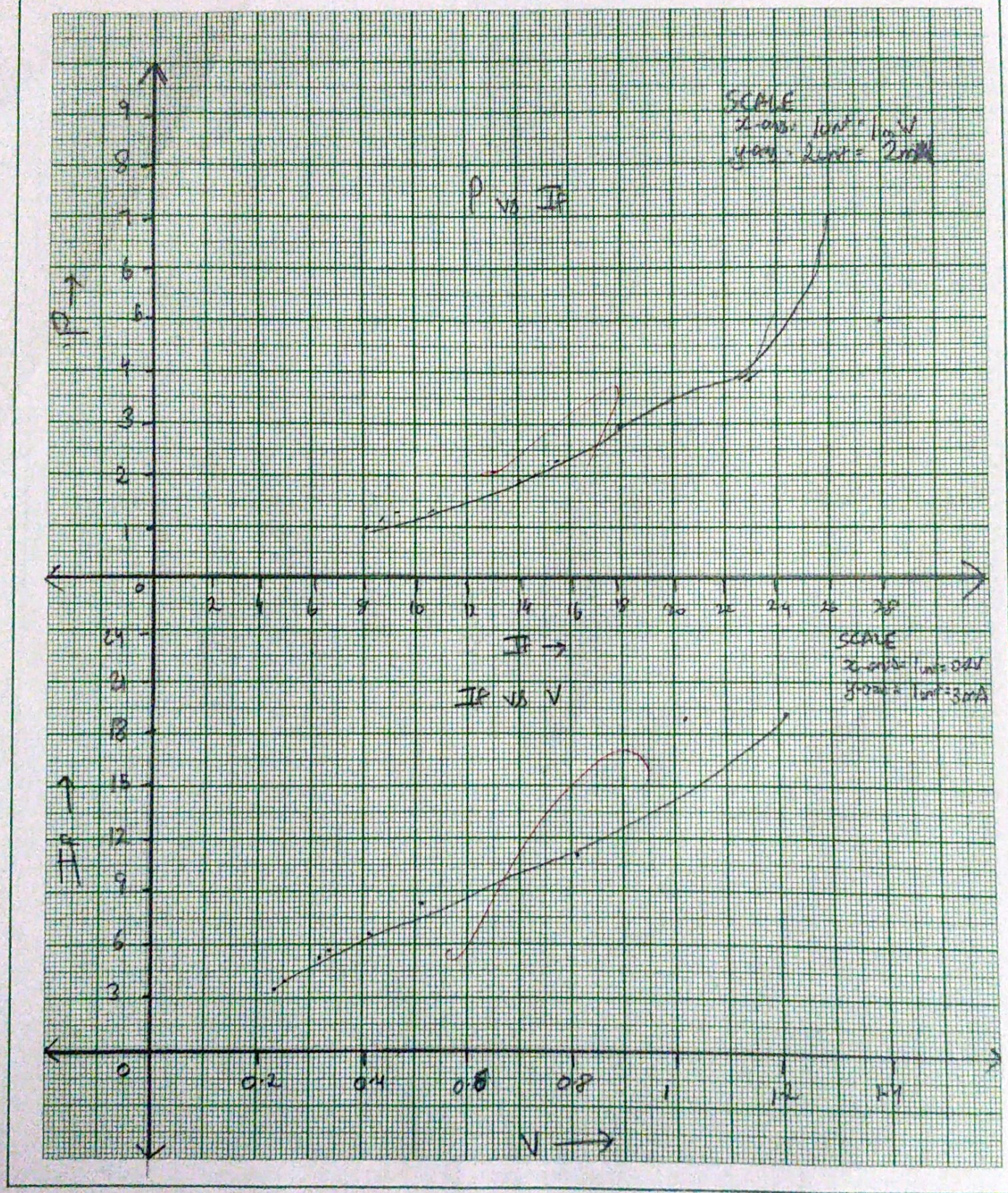
$P_{peak} = \frac{E}{\Delta t} = P_{single\ pulse}$

$P_{avg} \times T = P_{peak} \times \Delta t$

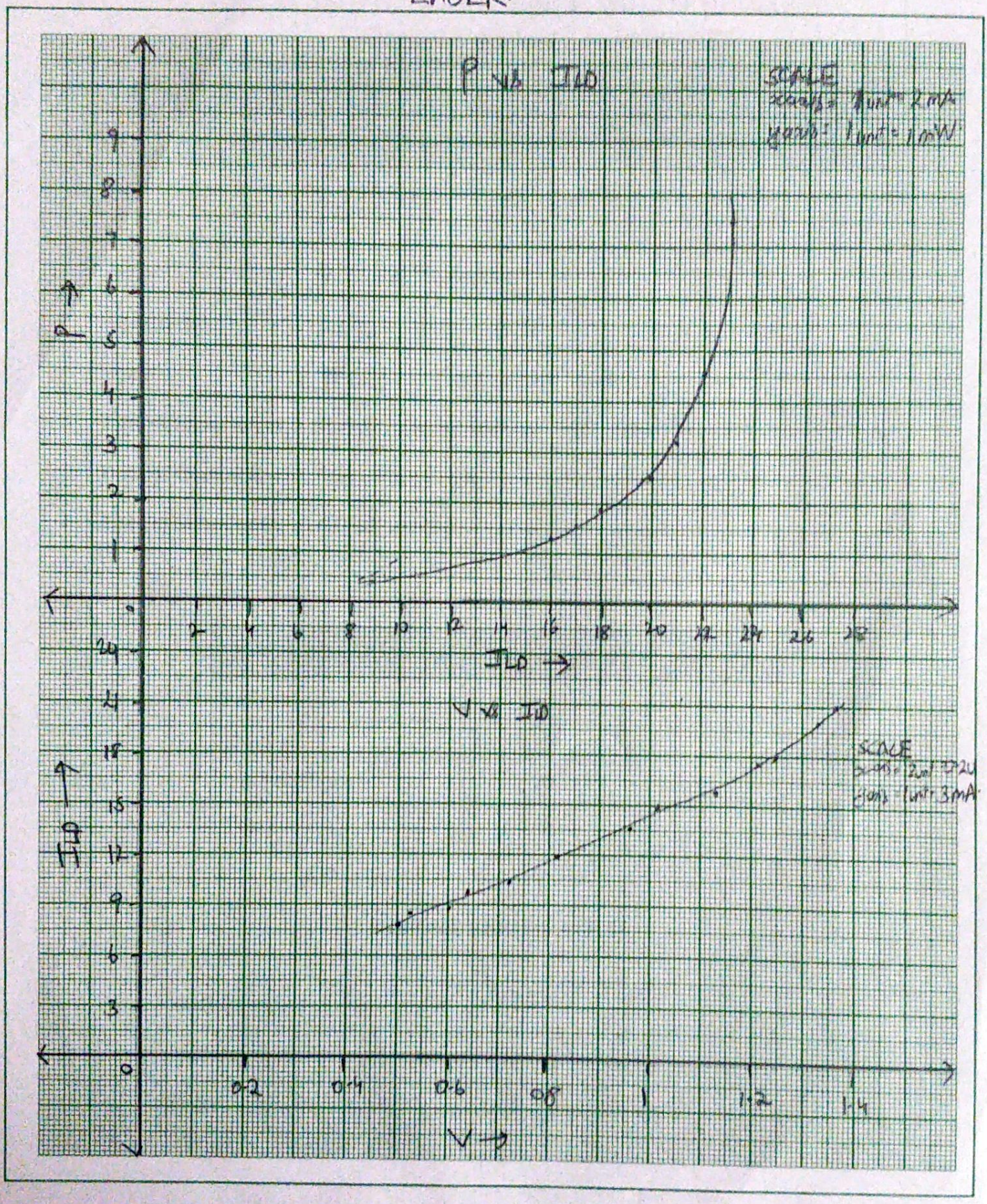
$P_{peak} = \frac{P_{avg} \times T}{\Delta t}$

$P_{peak} = \frac{1\text{mW} \times 1\text{msec}}{1\text{nsec}} = \frac{10^{-3} \times 10^{-3}}{10^{-9}} = 1000\text{ W}$

LED


SCALE
x-axis: 1 unit = 1 V
y-axis: 2 unit = 2 mW
P vs IF
P →
IF →
SCALE
x-axis: 1 unit = 0.2 V
y-axis: 1 unit = 3 mA
IF vs V
IF →
V →

LASER.


P Vs ILD
SCALE
x-axis: 1 unit = 2 mA
y-axis: 1 unit = 1 mW
P
ILD
V Vs ID
SCALE
x-axis: 1 unit = 0.2 V
y-axis: 1 unit = 3 mA
ID
V