Practical - 2

(PART-1)

- **Aim**:- Determination of Planck's Constant.

- **Apparatus**:- light source (12V/35W) halogen tungsten lamp, Guide, Scale (400mm), Draw tube (for placing colour filters), Cover, Focus lens, Vacuum Phototube, Filter set, Digital meter.

- **Observation**:-

S.No.	Filters	ν (sec^{-1} x 10^{14})	Stopping Voltage (V)
1.	Red (635 nm)	4.724×10^{14} sec^{-1}	−0.33 V.
2.	yellow-I (584 nm)	5.136×10^{14} sec^{-1}	−0.51V
3.	yellow-II (540 nm)	5.56×10^{14} sec^{-1}	−0.65 V.
4.	green (500 nm)	6×10^{14} sec^{-1}	−0.89 V
5.	Blue (460 nm)	6.52×10^{14} sec^{-1}	−1.08 V.

- Frequency :- $\left(\nu = \frac{c}{\lambda}\right)$

i) Red.

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8}{635 \times 10^{-9}} = 4.724 \times 10^{14} \text{ sec}^{-1}.$$

ii) yellow-I.

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8}{584 \times 10^{-9}} = 5.136 \times 10^{14} \text{ sec}^{-1}$$

iii) yellow - II

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^{8}}{540 \times 10^{-9}} = 5.56 \times 10^{14}\ sec^{-1}$$

iv) green

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^{8}}{500 \times 10^{-9}} = 6 \times 10^{14}\ sec^{-1}$$

v) Blue

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^{8}}{460 \times 10^{-9}} = 6.52 \times 10^{14}\ sec^{-1}$$

☆ Planck's constant $h = e \frac{\Delta V_s}{\Delta \nu}$; e = charge of electron

$$\therefore h = 1.602 \times 10^{-19} \times \frac{0.825}{2 \times 10^{14}}$$

$$\therefore h = 1.602 \times 10^{-19} \times 0.413 \times 10^{-14}$$

$$\therefore \boxed{h = 6.61 \times 10^{-34} \text{ Joules sec}}$$

Conclusion: After performing this experiment, we can conclude that kinetic energy of electrons measures as a function of the frequency of light. Experimentally determined value for Planck's constant $h = 6.61 \times 10^{-34}$ J.s is within acceptable limits as compared to the accepted value $h = 6.626 \times 10^{-34}$ J s.

(PART-2)

- Aim: To verify inverse square law of radiation using a photoelectric cell.

- Observation: Filter red (635 nm)
  Anode voltage 0.25 V.

S.No	Distance b/w (r) lamp & photocell	$\frac{1}{r^2} \times 10^3$ cm^{-2}	I (μA)
1.	18 cm	3.086 cm^{-2}	1.9 μA
2.	20 cm	2.5 cm^{-2}	1 [illegible] μA
3.	22 cm	2.066 cm^{-2}	1.92 μA
4.	24 cm	1.736 cm^{-2}	1.92 μA
5.	26 cm	1.479 cm^{-2}	1.70 μA
6.	28 cm	1.275 cm^{-2}	1.49 μA
7.	30 cm	1.111 cm^{-2}	1.31 μA

Conclusion: We can conclude that the intensity of the radiation is inversely proportional to the square of the distance.

Practical - 3

(PART-1)

- **Aim:** Study of Planck's constant by means of LED.

- **Apparatus:** Main unit (digital volt meter, Ammeter, 4 LED's) voltage adjuster

- **Observation:** 0 - 20 V, 0 - 200 μA

S.No	LED colour	voltage V (v)	λ (nm)	$f = \frac{c}{\lambda}$	$E = eV$ (10^{-19})	$h = \frac{eV\lambda}{c}$
1.	Red	1.6 V	635 nm	4.72×10^{14}	2.56	5.9×10^{-34}
2.	yellow	2.1 V	585 nm	5.12×10^{14}	3.36	6.5×10^{-34}
3.	Blue	0.6 V	460 nm	6.52×10^{14}	0.96	4.9×10^{-34}
4.	Green	1.9 V	500 nm	6×10^{14}	2.72	5.8×10^{-34}

Conclusion: Here LED's are used in the experement because each colour of LED has a different threshold voltage at which electrons start being produced. Measuring this voltage together with known values for the emission wavelength provides a path to find a value for the Planck constant

(PART-2)

- Aim: Table for V-I characteristic of LED's.

- Apparatus: Main unit (digit volt meter, Ammeter, 4 LED's), voltage adjuster

- Observation: 660 nm - Red, 583 nm - yellow, 565 nm - green, 430 nm - blue.

S.No	RED		YELLOW		GREEN		BLUE	
	I(μA)	V(v)	I(μA)	V(v)	I(μA)	V(v)	I(μA)	V(v)
1.	-1	0	-1	0	-1	0	-1	0
2.	-1	0.2	-1	0.2	-1	0.2	-1	0.2
3.	-1	0.4	-1	0.4	-1	0.4	-1	0.4
4.	-1	0.6	-1	0.6	-1	0.6	-1	0.6
5.	-1	0.8	-1	0.8	-1	0.8	-1	0.8
6.	-1	1	-1	1	-1	1	-1	1
7.	-1	1.2	-1	1.2	-1	1.2	-1	1.2
8.	-1	1.4	-1	1.4	-1	1.4	-1	1.4
9.	2	1.6	2	1.6	0	1.6	-1	1.6
10.	152	1.8	108	1.8	129	1.8	-1	1.8
11.	761	2	681	2	714	2	-1	2
12.	1495	2.2	1455	2.2	1425	2.2	0	2.2
13.	1.(1994)	2.33	1.(1995)	2.3	1.(1995)	2.35	18	2.4
14.							196	2.6
15.							617	2.8
16.							1188	3
17.							1837	3.2
							1.(1991)	3.25

Practical - 1

(Experiment - 1)

- **Aim:** To measure V-I characteristics and Power characteristics.

- **Apparatus:** Main Unit (with voltmeter & variable resistor), Lamp, connecting cords colour filters, photovoltaic panel.

- **Observation:**

S.No	R_L (ohm)	Voltage V_{dc} (volts)	Current I_{dc} (mA)	Power (mW)
1.	0	0	14	0
2.	100	1.4	14	19.6
3.	200	2.9	14	40.6
4.	300	3.8	12	45.6
5.	400	4.1	10	41
6.	500	4.2	8	33.6
7.	600	4.3	7	30.1
8.	700	4.4	6	26.4
9.	800	4.4	5	22.0
10.	900	4.5	5	22.5
11.	1000	4.5	4	18.

Conclusion: Through this experiment, it can be conclude that more power can be generated through solar cell if ~~it~~ it is connected in parallel connection with a number of cells and value of voltage changes as the angle of incidence of light is changed.

(Experiment - 3)

- Aim: To study effect of incidence wavelength.

- Observation:

S.NO	Colour	Voltage (V)	Current (mA)	Power (mW)
1.	White	2.1	21	44.1
2.	Blue	4.5	15	67.5
3.	Green	4.8	16	76.8
4.	Red	4.9	16	78.4
5.	Yellow	5.0	16	80.

(Experiment - 4)

- Aim: To study the effect of solar cell in series and parallel.

- Series

Observation:

S.No	Connection	Voltage (V)	Current (mA)	Power (mW)
1.	R_1	5	14	70
2.	$R_1 + R_2$	9.5	13	123.5
3.	$R_1 + R_2 + R_3$	14	10	140
4.	$R_1 + R_2 + R_3 + R_4$	18.6	10	186.

· Parallel

Observation:

S.No	Connection	Valtage (V)	Current (mA)	Power (mW)
1	$1/R_1$	4.9	14	68.6
2.	$1/R_1 + 1/R_2$	4.9	32	156.8
3.	$1/R_1 + 1/R_2 + 1/R_3$	4.9	44	215.6
4.	$1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$	5	65	325

Practical - 4

- **Aim:** To study the forbidden energy gap in semiconductor diode.

- **Apparatus:** Thermometer (0-110°C), Main Unit (semi conductor diode), oven, digital ammeter

- **Observation:** OA-79, ammeter - 200 µA, DC - 2V

Reverse saturation current in µA (I_s)	Temperature in °C (absolute)	Temp T in °K	$10^3/T$	log I_s
140.5	80	353.15	2.83	2.14
73.4	75	348.15	2.87	1.86
54.0	70	343.15	2.91	1.73
39.5	65	338.15	2.95	1.59
38.2	60	333.15	3.00	1.58
21.8	55	328.15	3.04	1.33
16.7	50	323.15	3.09	1.22
13.5	45	318.15	3.14	1.13
10.8	40	313.15	3.19	1.03

Conclusion: After performing the experiment, we for the value of slope, by plotting graph of $10^3/T$ vs log I_s and get the value 0.68 which is equal to 0.1 and concluded that the hit inbuild semi-conductor is ~~Germanium~~ Germanium.

Practical - 5

* Least Square Fitting Method Experiment :-

Q.1 Find the least square regression line equation with the given x and y values. Consider the values.

x T(C)	y l(mm)	x^2 (°C)	xy
1	1.5	1	1.5
2	1.6	4	3.2
3	2.1	9	6.3
4	3.1	16	12.4
5	5.5	25	27.5
$15 = x_i$	$13.8 \times 10^{-3} = y_i$	$55 = x^2$	$50.9 \times 10^{-3} = x_i y_i$

→ From the above data, the eq^n are

$$m a_0 + x_i a_1 = y_i$$

$$\therefore 5a_0 + 15a_1 = 13.8 \times 10^{-3} \quad \text{—} (1)$$

$$x_i a_0 + x^2 a_1 = x_i y_i$$

$$15 a_0 + 55 a_1 = 50.9 \times 10^{-3} \quad \text{—} (2)$$

Multiply eq (1) with 3 and eliminate

$$15a_0 + 45a_1 = 41.4 \times 10^{-3}$$

$$-15a_0 - 55a_1 = -50.9 \times 10^{-3}$$

$$-10a_1 = -9.5 \times 10^{-3}$$

$$\therefore \boxed{a_1 = 0.95 \times 10^{-3}}$$

Put the value of a_1 in eq (1).

$$5a_0 + 15a_1 = 13.8 \times 10^{-3}$$

$\therefore 5a_0 + 15(0.95 \times 10^{-3}) = 13.8 \times 10^{-3}$

$\therefore 5a_0 + 14.25 \times 10^{-3} = 13.8 \times 10^{-3}$

$\therefore 5a_0 = -0.45 \times 10^{-3}$

$\therefore \boxed{a_0 = -0.09 \times 10^{-3}}$

Verification : $y_1 = a_0 + a_1 |x_1|$

$\therefore y_1 = (-0.09 \times 10^{-3}) + (0.95 \times 10^{-3})(1)$

$\therefore \boxed{y_1 = 0.86\,mm}$

Q.2 Find the least square regression line equation with the given x and y values. Consider the values.

x T(°C)	y l(mm)	T^2 (°C)	xy
0.0	0.0	0	0
0.5	1.5	0.25	0.75
1.0	3.0	1	3
1.5	4.5	2.25	6.75
2.0	6.0	4	8
2.5	7.5	6.25	18.~~685~~ 75
$7.5 = x_i$	$22.5 \times 10^{-3} = y_i$	$13.75 = x^2$	$41.25 \times 10^{-3} = x_i y_i$

-4 From the above data, the eq^n are.

$6a_0 + 7.5a_1 = 22.5 \times 10^{-3}$ — ①

$7.5a_0 + 13.75a_1 = \cancel{34.125}\ 41.25 \times 10^{-3}$ — ②

Multiply eq ① with 7.5 & eq ② with 6 & eliminate

$45a_0 + 56.25a_1 = 168.75 \times 10^{-3}$

$-\cancel{45}a_0 + 82.5a_1 = 247.5 \times 10^{-3}$

$-26.25a_1 = -78.75 \times 10^{-3}$

$\therefore \boxed{a_1 = 3 \times 10^{-3}}$

Put the value of a_1 in eq ①

$$6a_0 + 7.5\,a_1 = 22.5 \times 10^{-3}$$

$$6a_0 + 7.5(3) = 22.5 \times 10^{-3}$$

$$\therefore \boxed{a_0 = 0}$$

Verification: $y_1 = a_0 + a_1 |x_1|$

$$y_1 = 0 + 3(0)$$

$$\boxed{y_1 = 0}$$

Q.3 Find the least square regression line equation with the given x and y value. Consider the ~~equation~~ values.

x T(°C)	y l(mm)	T^2 (°C)	xy
60	3.1	3600	186
61	3.6	3721	219.6
62	3.8	3844	235.6
63	4	3969	252
65	4.1	4225	266.5
$311 = x_i$	$18.6 = y_i$	$19359 = x^2$	$1159.7 = x_i y_i$

→ From the above data, the eqn made are

$$5a_0 + 311a_1 = 18.6 \quad —①$$

$$311a_0 + 19359\,a_1 = 1159.7 \quad —②$$

Multiply eq ① with 311 and eq ② with 5 & eliminate

$$1555a_0 + 96721\,a_1 = 5784.6$$

$$-1555\,a_0 - 96795\,a_1 = -5797.5$$

$$-74a_1 = -12.9$$

$$\therefore \boxed{a_1 = 0.1743}$$

~~Multiply~~ Put the value of a_1 in eq ①

$$5a_0 + 311a_1 = 18.6$$
$$5a_0 + 311(0.1743) = 18.6$$
$$\therefore \boxed{a_0 = -7.12146}$$

Verification : $y_1 = a_0 + a_1 |x_1|$

$$\therefore y_1 = -7.12146 + (0.1743)(60)$$
$$\therefore \boxed{y_1 = 3.33654}$$

Q.4 Find the least square regression line equation with the given x and y value. Consider the value.

x T(°C)	y l(mm)	T^2 (°C)	xy
1	0.5	1	0.5
2	2.5	4	5
3	2.0	9	6
4	4.0	16	16
5	3.5	25	17.5
6	6.0	36	36
7	5.5	49	38.5
$28 = x_i$	$24 = y_i$	$140 = x^2$	$119.5 = x_i y_i$

→ From the above data, the eq^n made are

$$7a_0 + 28a_1 = 24 \quad \text{—①}$$
$$28a_0 + 140a_1 = 119.5 \quad \text{—②}$$

Multiply eq ① with 4 and eliminate

$$28a_0 + 112a_1 = 96$$
$$-28a_0 \mp 140a_1 = -119.5$$
$$-28a_1 = \mp 23.5$$
$$\therefore \boxed{a_1 = 0.839}$$

Put the value of a_1 in eq ①

$$7a_0 + 28a_1 = 24$$
$$\therefore 7a_0 + 28(0.839) = 24.$$
$$\therefore 7a_0 = 24 - 23.492$$
$$\therefore \boxed{a_0 = 0.0725}$$

Verification: $y = a_0 + a_1 |x_1|$
$$\therefore y = 0.0725 + (0.839)(1)$$
$$\therefore \boxed{y = 0.9115}$$

Q.5 Find the least square regression line equation with the given x and y values. Consider the values.

x T(°C)	y l(mm)	T^2 (°C)	xy
1	1.5	1	1.5
2	1.6	4	3.2
3	2.1	9	6.3
4	3.0	16	12
5	5.5	25	27.5
6	6.7	36	40.2
7	7.5	49	52.5
8	8.5	64	68
$36 = x_i$	$36.4 = y_i$	$204 = x_i^2$	$211.2 = x_iy_i$

From the above data, eq^n made are

$$8a_0 + 36a_1 = 36.4 \quad \text{— ①}$$
$$36a_0 + 204a_1 = 211.2 \quad \text{— ②}$$

Multiply eq ① by 36 & eq ② by 8 & eliminate

$$\cancel{288}a_0 + 1296a_1 = 1310.4$$
$$-\cancel{288}a_0 + 1632a_1 = -1689.6$$
$$-336a_1 = -379.2$$
$$\therefore \boxed{a_1 = 1.1285}$$

Put the value of a_1 in eq (1)

$$8a_0 + 36a_1 = 36.4$$
$$\therefore 8a_0 + 36(1.1285) = 36.4$$
$$\therefore 8a_0 = -4.226$$
$$\therefore \boxed{a_0 = -0.52825}$$

Verification: $y = a_0 + a_1(x_1)$

$$\therefore y = -0.52825 + (1.1285)(1)$$
$$\therefore \boxed{y = 0.60025}$$

~~Conclusion~~:

Practical - 6

- **Aim:** To determine wavelength measurement of laser by diffraction grating.

- **Apparatus:-** Optical bench, grating holder, screen holder, laser light source, diffraction grating

- **Observation:** $(a+b) = \frac{1}{N}$

  N = number of lines on diffraction grating.

  N = 15000 per inch / 5905.5 per cm.

  (r = 9.5cm)

order of spectrum	dist. b/w bright spot (cm)			angle of diffraction $\theta = X/r$ (radian)	$\theta = \frac{X}{r} \times \frac{180}{\pi}$ (Degree)	$\sin\theta$	$\lambda = \frac{(a+b)\sin\theta}{n}$ (cm)
	x_1	x_2	$X = \frac{x_1+x_2}{2}$				
1. For 1st order (n=1)	3.5	3.5	3.5	0.368	21.09	0.359	0.606
2. For 2nd order (n=2)	8.5	7.5	8	0.9524	54.567	0.815	0.678

i) $X = \frac{x_1+x_2}{2} = \frac{3.5+3.5}{2} = 3.5$ cm

$\therefore \theta = \frac{X}{r} = \frac{3.5}{9.5} = 0.368$ radian

$\therefore \theta = \frac{X}{r} \times \frac{180}{\pi} = \frac{3.5}{9.5} \times \frac{180}{3.14} = 21.09^\circ$

$\therefore \sin\theta = \sin(21.09) = 0.359$

$\therefore \lambda = \frac{(a+b)\sin\theta}{n} = \frac{(1.69 \times 10^{-4})(0.359)}{1} = 0.606$

ii) $X = \frac{x_1 + x_2}{2} = \frac{8.5 + 7.5}{2} = 8$ cm

$\therefore \theta = \frac{X}{r} = \frac{8}{8.4} = 0.9524$ radian

$\therefore \theta = \frac{X}{r} \times \frac{180}{\pi} = \frac{8}{8.4} \times \frac{180}{3.14} = 54.567^\circ$

$\therefore \sin\theta = \sin(54.567) = 0.815$

$\therefore \lambda = \frac{(a+b)\sin\theta}{n} = 0.678$

Conclusion: We found out a diffraction grating has a very large number of equally spaced slits. When parallel light is incident on a diffraction grating each slit acts as a source of diffracted wave of different wavelength.