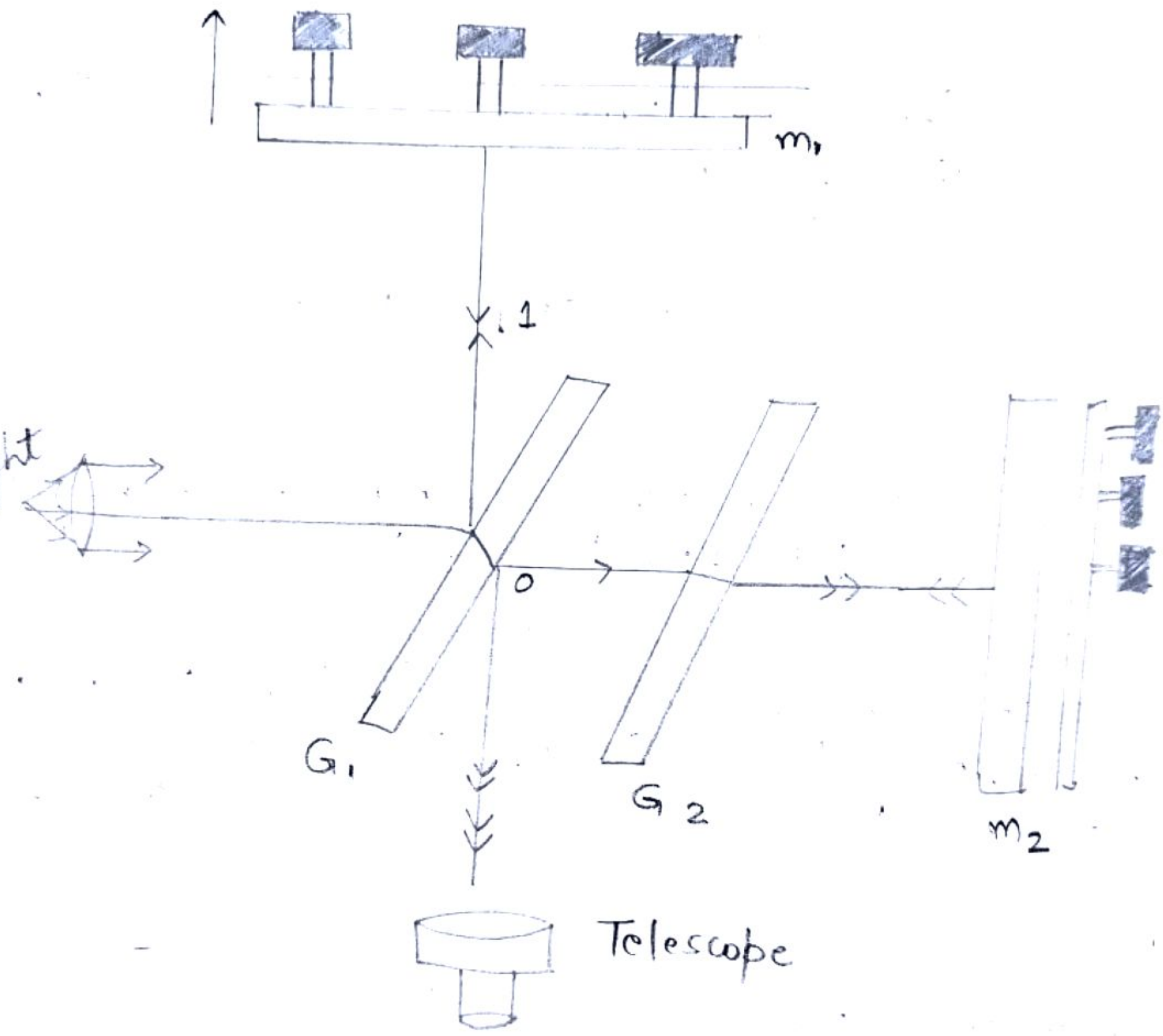
Sr. No.	Experiment	Page	E
1.	To find the wavelength of sod. light & diff of two wavelength of Sod. light by Michelson Interferometer		
2.	To study the operations of op. Amp		
3.	To plot output characteristics of FET and measure pinch off voltage.		
4.	To study the characteristics of zener diode.		
5.	To plot SCR characteristic under different gate conditions.		
6.	To study Half/Full wave rectifier		
7.	To study analog to digital and digit to analog conversion		
8.	Study of the characteristics of two stage R-C coupled transistor amplifier.		
9.	Determine Planck's constant using solar cell and optical filter.		
10.	To determine the planck constant with the help of photocell.		



Michelson Interferometer

Expt No. 1 Michelson Interferrometer Date

Aim :- To find the wavelength of sodium light and difference of two wavelength of sodium light lines by Michelson Interferometer.

Apparatus :- Sodium lamp, Michelson Interferometer

Theory :- (i) Interference :- When two waves of same frequency, nearly same amplitude and constant initial phase difference travel in same direction along same straight lines. They superimpose in such a way that in the region of superposition The intensity is maximum at some points & minimum at some other points. This is called interference of light.

(i) Constructive Interference :- At the points, where the resultant of light is maximum.

(ii) Destructive Interference :- At the points where the resultant of light (intensity) is minimum.

2. Introduction of Michelson Interferrometer :-
The Michelson Interferometer first developed by Albert michelson in 1881. has proved of vital importance in the development of modern physics. This versatile instrument was used to established

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experiment evidence for the development for the validity of the special theory of relativity to detect and measure hyperfine structure in line spectra Michelson himself pioneered of this work.

3. Adjustment of the interometer :-

→ The distance G_1M_1 is made nearly equal to G_2M_2.

→ Adjust the angle of beam spilitter as needed so that the reflected beam hits the fixed mirror m_1 near its centre.

→ Adjust the angle of mirror M_1 & M_2 such that the two beams overlap on the screen.

→ The fringes initially will be very close. The no. of fringes can be increased by increasing the path difference b/w the two arms.

4. Formula used :-

(i) The wavelength λ of sodium light is given by

$$\lambda = \frac{2(x_2 - x_1)}{N} = \frac{2d}{N}$$

$x_1 \rightarrow$ initial position of the mirror m_1

$x_2 \rightarrow$ final position of the mirror M_2

$d \rightarrow$ distance moved by mirror M_1

$N \rightarrow$ Number of fringes.

(ii) The difference of two wavelength of sodium lines $(\lambda_2 - \lambda_1)$ is given by-

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Calculations :-

(i) for wavelength of sodium light :-

Distance moved by micrometer $M_1 = \frac{D}{5} = x$

$$D = \frac{0.16 + 0.12 + 0.17 + 0.07 + 0.36 + 0.11 + 0.20 + 0.13 + 0.21 + 0.02}{10}$$

$$D = \frac{1.55}{10} = 0.155\ mm$$

$$x = \frac{D}{5} = \frac{0.155}{5} = 0.031\ mm$$

→ No. of fringes $N = 100$

$$\therefore \lambda = \frac{2x}{N} = \frac{2 \times 0.031 \times 10^{-3}}{100} = 6200\ A^\circ$$

$$\text{Error \%} = \frac{\text{Experiment value} - \text{standard value}}{\text{Standard value}}$$

$$= \frac{6200 - 5893}{5893} \times 100\ \%$$

$$= 5.2\%$$

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$$\lambda_2 - \lambda_1 = \frac{\lambda^2_{avg.}}{2X}$$

where $\lambda^2_{avg.} = \lambda_1 \lambda_2$

X = distance b/w the two indistinct position of mirror M_1

Observations :-

(i) Table for wavelength of sodium light :-

least count of micrometer screw = 0.01 mm.

Table :-1

S.No	No. of fringes Appeared	Mainscale Reading	V_R scale Reading	Table T_n (mm)	$T_{n+1} - T_n = D$ (mm)
1.	0	0	0	0	0
2.	100	0	16	0+16×0.1 = 0.16	0.16
3.	200	0	28	0+28×0.1 = 0.28	0.12
4.	300	0	45	0+45×0.1 = 0.45	0.1[illegible]
5.	400	0	52	0+52×0.1 = 0.52	0.07
6.	500	0	88	0+88×0.1 = 0.88	0.3[illegible]
7.	600	0	99	0+99×0.1 = 0.99	0.1
8.	700	1	12	1+12×0.1 = 1.12	0.1
9.	800	1	32	1+32×0.1 = 1.32	0.2
10.	900	1	53	1+53×0.1 = 1.53	0.2
11.	1000	1	55	1+55×0.1 = 1.55	0.[illegible]

(ii) Table for difference of wavelength :-

least count of micrometer screw = 0.01

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(ii) For difference of wavelength :-

Distance b/w the two indistinct position of mirror M_1

$$M_1 = \frac{D}{5} = x \text{ (mm)}$$

$$D = \frac{1.67 + 1.31 + 1.58 + 1.64 + 1.65 + 1.60 + 1.42 + 1.53}{8}$$

$$= \frac{12.4}{8} = 1.55 \text{ mm}$$

$$x = \frac{D}{5} = \frac{1.55}{5} = 0.31 \text{ mm}$$

Difference b/w two wavelength of sodium lines

$$\lambda_2 - \lambda_1 = \frac{\lambda^2_{avg}}{2x}$$

$$= \frac{(5893 \times 10^{-10} \text{ m})^2}{2 \times 0.31 \times 10^{-3} \text{ m}}$$

$$= 5.6 \text{ A}^0$$

$$\text{Error\%} = \frac{\text{Experimental value} - \text{Standard value}}{\text{Standard value}}$$

$$= \frac{5.6 \text{ A}^0 - 6 \text{ A}^0}{6 \text{ A}^0} \times 100\%$$

$$= -6.67\%$$

S.N.	When max. intensity fringes appeared disappeared & reappeared Main Scale Readings	V_R scale Readings	Total = T_n ($M.S. + V_R \times 0.1$ mm)	$T_{n+1} - T_n = D$ (in mm)
1.	0	0	0	0
2.	1	67	$1+67\times0.1 = 1.67$	1.67
3.	2	98	$2+98\times0.1 = 2.98$	1.31
4.	4	56	$4+56\times0.1 = 4.56$	1.58
5.	6	20	$6+20\times0.1 = 6.20$	1.64
6.	7	35	$7+85\times0.1 = 7.85$	1.65
7.	9	45	$9+45\times0.1 = 9.45$	1.60
8.	10	37	$10+87\times0.1 = 10.87$	1.4
9.	12	40	$12+40\times0.1 = 12.4$	1.5

Result :-

(i) Wavelength of sodium light = 6200 A°

(ii) The difference of wavelength = 5.6 A°

(iii) Standard value of sodium light = 5893 A°

Error % = 5.2 %

(iv) Standard wavelength difference = 6 A°

Error % = − 6.67 %

Precautions :- 1. Glass plates G_1 G_2 & mirror M_1, M_2 should not be touched.

2. The micrometer screw should be handle carefully.

3. The screws behind the mirror M_2 should be rotated

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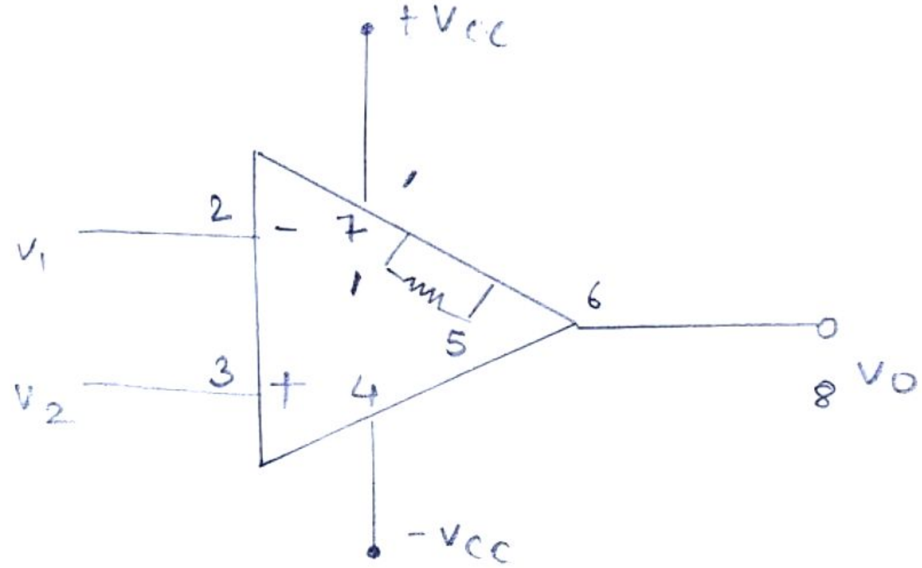
through a very small angle.

4. There so should not be linear or lateral displacement of circular fringes when viewed by eye

5. The position of maximum indistinctness, the fringes should almost disappear.



op-amp circuit

Expt No. 2

Date

Aim :-

To study the operations of operational amplifier as : 1. Inverting Amplifier
2. Non-inverting Amplifier

Apparatus :- op-Amp (741), C.R.O. (Cathode Ray oscilloscope), A.C. voltmeter & multimeter, training board of an amplifier feedback resistance.

Theory :-

Operational Amplifier :-

Op-Amp is a direct coupled high gain amplifier. This is the voltage gain op-amp differential amplifier.

Observation Table :-

Feedback resistance $R_F = 10k\Omega$

Input resistance $R_{in} = 1k\Omega$

S.No.	Vin (Volt)	V_o (Volt)	Voltage gain (A_v)
1.	0.1	-1	-10
2.	0.2	-2	-10
3.	0.3	-3	-10
4.	0.4	-4	-10
5.	0.5	-5	-10
6.	0.6	-6	-10
7.	0.7	-7	-10
8.	0.8	-8	-10

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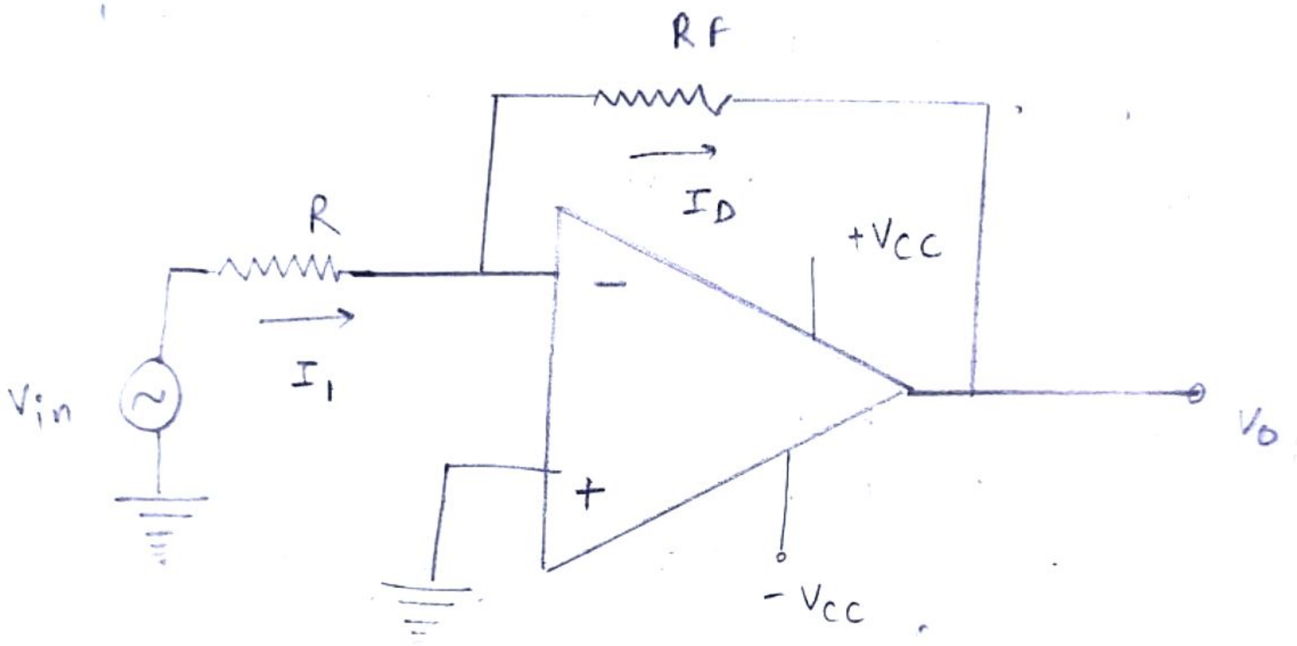

Fig:- Inverting op-amp

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9.	0.9	-9	-10
10.	1.0	-10	-10

The value of voltage gain Av of op-amp is infinite So, it produces output voltage at zero input voltage Applying Kirchoff's law of Node point A is $I_1 = I_2$

Due to concept of virtual ground voltage node point A is zero.

$$\frac{V_{in} - 0}{R_{in}} = \frac{0 - V_o}{R_f}$$

$$\frac{V_{in}}{R_{in}} = \frac{-V_o}{R_f}$$

$$\frac{V_o}{V_{in}} = \frac{-R_f}{R_{in}}$$

$$A_V = \frac{-R_f}{R_{in}} \quad —(1)$$

This is the voltage gain of inverting op-amp.

Observation Table :-

Feedback resistance $R_f = 10k\Omega$

Input resistance $R_{in} = 1k\Omega$

S.No.	Vin (volt)	Vo (volt)	Voltage gain (AV)
1.	0.1	-1	-10
2.	0.2	-2	-10
3.	0.3	-3	-10
4.	0.4	-4	-10

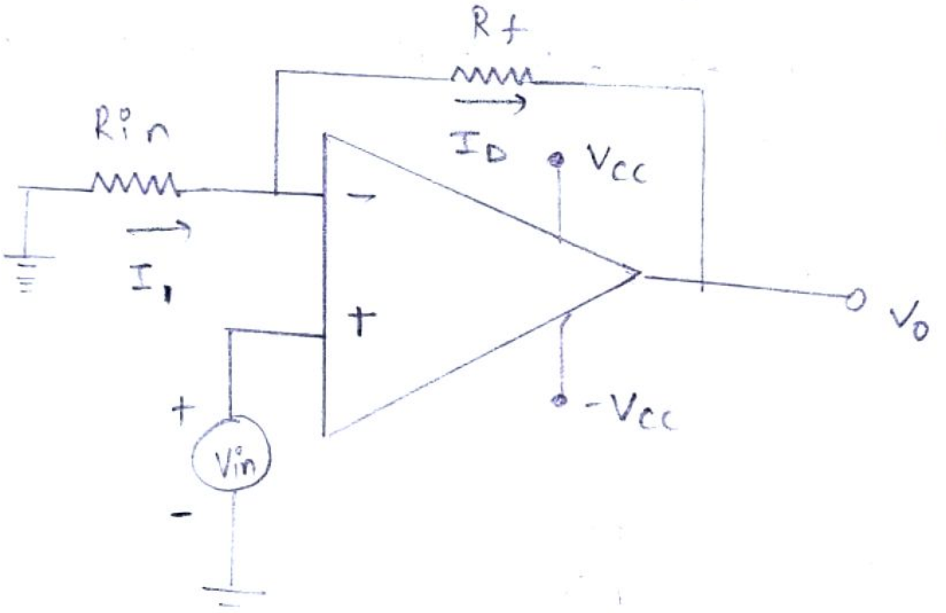

Fig :- Non-inverting Op-Amp.

5.	0.5	-5	-10	
6.	0.6	-6	-10	
7.	0.7	-7	-10	
8.	0.8	-8	-10	
9.	0.9	-9	-10	
10.	1.0	-10	-10	

for inverting op-amp
Theoretical & practical voltage gain are same that is

$$A_v = -\frac{R_f}{R_{in}} = -10 \text{ volt}.$$

Non-inverting op-amp :-

In the circuit diagram of non-inverting feedback is added to inverting terminal from Rin & this terminal is grounded & we give input through the non-inverting (+) terminal

Applying Kirchoff's law at point A

$$I_1 = I_2$$

from the concept of virtual ground

$$\frac{0 - V_{in}}{R_{in}} = \frac{V_{in} - V_o}{R_f}$$

$$A_v = \frac{V_o}{V_{in}} = 1 + \frac{R_f}{R_{in}} \quad — ②$$

voltage gain of non-inverting op-amp is +ve i.e. output voltage & input voltage are in same phase. So, without any change of phase, we can get

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sufficient gain it.

Observation Table :-

Feedback resistance R_f = 1kΩ
Input resistance R_{in} = 10kΩ

S.N.	Vin (Volt)	Vo (Volt)	Voltage gain
1.	1	1.1	1.1
2.	2	2.2	1.1
3.	3	3.3	1.1
4.	4	4.4	1.1
5.	5	5.5	1.1
6.	6	6.6	1.1
7.	7	7.7	1.1
8.	8	8.8	1.1
9.	9	9.9	1.1
10.	10	11.0	1.1

for non-inverting op-amp
Theoretical & practically voltage gain are same that is $A_V = 1 + \frac{R_f}{R_{in}}$

$= 1.1$

Result :- 1. The observed voltage gain for inverting op-amp is equal to the theoretical voltage gain & it is = -10.

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9. The practical voltage gain for non-inverting op-amp is equal to the theoretical voltage gai[n] & voltage gain is equal to 1·1.

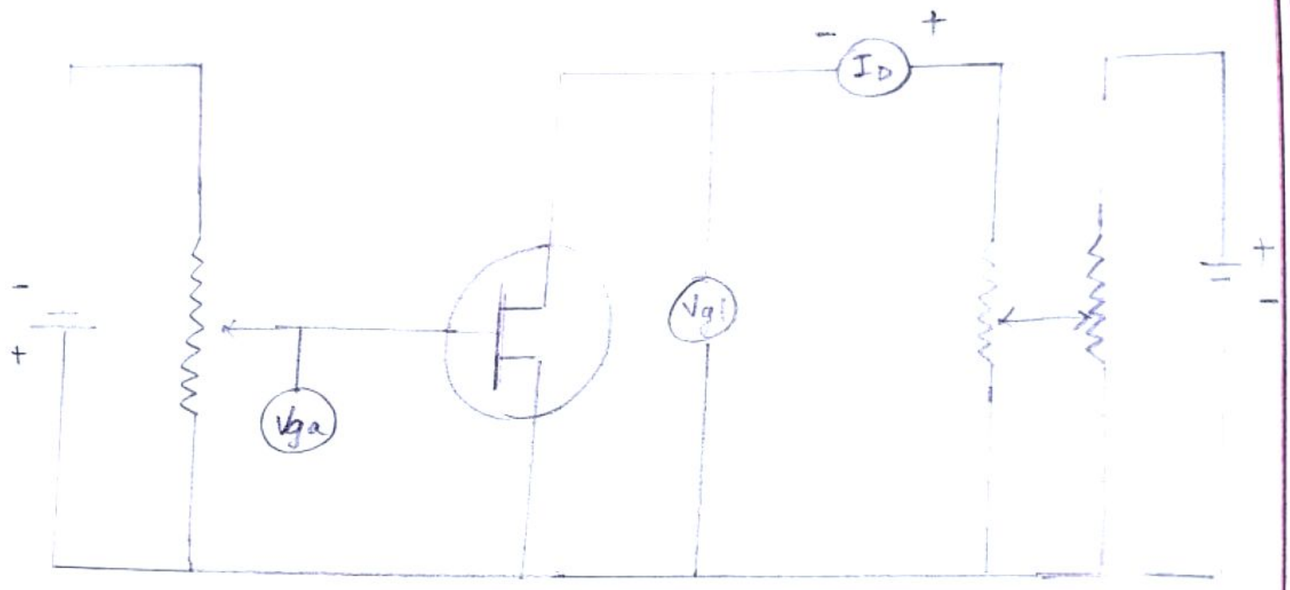

Fig:- FET (Field Effect Transistor)

Expt No. 3

Date

Object :- To plot output characteristics of FET and measure pinch off voltage.

Apparatus :-
FET (BF w/o or BF w/e)
D.C. voltmeter (0-30V & 0-10V) D.C.
Miliameter (0-50mA & 0-50μA)
D.C. Power supplies (for V_{GG} & V_{DD})

Circuit :- Circuit is shown in fig 1 G is gate D is drain & source current meter ID may have a switch to put milimeter & micrometer to the circuit (which is needed).

Procedure :- (i) Now apply V_{GG} and find 0 value for which to LC cores zero This value of V_{GG} is Caeyed V_p the pinch off voltage.
(ii) Now vary V_{DD} & note I_D for a fixed value of V_{GG} Repeat this observation for various values of V_{GG} as shown in table.

Observation :- (i) Pinch off voltage V_p = 3.5 volt
(ii) Table for output characteristics

S.No.	V_{GS} = -1.5V		V_{GS} = -1.0V		V_{GS} = -0.8V		V_{GS} = -0V	
	V_{DS}	I_D	V_{DS}	I_D	V_{DS}	I_D	V_{DS}	I_D
1.	1.2V	2.1	1.1V	1.0	1.4V	1.3	1.5V	2.1
2.	1.5V	1.3	1.8V	1.6	2.0V	2.1	2.5V	3.0

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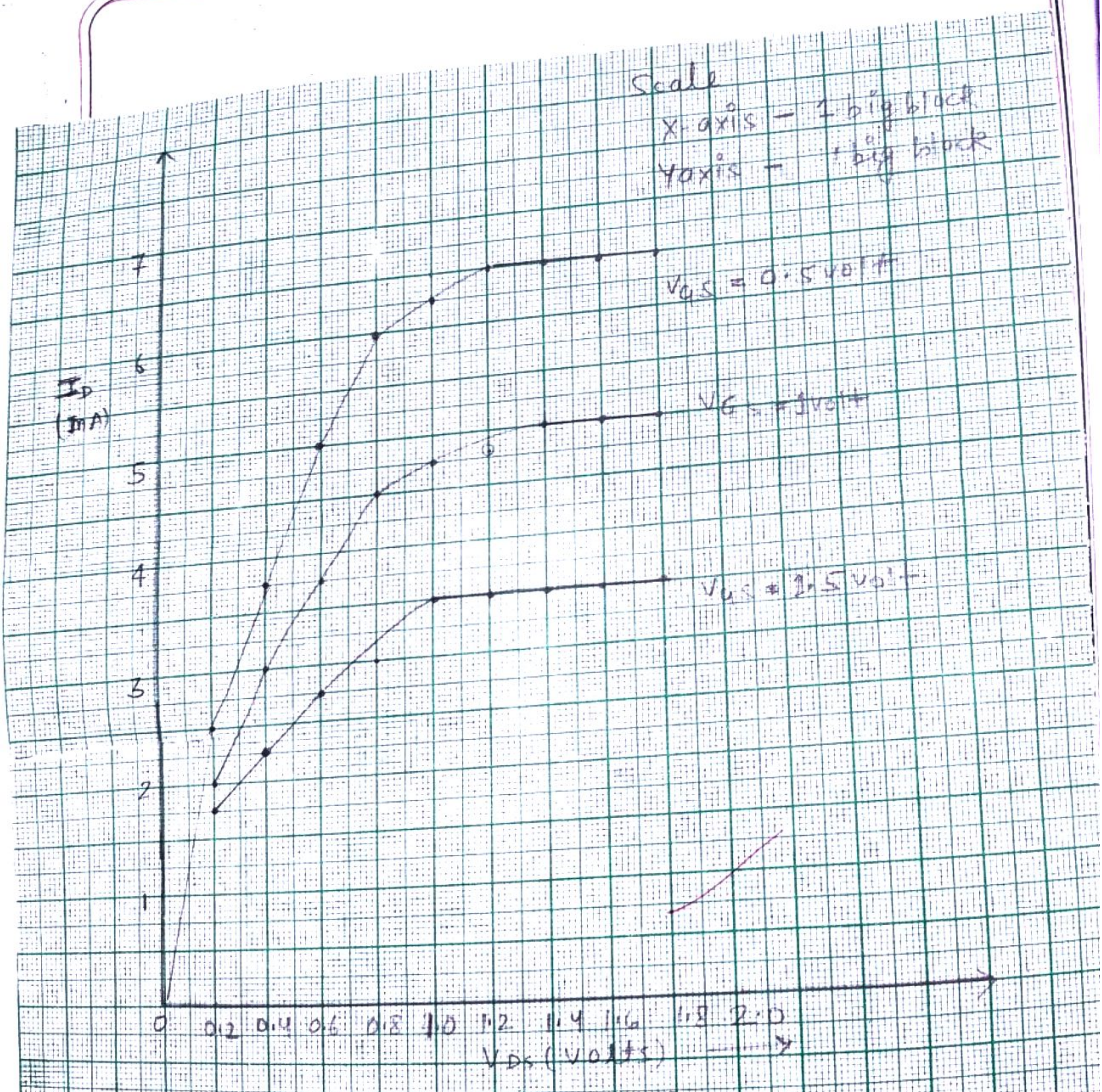

Graph b/w VDS and ID

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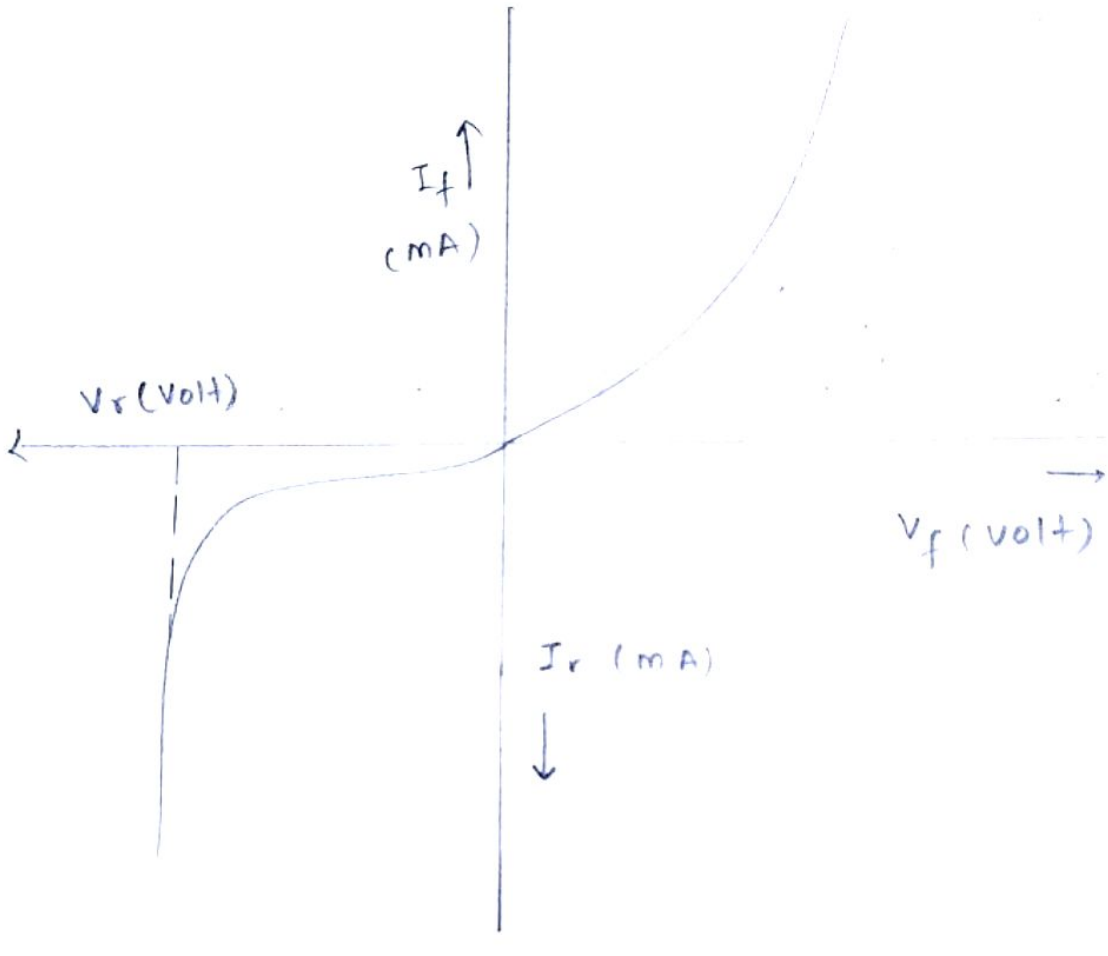
3.	1.8 V	1.5	2.0 V	1.9	2.0 V	2.25	3.0 V	3.1
4.	2.0 V	1.5	2.6 V	2.3	2.8 V	2.5	3.5 V	3.2
5.	2.5 V	1.6	3.0 V	2.5	3.3 V	2.75	4.0 V	3.2

Result :- Plot a graph in V_{DS} and I_D for various value of V_{GS}. There are called output characteristics of FET.

Source of error and Precautions :-

1. Hande FET gently
2. Rate should never be given +ve voltage.
3. Voltage applied should not exceed the rate values.



Characteristic curve for zener diode

Expt No. 4

Date

Object :- To study the characteristic of zener diode.

Apparatus :- Zener diode of particular rating, milimeter, voltmeter, Rheostat, connecting wire, etc.

Theory :- Zener diode is the special case of diode which permits current to flow in the forward direction but there is a difference b/w general diodes and zener diode and its as zener diode will allow to flow current in the reverse bias also they a voltage is above a certain value This breakdown voltage is zener dio voltage. In a standard diode The zener voltage is high in the forward bias zener work as Normal Si diode in the reverse bias.

Zener breakdown :- If both P-side and n-side of the diode are heavily doped, depletion region at the junction reduces compared to the width in normal dopping. Applying a reverse bias cause a strong electric field applied across the device As the reverse bias is ↑ the e-field becomes strong enough to repulse covalent bond and generated large no. of charge.

for Reverse bias -

Least count for milimeter $\frac{300}{60}$ = 0.05 mA/div

Least count for voltmeter $\frac{15}{60}$ = 0.25 V/div.

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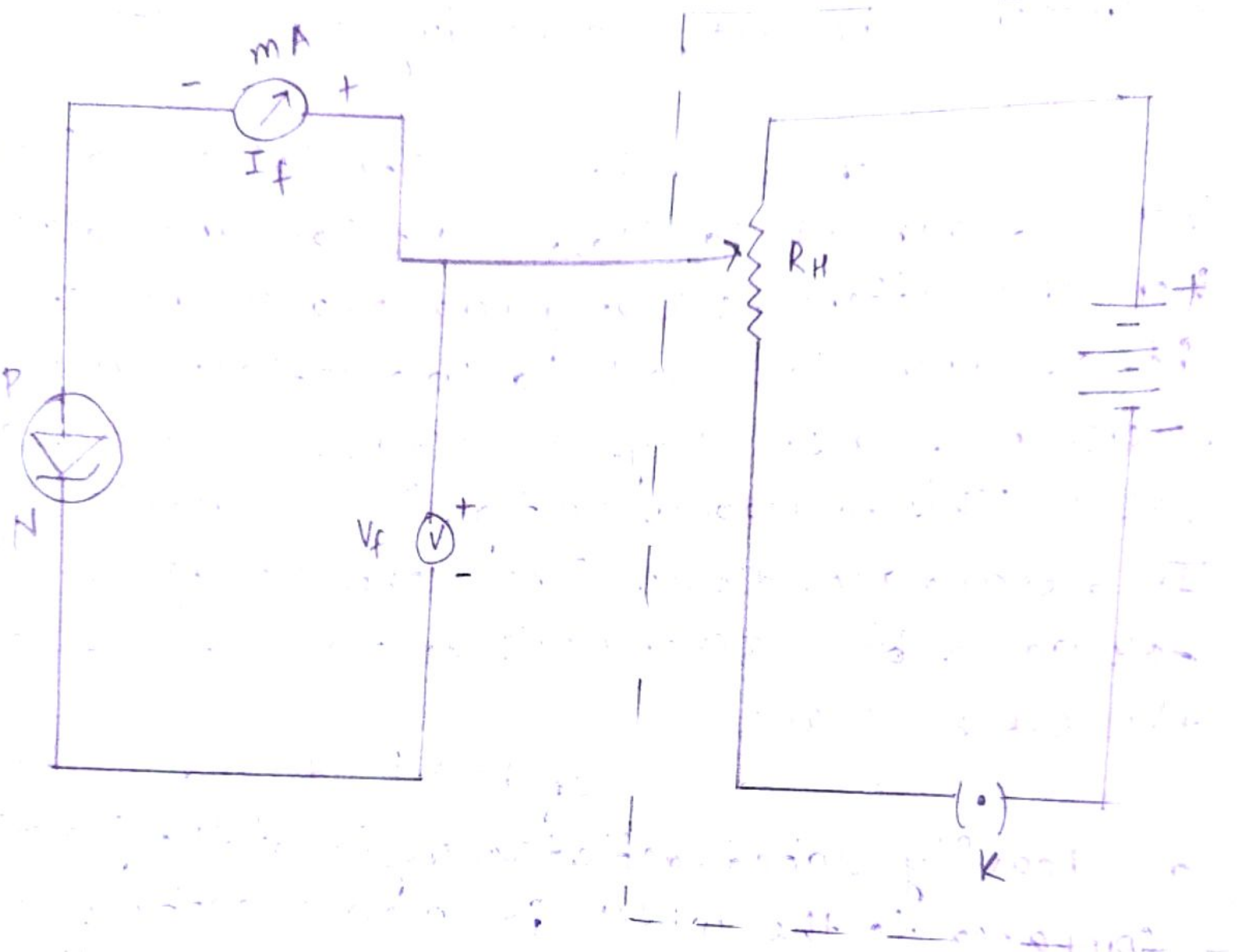
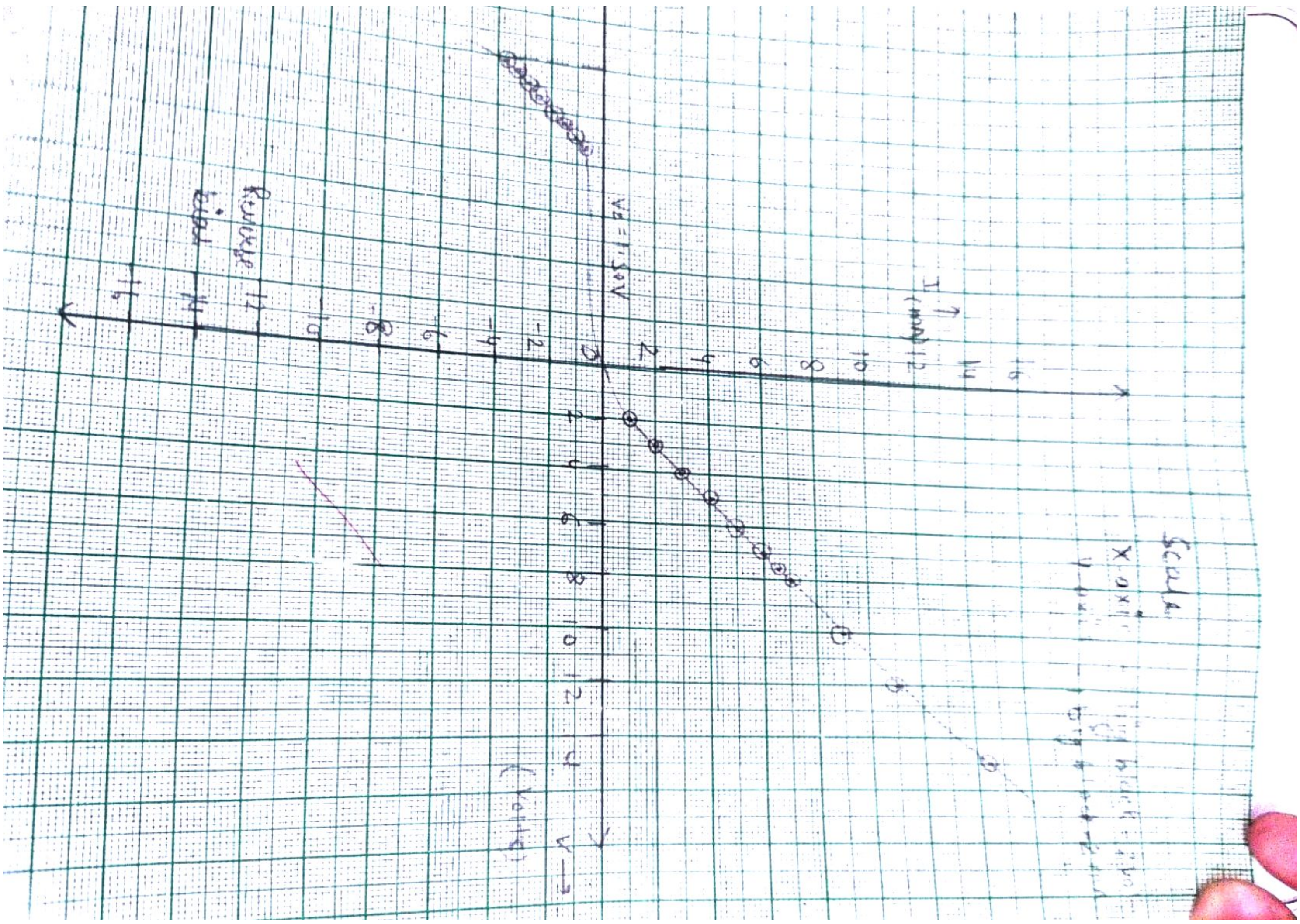


circuit for forward bias



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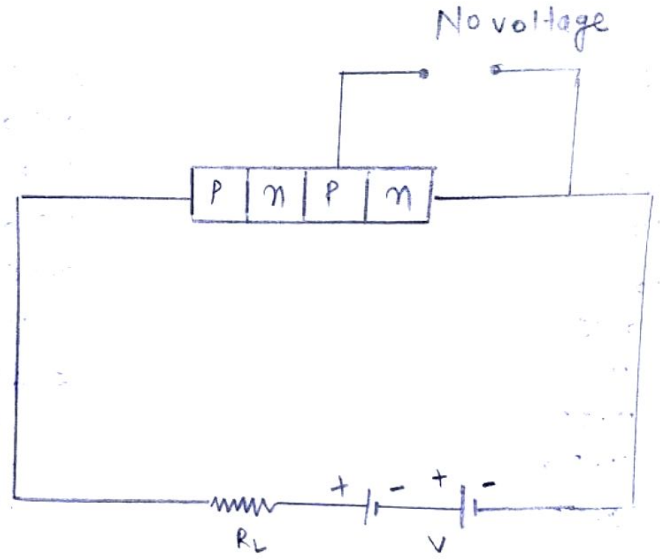
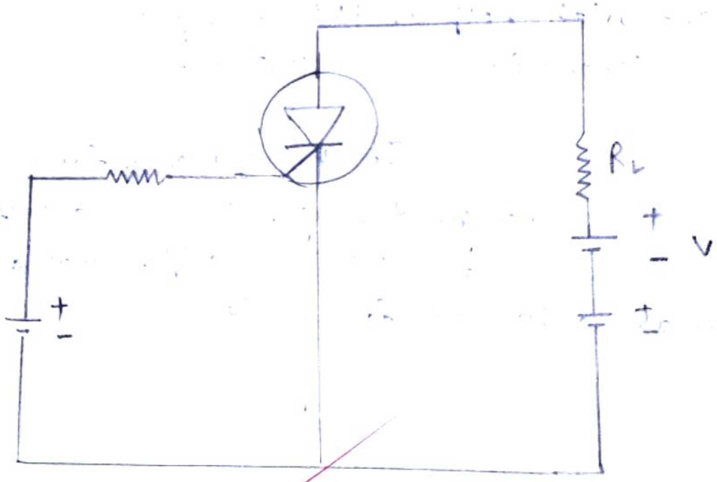
S.No.	Reverse voltage (volts)	Current (I)
1.	8.75	0.55
2.	9.0	0.70
3.	9.25	1.0
4.	10	1.70
5.	10.5	2.05
6.	10.75	2.4
7.	11	2.65
8.	11.25	2.85
9.	11.50	3.0
10.	9.75	1.15

Results :- Graph is plotted b/w current and volt and with help of this we get
Zenerdiode $V_Z = 11.5$ volt.

Precautions - In the state of forward bias voltage must be change through small values and the value of current due to ↑ voltage should not exceed the max. allowed for diode.



When Gate is OFF



When Gate is ON

Expt No. 5 | Date

Object :- To plot SCR characteristic under differ gate conditions.

Apparatus - 1) Two continuous variable DC regulat power supplies of 0.5 and 0-30 V.

2) Three meters to measured voltage and curre mounted on front of power and connections o on 4mm sockets.

3) SCR (2 RCM) placed outside the cabinet and connections are brought out of stockets.

Theory :- SCR is a three terminal device SCR are use as a controlled switch. It's a uni-directional power switch. In SCR load is connected in series with anod. The anode is always kept +ve with respect to cathod. The working of SCR can be ~~studies~~ under the following tu steps -

when gate is open :-

Gate is open that is no voltage is applied to the gate under this condition Junction J_3 is reverse biased while Junctions J_1 and J_2 are forward biased no curren flow through R_L and the SCR is cutoff. If the applied voltag is ↑ a stage is reached when reverse biased junction J_2 breaks down. The SCR now conducts heavily and said to be unstate

Breakdown voltage :- applied voltage at which SCR conducts heavily without gate voltage.

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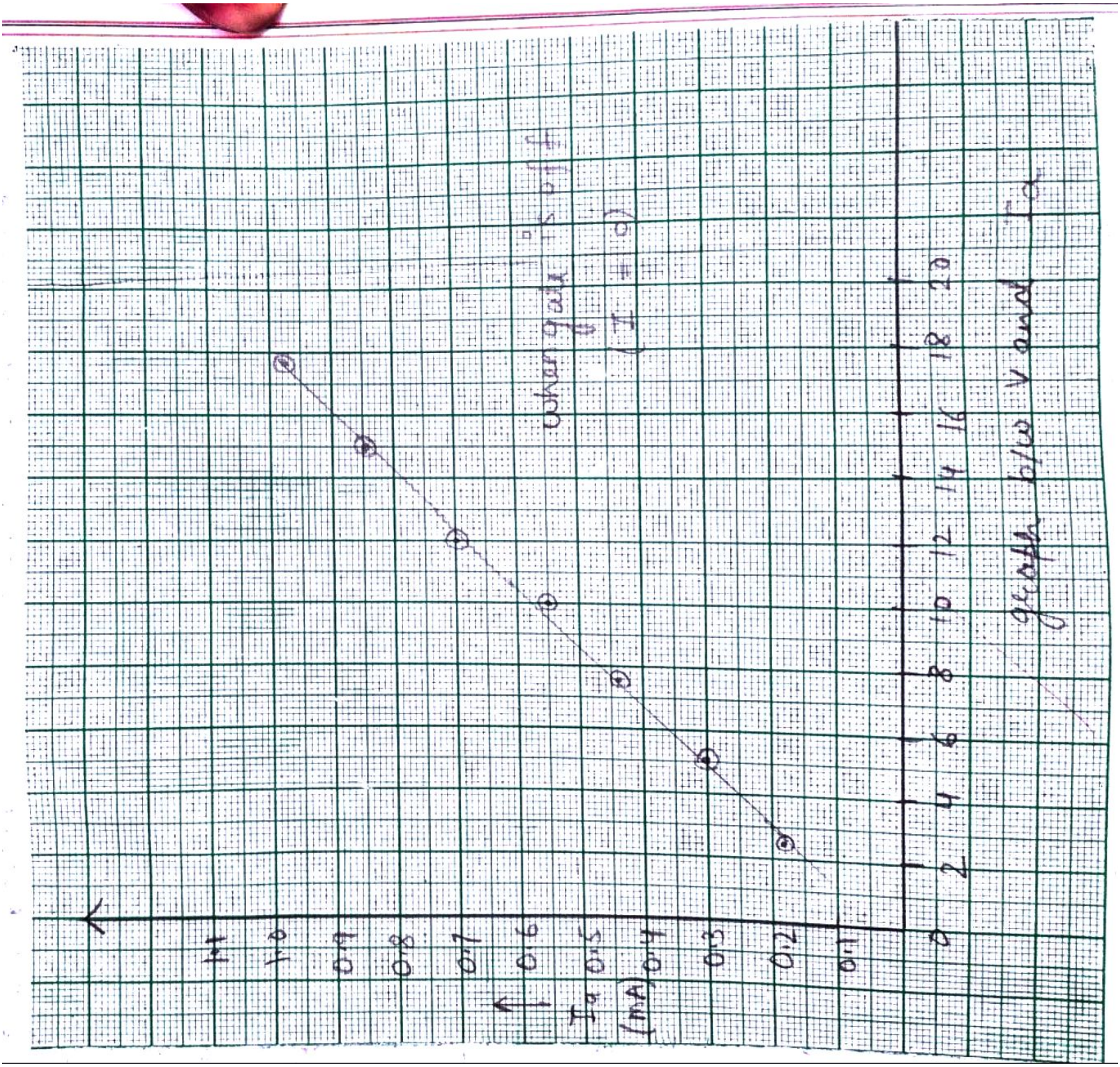
when gate is positive with respect to cathode :-
SCR can be made to conduct heavily at smaller applied voltage small + potential to the gate J_3 is forward bias and J_2 is reverse biased and gate cu[rrent] starts following as soon as gain current flows, an[d] current ↑ and J_4 entering small time, J_2 break[s] down and SCR starts conducting The gate lose al[l] controls every if gate voltage is removed. The ano[de] current do not decrease at all The only way to be SCR in off condition is to reduces The applied voltage are zero.

Peak reverse voltage:- Maximum reverse voltage that can be applied to an SCR without conducting in the reverse condition.

Holding current :- maximum anode current gate being open at which SCR is turned off from on conditions

Observations :- Least count voltage = 0.5 v/div.
Least count of milimeter 0.02 v ma/di[v]

when gate is off (that $i_g = 0$)


graph b/w V and Ia
when gate is off
(I = 0)
Ia (mA)
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
0
2
4
6
8
10
12
14
16
18
20

S. No.	v (volt)	Ia (mA)
1.	0	0.04
2.	2.5	0.18
3.	5.0	0.30
4.	7.5	0.44
5.	10.0	0.56
6.	12.5	0.70
7.	15.0	0.84
8.	17.5	0.98
9.	20.0	1.10

Results :- A Graph is drawn b/w Ia and v for various gate voltages and thus we get SCR characteristics,

Precautions :-

1. SCR should not be operated in the Avalance brea down region because SCR is a unidirectiona device.
2. SCR must be hold gently.

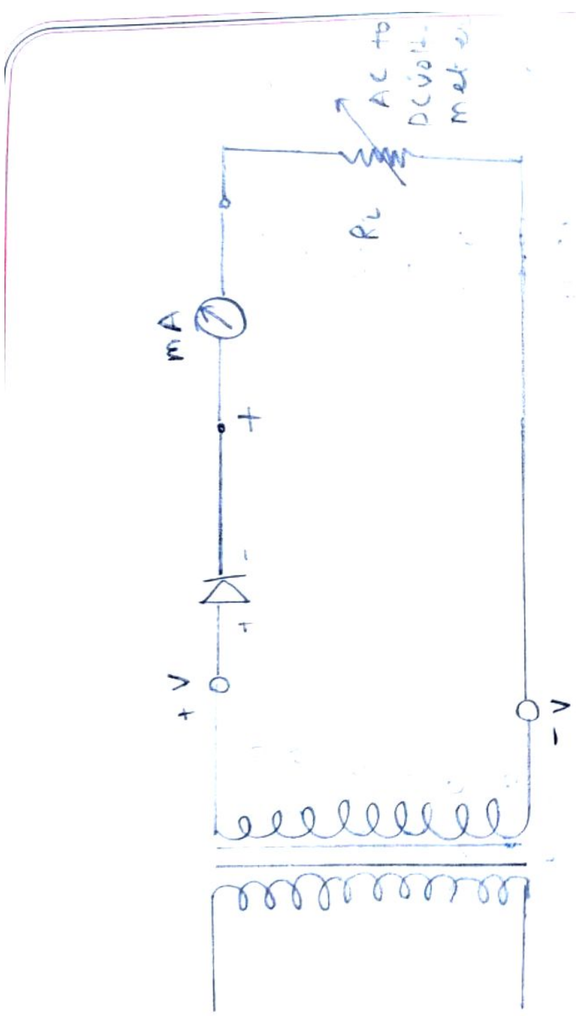
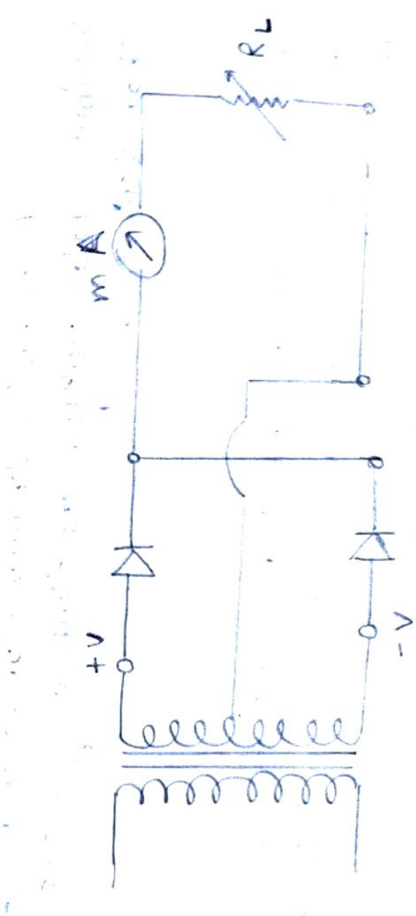


fig. Half Wave rectifier



full wave rectifier

No. 6

Date

Object:- To study Half/Full wave rectifier

Apparatus: New tech electronic training board type NTI-112
VTVM (vaccum tube voltmeter) or
AC voltmeter

Theory:- The ripple factor (r) of a power supply percentage is defined as

$$r = \frac{V_{ac}}{V_{dc}} \times 100\%$$

where r = ripple factor at given load
V_{ac} = AC output voltage
V_{dc} = DC output voltage

In electronic devices operation DC voltages and currents are required so the process by which AC is converted into DC is known as Rectification. The process when a diode conducts during either positive or negative half of input cycle is called Half wave rectification.

When two rectifiers are used with a center tapping transformer Full wave rectification is obtained there two diode D_1 and D_2 alternatively conduct in two alternation of input sin wave.

Calculation :-

Set 1st :- For Half wave Rectifier → Ripple factor (r) $= \frac{V_{ac}}{V_{dc}}$

(i) $R_L = 1\Omega$, $V_{DC} = 2V$, $I_L = 200mA$, $V_{AC} = 2V$

$r = \frac{2}{2} = 1$

(ii) $R_L = 2\Omega$, $V_{DC} = 3.2V$, $I_L = 160 mA$, $V_{AC} = 3.8V$

$r = \frac{3.8}{3.2} = 1.1875$

(iii) $R_L = 3\Omega$, $V_{DC} = 4.0V$, $I_L = 140mA$, $V_{AC} = 5.0V$, $r = \frac{5}{4} = 1.25$

(iv) $R_L = 4\Omega$, $V_{DC} = 4.6V$, $I_L = 120mA$, $V_{AC} = 5.8V$, $r = \frac{5.8}{4.6} = 1.26$

(v) $R_L = 5\Omega$, $V_{DC} = 5V$, $I_L = 100mA$, $V_{AC} = 6.4V$, $r = \frac{6.4}{5} = 1.28$

(vi) $R_L = 6\Omega$, $V_{DC} = 5.4V$, $I_L = 90mA$, $V_{AC} = 7.0V$, $r = 7/5.4 = 1.29$

(vii) $R_L = 7\Omega$, $V_{DC} = 5.8V$, $I_L = 80mA$, $V_{AC} = 7.4V$, $r = \frac{7.4}{5.8} = 1.275$

(viii) $R_L = 8\Omega$, $V_{DC} = 6.0V$, $I_L = 70mA$, $V_{AC} = 7.8V$, $r = \frac{7.8}{6.0} = 1.3$

Ripple factor of half wave rectifier

$$r = \frac{1 + 1.1875 + 1.25 + 1.26 + 1.28 + 1.29 + 1.275 + 1.3}{8}$$

$r = 1.2303$

theoretical value $= 1.21$

% error $= \frac{Th - Pr}{Th} \times 100\% = 1.67\%$

Expt No.

Observation:- Least count of Vdc voltmeter = 0.2 volt
least count of V_{AC} voltmeter = 0.2 vo
least count of load current (I_{ac}) = 5mA

Operation table:- For Half wave rectifier:-

S.No.	Load Resistance	DC o/p voltage (V)	least current I_L(mA)	Vac (V)	Ripple factor $r = \frac{Vac}{Vdc}$
1.	1	2	200	2	1
2.	2	3.2	160	3.8	1.1875
3.	3	4.0	140	5.0	1.25
4.	4	4.6	120	5.8	1.260
5.	5	5.0	100	6.4	1.28
6.	6	5.4	90	7.0	1.29
7.	7	5.8	80	7.4	1.275
8.	8	6.0	70	7.8	1.3

For full wave rectifier

S.No.	Load Resistance (R_L)	DC voltage	Load current I_L(mA)	Vac (V)	Ripple factor $r = \frac{Vac}{Vdc}$
1	1	3.2	250	1.8	0.5625
2	2	4.8	240	2.4	0.50
3	3	6.2	210	3.6	0.5806
4	4	6.8	170	3.8	0.5588
5	5	7.2	140	4.0	0.55

Set 2nd

For full wave rectifier - Ripple factor (r) = $\frac{V_{ac}}{V_{dc}}$

(i) $R_L = 1\,\Omega$, $V_{DC} = 3.2\,V$, $I_L = 250\,mA$, $V_{ac} = 1.8\,V$

$r = \frac{V_{ac}}{V_{dc}} = \frac{1.8}{3.2}$

(ii) $R_L = 2\,\Omega$ $V_{DC} = 4.8\,V$, $I_L = 240\,mA$, $V_{ac} = 2.4\,V$, $r = \frac{2.4}{4.8} = 0.50$

(iii) $R_L = 3\,\Omega$, $V_{DC} = 6.2\,V$, $I_L = 210\,mA$, $V_{ac} = 3.6\,V$, $r = \frac{3.6}{6.2} = 0.5806$

(iv) $R_L = 4\,\Omega$, $V_{DC} = 6.8\,V$, $I_L = 170\,mA$, $V_{ac} = 3.8\,V$, $r = \frac{3.8}{6.8} = 0.5588$

(v) $R_L = 5\,\Omega$, $V_{DC} = 7.2\,V$, $I_L = 140\,mA$, $V_{ac} = 4.0\,V$, $r = \frac{4.0}{7.2} = 0.55$

(vi) $R_L = 6\,\Omega$, $V_{DC} = 7.6\,V$, $I_C = 125\,mA$, $V_{ac} = 4.2\,V$, $r = \frac{4.2}{7.6} = 0.5526$

Ripple factor for full wave rectifier

$$r = \frac{0.5625 + 0.50 + 0.5806 + 0.5588 + 0.55 + 0.5526}{6}$$

$= 0.55075$

theoretical value $= 0.48$

% error $= \frac{Th - Pr}{Th} \times 100\% = \frac{0.48 - 0.55075}{0.48} \times 100 = -14.78\%$

Expt No.

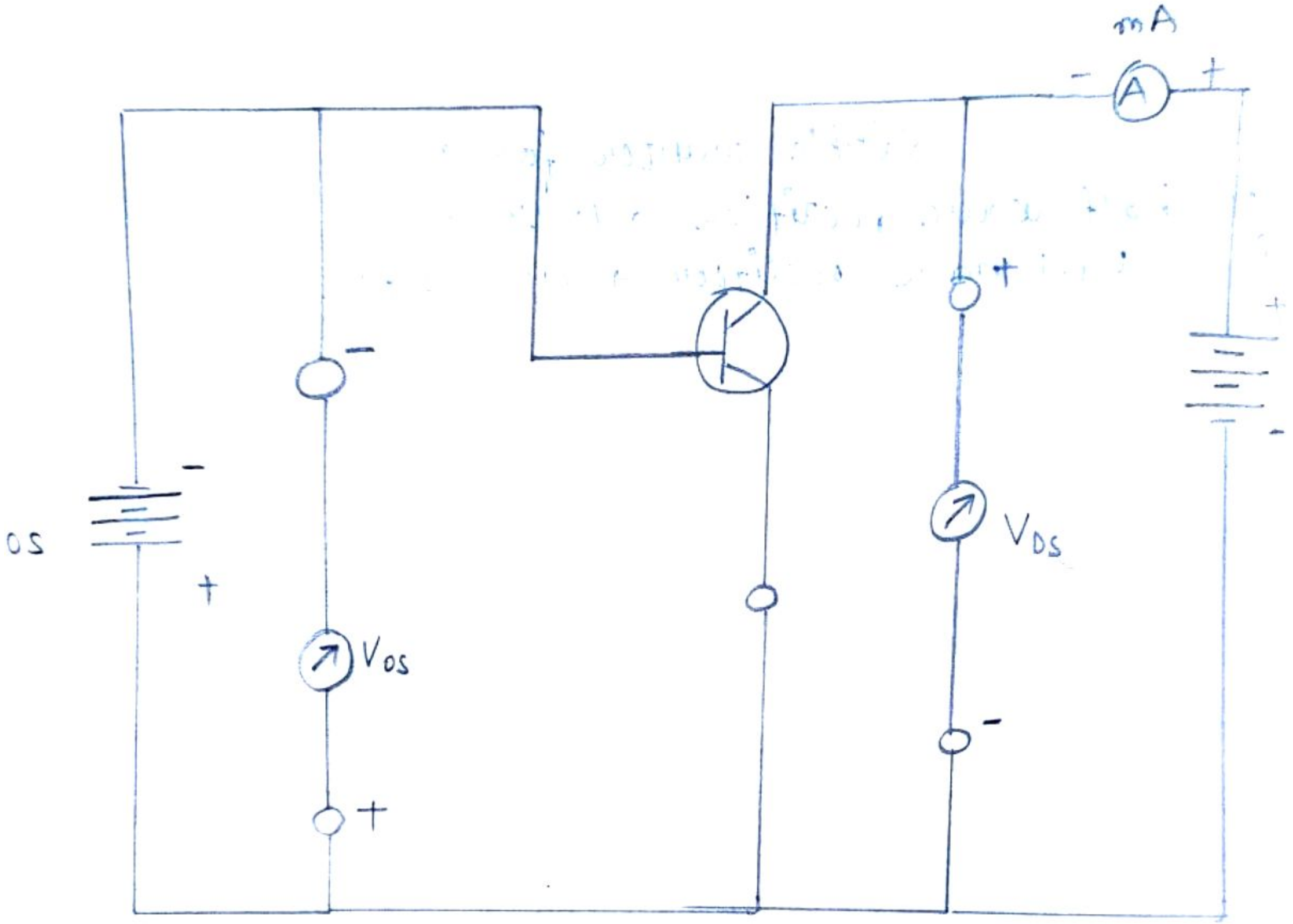
6	6	7.6	12.5	4.2	0.5526

Results :-

Ripple counter for →

(i) half wave rectifier → 1.2303

(ii) Full wave rectifier → 0.55075


mA
A
VDS
VOS
OS

Expt No. 7

Object :- To study analog to digital and digital to analog conversion.

Apparatus :- Analog to digital converter pannel board, connecting wires.

Theory :- The data in a processor is in digital terms this different beam of outsides used where data this analog form to get digital data form

We need to use the analog to digital it converts analog voltage word after an CRO has proceed data answer into and analog voltage or the conversion a D/A convertion.

Observation Table :-

(A) For D/A converter -

S.No.	I/P Digital Signal 2^0 A	2^1 B	2^2 C	2^3 D	Calculated O/P (Volt)	Observed voltage (V)	Calculated O/P voltage
1	0	0	0	0	0	0.26	0
2	1	0	0	0	0.33	0.56	1
3	0	1	0	0	0.66	0.86	2
4	1	1	0	0	1.0	1.16	3
5	0	0	1	0	1.33	1.43	4
6	1	0	1	1	1.66	1.73	5
7	0	1	1	0	2.0	2.03	6

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8	1	1	1	0	2.33	2.33	7	
9	0	0	0	1	2.66	2.60	8	
10	1	0	0	1	3.0	2.90	9	
11	0	1	0	1	3.33	3.20	10	
12	1	1	0	1	3.66	3.50	11	
13	0	0	1	1	4.0	3.78	12	
14	1	0	1	1	4.33	4.08	13	
15	0	1	1	1	4.66	4.39	14	
16	1	1	1	1	8.0	4.70	15	

For A/D converter -

S.No	Analog i/p voltage	Digital o/p voltage 2^0	2^1	2^2	2^3	7-Segment Display
1	0	0	0	0	0	0
2	1	1	0	0	0	1
3	2	0	1	0	0	2
4	3	1	1	0	0	3
5	4	0	0	1	0	4
6	5	1	0	1	0	5
7	6	0	1	1	0	6
8	7	1	1	1	0	7
9	8	0	0	0	1	8
10	9	1	0	0	1	9
11	10	0	1	0	1	10
12	11	1	1	0	1	11

No.

13	12	0	0	1	1	1.2	
14	13	1	0	1	1	1.3	
15	14	0	1	1	1	1.4	
16	15	1	1	1	1	1.5	

RESULT :- A/D convertor → we get digital o/p as shown in the table.

D/A converter → we get analog o/p of digit input in table.

PRECAUTIONS :- (i) Keep the circuit switched off while not taking any it may damage circuit

(ii) Note readings carefully.

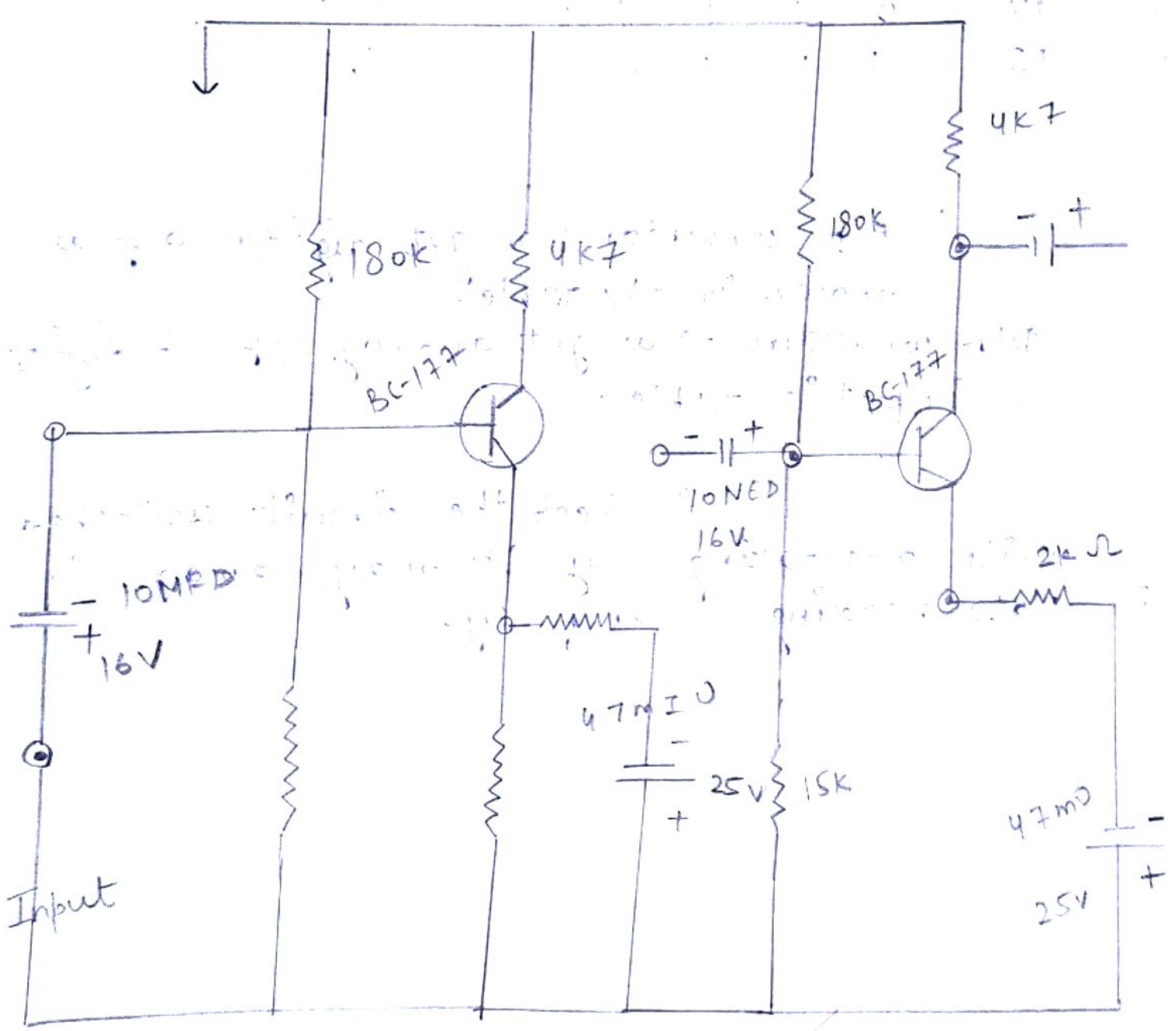

Fig - RC - coupled transistor amplifier

Date

Expt No. 8

Object:- Study of the characteristic of two stage R-C coupled transistor Amplifier
Study of the frequency response of the Individual as well as R-C coupled Amplifier.

Apparatus:-
OMGO - Type ETB-45 experiment at raining Board two PNP transistor AC melimeter cathode Roy oscilloscope main ON / OFF switch phone.

INTRODUCTION:- This is the most popular type of coupling because it is cheap & provides excellent audio frequency (because d) fidelity over a wide range of frequency. It is usually employee for voltage amplification fig(1) shows two stage of an RC coupled amplifier.

Circuit Description:- Since fig(1) shows two stage of an RC-coupled amplifier A coupled capacitor C_c is used to connect the output of the first stage to the base (i.e. input) of the s stage is so on the Resistance R_1, R_2 & R_E form the basing & stabalisation network. The emitter by pass capacitor. A low resistance path to the signal without it. The voltage gain of each stage would be last. The coupling capacitor C_c transit Ac signal but block DC. This present DC interference b/w voouous stage and the shifting

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Calculations :-

Current = 2mA (constant)
distance b/w probes = 0.9cm
thickness of crystals = 0.05cm

1) For the given sample $\left(\frac{\omega}{89}\right) = \frac{0.05}{0.2} = 0.25$

2) The correction factor $= \frac{25}{\omega} \log 2$

$$= \frac{2 \times 0.2 \times 2.303 \times 0.3010}{0.05}$$

$$= 5.54$$

At temp $32^{\circ}C = 305 K$

$$\therefore \frac{10^3}{T} = \frac{10^3}{30} = 328$$

$I = 2mA$; $V = 89.35 mV$; $e = \frac{V}{I} = \frac{35}{\ell\left(\frac{\omega}{s}\right)}$

$$\rho = \frac{78.6 \times 2 \times 1.314 \times 0.2}{5.54}$$

$$= 786 (\cdot 326)$$

$$= 17.29 \, \Omega cm$$

Similarly it calculates for all temp & slope b/w 10^3 & loge is

$$= \frac{1.10 - 1.05}{2.75 - 2.72} = \frac{0.05}{0.03} = 2.66 \, cm$$

Energy gap $E_g = 2.303 \times 10^3 \times 2K \times$ slope

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of operation.

When AC signal is applied to the base of the first transistor it applied In the amplified from across it's collector. load RC. The amplified signal developed across R_C is given to base of next stage through coupling capacitor C_c. The 2^{nd} stage does further amplification of the signal on the way the cascoded cone of after another stage amplified the signal & the over all gain is considerably increased.

It may be that total gain is less than the product to gain of individual stages. It is because when a 2^{nd} stage is made to follow the first stage the effective load resistance of the first stage is reduced due to the shunting effect of the input resistance of 2^{nd} stage. This reduce due to the shunting effect of the input resistance of 2^{nd} stage. This reduce the gain of the stage which is loaded by next stage.

Observation table:-

S.No.	Frequeny	V_i (V)	V_o (V)	Gain $A_p = V_o/V_i$
1.	23.3 Hz	2.6 x 50 mV = 0.13 V	1.6 x 0.2 V = 0.32 V	2.4
2.	40.72 Hz	0.13 V	1.8 x 0.2 V = 0.36 V	2.7
3.	81.00 Hz	0.13 V	2 x 0.2 V = 0.4 V	3.07
4.	140.2 Hz	0.13 V	2.2 x 0.3 V = 0.44 V	3.3
5.	221.6 Hz	0.13 V	2.4 x 0.2 V = 0.48 V	3.692

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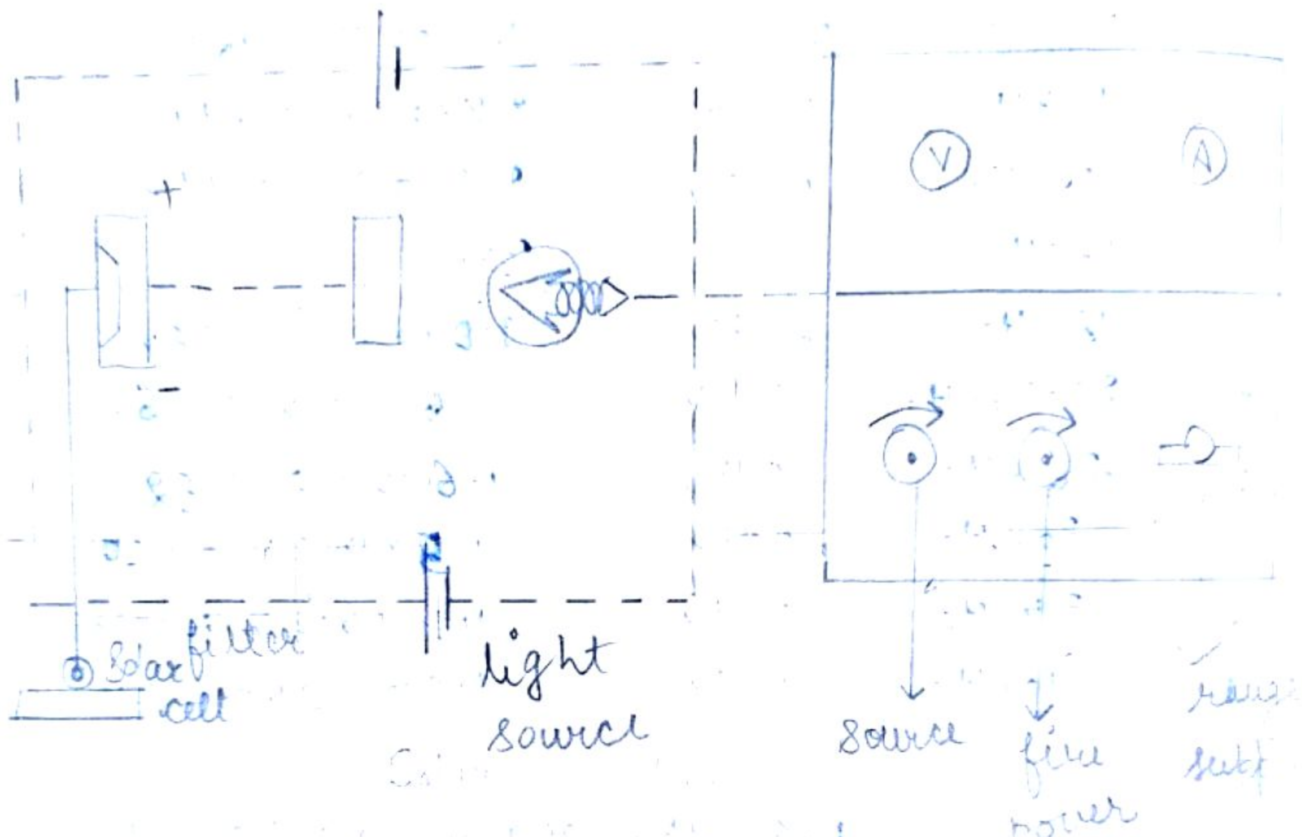
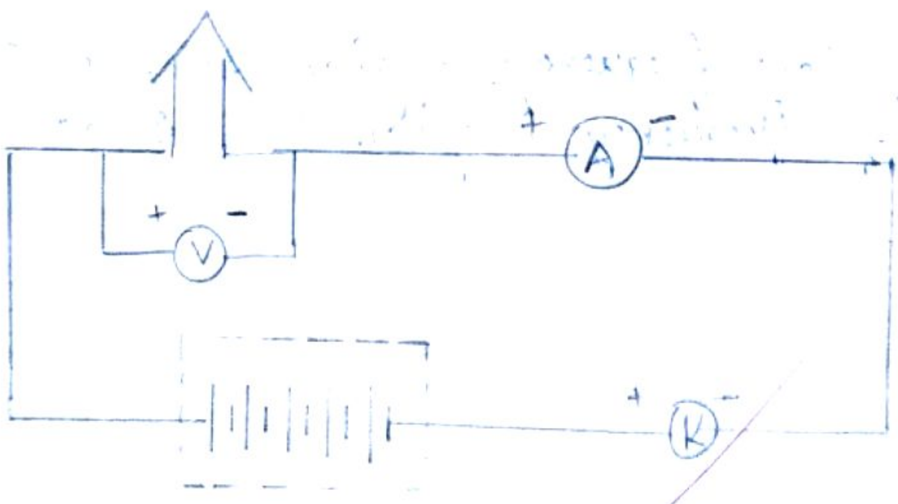
6.	506.6	0.13 V	2.4×0.2V = 0.48V	3.692
7.	1KHz	0.13V	2.4×0.2 = 0.48V	3.692
8.	2KHz	0.13 V	2.4×0.2 = 0.48V	3.692
9.	10KHz	0.13V	2.4×0.2 = 0.48V	3.692
10.	12KHz	0.13V	2.4×0.2 = 0.48V	3.692
11.	14kHz	0.13V	2.2×0.2V = 0.44V	3.38
12.	15kHz	0.13V	2.2×0.2 = 0.44V	3.38
13.	16KHz	0.13V	2×0.2 = 0.38V	3.07
14.	18KHz	0.13V	2.8×0.24 = 0.38V	2.92
15.	23.56kHz	0.13V	1.8×0.2 V = 0.36V	2.76
16.	26kHz	0.13V	1.6×0.2V = 0.32V	2.46
17.	30KHz	0.13V	1.5×0.2V = 0.30V	2.30
18.	34KHz	0.13V	1.4×0.2V = 0.28V	2.15
19.	40KHz	0.13V	1.2×0.2V = 0.24	1.846

Result:- From the graph we see that

(i) The cut off low frequency region 3.69 at 506.6Hz

(ii) High cut off frequency region 3.692 at 1200Hz or 12KHz





Circuit diagram

Expt No. 9

Date

Object :- Determine Planck's constant using Solar cell and optical filter.

Apparatus :- The new tech type board EM 102 is contact. It comprises a DC micrometer, DC vol Three knots course fine range one LED & ON Blue, Red, green filter, s

Theory :- for Black body energy distribution is given

$$E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5} \exp\left(\frac{-h\nu}{KT} - 1\right) d\lambda$$

where $E_\lambda d\lambda$ is total energy radiated by black body to $\lambda + d\lambda$ interval.

h → plank constant

c → Velocity of light

T → Absolute temp.

K → Boltzmann factor

According to wein's formula

$$E_\lambda = \frac{8\pi hc}{\lambda^5} e^{-hc/\lambda KT} \quad \text{—} (1)$$

Taking $\log_e$ of eqn (1)

$$\ln E_\lambda = \ln A - \ln \frac{hc}{\lambda KT}$$

we know energy radiated directly proportional to photo

$$E_\lambda \propto \theta$$

$$\ln E_\lambda = \ln A + \ln \theta \quad \text{—} (2)$$

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Calculations :-

(i) for first and second filter

$$h_1 = \frac{e(V_2 - V_1)\lambda_1\lambda_2}{c(\lambda_1 - \lambda_2)} \text{ J-sec}$$

$$h_1 = \frac{1.6\times10^{-19}\times(V_2 - V_1)\times 6143\times5645\times10^{-20}}{3\times10^{8}\times498\times10^{-10}}$$

$$h_1 = 37.14(V_2 - V_1)\times10^{-34}$$

$$= 37.14\times(2.20 - 1.98)\times10^{-34} = 8.17\times10^{-34}$$

$$\boxed{h_1 = 8.17\times10^{-34} \text{ J-sec}}$$

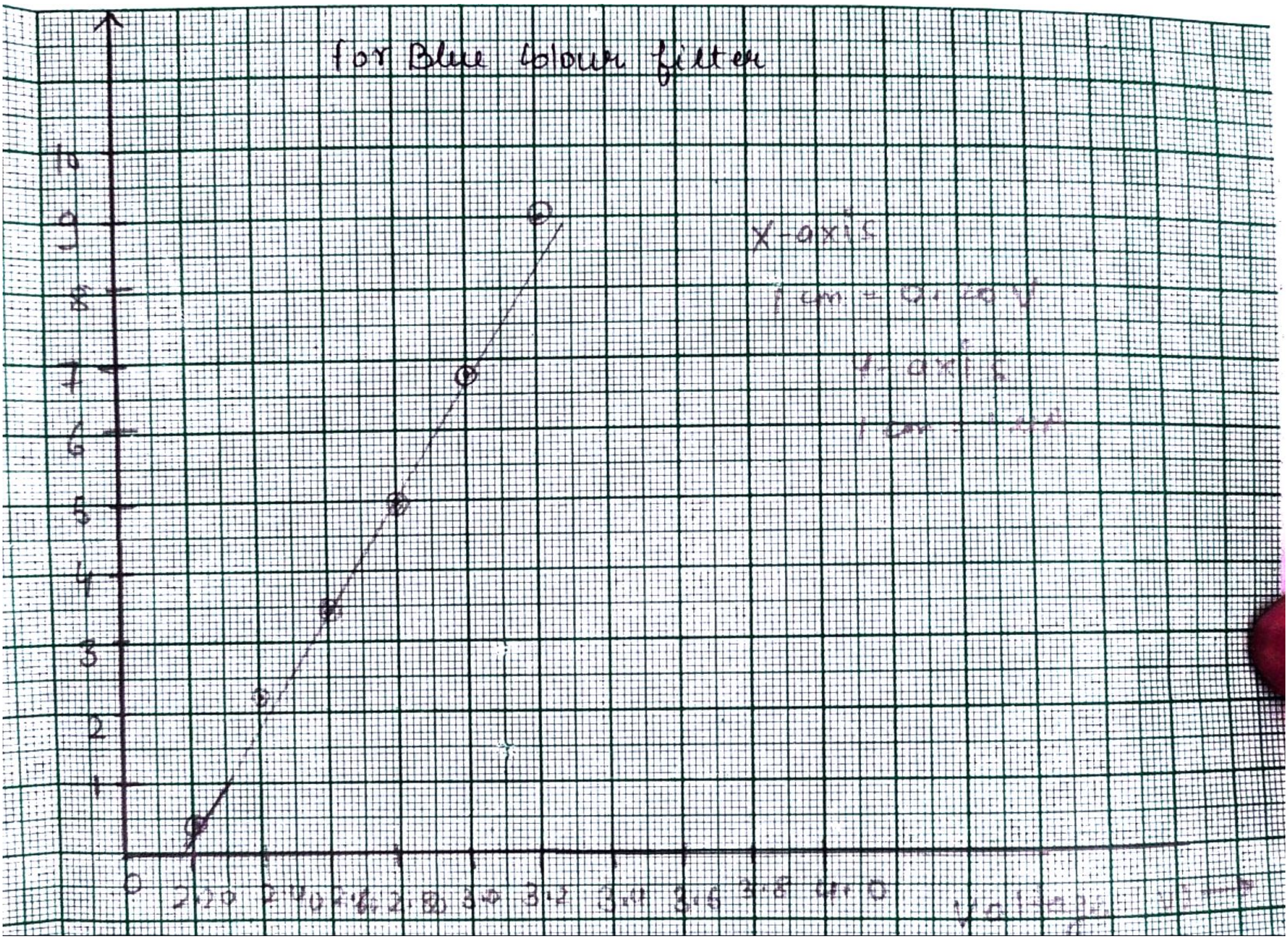
(ii) for second and third filter.

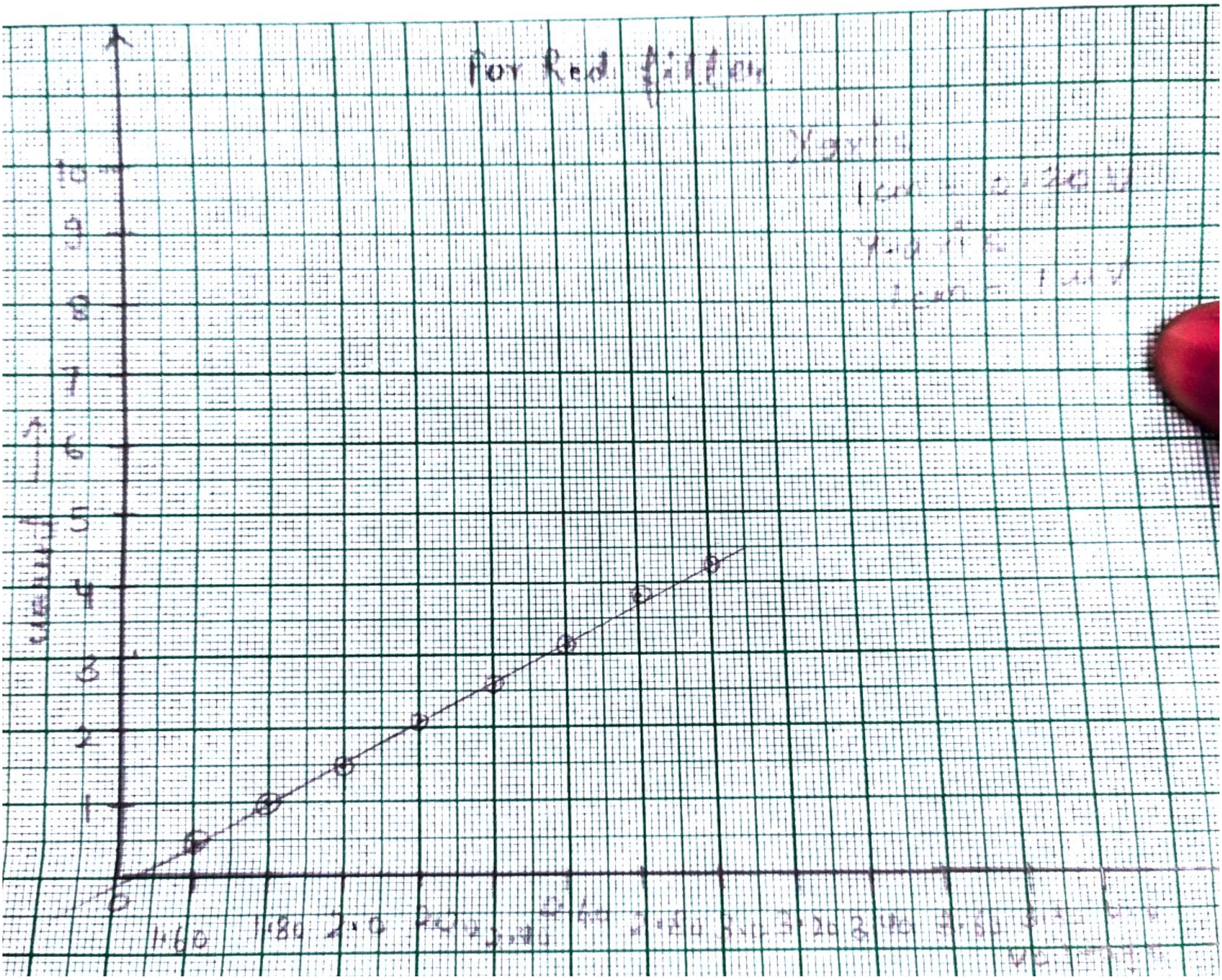
$$h_2 = \frac{e(V_3 - V_2)\lambda_2\lambda_3}{c(\lambda_2 - \lambda_3)} \text{ J-sec}$$

$$h_2 = \frac{1.6\times10^{-19}(V_2 - V_3)\,5645\times4865\times10^{-20}}{3\times10^{8}\times780\times10^{-10}}$$

$$h_2 = 18.78(V_3 - V_2)\times10^{-34}$$

$$\boxed{h_2 = 15.02\times10^{-34} \text{ Joule-sec}}$$


for Blue colour filter
X-axis
Y-axis


for Red filter
Y axis
X axis
0
1
2
3
4
5
6
7
8
9
10
1.60
1.80
2.0

Date

By eq^n (1) and (2)

$$\ln m + \ln \theta = \ln A - \frac{hc}{2.303}(\lambda k T)^{-1}.$$

$$\ln \theta = \ln B - \frac{hc}{2.303}(\lambda k T)^{-1} \quad \text{where } \ln B = \ln\left(\frac{A}{m}\right)$$

The graph plotted b/w $\ln \theta \propto \frac{1}{T}$ is straight line & it's slope is given by $\frac{hc}{2.303\lambda}$

The planck constant $h = \frac{2.303\lambda k}{c} \times$ slope of line.

Temperature of filament of bulb

let R_T be the resistance of the filament of bulb of temp. T and R_0 at room temp. Then

$$\frac{R_T}{R_0} = \left(\frac{T}{T_0}\right)^{1.2}$$

$$T = T_0\left(\frac{R_T}{R_0}\right)^{0.833}$$

$R_0 \rightarrow$ measured at mV

$R_T \rightarrow$ measured resistance at V_0 mode.

Observation Table :-

Resistance of filament at room temp.

in VA mode the stopping potential for the filter are -

for red filter $V_3 = 3V$

green filter $V_2 = 2.20V$

Blue filter $V_1 = 1.98V$

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

speed of light $(c) = 3 \times 10^8$ m/sec

(iii) for third and first filter

$$h_3 = \frac{e(V_3 - V_2)\lambda_1\lambda_3}{c(\lambda_1 - \lambda_2)}$$

$$h_3 = \frac{1.6\times10^{-19}(V_3 - V_1)\, 6143 \times 4865 \times 10^{-34}}{3000 \times 1278}$$

$$h_3 = 12.47(V_3 - V_1)\times10^{-34}\ \text{J sec}$$

$$h_3 = 12.47(3 - 1.98)\times10^{-34}$$

$$\boxed{h_3 = 12.71\times10^{-34}\ \text{J-sec}}$$

Mean value of Planck Constant

$$h = \frac{h_1 + h_2 + h_3}{3}$$

$$\boxed{h = 11.96\times10^{-34}\ \text{J-sec}}$$

$$\text{Percentage Error} = \frac{\text{Experimental value} - \text{Standard value}}{\text{Standard value}} \times 100\%$$

$$= 44.69\%$$

wavelength of Blue (1st) filter $\lambda_1 = 6148 \times 10^{-10} \pm 2\%$ m
wavelength of green (IInd) filter $\lambda_2 = 5645 \times 10^{-10} \pm 2\%$ m
wavelength of Red (3^{rd}) filter $\lambda_3 = 4865 \times 10^{-10} \pm 2\%$ m

Planck constant of first and second filter

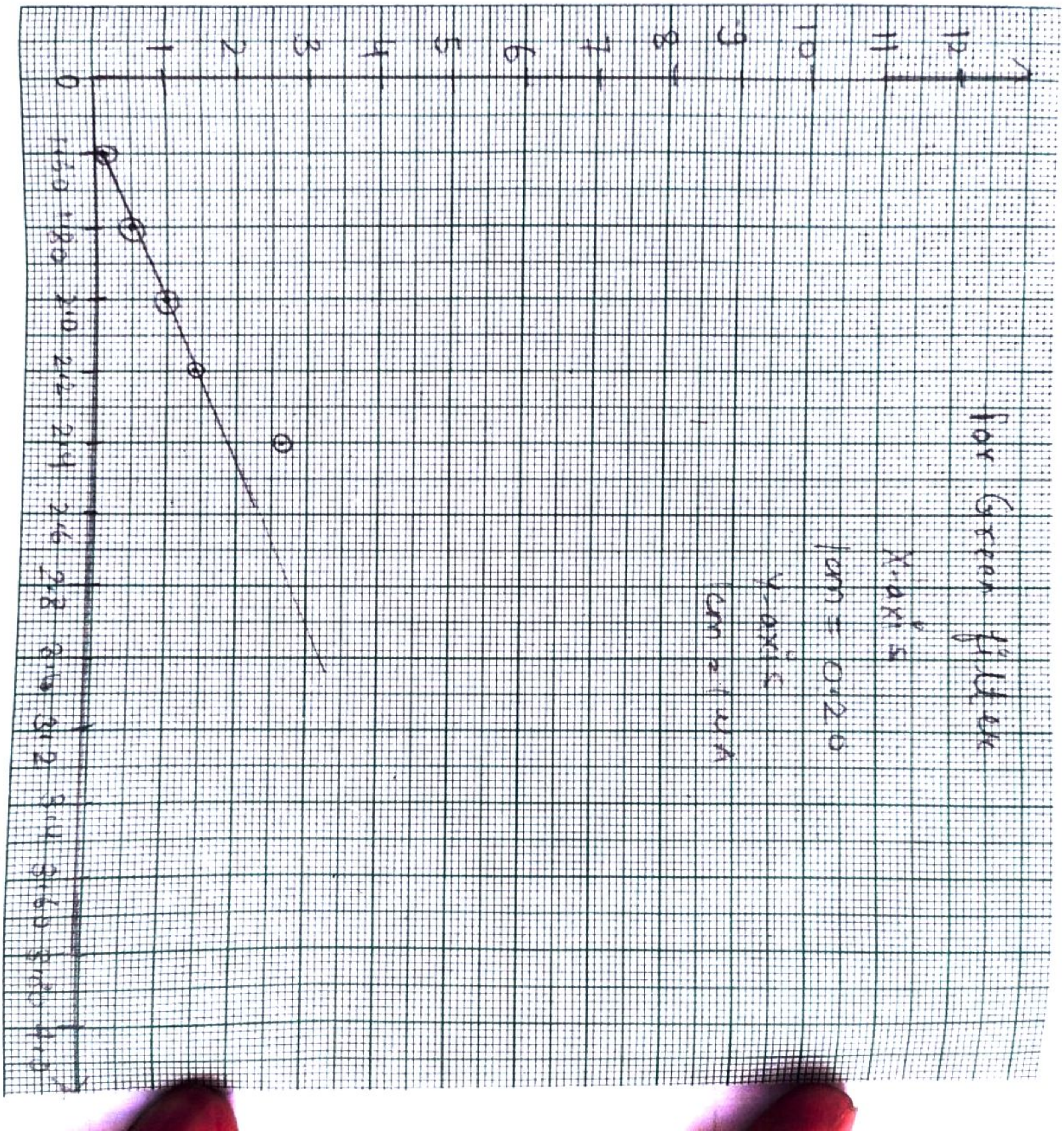
$$h_1 = \frac{e(V_2 - V_1)\lambda_1 \lambda_2}{c(\lambda_1 - \lambda_2)}$$

Similarly, for h_2 & h_3.

Observation Table :-

For Blue colour

	voltage (V)	current (μA)
1.	2.20	0.4
2	2.40	2.4
3	2.60	3.4
4	2.80	5.0
5	3.00	6.8
6	3.20	9.0
7	3.40	11.0
8	3.60	13.6
9	3.80	16.6
10	4.00	20.6


For Green light
X-axis
1cm = 0.20
Y-axis
1cm = 1μA

for green colour

voltage (V)	Current (μA)
1.60	0.1
1.80	0.4
2.00	1.0
2.20	1.6
2.40	2.6
2.60	3.6
2.80	5.2
3.00	6.8
3.20	9.2
3.40	10.8
3.60	14.0
3.80	16.6
4.00	20.0

for Red filter

S.No.	Voltage (V)	Current
1	1.60	0.4
2	1.80	0.5
3	2.0	1.1
4	2.20	1.9
5	2.40	2.4
6	2.60	3.6
7	2.80	4.6
8	3.00	7.4
9	3.20	8.6
10	3.40	11.2
11	3.60	13.6
12	3.80	16.8
13	4.00	20.8

Result:- Theoretical value of Planck constant is

$$h_T = 6.65 \times 10^{-34} \text{ J-sec}$$

Experimental value of planck's constant is

$$h_e = 11.96 \times 10^{-34} \text{ J-sec.}$$

Percentage error in the value is given as

$$\% \text{ error} = 44.69\%$$

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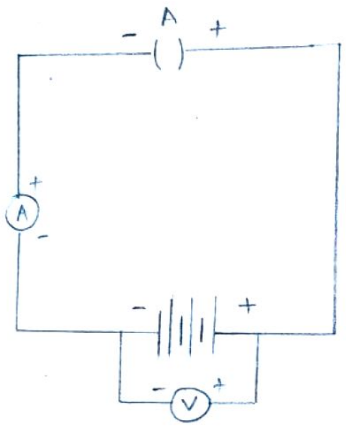
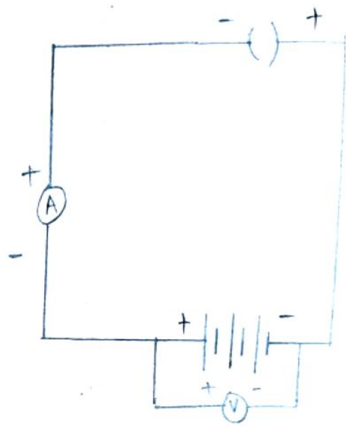
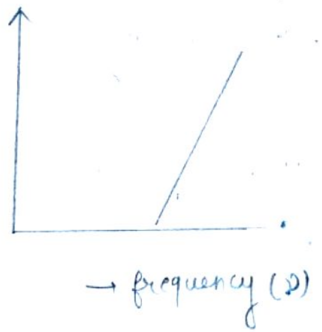
Photocell



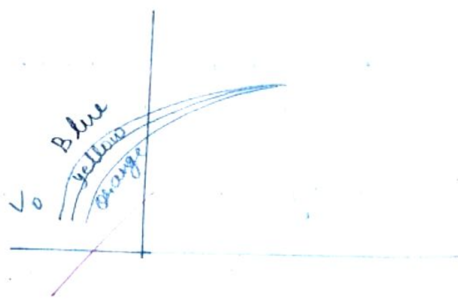
forward bias



Reverse bias



(a)



(b)

Aim:- To determine the planck constant with the help of photocell.

Apparatus:- Photocell, wooden box to photocell, blue, green and orange filter etc.

Theory:- It is well known that light has dual nature when light properties progates from one point to another, it behaves like an Electromagnetic wave but when it interacts with matter, it behaves like a particle or quanta known as Photon

$$E = h\nu$$

where h = Planck's constant

Now, from Einstein Photocell electric equation

$$\frac{1}{2}mv^2 = eV_0 = h\nu - h\nu_0$$

$$V_0 = V_0 = (h/e)\,\nu - \left(\frac{h}{e}\right)\nu_0 \quad \text{--- (1)}$$

Here,
m = mass of electron
ν_0 = threshold frequency
~~ν~~ = v = velocity of photoelectron
e = electric charge

Slope of equation (1) $h = e\tan\theta$

Make connection according to figure with light source and align filter properly.

First place blue filter at the stand such that the light of photocell falls on the lamp while passing through the blue filter.

Teacher's Signature : ______

Calculations :- $e = 1.6\times10^{-19}C$ $\quad c = 3\times10^{8}\ m/sec$

wavelength of orange filter $\lambda_o = 5400\times10^{-8}$ cm

wavelength of blue filter $\lambda_B = 5700\times10^{-8}$ cm

wavelength of green filter $\lambda_a = 5200\times10^{-8}$ cm

frequency of blue filter $(\nu_B) = \frac{c}{\lambda_B} = 58.8\times10^{13}\ sec^{-1}$

frequency of green filter $(\nu_a) = \frac{c}{\lambda_a} = 57.6\times10^{13}\ sec^{-1}$

frequency of orange filter $(\nu_o) = \frac{c}{\lambda_o} = 55.5\times10^{13}\ sec^{-1}$

from graph, slope of straight line between stopping potential and frequency $\tan\theta = h/e$

$h = e\tan\theta$

$\tan\theta = \frac{40\times10^{-3}}{1.2\times10^{13}} = 33.33\times10^{-16}$

Now, $h = e\tan\theta \Rightarrow \tan\theta = \frac{40\times10^{-3}}{1.2\times10^{13}} = 33.33\times10^{-16}$

Now, $h = e\tan\theta = 1.6\times10^{-19}\times 83.33\times10^{-16}$

$h = 5.33\times10^{-34}$ J-sec.

Percentage error $= \frac{\text{Practical value} - \text{Standard value}}{\text{Practical value}} \times 100\ \%$

$= \frac{1.29}{6.62}\times100\%$

$= 0.1948\times100\%$

$= 19.48\ \%$

Date

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the current in ammeter doubles 400 μA for blue filter.

Now increase the voltage gradually & note down the corresponding reading of current in μA.

Similarly note down reading of V and I for R.B.

Repeat the steps for green and orange light.

Observation Table :-

Blue filter

Forward Bias		Reverse Bias	
Voltage (V)	Current (μA)	Voltage (mV)	Current (μA)
0	480	0	480
0.1	490	20	440
0.2	500	40	420
		60	400
		80	390
		100	380
		120	350
		140	330
		180	300
		200	280
		220	250
		240	200
		260	180
		280	150
		300	120
		320	90

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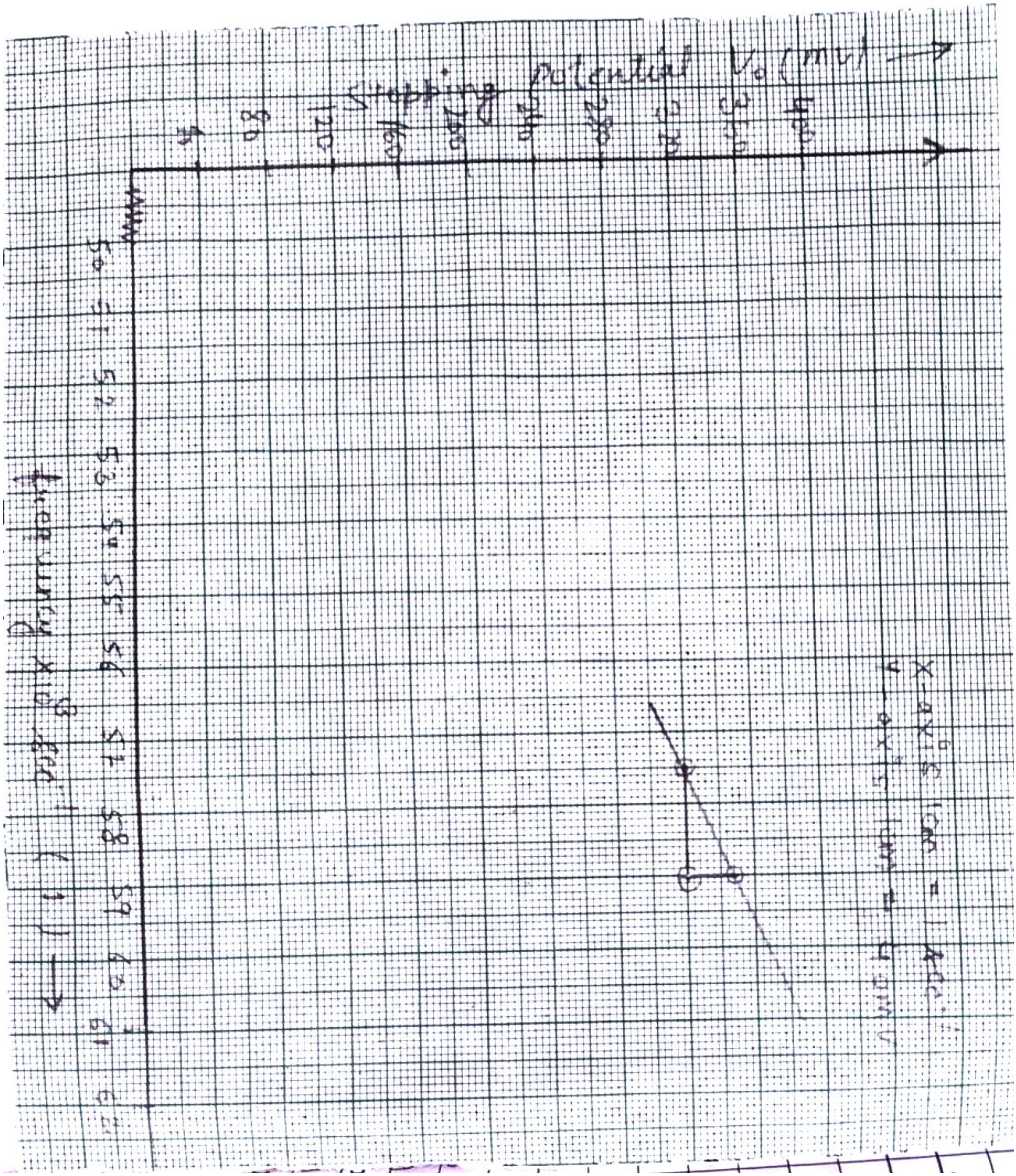

Stopping potential V0 (mV)
40
80
120
160
200
240
280
320
360
400
50 51 52 53 54 55 56 57 58 59 60 61 62
frequency

		320	50
		340	70
		360	0

Green filter

Forward Bias		Reverse bias	
Voltage (V)	Current (μA)	Voltage (mV)	Current (μA)
0	360	0	360
0.1	430	20	350
0.2	500	40	340
		60	330
		80	310
		100	300
		120	280
		140	260
		160	240
		180	220
		200	180
		220	160
		240	130
		280	100
		280	70
		300	40
		320	0

Orange filter

Forward Bias		Reverse Bias	
voltage (V)	Current (μA)	Voltage (mV)	current (μA)

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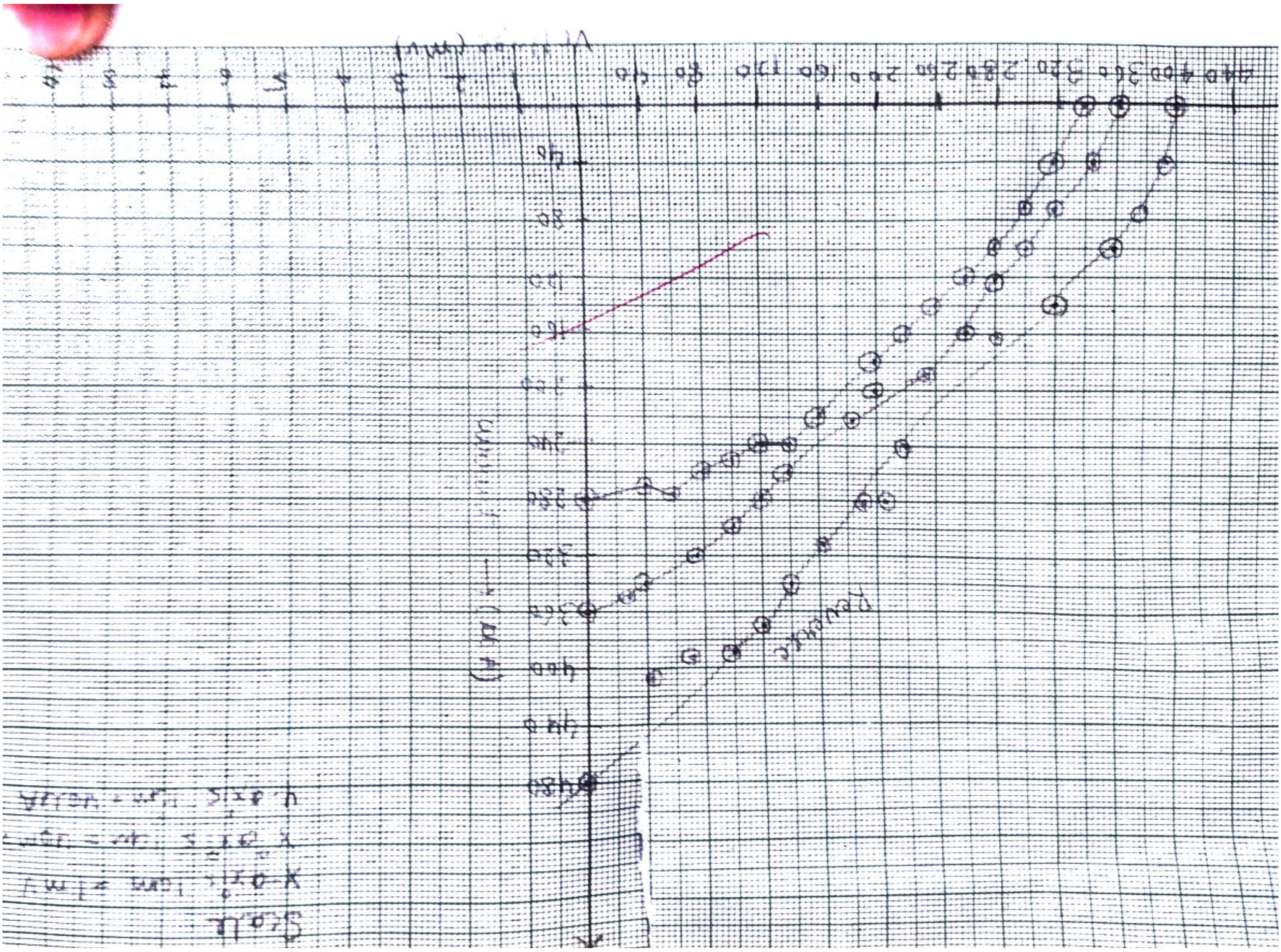
Scale
Reverse
440 400 360 320 280 260 200 160 120 80 40

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1	0	280	0	280	
2	1	360	20	270	
3	2	430	40	260	
4	3	500	60	250	
5			80	240	
6			100	280	
7			120	220	
8			140	210	
9			160	190	
10			180	170	
11			200	140	
12			220	120	
13			240	100	
14			260	70	
15			280	40	
16			300	0	

Result :-

Theoretical value of Planck's constant is 6.62×10^{-34} J-s.

Practical value of Planck's constant is $= 5.23 \times 10^{-34}$ Joule-sec.

Percentage error = 19.48%

filter	Frequency (sec^{-1})	Stopping potential V_0 (mV)
Blue	360	53.3×10^{13}
Green	320	57.6×10^{13}
orange	300	55.5×10^{13}

Teacher's Signature : [signature] 10/4/19