Laboratory Manual
B.Sc. 3rd Year

Honours Physics

RPS DEGREE COLLEGE
BALANA (MAHENDERGARH)123029

Experiment: 1

Aim:

Measurement of e/m ratio by Thomson's bar magnet method

Apparatus:

Cathode ray tube (CRT) with power supply unit, one pair of bar magnets, high resistance voltmeter, magnetometer, and stopwatch.

Formula used:

$yV/B^{2}lLd \times 10^{8}$ coulomb/gm

Where

l = length of deflecting plates
L = distance of screen from mid-point of point of plates
d = separation between the plates
B = strength of the applied filed to make the deflection zero

About experiment:

We have learnt that the electron has a negative charge whose magnitude e equals 1.6×10^{-19} Coulomb and mass (m) equal to 9.1×10^{-31} Kg. Millikan's Oil Drop method enables us to measure the electron charge but the mass of the electron cannot be measured directly. It is calculated by measuring the value of e/m. The aim of this experiment is to determine value of e/m by Thomson's method. This involves the motion of an electron in a cathode ray tube (CRT).

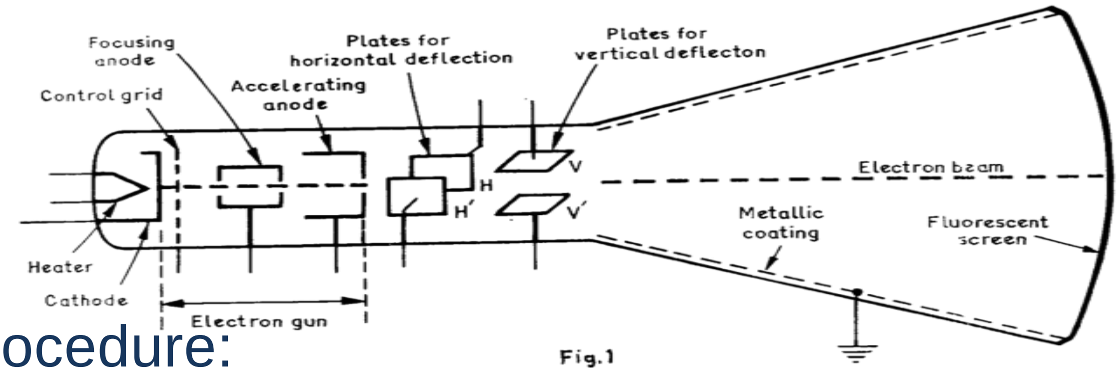


Fig.1

Procedure:

1. Draw the North South line using a compass needle. Also draw the East-West line. Place the cathode ray tube fitted in the wooden frame with its axis along the North South line so that the arms of the frame lie along the East West line.

2. Connect the cathode ray tube to the power supply unit. Switch on the current and wait till a luminous bright spot appears on the screen. Adjust the brightness and focus controls so as to get a sharp bright point spot in the middle of the screen. Note the initial position of the spot on the scale fitted on the screen.
3. Now apply a suitable deflecting voltage so that the luminous spot is deflected by about 0.5 to 1.0 cm. Note the deflecting voltage V and the position of the spot. Measure the distance through which the spot has moved and let it by y.
4. Place the bar a magnet symmetrically on either side of the cathode ray tube along the arms of the wooden stand on which the tube is fitted such that their opposite poles face each other and their common axis is exactly at right angles to the axis of the cathode ray tube. Adjust the polarity as well as the distance of the magnets so that the luminous spot comes back to its initial position. When the adjustment is perfect note the distance of the poles of the magnets on the side nearer to the cathode ray tube. Let the distances be r_1 and r_2.
5. Remove the bar magnet, switch off the electric field applied to the deflecting plates and again note the initial position of the luminous spot. Reverse the polarity of the potential difference applied to the electric deflecting plates with the help of the reversing switch fitted in the power supply unit thereby reversing the electric field. Again, note the final position of the luminous spot and calculate y.

   Again, place the bar magnets on the arms of the wooden stand as in the previous step and adjust their polarity as well as the distance so comes back to its initial position. When the adjustment is perfect again note the distances of the poles of the magnets on the side nearer to the cathode ray tube. Let the distances be r'_1 and r'_2. Switch off the power supply.
6. To find the value of the magnetic field B, carefully remove the magnets and the cathode ray tube from the wooden stand. Place the compass box (of a deflection magnetometer or tangent galvanometer) such that its centre lies exactly on the point where the common axis of the bar magnets and the axis of the cathode ray tube intersect. Rotate the compass box about its vertical axis so that the pointer lies along the 0-0 line.

   Place the magnets exactly in the same positions as in step 4 at distances r_1 and r_2. This produces a deflection in the magnetometer compass box and the two ends of the pointer give the deflection. Let the readings be θ_1 and θ_2.

   Now place the magnets exactly, in the same positions as in step 5 at distances r'_1 and r'_2 and again note the deflections θ'_1 and θ'_2 from the two ends of the pointer of the compass box. The mean of these four deflection θ_1, θ_2, θ'_2 and θ'_2 gives the mean deflection θ. If B_H is the horizontal component of earth's magnetic field, then $B = B_H \tan\theta$
7. Take two more sets of observations by changing the value of V and hence that of the electric field.

Precautions:

1. The Cathode ray tube should be accurately placed with its longitudinal axis in the magnetic meridian.
2. The spot on the screen should allowed to remain at a given position on the screen for a long time.
3. There should not be any other disturbing magnetic field near the apparatus.
4. While taking the observations for time periods, the maximum angular displacement of the magnetic needle should not exceed 40-50 degrees.

Observations and Results

<u>Constant Values</u>

Length of plate, a = 2 cm
Distance to screen from plate, L = ...cm Distance between the plates, S = ... cm
Horizontal component of earth's magnetic field B_E =........... T
PART A: Measurement of deflection y:
Initial position of spot, y_o = ______________________ cm (specify +ve or

Sr. No.	Applied voltage in volts		Direct filed				Reverse filed				
		Initial position of spot	Initial position of spot	Deflection 'y '	Distance of the magnet r1	Distance of the magnet r2	Initial position of spot	Initial position of spot	Deflection 'y '	Distance of the magnet r1	Distance of the magnet r2
V1 V2 V3 V4											

Experiment: 2

AIM:

Hysteresis loop for a ferromagnetic material (B-H curve)

Apparatus:

Two solenoid coils, S and C, ferromagnetic specimen rod, reversible key (R), ammeter, magnetometer, battery, solenoid, rheostat and transformer for demagnetizing set up.

About experiment:

A ferromagnetic rod is magnetized by placing it in the magnetic field of a solenoid. The magnetized rod causes a deflection (θ) in a magnetometer. The deflection is recorded as the current in the solenoid (I) is varied over a range of positive and negative values.

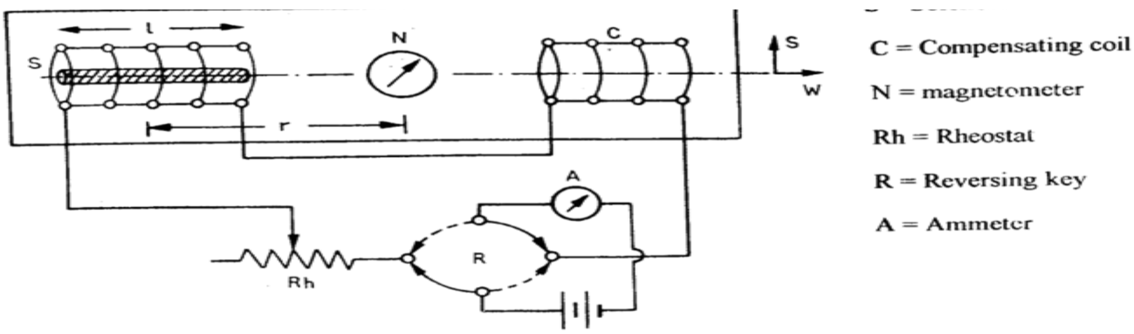
Hysteresis

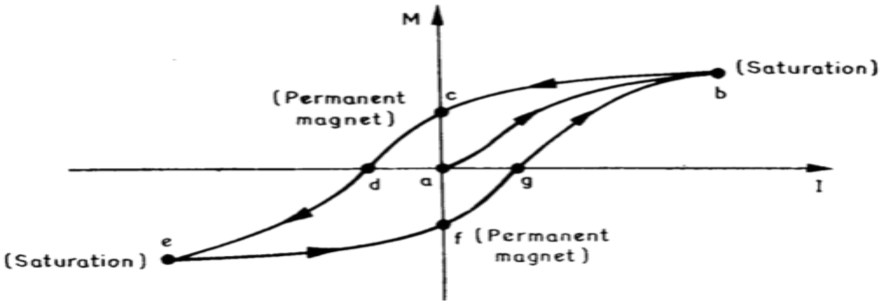
Hysteresis means “remaining” in Greek, an effect remains after its cause has disappeared. Hysteresis, a term coined by Sir James Alfred Ewing in 1881, a Scottish physicist and engineer (1855-1935), defined it as: When there are two physical quantities M and N such that cyclic variations of N cause cyclic variations of M, then if the changes of M lag behind those of N, we may say that there is hysteresis in the relation of M to N". The most notable example of hysteresis in physics is magnetism. Iron maintains some magnetization after it has been exposed to and removed from a magnetic field.

Magnetic Hysteresis Consider a magnetic material being subjected to a cycle of magnetization. The graph intensity of magnetization (M) vs. magnetizing field (H) gives a closed curve called M-H loop.

Hysteresis Loop

An initially un magnetized material is subjected to a cycle of magnetization. The values of intensity of magnetization M and the magnetizing field H are calculated at every stage and a closed loop is obtained on plotting a graph between M and H as shown in the figure. The point ‘O’ represents the initial un magnetized condition of the material. As the applied field is increased, the magnetization increases to the saturation point ‘A’ along ‘OA’. As the applied field is reduced, the loop follows the path ‘AB’. ‘OB’ represents the intensity of magnetization remaining in the material when the applied field is reduced to zero. This is called the residual magnetism or remanence. The property of retaining some magnetism on removing the magnetic field is called retentivity. OC represents the magnetizing field to be applied in the opposite direction to remove residual magnetism. This is called coercive field and the property is called coercivity. When the field is further increased in the reverse direction the material reaches negative saturation point ‘D’. When the field is increased in positive direction, the curve follows path ‘DEF’.





Procedure:

1. Complete the wiring of the apparatus according to the circuit diagram,
2. Alignment of apparatus:
   Rotate the dial of the magnetometer until $0^0 \pm 0^0$ position is aligned with the axis of the solenoid. Rotate the wooden arm, containing the solenoid, magnetometer and compensating coil, until the magnetic pointer coincides with the $0^0 \pm 0^0$ positions. In this position the wooden arm is along the E ± W position. The horizontal component of earth's magnetic field B_E (along S-N direction) is then perpendicular to the wooden arm.
3. Begin Measurements:

   i). To begin with, the current in the solenoid should be switched off.

   ii). Insert specimen rod so that it' s leading tip is at the edge of the solenoid.

   Note: There should be no deflection of the needle at this point. If deflection is observed, repeat step 3 for demagnetizing rod).

   (iii). Keep the reversing key R in a position so that current flows in a given direction. The rheostat position should correspond to maximum resistance.

iv). Switch on the current.

v). Vary the current using the rheostat from 0A ± 1.5A and back 1.5A ± 0A in steps of 0.1A and note the deflections $_1$&$_2$ for each setting of current.

vi). Reverse the position of the reversible key R and vary the current in the reverse direction 0A ± 1.5A, and back 1.5A ± 0A.

vii). Reverse the position of the key R and vary the current from 0 ± 1.5A. Again, note the deflections $_1$&$_2$

Observations

1. Distance, r = ______________________________ m
2. Length of specimen, *l* = _____________________ m
3. No. of turns per unit length of solenoid, n = 1600 turns/m.
4. Area of cross-section of rod, S = 1.84 x 10^{-5} m^2.
5. Horizontal component of earth's magnetic field, BE = 3.53 x 10^{-5} T.

Sr. No	Area of B-H loop in term of no. of small square inside the loop (a)	Lag a	B max	Log B max
1. 2. 3. 4.				

Calculations:

1. Attach graph of Tan□ vs. I.
2. cf = ________________________
   dg = _______________________
3. Calculation of retentivity M_O:

   Calculation of coercivity B_O:

Precaution:

1. All connection should be as per diagram, proper and tight.
2. B-H loop should be clear.
3. CRO should be operated carefully.
4. Knob of horizontal and vertical gains should not be disturbed throughout the experiment.
5. Ac supply should be switched on while taking the observation else it should be switched off.

Results:

Retentivity M_O = _________________

Coercivity B_O = __________________

Experiment: 3

AIM:

To find the velocity of ultrasonic wave sin a given liquid (say kerosene oil).

APPARATUS:

A glass cell, kerosene oil, quartz crystal slab fitted with two leads, ultra-sonic spectrometer, convex lens, sodium amp, radio frequency oscillator with frequency measuring meter, spirit level etc.

Formula Used:

d $\sin\theta_n = n\lambda$

Where $\lambda \rightarrow$ wavelength of sodium light

d $\rightarrow$ distance between two nodal or anti nodal waves

$\theta_n \rightarrow$ angle of diffraction for nth order$\rightarrow$ 1, 2, 3 etc. i.e. order of spectrum

If λ_m is the wavelength of ultrasonic through the medium, then

$$d = \lambda m / 2 \quad = 2Nd$$

The above method is useful for determination of velocity of ultrasonic waves through liquid sand gases at various temperatures.

$$n\lambda m = \frac{\lambda D}{D_n}$$

About experiment:

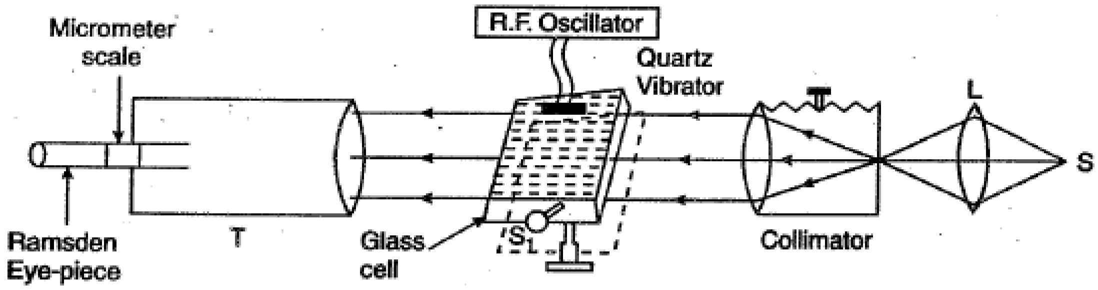
We can find the velocity of sound in a liquid (say kerosene oil) using ultrasonic.

A quartz crystal Q is placed between two metal plates. These two plates are connected to an audio frequency oscillator whose frequency so adjusted that the crystal vibrates in resonance with the oscillator. Due to longitudinal compression and rarefactions of the waves, ultrasonic are produced. Those waves are reflected by the reflector R (figure1). Dueto superposition of the forward are reflected waves longitudinal stationary waves are produced in the medium and consequently fixed values of node sand anti node scan be assigned. At nodes density is maximum and at anti nodes density is minimum. The arrangement is just similar to diffraction grating and so is called acoustic grating. The ultrasonic spectrometer is just like an optical spectrometer the following three parts.

a) A Collimator. It is brass tube with a fine adjustable slit at one end and an achromatic convex lens at the other end fitted with a rock and pinion arrangement.

b) A telescope. It consists of an objective of large focal length and aeye piece provided with a horizontal micrometer scale.

c) A table. The cell containing the experimental liquid is placed on the table. Which is fitted with as crew $S_1$to give it a horizontal motion and a screw $S_2$to give it a vertical motion.



PROCEDURE:

1) Make these of the telescope and collimator of the ultrasonic spectrometer in the same way as is done in case of optical spectrometer.
2) Place the glass cell containing the experiment all the spectrometer tablewith its opposite parallel sides facing the telescope and the collimatorrespectively.
3) Mount the quartz crystal slab in its holder and intothe liquid near a wall of the glass cell so that the ultrasonic waves produced by the crystal travel in the liquid in a direction perpendicular to that of the incident light. Connect the leads of the crystal slab with the output terminals of the R.
4) Put the quartz crystal in its holder and place it in the liquid near a wall of the glass cell so that the ultrasonic produced by the crystal move perpendicularly to the direction of incident light. Make the connection of R.F. oscillator with the leads of crystal slab.
5) Focus the light from sodium lamp on the slit collimator. Look through the telescope eye-piece and get a wall defined image of the slit at the Centre of the micrometer scale fitted in the eye-piece of the telescope.
6) Switch on the R.F. Oscillator so that the ultrasonic waves are produced in the liquid. the adjustment of frequency from the oscillator so that it becomes equal to the natural frequency of the crystal slab and resonance takes place and diffraction image soft the slit will be visible through the telescope.
7) Note down the distance of various order diffraction image on both sides of the central zero using the micrometer scale of the eye piece of telescope.
8) Also measure the distance D between the objective lens of telescope and the crosswire (micrometer scale). It will correspond to the focal length of the objective lens and is normally provided by the manufacture of the instrument.

PRECAUTIONS:

1. The diffraction pattern should be sharp and narrow.
2. The glass cells could be thoroughly cleaned and filled with the liquid.
3. The crystal slab should be setin such away that the ultrasonic waves produced by ittravel be kept constant during the experiment.

OBSERVATIONS:

Wavelength of Sodium light□ □□= 5893x 10^{10}m

Room temperature=° …………C

Distance D =………………. cm

Frequency of the oscillator usedv=……Hz

Least count of the micrometer scale..….mm

Sr. No.	Order of diffraction maxima N	Position of diffracted image in cm						$dn = \frac{x-y}{2}$	$\frac{d_n}{n}$ cm
		Left of central image			Right of central image				
		Main scale	Vernier scale	Total	Main scale	Verniersca le	Totally		
1									
2									
3									
4									
5									

RESULT:

Experiment: 4

Aim:

To study the Hall effect in semiconductors and determine

(A) Hall coefficient and hall voltage

(B) No. of charge carriers / unit volume

(C) Hall mobility and Hall angle.

Apparatus Required:

Hall probe (n type or p type), Hall effect setup, Electromagnet, constant current power supply, gauss meter etc.

Formula:

Hall coeff. $R_H = \frac{V_H d\times10^{-8}}{Bl} cm^{-3}$

V_H=Hall voltage in volt

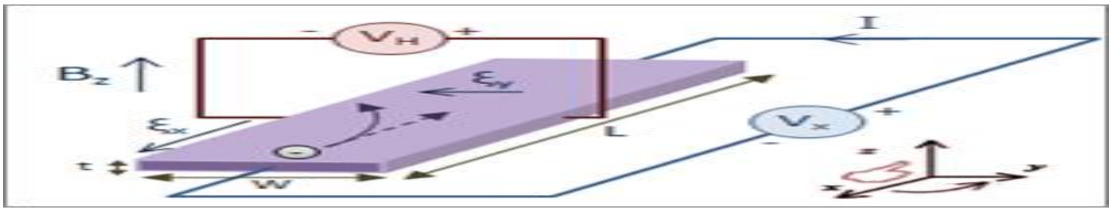
D= thickness of Ge wafer in cm

B= magnetic flux density in gauss

I = Current through the material

About experiment:

Hall effect: When a current carrying conductor is placed in a transverse magnetic field, a potentialdifference is developed across the conductor in a direction perpendicular to both the current and the magnetic field.



Procedure:

1. Connect the width wise contacts of the hall probe to the terminals marked as „voltage‟
2. Switch on the Hall Effect setup and adjust the current say 0.2 mA.
3. Switch over the display in the Hall Effect setup to the voltage side.
4. Now place the probe in the magnetic field as shown in fig and switch on the electromagnetic power supply and adjust the current to any desired value. Rotate the Hall probe until it become perpendicular to magnetic field. Hall voltage will be maximum in this adjustment.
5. Measure the hall voltage and tabulate the readings.

6. Measure the Hall voltage for different magnetic fields and tabulate the readings.
7. Measure the magnetic field using Gauss meter.
8. From the data, calculate the Hall coefficient, carrier mobility and current density.

Calculation:

Hall coefficient $R_{H=\{\frac{V_H}{I}\}\times\frac{d}{a}\times 10^8 cm^{-3}/c}$

Observation:

Table Measurement of Hall coefficient

current in the Hall effect setup =. mA

Current in the constant current power supply (A)	magnetic field (H) (Gauss)	Hall Voltage (V_H) (volts)	Hall coefficient (R_H) $cm^3\ C^{-1}$

Precautions:

1. Since hall voltage developed is very small, so it should be measured very carefully and the Milli voltmeter used should be quite sensitive.
2. The variations of $V_{H\ w.r.t}$. Ix should be preferred over variation of V_H w.r.t. B_z as it is difficult to measure B_Z very accurately.
3. Find the resistance of the specimen for various values of magnetic fields using the relation $R = V_x/I_x$ as the resistance of the specimen changes with the variation of applied magnetic field due to the variation of mobility of the charge carriers.

Result:

The Hall coefficient of the given semi conducting material =

The carrier density

The carrier mobility

Experiment: 5

Aim:

- To find the resolving power of the prism.
  - $\frac{\lambda}{d\lambda}$= -t$\frac{d\mu}{d\lambda}$= t. $\frac{2B}{\lambda^3}$
  -
  - Where meaningful length $\frac{\lambda_1+\lambda_2}{2}$
  - ii> Resolving power of the prism:
  - =($\frac{d}{d\lambda}$).$\frac{d}{a}$
  - Where d is the length of the base of given and a is the width of aperture for just resolution.

About experiment:

If a spectrograph can just resolve two lines near wavelength with a separation of, the resolving power is defined as

$$\frac{\lambda}{\Delta\lambda}$$

Prism Spectroscopy:

Newton demonstrated in the 1600's that white light passing through a prism could be separated into its different colures. While at that time he believed in the corpuscular theory of light, we know now that these individual colours represent different wavelengths or frequencies. From our introduction to refraction it is to be expected that light of different colours will bed through different angles.
Perhaps the simplest form of astronomical spectroscopy is the objective prism.

Controls

Switches

Switch On/Off Light: Used to switch on/off the light.
Place Prism/Remove Prism: This switch used to place the prism on the prism table or remove prism from the prism table.

Slider

Slit focus: This slider used to focus the slit while looking through telescope.
Slit width: Using this slider, width of the slit can be adjusted.
Telescope: Using this slider one can move the telescope from its position.
Vernier Table: Vernier table can be rotate using this slider.

Fine Angle adjustment

Telescope: This is used to fine adjust the telescope.
Vernier Table: Using this slider, we can rotate fine angle.

Measurements

Here we get the zoomed view of Vernier I and II by placing mouse pointer over it.

Procedure:

1. Turn the telescope towards the white wall or screen and looking through eye-piece, adjust its position till the cross wires are clearly seen.
2. Turn the telescope towards window, focus the telescope to a long distant object.
3. Place the telescope parallel to collimator.
4. Place the collimator directed towards sodium vapor lamb. Switch on the lamp.
5. Focus collimator slit using collimator focusing adjustment.
6. Adjust the collimator slit width.
7. Place prism table, note that the surface of the table is just below the level of telescope and collimator.
8. Place spirit level on prism table. Adjust the base levelling screw till the bubble come at the centre of spirit level.
9. Clamp the prism holder.
   Clamp the prism in which the sharp edge is facing towards the collimator, and base of the prism is at the clamp.

Least Count of Spectrometer

One main scale division (N) =...............minute
Number of divisions on Vernier (v) = ...

L.C $= \frac{N}{v}$ = ...minute

To determine the Angle of minimum deviation:

Direct method

1. Rotate the prism table so that the light from the collimator falling on one of the faces of the prism and emerges through the other face.
2. The telescope is turned to view the refracted image of the slit on the other face.
3. The Vernier table is slowly turned in such a direction that the image of slit is move directed towards the directed ray; i.e., in the direction of decreasing angle of deviation.
4. It will be found that at a certain position, the image is stationary for some moment. Vernier table is fixed at the position where the image remains stationary.
5. Note the readings on main scale and Vernier scale.
6. Carefully remove the prism from the prism table.
7. Turn the telescope parallel to collimator, and note the direct ray readings.
8. Find the difference between the direct ray readings and deviated readings. This angle is called angle of minimum deviation (D).

To determine the Resolving power of prism:

1. Rotate the Vernier table so as to fall the light from the collimator to one face of the prism and emerged through another face. (refer the given figure).
2. The emerged ray has different colures.
3. Turn the telescope to each colour, and note the readings for different colours.

4. Remove the prism, hence note direct ray reading.
5. Find the angle of minimum deviation for different colour. (Say, violet, blue, green, yellow).
6. Find the refractive index for these colures. Using equation **(3).**
7. Resolving power for yellow and blue

$$\omega = \frac{n_b - n_y}{n - 1}$$

,

$$n = \frac{n_b + n_y}{2}$$

Where n_b and n_y are the refractive index of blue and yellow, and

Line	Vernier	Refracted ray readings	Direct readings	Difference (Minimum Deviation)	Mean D	n
	v_1					
	v_2					
	v_1					
	v_2					
	v_1					
	v_2					
	v_1					
	v_2					

Refractive index for the line _________ n1 =
Refractive index for the line _________ n2 =

Average refractive index n = $\frac{n1 + n2}{2}$

Resolving power for ______ and ______ line ω = $\frac{n2 - n1}{n - 1}$ =

Result:

Angle of the Prism =

Angle of minimum deviation of the prism =

Refractive index of the material of the prism =

Experiment: 6

Aim:

Study the double slit experiment by He-Ne laser.

Apparatus:

He-Ne laser source, two uprights with micro meter, laser screen, graph paper, optical bench of laser source etc

Formula used:

The wavelength of He-Ne laser is given by the formula:

$\lambda = \beta\, d/D$

Where β = fringe width

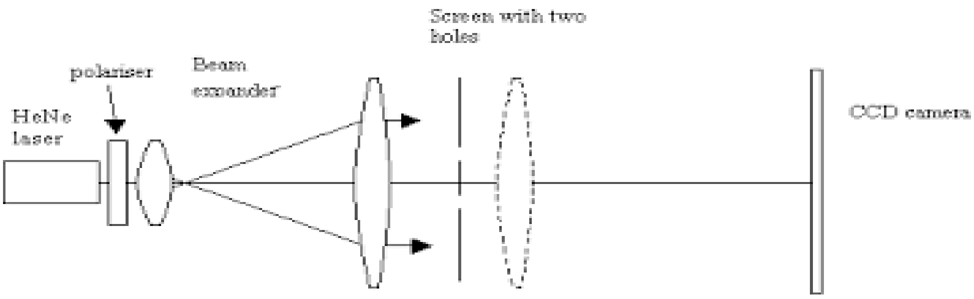
D = Distance between slit and the screen

λ = wavelength of He-Ne laser source (=6328 A)

d = distance between two slits.

About experiment:

The acronym LASER stands for "Light Amplification through Stimulated Emission of Radiation". n a double-slit experiment, He-Ne laser light of wavelength 633 nm produced an interference pattern on a screen placed at some distance from the slits. When one of the slits were covered with a thin glass slide of thickness 12.0 µm, the central fringe shifted to the point occupied earlier by the 10th dark fringe.



Procedure:

1. Mount the double slits on the uprights and place near the laser.
2. Adjust the position of the screen and the double slit to get a clear parallel fringe pattern on the screen.
3. note the fringe pattern on the graph paper from the screen.
4. Find the distance between the slit and screen and also find the distance between the two slits.
5. Now change the distance between the source and the slits and record theformed on

the screen.

6. After recording the pattern find the distance between every two-consecutive pattern.

Observations Table:

S. No.	Fringe width β cms.
1 2 3 4	β1= β2= β3= β4=

S. No.	Fringe width β2 cms.
1 2 3 4	β1= β2= β3= β4=

Calculations:

Mean $\beta = (\beta 1 + \beta 2 + \beta 3 + \beta 4) / 4$ (For I case)

Mean $\beta = (\beta 1 + \beta 2 + \beta 3 + \beta 4) / 4$ (For II case)

For case I: $\lambda 1 = \beta\ d1 / D$ λ = ….cms.

For case II: $\lambda = \beta\ d2 / D$ λ = ….cms.

Precautions:

1 The slit must be narrow and close to each other as laser beam is very thin.

2 Keep the distance of the screen on the eyepiece from the slit sufficiently large to observe measurable fringe width.

3 slit should be adjusted for a vertical position and very near the beam coming from the laser source.

Result:

The wavelength of Laser beam is …….

Experiment: 7

Aim:

Determine the resolving power of grating.

Apparatus:

Spectrometer, diffraction grating, mercury light source, high voltage power supply, magnifying lens, spirit level, torch light, etc.

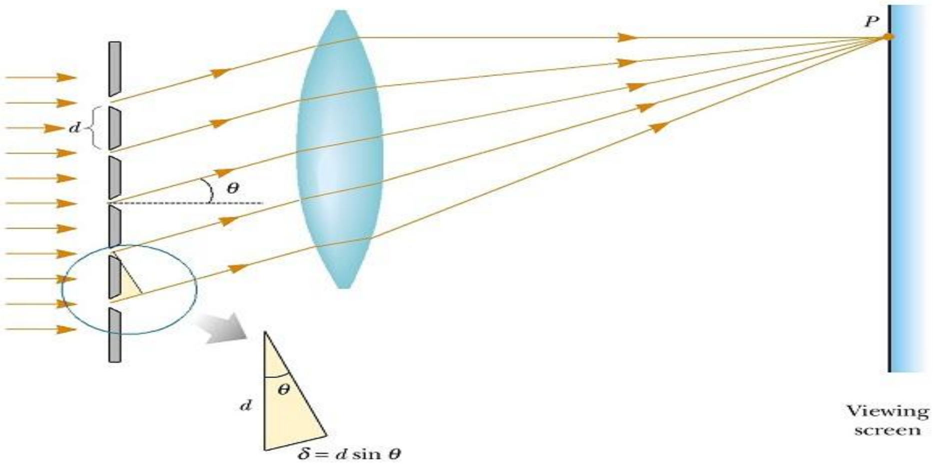
Formula used:

$=\frac{\lambda}{d\lambda}$

Where $d\lambda$ =difference in wavelength of the two spectral line to be resolved and λ =mean wavelength.

About experiment:

The **diffraction grating**, a useful device for analysing light sources, consists of a large number of equally spaced parallel slits. A **transmission grating** can be made by cutting parallel lines on a glass plate with a precision ruling machine. The spaces between the lines are transparent to the light and hence act as separate slits. A **reflection grating** can be made by cutting parallel lines on the surface of a reflective material. The reflection of light from the spaces between the lines is specular, and the reflection from the lines cut into the material is diffuse. Thus, the spaces between the lines act as parallel sources of reflected light, like the slits in a transmission grating.



Procedure:

1. **Telescope Calibrate Slider:** This slider helps the user to change the focus of telescope.
2. **Start Button**: Helps the user to start the experiment after setting the focus of telescope. The Start Button can be activated only if the focus of the telescope is proper.
3. **Light Toggle Button:** Helps the user to switch the lamp ON or OFF.
4. **Grating Toggle Button:** Helps the user to place or remove the grating.
5. **Telescope Angle Slider:** This slider helps the user to change the angle of telescope.
6. **Vernier Angle Slider:** This slider helps the user to change the angle of the Vernier.

7. **Telescope Angle Slider:** Helps make minute changes of the telescope angle.
8. **Calibrating Telescope Button:** Helps the user to calibrate the telescope after starting the experiment, if needed.

Observation:

Spectrum order	Sr. No.	Reading on left side			Reading on right side			Mean d in Cm $\frac{d+a'}{2}$	
		Micro Meter reading for just resolution Micro Meter reading for zero intensity b(in cm) d=a-b (in cm) Slit width for limiting resolution (in cm)			Micro Meter reading for just intensity a' b(in cm) Micro Meter reading for zero resolution Slit width for limiting resolution d''=a'-b'				
1st	1 2 3								
2nd	1 2 3								

Calculation:

(i) Resolving power of grating for width d1=n.N$d_{1=n.N_{0=1\times N_0}}$

(ii) Resolving power of grating for width$d_{2=\mathrm{n.N}d_{1=n.N_{0=1\times N_0}}}$.

Precaution:

1. While setting of the spectrometer, collimator and telescope should to set for parallel rays.
2. The grating setting is very carefully.

Result:

Experiment: 8

AIM:

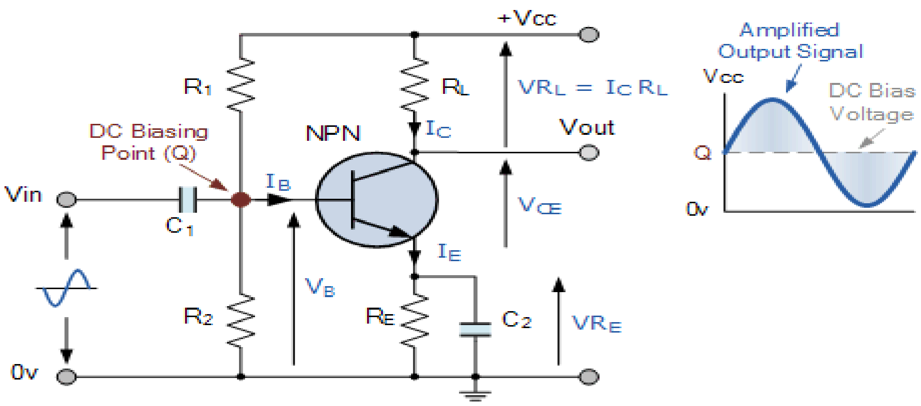
Study the CB Transistor amplifier.

APPARATUS:

CRO, CB Kit, Function Generator, Multi meter, Connecting Wire.

About experiment:

The circuit of a single-stage CB amplifier using NPN transistor. As seen, input ac signal is injected into the emitter-base circuit and output is taken from the collector-base circuit. The E/B junction is forward-biased by VEE whereas C/B junction is reverse-biased by VCC. The Q-point or dc working conditions are determined by dc batteries along with resistors RE and RC. In other words, values of IE, IB and VCB are decided by VCC, VEE, RE and RC. The voltage VCB is given by the equation VCB= VCC – ICRC. When no signal is applied to the input circuit, the output just sits at the Q-point so that there is no output signal. Let us now see what happens when we apply an ac signal to the E/B junction via a coupling capacitor C1 (which is assumed to offer no reactance to the signal).



PROCEDURE:

1. Connect the wire in
2. Measure Ic and Ie.
3. Draw output waveform on graph paper.
4. Give an input to the amplifier so that the output is 4Vpp at 1 kHz Measure the input voltage (f=1 kHz).
5. Give an input of 0.5V p-p to the amplifier.

Observation:

Sr. No.	Input signal voltage (in mV) V1	Amplified output voltage V2(in mV)	Voltage gain Av=Vo/V1
1 2 3			

Sr. No.	I/p signal freq. (HZ)	log10f	Output voltage V (in mV0)	Volta. gain Av=Vo/V1
1	50			
2	100			
3	150			
4	200			
5	:			
6	:			
7	300			
8	400			
9	500			
10	:			
11	:			
12	1000			
13	1500			
14	2500			
15	:			
16	:			
17	6000			
18	7000			
19	8000			
20	10000			

Precautions:

1. All connection should be tight.
2. Biasing should be proper.
3. Input signal should be few mV only.

Result:

Maximum voltage gain Av (Max) =.........................

0.707 of AV (max)=...........................

From frequency gain plot, =...........................

Higher cut off frequency, v2 =...........................Hz

Lower cut off frequency, v1 =...........................Hz

Bandwidth = V2-V1

Experiment: 9

Aim:

To determine the energy band gap of a semiconductor (germanium) using four probemethod.

Apparatus Required:

Probes arrangement (it should have four probes, coated with zinc at thetips. The probes should be equally spaced and must be in good electrical contact with the sample), Sample (germanium or silicon crystal chip with non-conducting base), Oven (for the variation of temperature of the crystal from room temperature to about 200^{0}C), A constant current generator (open circuit voltage about 20 V, current range 0 to 10 mA), Millivoltmeter (range from 100mV to 3V, electronic is better.), power supply for oven, thermometer.

Formula Used:

The energy band gap, E_g, of semiconductor is given by

$$Eg=\frac{0.396 log_{10}(p)}{\frac{1000}{T}} eV$$

For function f (W/s) refer to the data table given in the calculations. S is the distance between the probes and W is the thickness of semi conducting crystal. V and I are the voltages and current across and through the crystal chip.

About experiment:

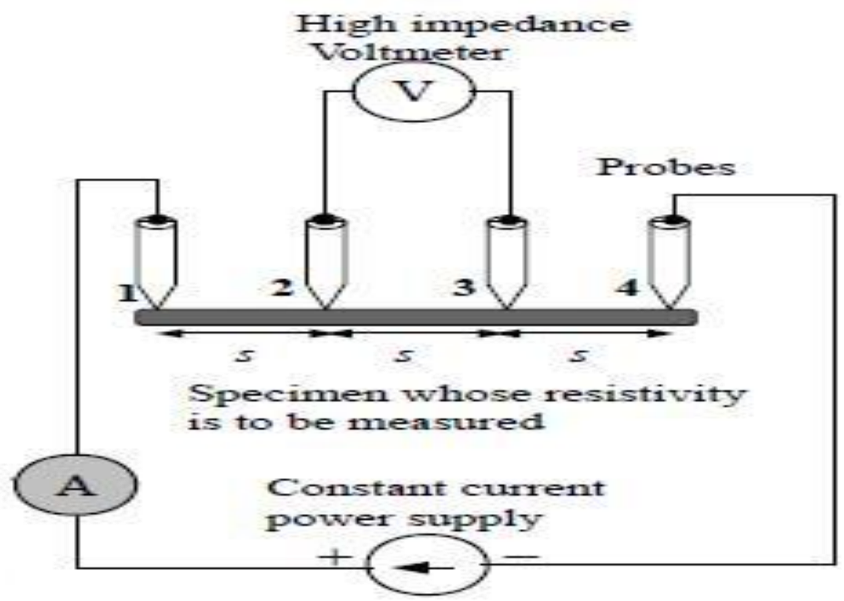
At a constant temperature, the resistance, R of a conductor is proportional to its length L and inversely proportional to its area of cross section A.

$$R = \rho \frac{L}{A}$$

Where ρ is the resistivity of the conductor and its unit is ohmmeter.

A semiconductor has electrical conductivity intermediate in magnitude between that of a conductor and insulator. Semiconductor differs from metals in their characteristic property of decreasing electrical resistivity with increasing temperature.

According to band theory, the energy levels of semiconductors can be grouped into two bands, valence band and the conduction band. In the presence of an external electric field it is electrons in the valence band that can move freely, thereby responsible for the electrical conductivity of semiconductors. In case of intrinsic semiconductors, the Fermi level lies in between the conduction band minimum and valence band maximum. Since conduction band lies above the Fermi level at 0K, when no thermal excitations are available, the conduction band remains unoccupied. So, conduction is not possible at 0K, and resistance is infinite. As temperature increases, the occupancy of conduction band goes up, thereby resulting in decrease of electrical resistivity of semiconductor.



Procedure:

1. Select the semiconductor material from the combo box.
2. Select the source current from the slider. Restrict the slider based on the range of current.
3. Select the Range of oven from the combo box.
4. Set the temperature from the slider.
5. Click on the Run Button to start heating the oven in a particular interval, from the default 25^0C to the temperature that we set already Click on the Wait button to stop heating.
6. Click on the Set button to display the temperature that we set in the oven.
7. Click on the Measure button to display the present temperature in the oven.
8. Select the range of voltmeter from the combo box.
9. Measure the Voltage using Voltmeter.
10. Calculate the Resistivity of semiconductor in eV for the given temperature using equation (2) and (3).
11. A Graph is plotted with Temperature along x-axis and resistivity of semiconductor along y-axis.

Precautions:

1. The resistivity of the material should be uniform in the area of measurement. The surface on which the probes rest should be flat with no surface leakage.
2. The diameter of the contact between the metallic probes and the semiconductor crystal chip should be small compared to the distance between the probes.

Observations:

(i) Distance between probes (s) = ……mm

(ii) Thickness of the crystal chip (W) = ……mm
(iii) T and V for current (I) = ……. mA (constant

S.No.	Temperature		Voltage V in volts
	In 0 C	in K	
1			
2			
3			
4			
5			
6			

Calculations:

First find resistivity, ρ, corresponding to temperatures in K using the relation:
$\rho = \rho_o / f(W/s)$, Where ρ_o
= V / I x …. ohms.
Corresponding to different values of V, there will be different values of ρ_o. Find them after putting for I and s from the table.
Finally plot a graph in ($1/T \times 10^3$) and $\log_{10} \rho$ as in fig. Find the slope of the curve AB/BC = $\log_{10} \rho / (1/T) \times 1000$
So, the energy band gap of semiconductor (germanium) is given by: $E_g = 2k. 2.3026 \times \log_{10} \rho / 1$

Result:

Energy band gap for semiconductor (….) is E_g= ………. eV

Experiment: 10

Aim:

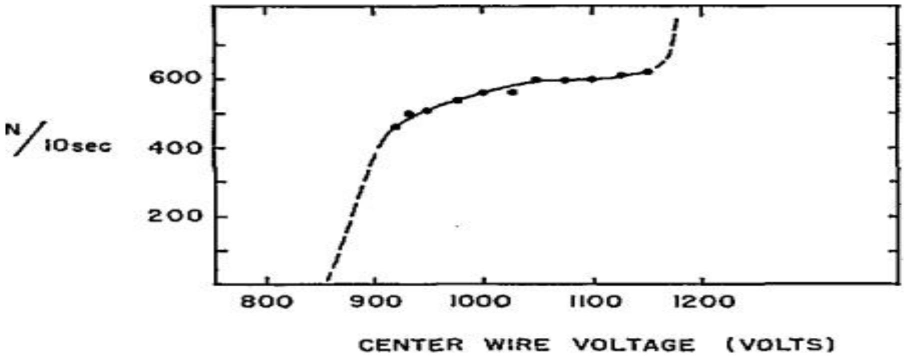
Draw the plateau curve using GM counter.

Apparatus:

Geiger-Muller counter, Radioactive Source

About experiment:

Geiger-Muller (GM) counters were invented by H. Geiger and E.W. Muller in 1928, and are used to detect radioactive particles. A typical GM Counter consists of a GM tube having a thin end window (e.g. made of mica), a high voltage supply for the tube, a scalar to record the number of particles detected by the tube, and a timer which will stop the action of the scalar at the end of a pre-set interval. The sensitivity of the GM tube is such that any particle capable of ionizing a single atom of the filling gas of the tube will initiate an avalanche of electrons and ions in the tube. The collection of the charge thus produced results in the formation of a pulse of voltage at the output of the tube. The amplitude of this pulse, on the order of a volt or so, is sufficient to operate the scalar circuit with little or no further amplification. The pulse amplitude is largely independent of the properties of the particle detected, and gives therefore little information as to the nature of the particle. Even so, the GM Counter is a versatile device which may be used for counting alpha particles, beta particles, and gamma rays, albeit with varying degrees of efficiency.0



Procedure:

1. Plug in the transformer/power supply into any normal electricity outlet and into the back of the ST-360 box. Next, remove the red or black end cap from the GM tube VERY CAREFULLY.
2. Turn the power switch on the back of the ST-360 to the ON position, and double click the STX software icon to start the program. You should then see the blue control panel appear on your screen.
3. Go to the Setup menu and select the HV Setting option. In the High Voltage (HV) window, start with 700 Volts. In the Step Voltage window, enter 20. Under Spectrum Techniques Student Lab Manual 15 Enable Step Voltage, select on (the default selection is off).
4. 4. Go under the Pre-set option and select Time. Enter 30 for the number of seconds and choose OK. Then also under the Pre-set option choose Number of Runs. In the window, enter 26 for the number of runs to make.
5. You should see a screen with a large window for the number of Counts and Data for all the runs on the left half of the screen. On the right half, you should see a window for the Pre-set Time, Elapsed Time, Runs Remaining, and High Voltage. If not, go to the view option and select Scaler Counts.
6. Make sure no other previous data by choosing the Erase All Data button (with the red “X” or press F3). Then select the green diamond to start taking data.
7. When all the runs are taken, choose the File menu and Save As. Then you may save the data file anywhere on the hard drive or onto a floppy disk.
8. You can repeat the data collection again with different values for step voltage and duration of time for counting. However, the GM tubes you are using are not allowed to have more than 1200 V applied to them. Consider this when choosing new values.

Observation Table:

Voltage (V)	Count	Count rate

Precaution:

1. Skin dose main external hazard. Call EHS if skin is contaminated. High skin dose can occur in a short period of time. For example - 1 µCi on skin for 8 hrs = over NRC ANNUAL skin dose limit of 50,000 mrem. Personal surveys are vital.
2. Use of safety glasses is important when working with 32P. Safety glasses serve as aRadiations held against the 32P betas as well as providing splash protection
3. Wear double gloves and change gloves often.

Result:

Experiment: 11

Aim:

Determination of Young's modulus of the material of a wire by Searle's method:

Apparatus:

Searle's apparatus, screw - gauge, slotted weights, metre scale etc.

Formula used:

Within elastic limit, stress proportional to strain. Now, Young's.

Now, Young's modulus

Y=Stress/Strain =Mg/(πr^2)/(l/L)

Where Y= Young's modulus

L cm = length of the wire;

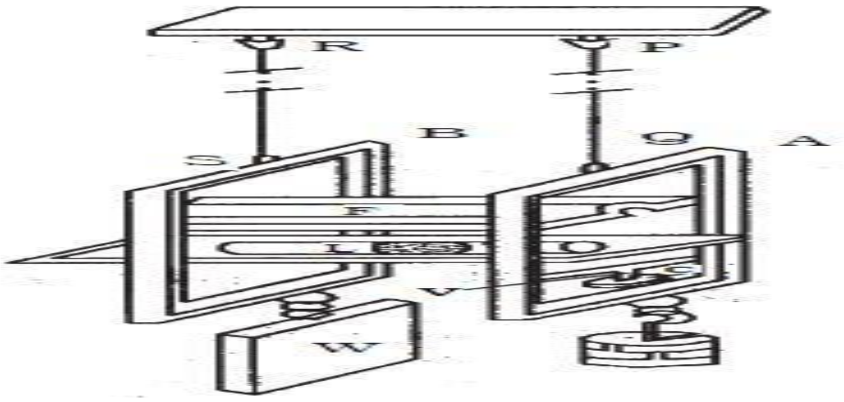
M gm = load applied;

l cm= elongation of the wire;

d cm – diameter of the wire.

About experiment:

Searle's apparatus consists of two metal frames F1 and F2. Each frame has a torsion head at the upper side and a hook at the lower side. These frames are suspended from two wires AB and CD of same material, length and cross-section. The upper ends of the wires are screwed tightly in two torsion heads fixed in the same rigid support. A spirit level rests horizontally with one end hinged in the frame F2. The other end of the spirit level rests on the tip of a spherometer screw, fitted in the frame F1. The spherometer screw can be rotated up and down along a vertical pitch scale marked in millimetres. The two frames are kept together by cross bars E1 and E2.



Procedure:

1. With the help of a screw gauge, measure the diameter (d) of the wire A. This measurement is to be taken, at least, at five different places of the wire and in mutually right-angle directions at each place. Fromtheseobservations, mean diameter to be calculated. Then compute the value of the cross-sectional area ($\pi d^{2}/4$) of the wire A.
2. Multiplying the cross-sectional area by the breaking stress of the material of the wire (to be supplied), breaking weight may be obtained. It is to be noted that the total load placed on the scale-pan attached to the frame-work M_1 should, under no circumstances, exceed half the breaking weight. For example, if the breaking weight be 14Kg, the maximum permissible load is 7Kg.

3. Put the maximum permissible load (say, 7Kg) on the hook of the frame-work M_1. Allow the wire to remain stretched for some time Then, keeping a small weight (say, 1Kg) on the hook, remove the others. This small weight left on the hook will keep the wire A free from kinks. It is called dead-load.
4. With the help of a long wooden rod and metre scale, ascertain the length of the wire A from T_1 to N_1. Repeat the measurement, at least, thrice and find the mean length (L.)
5. Now turning the micrometer screw, bring the bubble at the centre of the spirit level. Take care that the micrometer screw is rotated always in the same direction; otherwise back –lash error will come in. Note the readings of the linear scale and the circular scale. This is the initial reading.
6. Divide the additional permissible load (over and above the dead-load) that may be put on the hook of the frame –work M_1 (for example , 7kg -1kg=6kg) in to 10 or 12 equal instalments , each of $^1/_2$ kg or 1kg (1 kg instalment is preferable if the load is large while$^1/_2$ kg instalment in the case where the load is comparatively smaller).Now , go on putting weights by steps of $^1/_2$ kg or 1kg over the dead-load till the maximum permissible load is reached . At every step, the bubble of the spirit level will be displaced due to the elongation of the wire A but at every step, the bubble is to be brought back at the centre by turning the micrometer screw always in the same direction. The readings of the linear scale and the circular scale are also to be noted.
7. Now remove the $^1/_2$ kg (or ,1kg) weights from the hook, one by one and read the linear and circular scales at every step after bringing the bubble at the centre. This will give two readings for each load-one while the loads were increasing and the other while they were decreasing. Find the mean value of these two readings in each case. From these readings, different loads and corresponding elongations can be found out.
8. Draw a graph plotting the additional load (except the deadload) expressed in kilogram along the X-axis and the elongation of the wire expressed in centimeter along the Y-axis. Origin should be the (0,0) point. The graph will be a straight line passing through the origin []. Take any convenient point P on the straight line and draw PM perpendicular on the C-axis. Find from the graph the value of the load OM and the corresponding elongation PM.
9. Substitute these values in the equation mentioned in the theory and calculate the value of Young's modulus.

Observations:

To find the diameter of the wire using a screw gauge.
Distance moved by the screw for 4 rotations, x =………mm

Pitch of the screw, P =………….. mm

Number of divisions on the circular scale, N=................

Least Count (L.C) of the screw gauge =……………………….mm

Zero Correction, z =……………………. dvs

S.No	PSR(mm)	HSR (div)	Corrected HSR=HSR+z(div)	Total Reading= (PSR+ (corrected HSR $\times$ L.C)) mm
Mean Diameter, d				

Calculations:

Mean extension for 2 kg load, l = …………..x10^{-3}m
Load, M = 2 kg

Young's modulus, $Y = \frac{MgL}{\pi r^2 l}$

= …………………………Nm^{-2}

Result:

The Young's modulus for the material of the wire as determined by Searle's apparatus, Y = ………………Nm^{-2}

Experiment: 12

Aim:

To study the Common Emitter (CE) Transistor Amplifier

Apparatus:

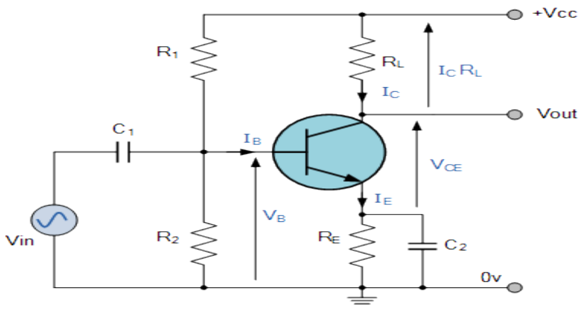
CRO,CE Kit, Function Generator, Multi meter, Connecting Wire

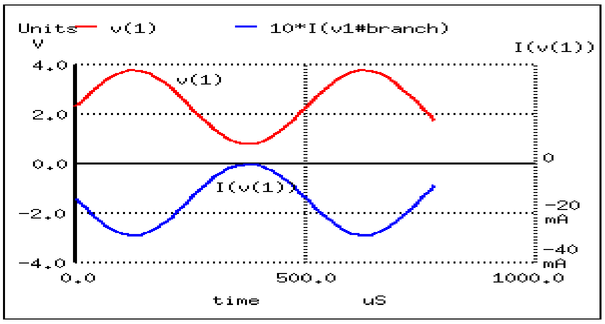
Formula used:

Voltage gain (Av) = Output voltage (VO)/Input Voltage (Vi)

About experiment:

The circuit of a single-stage CE amplifier using an NPN transistor. Here, base is the driven element. The input signal is injected into the base emitter circuit whereas output signal is taken out from the collector emitter circuit. The E/B junction is forward biased by VBB and C/B junction is reversed-biased by VCC (in fact, same battery VCC can provide dc power for both base and collector. The Q-point or working condition is determined by VCC together with RB and RC.





Procedure:

1. Connect the wire in
2. Measure Ic and Ie.
3. Draw output waveform on graph paper.
4- Give an input to the amplifier so that the output is 4Vpp at 1 kHz Measure the input voltage (f=1 kHz).
5- Give an input of 0.5V p-p to the amplifier.

Observation table:

Sr. No.	Input signal voltage(in mV)V1	Amplified o/P volt. V2(in mV)	Voltage gain Av=Vo/V1
1 2 3			

Sr. No.	Input signal frequency(HZ)	log10f	O/P voltage V(in mV0)	Voltage gain Av=Vo/V1
1	50			
2	100			
3	150			
4	200			
5	:			
6	:			
7	300			
8	400			
9	500			
10	:			
11	:			
12	1000			
13	1500			
14	2500			
15	:			
16	:			
17	6000			
18	7000			
19	8000			
20	10000			

Precautions:

1. All connection should be tight.
2. Biasing should be proper.
3. Input signal should be few mV only.

Result:

Maximum voltage gain Av (Max) =.........................

0.707 Of AV (max)=...........................

From frequency gain plot, =...........................

Higher cut off frequency, v2 =...........................Hz

Lower cut off frequency, v1 =...........................Hz

Bandwidth = V2-V1

Experiment: 13

Aim:

To find the wavelength of Sodium light by Fresnel's bi-prism experiment.

Apparatus used:

Optical bench with uprights, sodium lamp, bi-prism, convex lens, slit and micro-meter eye piece are already fitted on the optical bench.

Formula used:

The wavelength λ of the sodium light is given by the formula in case of bi-prism experiment. $\lambda = \beta\, 2d / D$

Where β = fringe width,

2d = distance between the two virtual sources,

D = distance between the slit and screen.

Again $2d = \sqrt{(d_1 d_2)}$

Where d_1 = distance between the two images formed by the convex lens in one position.

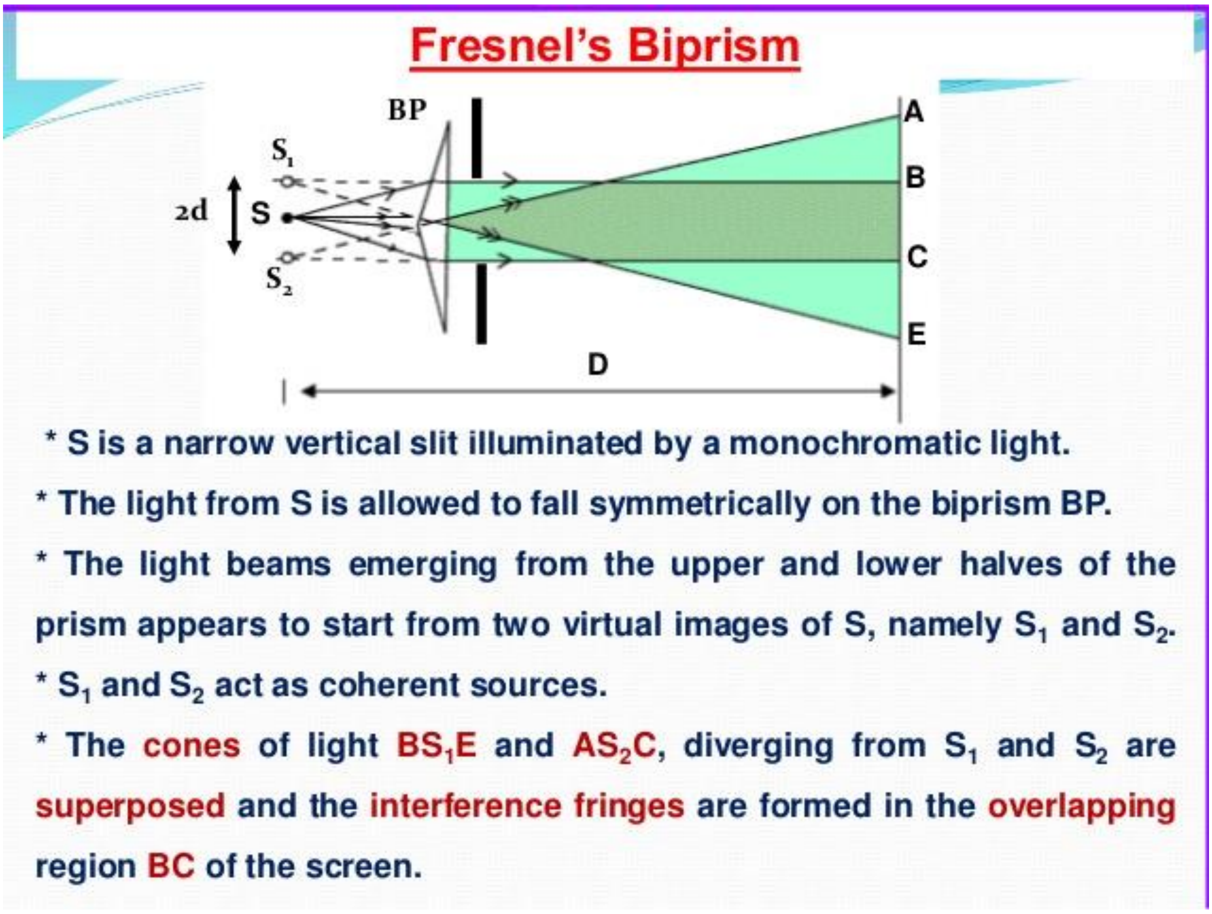
d_2 = distance between the two images formed by the convex lens in the second position.

About experiment:

Two coherent sources, from a single source, to produce interference pattern are obtained with the help of a Bi-prism. A bi-prism may be regarded as made up of two prisms of very small refracting angles placed base to base. In actual practice a single glass plate is suitably grinded and polished to give a single prism of obtuse angle 170 0 leaving remaining two acute angles of 30' each.

The optical bench used in the experiment consists of a heavy cast iron base supported on four levelling screws. There is a graduated scale along its one arm. Te bench is provided with four uprights which can be clamped anywhere and the position can be read by means of Vernier attached to it. Each of the uprights is subjected to the following motions: i) Motion along bench ii) Transverse motion iii) Rotation about the axis of the up[right. iv) With the help of the tangent screw, the slit and bi-prism can be rotated in their own vertical planes.

Monochromatic light source S falls on two points of the prism and is bent towards the base. Due to the division of wave front, the refracted light appears to come from S1 and S2. The waves from two sources unite and give interference pattern. The fringed are hyperbolic, but due to high eccentricity they appear to be straight lines in the focal plane of eyepiece.



Procedure:

1. Level the bed of optical bench with the help of spirit level and levelling screws
2. The slit, Bi-prism and eye-piece are adjusted at the same height. The slit and the cross wire of eye piece are made vertical.
3. The micrometer eye piece is focused on cross wires.
4. With an opening provided to cover the monochromatic source, the light is allowed to incident on the slit and the bench is so adjusted that light comes straight along its lengths. This adjustment is made to avoid the loss of light intensity for the interference pattern.
5. v) Place the bi-prism upright near the slit and move the eye piece sideways. See the two images of the slit through Bi-prism; if they are not seen, move the upright of Bi prism right angle to the bench till they are obtained. Make the two images parallel by rotating bi-prism in its own plane.
6. Bring the eye piece near to the bi prism and give it a rotation at right angle of the bench to obtain a patch of light. As a matter of fact, the interference fringes are obtained in this patch provided that the edge of the prism is parallel to the slit
7. To make the edge of the Bi prism parallel to the slit, the bi prism is rotated with the help of tangent screw till a clear interference pattern is obtained. These fringes can be easily seen even with the naked eye.

8. The line joining the centre of the slit and the edge of the Bi prism should be parallel to the bed of the bench. If this is not so, there will be a lateral shift and the removal is most important.

Observation:

(A) Measurement of fringe width (β):

i) Find out the least count of the micro meter screw

Pitch of the screw = …. cm.

No. of division the circular head = ….

No. of fringes	Micro-meter reading (in cm)	No. of fringes	Micro-meter reading (in cm)	Separation of 10 bands (in cm) (b-a)
1		11		
2		12		
3		13		
4		14		
5		15		
6		16		
7		17		
8		18		
9		19		
10		20		

Least count of the micro-meter screw = …. cm.

(B)Measurement of d

Without changing the position of the slit, bi-prism and the eye-piece; a convex lens is mounted on the optical bench between the latter two. The distances d1 and d2 between the well-defined images of the two virtual slits S1 and S2 are measured with the micro-meter screw for the two positions of the lens. Then the distance between S1 and S2 is given by

Position of the slit (in cm)	slit (in cm) x Position of eye-piece (in cm) y	Position of lens near the bi-prism (in cm)	* u (z-x) (cm	* v (y-z) (cm)	D (y-x) (cm)	* (u / v) x d1 (cm)

Position of the slit (in cm)	slit (in cm) x Position of eye-piece (in cm) y	Position of lens near the bi-prism (in cm)	* u (z-x) (cm	* v (y-z) (cm)	D (y-x) (cm)	* (u / v) x d1 (cm)

S.No.	Micro-meter readings when lens is near the slit (in cm)		d1 = d - c (in cm)	Micro-meter readings when lens is near the eye-piece (in cm)		d2 = d'-c'	d = √(d1d2) (in cm)
	1 st image c	2nd image d		1 st image c'	2nd image d		

d = √(d1d2) Readings for the determination

[C] Readings for the determination of D

Precautions:

The setting of uprights at the same level is essential.
The slit should be vertical and narrow.

1. Crosswire should be fixed in the Centre of the fringe while taking observations for fringe width.

2. The micrometer screw should be rotated only in one direction to avoid backlash error.
3. The fringe width should be measured at a fairly large distance.
4. Convex lens of shorter focal length should be used (f = 25 cms. approx.)
5. Motion of eyepiece should be perpendicular to the lengths of the bench.

Result:

Mean fringe width for one fringe = ….cm
Value of D = …. cm.
λ= d/ = ………Å.
The wave length of the monochromatic source = (…………. ± Maximum probable error) Å.

Experiment: 14

AIM: -

Determination of the thickness of paper by obtaining fringes in wedge shaped air film.

APPARATUS:

A sodium vapour lamp, a travelling microscope, two microscope slides, a thin paper, a setup consisting of a plane glass plate fixed in holder making an angle of 45 degrees with horizontal direction.

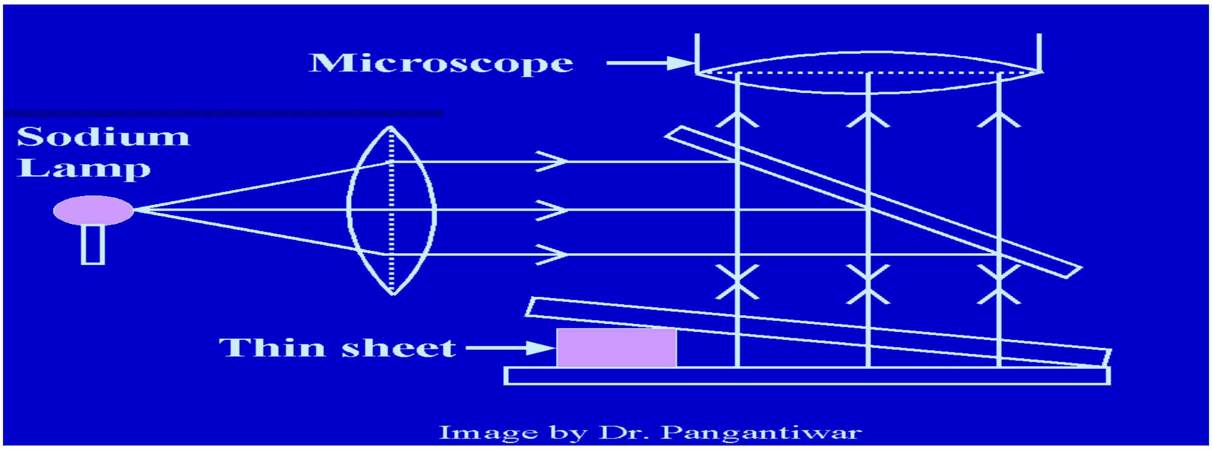
FORMULAE:

i) The fringe width, beta = $(x_2 - x_1) / (N - n)$
ii) The wedge angle, theta = $\lambda / 2b$
iii) The thickness of paper, t = $l \times \theta = (l \times \lambda / (2 \times b) = [l \times \lambda \times (N - n)] / [2 (x_2 - x_1)]$

where, x_1 is the position of n^{th} dark fringe, x_2 is the position of the N^{th} dark fringe, l is the length of the air wedge and lλ is the wavelength of the sodium light used.

About experiment:

If two glass plates are placed face to face with one end separated by a piece of tissue paper or thin metal foil an air wedge will be formed between them. If monochromatic light is shone on the plates a series of straight-line fringes will be seen parallel to the line along which they touch (Figure 1). This is due to interference by division of amplitude, as with Newton's rings. Some light is reflected from the bottom surface of the top plate and some from the top surface of the bottom plate.



PROCEDURE: -

1. Hold your sandwich of plates and tilt it until you see the yellow sodium light reflected brightly.
2. Press the sheets of flat glass tightly together as shown, so that the two inner reflecting surfaces are very close indeed. Hold the plates as if they were a book you are trying to read by the yellow light. You may see a black spot if you squeeze the plates together tightly.
3. Now open the plates and prop them apart at one end with a scrap of very thin paper, forming an air wedge. Hold them tightly clamped together with a bulldog clip at each end.
4. Look for the zebra stripes. If you knew the wavelength of light, what could you estimate by counting the stripes? Focus your eyes directly on the surface of the glass plates, not on the reflection image of the light source farther behind.

OBSERVATIONS: -

a) TO FIND FRINGE WIDTH, beta :

Sr. No	Position of nth dark fringe			Position of (n+N)th dark fringe			N	Fringe width, beta = $[(x_2 - x_1) / N]$ (cm)	Mean beta (cm)
	MSR (cm)	VSD	TR (x_1) (cm)	MSR (cm)	VSD	TR (x_2) (cm)			
1 2 3									

b) TO FIND LENGTH OF THE AIR FILM, l :-

Sr. No.	Reading at the contact edge of glass plates, MSR(cm) + VSD = TR (cm) (s_1)	Reading at the inner edge of thin paper, MSR(cm) + VSD = TR (cm) (s_2)	Length of air film, l = (s_2 - s_1) (cm)	Mean l (cm)
1 2 3				

Calculation: -

i) the eta = (λ) / (2 beta) = ... radians.
ii) t = l θ = ... cms.

PRECAUTIONS: -

1. While using microscope to measure fringe width etc., it is moved in one direction only from left to right or right to left, so that back lash error is avoided.
2. To achieve good accuracy in the measurements of beta and l, measurements are repeated thrice

Result:-

(i) The fringe width, beta = cms.
ii) The wedge angle, theta = radians.
iii) The thickness of paper = cms.

Experiment: 15

Program

TO COMPLETE PRODUCT OF TWO MATRICES

```
C       MAIN PROGRAM TO COMPUTE PRODUCT OF TWO MATRICES
        PARAMETER (MAX = 5)
        INTEGER ROW1, COLM1, ROW2, COLM2
        REAL A(MAX, MAX) , B (MAX, MAX), C(MAX, MAX)
        PRINT (*,*) 'ENTER THE ORDER OF FIRST MATRIX'
READ (*,*) ROW1, COLM1
PRINT (*,*) 'ENTER THE ORDER OF SECOND MATRIX'
READ (*, *) ROW2,COLM2
IF (COLM1 .NE.ROW2) THEN
        PRINT (*,*) 'MATRIX MULTIPLICATION NOT POSSIBLE'
        ELSE
CALL MATMUL(A, B, C, ROW1, COLM1, COLM2)
        ENDIF
        STOP
        END
C    SUBROUTINE TO COMPUTE PRODUCT OF MATRICES
SUBROUTINE MATMUL (A,B,C, R1, C1, R2, C2)
INTEGER RI, CI, R2, C2
        REAL A(R1, c1),B(R2, C2), C(R1, C2)
        PRINT (*, *) 'ENTER ELEMENTS OF FIRST MATRIX ROW WISE'
        READ (*,*) ((A (I, J), J = 1, COLM1), I =1, ROW1)
        PRINT (*, *) 'ENTER ELEMENT OF SECOND MATRIX ROW WISE'
        READ (*, *) ((B (I, J), J = 1, COLM1), I 1 ROW2)
        WRITE (*, *) 'FIRST MATRIX IS'
WRITE (*, 400) ((A (I, J), J =1, C1), I= 1, R1)
400     FORMAT (5 (4X, FS.2))
        WRITE (*,*) 'SECOND MATRIX IS'
        WRITE (* 500) ((B (I, J), J = 1, C2), I 1, R2)
500    FORMAT (5 (4X, FS.2))
                DO 10 I= 1, RI
                DO 20 J= 1, C2
                C(I, J)= 0
                DO 30 K =1, CI
     C (I, J) = C (I, J) + A (I, K)*B (K, J)
```

```
30 CONTINUE
20 CONTINUE
10 CONTINUE
         PRINT (*, *) 'RESULTANT MATRIX IS'
         WRITE (*, 600) ((C (I, J), J =1, C2), I 1, RI)
600     FORMAT (5 (4X, FS.2)
        RETURN
END
```

Experiment: 16

Program:

Using array variable, find out. the average and standard deviation.

```
    C          TO FIND OUT THE AVERAGE AND STANDARD DEVIATION DIMENSION X(20)
    10         WRITE (*, * ) 'ENTER THE NUMBER OF ELEMENTS <20'
    READ(*, *) N
IF (N ·.GT. 20) THEN
WRITE ( * , * ) 'ENTER THE VALUE OF N AGAIN'
GOT010
          ENDIF
          WRITE (*, *) 'ENTER' ,N, 'ELEMENTS OF ARRAY'
          READ (*,*) (X (I), I =1, N
    C     COMPUTE AVERAGE
         SUM =0.0
DO 20             I =1, N
         SUM =SUM + X (I)
          20CONTINUE
          AVERGE =SUM/N
    C     COMPUTE STANDARD DEVIATION
          SUM1 =0.0
          DO 30 I =1, N
          SUM1 =SUM1 + (X(I) -AVERGE) **2
          30 CONTINUE
          STDEV =SQRT (SUMliN)

                11
          30 CONTINUE
          STDEV =SQRT (NUM1/N)
                  WRITE (*,*) 'AVERGE =' AVERGE
                  WRITE (*,*) 'STANDARD DEVIATION =',
                  STDEV STOP
                  END
```

Experiment: 17

Program:

Compute the sum of a finite series up to correct three decimal places.

```
C       TO COMPUTE SUM OF A FINITE SERIES
         INTEGER SIGN, FACTNUM
         WRITE (*, *) 'ENTER THE VALUE OF X'
         READ (*,*) X
         WRITE (*, * ) \ HOW MANY TERMS YOU WANT TO SUM?'
          READ (*,*) N
         SUM = X
         SIGN = -1
         FACTNUM = 3
         DO 10 I = 2; N
         TERM = SIGN* (X**I) /FACT (FACTNUM)
         SUM = SUM + TERM
         FACTNUM = FACTNUM+ 2
         SIGN = - SIGN
10        CONTINUE
         WRITE" (*, *) \ SUM OF THE SERIES IS'
         WRITE (*, 15) SUM
                     "         "
         FORMAT (X*, F8.3)
         STOP
END
C        FUNCTION SUBPROGRAM FACT ()
         FUNCTION FACT (NUM)
         PROD = 1
DO        30 J = 1, NUM
          PROD = PROD*J
          CONTINUE
         FACT = PROD
         RETURN
         END
```

Experiment: 18

Program:

```
          TO ARRANGE THE MARKS OF N (SAY =100) STUDENTS IN ASCENDING ORDER
C         TO ARRANGE THE MARKS OF N (SAY =100) STUDENTS IN ASCENDING ORDER
DIMENSION      A(100)
 10        WRITE (*, *) 'ENTER THE NUMBER OF STUDENTS <=100'
           READ (*,*) N
           IF (N .GT. 100) THEN
           WRITE (*, *) 'ENTER THE VALUE OF N AGAIN'
           GOTO 10
           ENDIF
           WRITE (*,*) 'ENTER' ,N, 'ELEMENTS OF ARRAY'
           READ (*, * ), (A ( I), I =1, N),
           WRITE (*, *) 'ENTERED MARKS ARE'
           WRITE (*,15) (A(I), I = 1, N)
 15 FORMAT (IX, FS.2)
C          SORTING
          DO 20 I = 1, N - 1
           DO 30 J  = I +-1, N
IF (A (I) .GT. A (J)) THEN
                    TEMP = A (I)
          A (I) =A(J)
                    A (J) =TEMP
         ENDIF
30       CONTINUE
20 CONTINUE
WRITE (*, *) 'MARKS IN ASCENDING ORDER ARE'
  WRITE (*,*)
 WRITE (*, 50) (A (I), I =1, N)
    50  FORMAT (IX, FS.2)
        STOP
        END
```

Experiment: 19

Program:

Fitting of a straight line using least-square method

```
C       FITTING OF A STRAIGHTLINE USING LEAST-SQUARE METHOD
DIMENSION X(10), Y(10)
   WRITE (*,*) 'ENTER NUMBER OF DATA POINTS <=10'
  READ (*, *) N
```

```
WRITE (*, *) 'ENTER X AND Y VALUES ONE SET ON EACH LINE'
      DO 10 I  = 1, N
      READ (*, *) X (I), Y(I)
   10       CONTINUE
   C       COMPUTING CONSTANTS A AND B
   SUMX = 0.0
      SUMX = 0.0
      SUMY = 0.0
       SUMXY = 0.0
              SUMXX = 0.0
              DO 20 I = 1, N
      SUM X = SUMX + X ( I )
SUM Y = SUNY + Y ( I )
   SUM XX = SUMXX + (X ( I) * * 2 )
   SUM XY = SUMXY+ X(I) *y (I)
   20 CONTINUE
      DENDOM = N* SUMXX - (SUMX **2)
               IF DENOM. EQ. 0)
               WRITE (*,*) 'NO SOLUTION'
              GOTO 50
              ELSE
              XMEAN = SUMX/N
              YMEAN = SUMY /N
B = (N*SUMXY-SUMX * SUMY) /DENOM
              A = YMEAN - B * XMEAN
              WRITE (*,*) 'EQUATION OF BEST FIT IS'
              WRITE (*, *)
               WRITE (*, 30) A, B
           30   FORMAT (IX, 'Y =' F8.2 '+', F8.2, 'X')
      50 STOP
              END
```

Experiment: 20

Aim:

Diameter of a thin wire by diffraction method (using He-Ne Laser).

Apparatus:

He-Ne laser, hair, steel ruler (instead of diffraction grating), white screen, meter stick, computer, Microsoft EXCEL (or any other software with graphing capabilities).

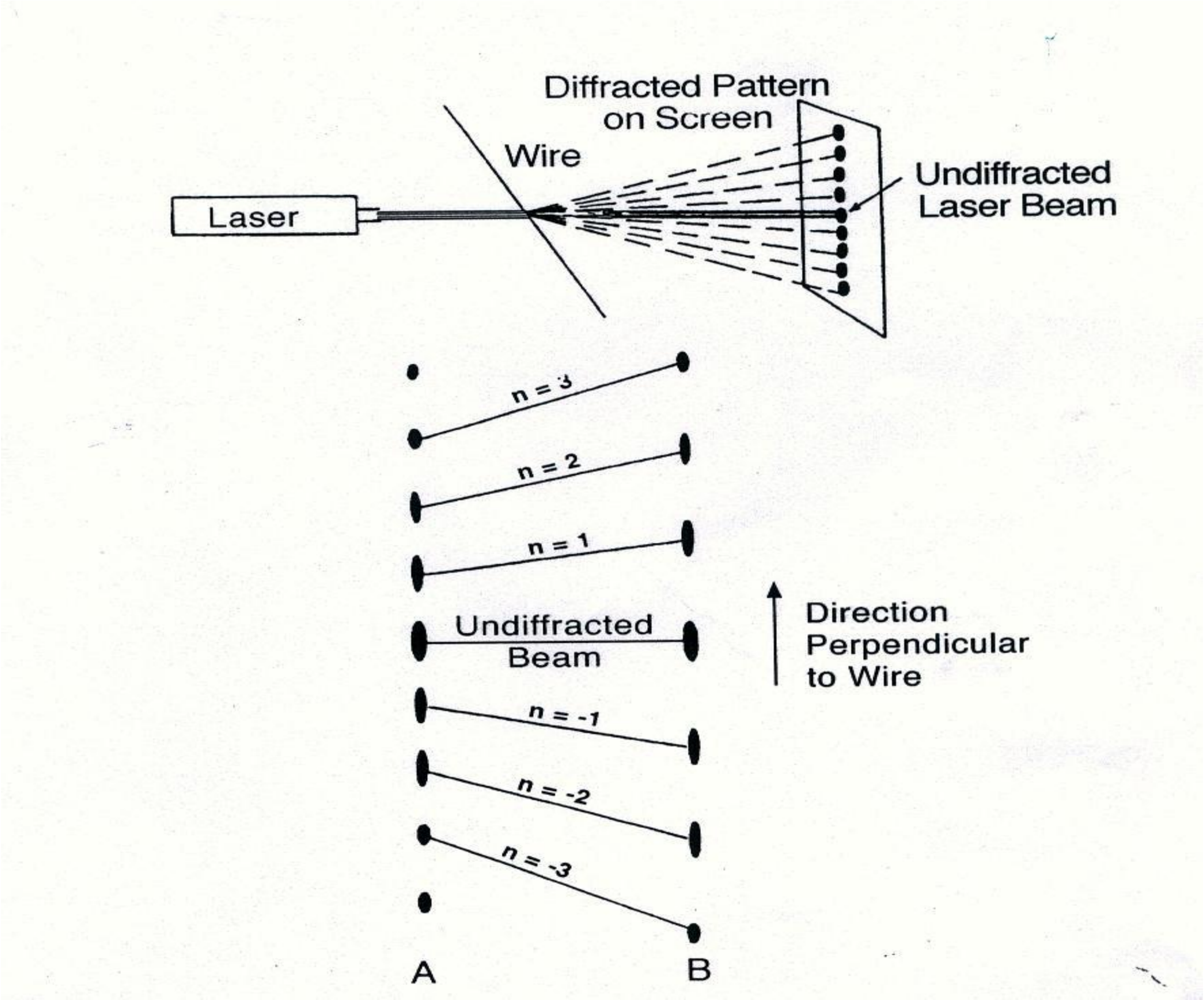
Formula used:

Thickness of given wire =d=AB=$\frac{D\lambda}{B}$

Here, λ is the wavelength of light used,
B is the wavelength of light
D is the normal distance between the wire and micro meter eye piece.

About experiment:

The laser diffraction is a robust and precise technique to monitor wire diameters in-line. However, classical Fraunhofer diffraction formulas are not appropriate for 3-dimensional object size determination. TheBabinet's principle allow to use such formulas only for angles of diffraction that tend to zero. A real diffraction measurement necessarily takes a finite angular range (approximately 10 degrees) and therefore, an error will be introduced if using classical formulas. The exact electromagnetic formulation is not appropriate to deal with 3-D objects, basically because it does not provide explicit formulas to determine the wire diameter. We have worked a pseudo-empirical approach out to reach simple accurate and reliable diffraction formulas that use exclusively the fringe pattern.



Procedure:

1. Mount the double slits on the uprights and place near the laser.
2. Adjust the position of the screen and the double slit to get a clear parallel fringe pattern on the screen.
3. Note the fringe pattern on the graph paper from the screen.
4. Find the distance between the slit and screen and also find the distance between the two slits.
5. Now change the distance between the source and the slits and record the pattern formed on the screen.
6. After recording the pattern find the distance between every two-consecutive pattern

Observations:

S.No.	Order of Frings	Micrometer Reading (in cm)	Displacement for 3 fringes (in cm)	fringe Width (B)(in cm)
1.	X			
2.	X+1			
3.	X+2			
4.	X+3			
5.	X+4			
6.	X+5			

Wavelength of light used =$\lambda = 5893 \times 10^{-8} cm$

Calculations:

Diameter of the wire AB = d = $d\lambda/B$

Result: