COLLEGE OF ENGINEERING
(AUTONOMOUS)

APPLIED PHYSICS LAB MANUAL

Name :

Branch:

Section:

Roll. No:

INSTRUCTIONS

1. Each student has to perform given experiment individually.

2. Students should come prepared for the experiment concerned and attend to the lab well in time. A proper record maintenance is important and compulsory.

3. It is desirable for a candidate to put up 100% attendance in the practical class. The student who gets less than a minimum of 80 % attendance will not be permitted to take semester end examination.

4. Each experiment is evaluated for 20 marks and average of all experiments be considered for final marks. Two internal practical exams will be conducted for 20 marks each at the end of each cycle and average is taken. The semester end practical exam (external) will be conducted for 60 marks.

The scheme of valuation for the External and internal examination is as follows:

	External	Internal
Aim , Apparatus, formula, Table and diagram (Ray or Circuit)	**12 marks**	**4 marks**
Observations	**14 marks**	**5 marks**
Calculations and graph	**12 marks**	**4 marks**
Result with units	**10 marks**	**3 marks**
Record and Viva-Voce	**5+7 marks**	**2+2 marks**
Day to Day analysis		**20 Marks**
Total	**60 marks**	**40 marks**

CODE: 19BP1102

Applied Physics Lab

Course Outcomes:

At the end the course, the student will be able to

CO1 interpolate some of the physical parameters based on optical phenomena (Expts. 1, 2, 3 & 4)

CO2 analyse the dielectric behaviour of a material. (Expt. 10)

CO3 identify the characteristics of semiconducting materials.(Expts. 8, 9, 11 and 12)

CO4 estimate the strength of the magnetic field and asses the losses in magnetization(Expt. 5 and 7)

CO5 demonstrate the mechanical parameter using sensors. (Expt.6)

List of Experiments

GAYATRI VIDYA PARISHAD COLLEGE OF ENGINEERING (Autonomous)
Madhurawada, Visakhapatnam-530048
DEPARTMENT OF PHYSICS

LAB CONTINOUS ASSESSMENT SHEET

1. Name of the student :
2. Registration Number :
3. Year : Semester:
4. Name of the Experiment :
5. Date of Experiment :
6. Date of submission of Manual:

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1	Initial preparation, Aim, Apparatus, formula and procedure	4		
2	Observations	5		
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Date: Signature of Faculty

Expt. No. **Date:**

DIFFRACTION GRATING-MINIMUM DEVIATION

AIM:

Determination of wavelength of light by using plane diffraction grating - minimum deviation method.

APPARATUS:

Plane diffraction grating, spectrometer, reading lens and mercury vapour lamp.

FORMULA:

$$\lambda = \frac{2\ Sin(\frac{D}{2})}{Nn}\ cm$$

Where,

D is the angle of minimum deviation

n is the order of the spectrum

N is the number of lines per cm

PROCEDURE:

1. Switch on the mercury lamp.
2. Focus the telescope towards a distant object. Adjust rack and pinion screw to get clear and sharp image
3. Adjust the rack and pinion screw of the collimator and micrometer screw for sharp and narrow slit.
4. Main scale and vernier scale are adjusted for direct reading i.e., 0 – 0 and 0 – 180 on vernier 1 and vernier 2 respectively.
5. The leveling screws of grating table are adjusted with the help of spirit level to make it horizontal
6. Grating is kept on its stand so that the incident light falls approximately normal to the grating.
7. Rotate the telescope towards left until the spectral lines whose wave lengths are to be determined is approximately in the center of the field of view.
8. Rotate the grating table in the same direction (towards left). You will notice that the spectral lines also rotate in the same direction first and then rotates in the opposite

direction (towards right) for a short distance and then, on further rotation of the grating, the line moves in the same direction (towards left).

9. Set and lock the grating table at the point of reversal which is called as position of minimum deviation.

10. Set the cross-wire of telescope at one of the spectral line by fine adjustment.

11. Note the reading on vernier 1 and vernier 2 (left).

12. Repeat the procedure on right side also.

13. Take the difference of left and right reading of vernier 1 and vernier 2. This will give the value of 2θ.

14. Take the average of 2θ and find θ

15. Use the formula to find the wave length (λ.) of the desired spectral line.

OBSERVATIONS:

Least count of spectrometer = $\frac{Value\ of\ 1\ M.S.D}{No.of\ divisions\ on\ VS}$

No. of lines per cm on the grating (N) =

Direct reading of the slit: Ver I = and Ver II =

Order of Spectrum (n)	Colour of spectral line	Spectrometer readings												2θ			θ	λ A^0
		Ver-I						Ver-II						Ver-I ($x_1 \sim x_2$)	Ver-II ($x_3 \sim x_4$)	mean		
		Left (X_1)			Right (X_2)			Left (X_3)			Right (X_4)							
		M.S.R	V.C×L.C	T.R	M.S.R	V.C×L.C	T.R	M.S.R	V.C×L.C	T.R	M.S.R	V.C×L.C	T.R					

CALCULATIONS

PRECAUTIONS:

1. The initial arrangement of the spectrometer should be done before starting the experiment.
2. The readings should be taken in systematic order.

RESULTS:

The wavelength of = Å

The wavelength of = Å

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Date: Signature of Faculty

Expt. No. **Date:**

NEWTON RINGS

AIM:

Determination of radius of curvature of a convex lens by forming Newton Rings.

APPARATUS:

Sodium vapour lamp, travelling microscope, reading lens, convex lens, and plane glass plates.

FORMULA:

$$\boldsymbol{R = \frac{{D_n}^2 - {D_m}^2}{4\lambda(n - m)} cm}$$

Where,

R = Radius of Curvature

D_n =Diameter of n^{th} ring

D_m= Diameter of m^{th} ring

λ = wavelength of the monochromatic light source used = 5893 Å

n and m = order of the rings

DESCRIPTION:

A black paper is placed on the platform of travelling microscope over which a plane glass plate P is placed. A Plano convex lens of long focal length is placed on the glass plate P. A glass plate G is placed directly above the centre of the lens, inclined at an angle of 45° to the vertical. A parallel beam of light is allowed to incident on the glass plate and is reflected on to the convex lens system. As a result of interference between of the light reflected from the lower surface of the lens and the upper surface of the glass plate concentric rings called Newton's rings with alternate bright and dark are formed with black centre.

Flow diagram showing the working steps for adjustment:

i) Adjust the microscope position by adjusting the rough screw in the middle of the scale provided.

ii) Adjust the R & P screw of the microscope stand such that the circular notch lies at the near edge of the microscope stand, by releasing the above screw. Ensure that the rough screw is again tightened after the adjustment.

iii) Place the Newton`s apparatus such that its centre lies almost vertically in the same line with the cross wires centre of the microscope.

iv) The glass plate is now placed and adjusted so as to get bright and uniform light in the entire field of view of the microscope. This makes Newton`s rings to appear bright in the field of view of the eye piece.

v) If the rings are not clear and contrast, the microscope need to be focused by the knob provided.

vi) The centre the rings pattern is then made to coincide with the crosswire centre by shifting the lens or the Newton`s rings apparatus carefully.

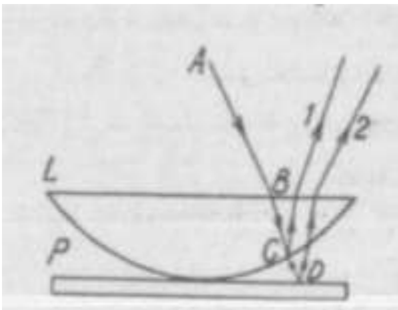
Then the microscope is moved by the fine screw on its stand to make the vertical cross wire coincides tangentially with the 12^{th} ring left edge. The MSR and VC readings are noted. The microscope is gradually shifted using the fine screw from 12^{th} ring left edge towards 12^{th} ring right edge. Alternative readings i.e. 12, 10, 8, … 8,10, 12 should be taken.

PROCEDURE:

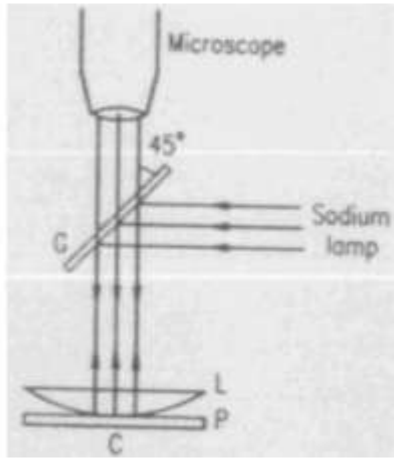
1. The travelling microscope is adjusted to view the centre of the rings system.
2. By working the tangential screw, microscope is moved to extreme left by counting 12dark rings. Then by coinciding the vertical cross wire tangentially with the $12^{\mathbf{th}}$ dark ring the corresponding reading is noted. The experiment is repeated by noting the readings for every alternate ring (say for all even rings) on the left side.
3. Observations are also noted by moving the microscope to the right of the centre of the rings system as explained above. From these observations the diameters of various rings can be found.
4. A graph is drawn between order of rings (on X – axis) and diameter square values (on Y– axis). A straight line passing through the origin is obtained. From the graph the value of D_n^2 and D_m^2 corresponding to n^{th} and m^{th} rings are found. The radius of the curvature is

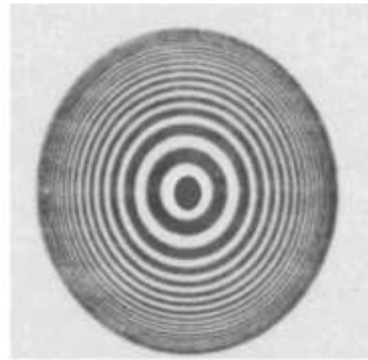
$$\boldsymbol{R} = \frac{\boldsymbol{D_n}^{\mathbf{2}} - \boldsymbol{D_m}^{\mathbf{2}}}{\mathbf{4}\lambda(\mathrm{n}-\mathrm{m})}\boldsymbol{cm}$$

It’s **important** to note that while taking observations care must be taken in moving the microscope in only one direction (i.e., **from 12^{th} ring on the left side to 12^{th} on the right side**) to avoid backlash error. Any screw type instrument will have backlash error. Least count of the travelling microscope is calculated. The observations are tabulated as shown in the tabular form.



Ray Diagram





Ring System

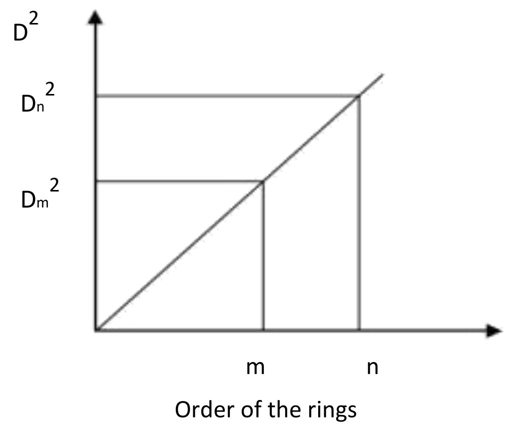
Table For the observations of diameter of the Newton's rings:

Least count of microscope (L.C) =

$$\frac{Value\ of\ 1\ M.S.D}{No.of\ divisions\ on\ VS} = \qquad \text{cm}$$

Sl. No.	Order of the Rings	Traveling Microscope Readings **(cms)**						Diameter (L ~ R) (cm)	D^2 (cm^2)
		Left edge (L)			Right edge (R)				
	(12^{th} to 2^{nd} ring)	M.S.R.	V.C. X L.C	T.R.	M.S.R.	V.C. X L.C	T.R.		

MODEL GRAPH



CALCULATIONS

Percentage error in Radius of Curvature R = $\frac{\Delta R}{R}$ ×100 %

PRECAUTIONS:

1) Wipe the lens and glass plates with clean cloth before starting the experiment
2) The centre of the rings must be dark
3) The microscope should be displaced in one direction only throughout the experiment to avoid back slash error.
4) Use reading lens while observing the readings.

RESULT:

The radius of curvature (R) of the given lens (from table) =

The radius of curvature (R) of the given lens (from graph) =

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Date: Signature of Faculty

Expt. No. **Date:**

PARTICLE SIZE DETERMINATION BY LASER

AIM:

Determinationof particle size of the given lycopodium powder using laser diffractionmethod.

APPARATUS:

Semiconductor laser, Lycopodium powder, glass plate, screen and metre scale

FORMULA:

Grain size (diameter) ‘2d’ of the grain

$$2d = n\lambda D/x_n \text{ μm}$$

Where

n Order of diffraction

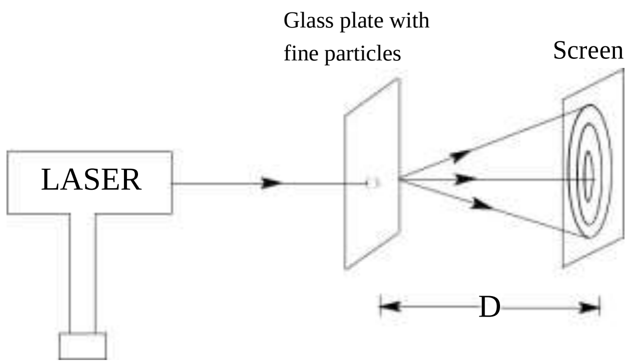
λ = Wavelength of laser light used in Å (6350 Å)

D = Distance between glass plate and the screen in centimetre

X_n= Distance between central bright spot and then the n_{th} fringe in centimetre

PROCEDURE:

1. Keep the laser stand and screen stand on a horizontal wooden plank such that the source and the screen faced to each other.
2. Switch on the laser source a beam of laser light will fall on the screen.
3. Insert the sample containing lycopodium powder in between the source and screen.
4. Adjust the distance between the source and screen to get circular diffraction rings pattern on the screen.
5. Measure the distance between the screen and the sample (D) with the help of a meter scale and note it.
6. Measure the radius of the circular dark rings (X_n) for n=1 and n=2 with the help of the graduated lines on the screen. Or mark the diffraction rings pattern on a trace paper sheet and measure the radius of the dark circular rings (X_n) for n =1 and n=2
7. Repeat the steps 3, 4, 5 and 6 for another value of D and note the values of (X_n) for n=1 and n=2
8. Calculate the particle size of the given lycopodium powder by using the formula
9. Calculate the average value of 2d.



Particle size determination by laser

Determination of size of the particles

Sl.No	**Distance between the screen and the glass plate (D)**	**Order of diffraction**	**Distance between the central bright point and n^{th} fringe** (x_n)	**Particle size** $2d = \frac{n\lambda D}{x_n}$
Unit	**Cm**		**Cm**	**cm**
1		1		
		2		
2		1		
		2		

Mean = ……………….

CALCULATIONS:

RESULT:

The average size of lycopodium particle is ________μm

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Expt. No. **Date:**

WAVELENGTH OF LASER LIGHT-USING GRATING

AIM:

To determine the wavelength of laser light using diffraction grating.

APPARATUS:

Semiconductor diode laser, Grating, screen, optical bench.

FORMULA:

Wavelength λ of a source of light incident normally on a transmission grating is

$$\lambda = \frac{Sin\theta}{nN} \quad A^0$$

Where

λ = wavelength of light

θ = angle of diffraction

N = number of lines per cm on the grating

n = order of spectrum

PROCEDURE:

1. The grating is mounted on the optical bench and the light beam from the He-Ne laser is made to fall normally on it.
2. The screen is mounted at a distance 'r', from the grating to observe diffraction spots (max) of different orders,
3. The distance (2x) between the first order maxima on either side of central maximum is measured. From this, the distance 'x' is noted. Similarly, x is determined for the second order also.
4. Now, 'r' is changed and corresponding 'x' is measured for first and second order diffraction pattern.
5. Assuming N, the value of λ is calculated using the formula $\lambda = (\text{Sin } \theta) / N n$

DIAGRAM:

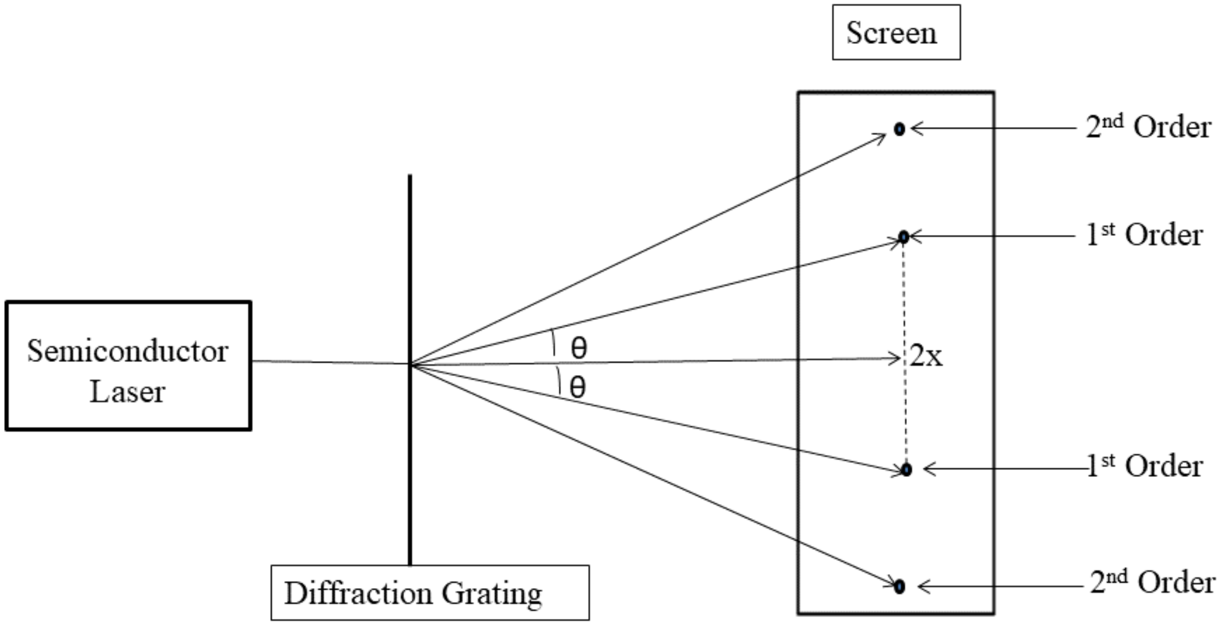

TABLE:

S. No.	Order	r (cm)	x (cm)	Tan θ = (x/r)	sin θ	$\lambda = \frac{Sin\theta}{nN}$

CALCULATIONS:

PRECAUTIONS:

1) Do not look into the laser light directly.
2) Take the reading without any parallax error

RESULT:

The wavelength of the laser light used is found to be ________

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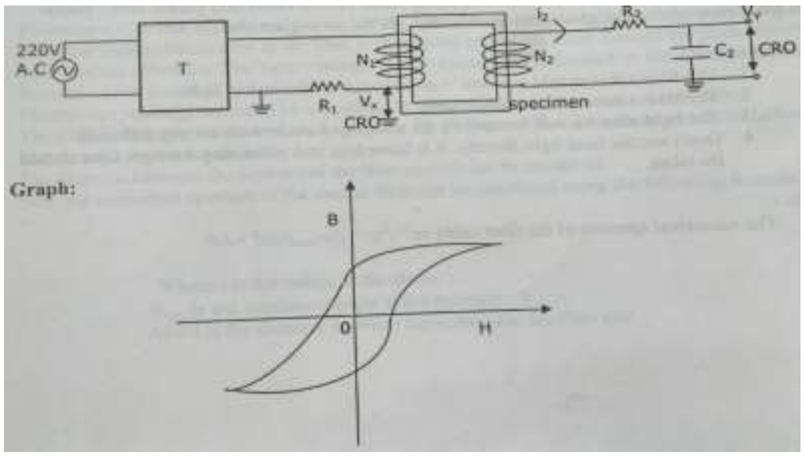
Exp. No. **Date**

B-H CURVE

AIM: Determination of coercivity, retentivity and energy loss of magnetic materials.

APPARATUS: CRO, Universal B-H curve tracer, core of the transformer, hacksaw blade and ferrite rod.

DIAGRAM:



FORMULA:

The energy loss is given by

$$E = \frac{0.5 \times N}{R \times L} \times S_V \times S_H \times area\ of\ the\ loop$$

Where

N is number of turns in the transformer (300 turns),

R represents resistance in the circuit (55 Ω),

L is length of the specimen (0.033 m),

A is the area of cross section of the specimen,

S_V and S_H are sensitivity of vertical and horizontal of CRO.

Coercivity $H_c = \frac{N \times V_x}{R \times L}$ $ampere\ turns/metre$

Retentivity $B_r = 0.5 \times V_y$ $Weber/m^2$

PROCEDURE:

1. Connect one terminal of the magnetizing coil to point C of main unit and the other to the terminal marked V1 (say 6 volts ac). Connect H to the horizontal input of the CRO and V to the vertical input of the CRO. Operate CRO in X-Y mode.
2. Connect the IC probe to the “IC” marked on the unit.
3. Switch ON the kit. To get proper loop vary the resistance to the maximum value with the help of knob P on the panel.
4. With no specimen through the coil adjust horizontal gain of the CRO until a convenient x- deflection is obtained. Note down this reading as S_H . Insert a magnetic specimen, e.g. a 5” nail, stampings or ferrite rod through the magnetizing coil such that it touches the probe at the center. **Make sure that sample is touching IC only and conducting tracks should not be shorted in any case.** Adjust the oscilloscope vertical gain/sensitivity (Y gain) and the horizontal gain/sensitivity (X gain) until a trace showing the B-H loop conveniently fills the screen. Note down these readings as S_V. <u>If the curve is back to front, reverse the connection of the magnetizing coil.</u>
5. Trace the area of the loop on the butter paper from the screen of the CRO and retrace it on graph paper.
6. Note down the X-intercept V_x and Y intercept V_y from the graph paper. Calculate the coercivity H and retentivity B using relation

$$H_c = \frac{N \times V_x}{R \times L}\ ampere\ turns/metre$$

$$B_r = 0.5 \times V_y\ Weber/m^2$$

7. Measure the area of the loop with the help of the graph paper. Then energy loss is calculated.

$$E = \frac{0.5 \times N}{R \times L} \times S_V \times S_H \times area\ of\ the\ loop$$ **Joules/cycle/Unit volume**

   Where S_v and S_H are vertical and horizontal sensitivities of the CRO for that particular setting of the gains.
8. Repeat the experiments with different specimen and note your comments on the properties of different materials

OBSERVATION TABLE:

Parameter	Hacksaw blade	Transformer stamping
N	300 turns	300 turns
R	55 Ω	55 Ω
L	0.033 m	0.033 m
S_V		
S_H		
V_x		
V_y		
Area of loop		

PRECAUTIONS:

1. The specimen should be at the center of the magnetizing coil very close to the probe.
2. If the area of the loop is expressed in cm^2, the sensitivity should be expressed in volt/ cm in either case the length of the coil should be in meters.

CALCULATIONS

RESULTS:

The energy loss of Hacksaw blade	=	J/cycle/ V
Coercivity (H_C)	=	
Retentivity (B_R)	=	
The energy loss of Transformer Stamping	=	J/cycle/ V
Coercivity (H_C)	=	
Retentivity (B_R)	=	

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Expt. No. **Date:**

STRAIN GAUGE SENSOR

AIM:

To find strain using strain gauge sensor

APPARATUS:

Strain gauge sensor, cantilever beam, weights

FORMULA:

$$\text{Micro strain} \qquad S = \frac{6\,MgL}{bd^2\,E}$$

Where M=mass applied in grams, g=1000 cm/sec^2

L = effective length of the beam in cm = 22cm

b = width of the beam = 2.8cm

d = thickness of the beam = 0.25cm

E = Youngs modulus = 2 x10^{12} dyne/cm^2

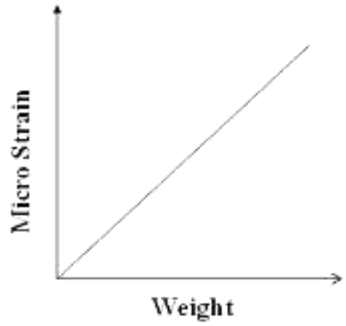
PROCEDURE:

1. Switch on the circuit and allow it for 5 minutes for initial warm up.
2. Adjust the ZERO ADJ Potentiometer knob on the panel till the display reads ‘000’.
3. Apply 1 kg load on the cantilever beam and adjust the CAL potentiometer knob till the display reads 377 micro strain.
4. Remove the weights. The display should come to zero. In case of any variation, adjust the ZERO ADJ potentiometer knob again and repeat the procedure again.
5. Now the instrument is calibrated to read the micro strain.
6. Apply load on the sensor using the loading arrangement provided in steps of 100gm up to 1kg.
7. The instrument displays exact micro strain received by the cantilever beam.
8. Note down the readings in the tabular form and calculate theoretical value of the micro strain for each weight using above formula.
9. Also calculate percentage error in each case using the formula

$$\%\,error = \frac{[(theoretical\ value - indicator\ reading)}{theoretical\ \text{value}} X\ 100$$

GRAPH:

A graph is drawn between load values taken along X-axis and corresponding micro strain values along Y-axis. It is a straight line passing through origin.



TABULAR FORM:

S.NO	Weight (gms)	Theoretical value of S (micro strain)	Indicator value	% error
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

CALCULATIONS:

PRECAUTIONS:

1) Do the zero adjustments should be done before measuring the actual reading
2) Take the readings carefully.
3) Handle the equipment with care.

RESULT:

The micro strain values shown by the sensor are noted and are compared with theoretical values.

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Expt. No. 5 **Date:**

STEWART AND GEE METHOD

AIM:

To study the variations in magnetic field with distance along the axis of circular current carrying loop.

APPARATUS:

Stewart and Gee type galvanometer, battery, commutator, rheostat, ammeter, mercury level and connecting wires.

FORMULA:

$$B_{th} = \frac{\mu_o n i a^2}{2(x^2+a^2)^{3/2}} \text{ Tesla}$$

Where $\mu_0 = 4\pi \times 10^{-7}$ Henry/m

n = No. of turn in the coil =

i = Current flowing through the circuit =

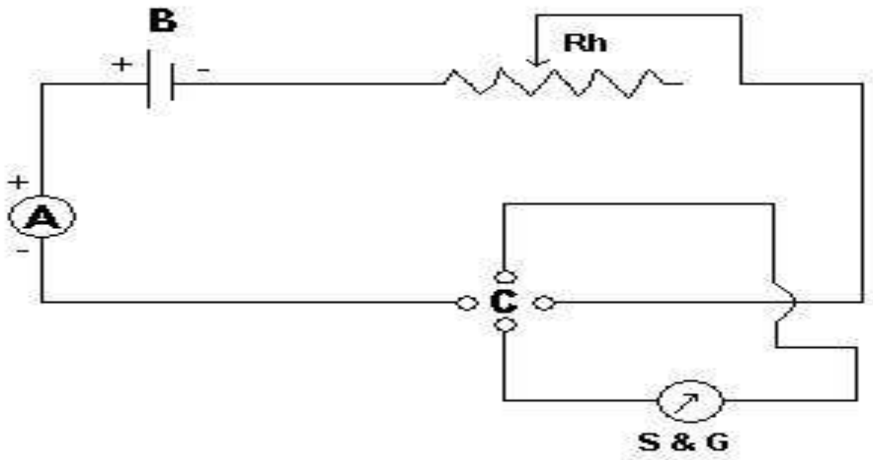
x = Distance of the magnetic compass from the center of the coil

a = Radius of the coil.

The perimeter of the circular coil is 68 cm

DIAGRAM:

CIRCUIT DIAGRAM:



DESCRIPTION:

It consists of a circular coil in a vertical plane fixed to a horizontal frame at its middle point. The ends of the coil are connected to binding screws. A magnetic compass is arranged such that it can slide along the horizontal scale passing through the center of the coil and is perpendicular to the plane of the coil. The magnetic compass consists of a small magnet and an aluminum pointer is fixed perpendicular to the small magnet situated at the center of the compass. The circular scale in the magnetic compass is divided into four quadrants to read the angles from 0 to 90. A plane mirror is fixed below the pointer such that the deflections can be observed without parallax.

PROCEDURE:

Adjustment of apparatus

1. Keep the apparatus perfectly horizontal with the help of a spirit level by adjusting the leveling screws at the base (if required).
2. Connect the circuit as shown in the circuit diagram.(take ‘n’ = 50)
3. Place the compass at the center of the coil on the arms of the magnetometer aluminum bars.
4. Adjust the plane of the coil along the magnetic meridian.
5. At this stage the north and south pole of the magnet in the compass lies along geographic north and south and along the plane of the coil. An aluminum pointer is fixed perpendicular to magnet in the compass. Now the arms of the apparatus are set along east-west direction by rotating the whole apparatus and aluminum pointer is kept parallel to the arms of the apparatus.

6. Rotate the compass alone in such a way that the aluminum pointer read 0°- 0°. (Make sure no current flows in circuit).
7. Switch on the battery eliminator and then current flows through the coil and produces a magnetic field along the axis of the coil. The resultant field of horizontal component of earth's magnetic field and the magnetic field of the circular coil causes deflections in compass.
8. By adjusting rheostat make the aluminum pointer to read $60^o – 60^o$ at the center.
9. Now change the current direction by exchanging keys positions in the commutator. Deflections will be in opposite direction, and the reading should be $60^o – 60^o$.
10. The deflections before and after the reversal of the current should not differ much (difference should be within five degrees). If it is more than five degrees, orientation of the apparatus is to be adjusted.
11. Move the compass gently to 10 cm from the center, on both side (east and west) and check the deflections in the compass by changing the polarity and confirm that the deflections before and after the reversal of the current are within the error limits. At this stage the apparatus is perfectly adjusted. Then the set up should not be disturbed till the end.

Readings and Calculations

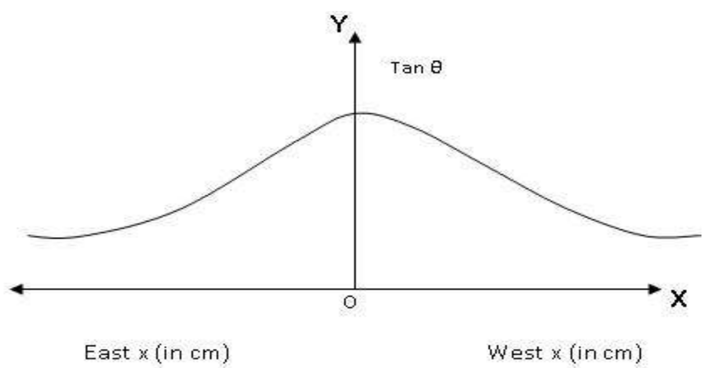
1. Note the current '***i***' flowing through the coil. (After this do not disturb the rheostat so that same current will flow through the circuit till the end of the experiment)
2. Bring back the compass to the center of the coil (x = 0 cm). The deflection in the magnetometer is noted by reading both the ends of the aluminum pointer, say 1 and 2.
3. Reverse the current direction and note down the deflection readings as 3 and 4.
4. Move the magnetometer compass to 2 cm along east direction. Note the deflections before ($\boldsymbol{\theta}_1$, $\boldsymbol{\theta}_2$) and after ($\boldsymbol{\theta}_3$, $\boldsymbol{\theta}_4$) reversal of the current direction.
5. The above procedure is repeated in steps of 2cm till the deflection decreases to 20^0.
6. Calculate the average value $(\theta_\mathbf{e}) = \theta_\mathbf{1}+ \theta_\mathbf{2}+ \theta_\mathbf{3}+ \theta_\mathbf{4}\mathbf{)\ /\ 4}$ and **tan** $\theta_\mathbf{e}$ for each step and note it.
7. Similarly the procedure (5, 6) is repeated in the west direction also. And the corresponding deflections $\boldsymbol{\theta}_5$, $\boldsymbol{\theta}_6$, $\boldsymbol{\theta}_7$ and $\boldsymbol{\theta}_8$ are noted. Remember that the values of deflections at center (at x=0) are compulsory and are same for both east and west directions.
8. Calculate the corresponding average value $(\theta_\mathbf{w}) = (\ \theta_\mathbf{5}+\theta_\mathbf{6}+\theta_\mathbf{7}+ \theta_\mathbf{8}\mathbf{)/4}$and **tan** $\theta_\mathbf{w}$ for each step and note it.
9. Calculate average (θ **)** of θ**e** and θ**w**

10. Calculate tan θ and then B exp using the formula $B_{exp} = H \tan\theta$ for each reading. (H = 0.38 Oersted).
11. Calculate B_{th} by using the formula $B_{th} = \frac{\mu_o n i a^2}{2(x^2+a^2)^{3/2}}$ and express it in Gauss. (1Tesla = 10^4 gauss)

Plotting the graph

1. A graph is plotted taking distance of the compass from the center of the coil along X-axis and tan **θ** along Y-axis for both east and west direction.
2. The shape of the curve is as shown in the figure and is symmetric about Y-axis. It shows that magnetic field strength is maximum at the center of the current carrying circular coil and decreases as we move away from the center of the coil on either side.

GRAPH:



S.No	Distance (x)	Deflection Magnetometer Readings												$\theta = \frac{\theta_e + \theta_w}{2}$	$tan\theta$	$B_{exp} = Htan\theta$	B_{th}
		EAST						WEST									
		Θ_1	Θ_2	Θ_3	Θ_4	Θ_e	$tan\theta_e$	Θ_5	Θ_6	Θ_7	Θ_8	Θ_w	$tan\theta_w$				

CALCULATIONS:

PRECAUTIONS:

1. The apparatus should be adjusted to Tan A position and for equal deflection at 10 cm positions in east- west directions.
2. After the adjustments the Stewart and Gee apparatus should not be disturbed.
3. Observations are noted without parallax.
4. The ammeter and rheostat should be kept away from the deflection magnetometer.

RESULT:

From the above experiment it is concluded that magnetic field strength is maximum at the centre of the current carrying circular loop and decreases as we move along the axis and away from the centre of the coil.

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2	Observations	5		
3	Calculation and graph	4		
4	Result with Units	3		
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Date: Signature of Faculty

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FOUR PROBE METHOD-I

AIM:

Determination of resistivity of a semiconductor (Ge).

APPARATUS:

Four Probe setup, Oven, Ge Crystal and thermometer.

DIAGRAM:

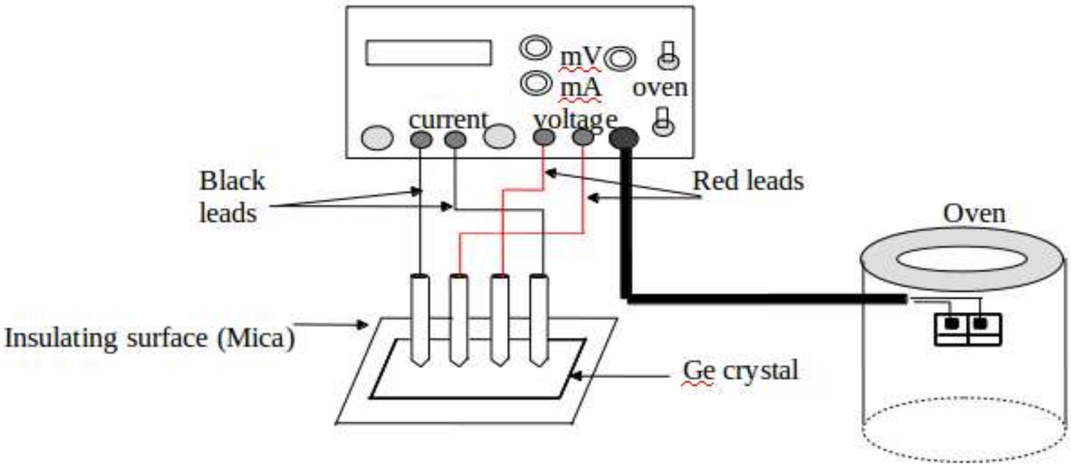

Figure 1: Experimental Setup / diagram

FORMULA:

Resistivity $$\rho = \frac{V}{I} X \frac{2\pi S}{G_7\left(\frac{W}{S}\right)}$$ units: Ω.cm

Where, V = Potential difference between probes 2 and 3

I = Current passed through the crystal

$S = S_1 = S_2 = S_3$ = Probe spacing,

$G_7\left(\frac{W}{S}\right)$ = Correction factor

PROCEDURE:

RESISTIVITY OF Ge CRYSTAL

1. Ensure that the Ge crystal is placed on the base plate of the four probe arrangement and the four probes rest in the middle of the Ge crystal.
2. Connect the outer pair of probes to the constant current terminals and the inner pair of probes to the voltage terminals.
3. Place the four probe arrangement in the oven.
4. Switch on the supply of the four probe setup and put the digital panel meter in the current measuring mode with the help of selector switch. Adjust the current to 2 mA. Now put the digital panel meter in the voltage measuring mode and note down the voltage.
5. Change the current in intervals of 1 mA starting from 2 mA up to 10 mA and note down the corresponding voltages in the given table.
6. Using the given formula the average resistivity of the Ge crystal at room temperature is to be calculated.

OBSERVATIONS:

RESISTIVITY OF Ge CRYSTAL

Room temperature (RT) = ° C.

Probe spacing S = 0.2 cm, Correction factor for the given crystal $G_7\left(\frac{W}{S}\right)$ = 5.89

S.No	Current (mA)	Potential Difference (mV)	Resistivity (Ω cm)	Average Resistivity (Ω cm)
1.	2			
2.	3			
3.	4			
4.	5			
5.	6			…………
6.	7			
7	8			
8	9			
9	10			

CALCULATIONS

PRECAUTIONS:

1. Do not apply pressure on the electrical contacts to the Ge crystal as it is very brittle.
2. Ensure that the oven is OFF.

RESULT:

Resistivity of the given Ge crystal at room temperature is found to be .... Ω cm

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Date: Signature of Faculty

Exp. No.: **Date**

FOUR PROBE METHOD-II

AIM:

Determination of band gap of a semiconductor (Ge).

APPARATUS:

Four Probe setup,, Oven, Ge Crystal and thermometer.

DIAGRAM:

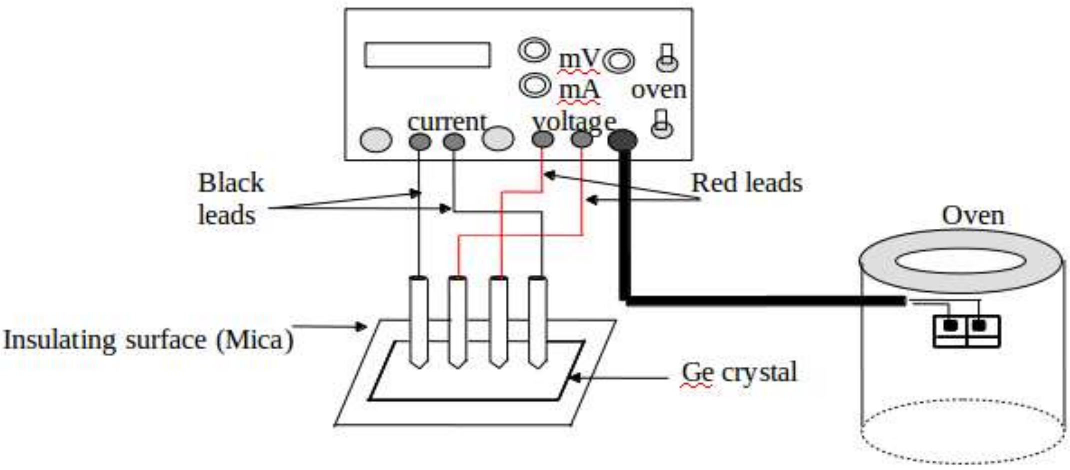

Figure 1: Experimental Setup / diagram

FORMULA:

Energy band gap $.E_g = 2k_B \frac{log_e \rho}{1/T}$ eV

Where, k_B = Boltzmann constant

ρ = Resistivity of the Ge crystal

T = Temperature in Kelvin

If a curve between $\log_{10} \rho$ and $10^3/T$ is plotted and BC/AB is the slope of the curve then

$$E_g = \frac{2x8.6x10^{-5} x2.3026}{10^{-3}} x \frac{BC}{AB} \text{ eV} \quad ....(3)$$

PROCEDURE:

1. Keep the digital panel meter in the current measuring mode and adjust the current to 5 mA. Keep it constant throughout the experiment.
2. At room temperature note down the voltage by shifting the panel to voltage measuring mode.
3. Switch on the power supply of the four probe kit and turn on the oven power supply. Select rate of heating as low (L). Keep the thermometer in the oven through the hole provided.
4. Now when the temperature reaches 40 ^oC, note down the corresponding voltage. In a similar fashion, note down the voltages when the temperature is raising (with an interval of 5 ^oC)
5. Turn off the power supply of oven and kit.
6. Calculate resistivity of the given Ge crystal at room temperature using the give formula

$$\rho = \frac{V}{I} X \frac{2\pi S}{G_7\left(\frac{W}{S}\right)}$$

OBSERVATIONS:

VARIATION OF RESISTIVITY OF THE Ge CRYSTAL

Current (I) = 5 mA.

S.No.	Temperature (° C)	Voltage (mV)	Temperature T (K)	Resistivity ρ (Ω cm)	$\frac{10^3}{T}$ (K^{-1})	$\log_{10}\rho$
1	RT =					
2	40					
3	45					
4	50					
5	55					
6	60					
7	65					
8	70					

GRAPH

1. Plot the graph $\log_{10}\rho$(y-axis) versus 10^3 / T (x-axis).
2. Determine the slope of the curve where it is vertical and hence calculate E_g using the given formula.

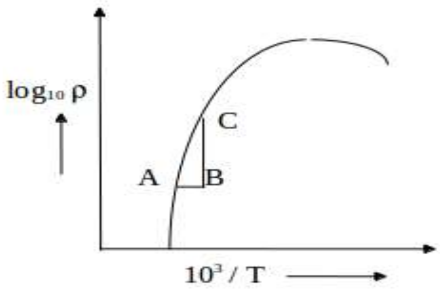

Fig 2. $\log_{10} \rho$ vs $10^3 / T$ curve

CALCULATIONS:

PRECAUTIONS:

1. Do not apply pressure on the electrical contacts to the Ge crystal as it is very brittle.
2. Ensure that the oven is OFF after completing the experiment.
3. Handle thermometer carefully

RESULT:

The energy band gap of the given Ge crystal is found to be ....eV

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DIELECTRIC CONSTANT

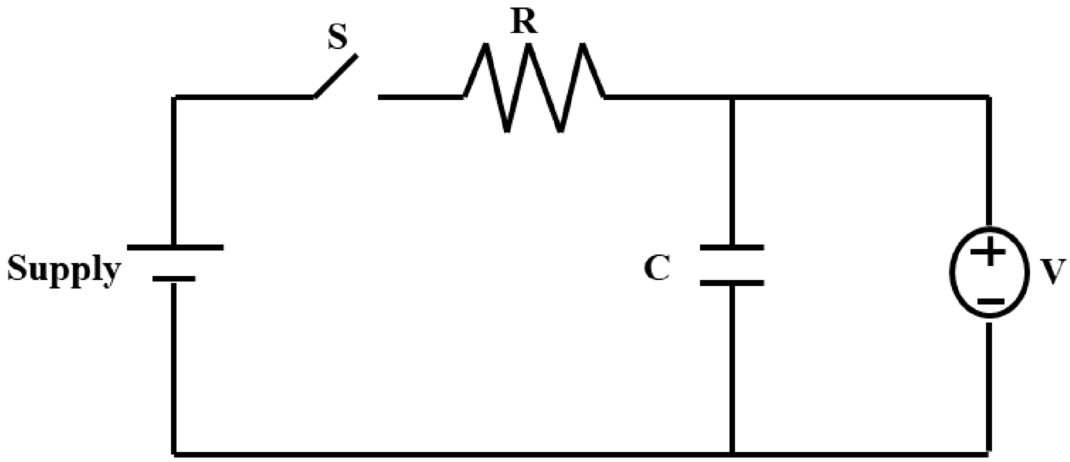
AIM:

Determination of dielectric constant of the dielectric material by charging and discharging of a capacitor.

APPARATUS:

DC Regulated power supply, Electrolytic Capacitor, Resistor, Digital voltmeter, Digital timer, Double plug key.

CIRCUIT DIAGRAM:



THEORY:

An electrolytic capacitor (e-cap) is a polarized capacitor whose anode or positive plate is made of a metal that forms an insulating oxide layer through anodization. This oxide layer acts as the dielectric of the capacitor. A solid, liquid, or gel electrolyte covers the surface of this oxide layer, serving as the (cathode) or negative plate of the capacitor. Due to their very thin dielectric oxide layer and enlarged anode surface, electrolytic capacitors have a much higher capacitance-voltage (CV) product per unit volume compared to ceramic capacitors or film capacitors, and so can have large capacitance values. There are three families of electrolytic capacitor: aluminum electrolytic capacitors, tantalum electrolytic capacitors, and niobium electrolytic capacitors.

The large capacitance of electrolytic capacitors makes them particularly suitable for passing or bypassing low-frequency signals, and for storing large amounts of energy. They are widely used for decoupling or noise filtering in power supplies and DC link circuits for variable-frequency drives, for coupling signals between amplifier stages, and storing energy as in a flash lamp.

Electrolytic capacitors are polarized components due to their asymmetrical construction, and must be operated with a higher voltage (ie, more positive) on the anode than on the cathode at all times. For this reason the anode terminal is marked with a plus sign and the cathode with a minus sign. Applying a reverse polarity voltage, or a voltage exceeding the maximum rated working voltage of as little as 1 or 1.5 volts, can destroy the dielectric and thus the capacitor. The failure of electrolytic capacitors can be hazardous, resulting in an explosion or fire. Bipolar electrolytic (aka non-polarized) capacitors which may be operated with either polarity are special constructions with two anodes connected in series.

FORMULA:

$$k = \frac{T_{1/2} \times d}{0.693 \times R \times A \times \varepsilon_0}\ x\ 10^{-6}$$

Where

$T_{1/2}$ represents the time required to charge or discharge a capacitor to 50 %
(intersection point of both charging and discharging curves from the graph),

d is the thickness of the dielectric medium used in the capacitor,

R is the resistance used (100 kΩ),

A is the area of the capacitor used and

ε_0 represents permittivity of free space.

PROCEDURE:

1. The circuit connections are made as shown in figure.
2. Move the switch S to discharge mode and check if capacitor voltage in the voltmeter is zero or not.
3.Then the switch S is changed to charging mode and the stop watch is switched on simultaneously.
4. Note down the voltage across the capacitor at every 20 seconds interval till the voltage readings become practically constant.
5. At this situation capacitor is fully charged. Note down the voltage value for discharge mode at time "0" secs. Now turn the switch S to discharge mode and note the voltage for 20 seconds interval till the capacitor value is practically zero.
6. Plot a graph between time (t) taken along x axis and capacitor voltage (V) along y-axis for both charging and discharging modes.
7. The two graphs intersect at a point P whose x-intercept gives the value $T_{1/2}$.
8. Determine the value of dielectric constant 'k' of the medium in the capacitor by using the above formula.

OBSERVATIONS:

Resistance (R) = 100 kΩ

Length (L) = 20.24 mm

Breadth (b) = 10.28 mm

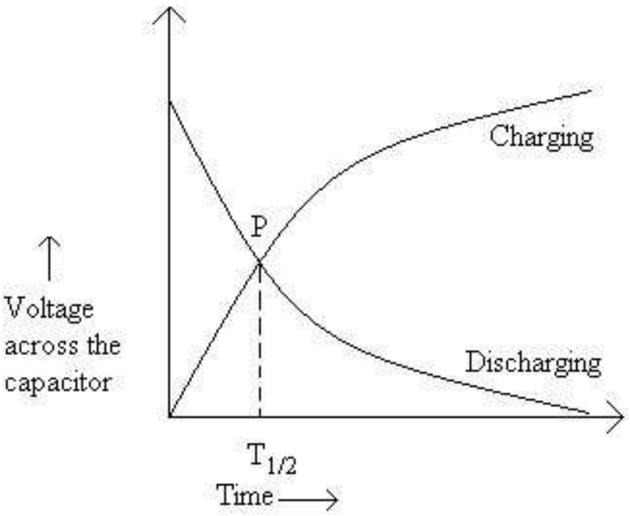
Thickness (d) = 5.37 μm

Area (A) = L × b =

TABLE 1:

Time (s)	**Voltage during charging (V)**	**Voltage during discharging (V)**

MODEL GRAPH:



CALCULATIONS

PRECAUTIONS:

All connections must perfect and there should not loose contacts

RESULT: The dielectric constant of the material in the given capacitor =

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ENERGY BAND GAP OF A SEMICONDUCTOR DIODE

AIM:

Determination of energy band gap of a p-n junction diode.

APPARATUS:

Germanium diode (OA 79), Thermometer, Copper Vessel, Regulated DC power supply, Micro ammeter, Heater, connecting wires & Bakelite lid.

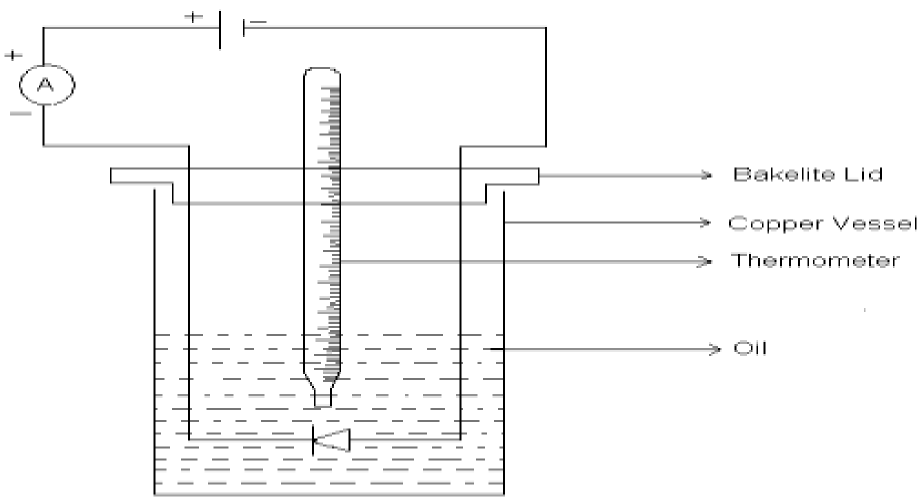
FORMULA:

The energy gap $$\mathbf{E_g} = \frac{\mathbf{2.303 \times 2 \times K \times slope}}{\mathbf{1.6 \times 10^{-19}}} \text{ eV},$$

Where K is Boltzmann Constant and [$K=1.3806503 \times 10^{-23}$ J/^{0}K]

PROCEDURE:

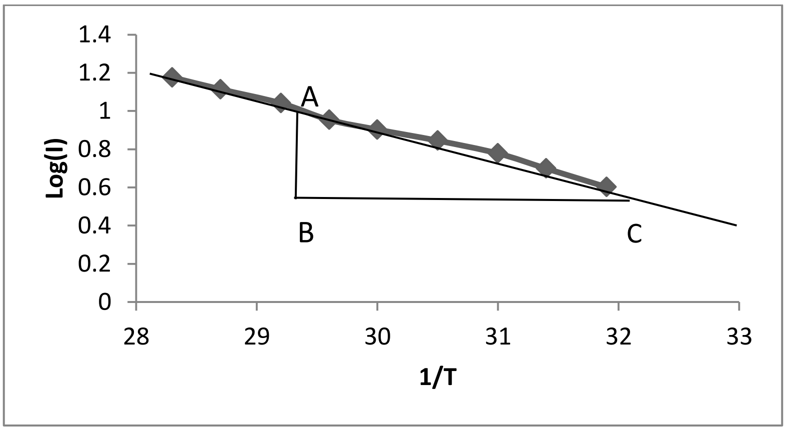
1. Connect as per the circuit diagram shown below such that the diode is reverse biased.



2. Insert the thermometer through the hole provided for it. Care should be taken such that the thermometer should not touch the bottom of the vessel and gently tight it by the screw provided.
3. Keep the voltage at 5 V.
4. Switch on the heater and wait till the temperature reaches at 75^{0}C.
5. Switch off the heater and wait till the temperature deceases to 70^{0}C and note the current.

6. Note the corresponding current for every 5^{o}C fall of temperature, till the temperature reaches 40^{0}C.
7. Plot the Graph between $\frac{1}{T}$(Temperature in Kelvin) on X-axis and $\log_{10}$ (I) on Y-axis, which will be a straight line.
8. Take any two points on the graph and find slope.
9. Calculate E_g by using the formula given above.

MODEL GRAPH



TABULAR FORM

S. No.	Temp in ^{o}C	T= (t + 273) in ^{o}K	Current (I) in µA	1 / T in (x 10^{-4} ^{o}K^{-1})	Log_{10} (I)

PRECAUTIONS:

1. Care must be taken in fixing the thermometer.

2. The current flow should not be too high. If the current is high, then the internal heating of the device will occur. This will cause actual temperature of the junction to be higher than the measured value. This will produce non linearity in the curve.
3. There may be contact potentials, thermo mfs and meter DC offsets which must be taken care off.
4. Poor contacts will result in the huge variations in the results.

CALCULATIONS:

RESULT:

The energy gap of the given PN Junction Diode is $\mathbf{E_g}$ = -------------------------------

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THERMISTOR

AIM:

To Determine the temperature coefficient of resistance with varying temperature

APPARATUS:

1 KΩ Thermistor, variable resistance box, 1 KΩ resistances, DC power supply, Galvanometer, Thermometer, Oil pot, connecting probes

FORMULA:

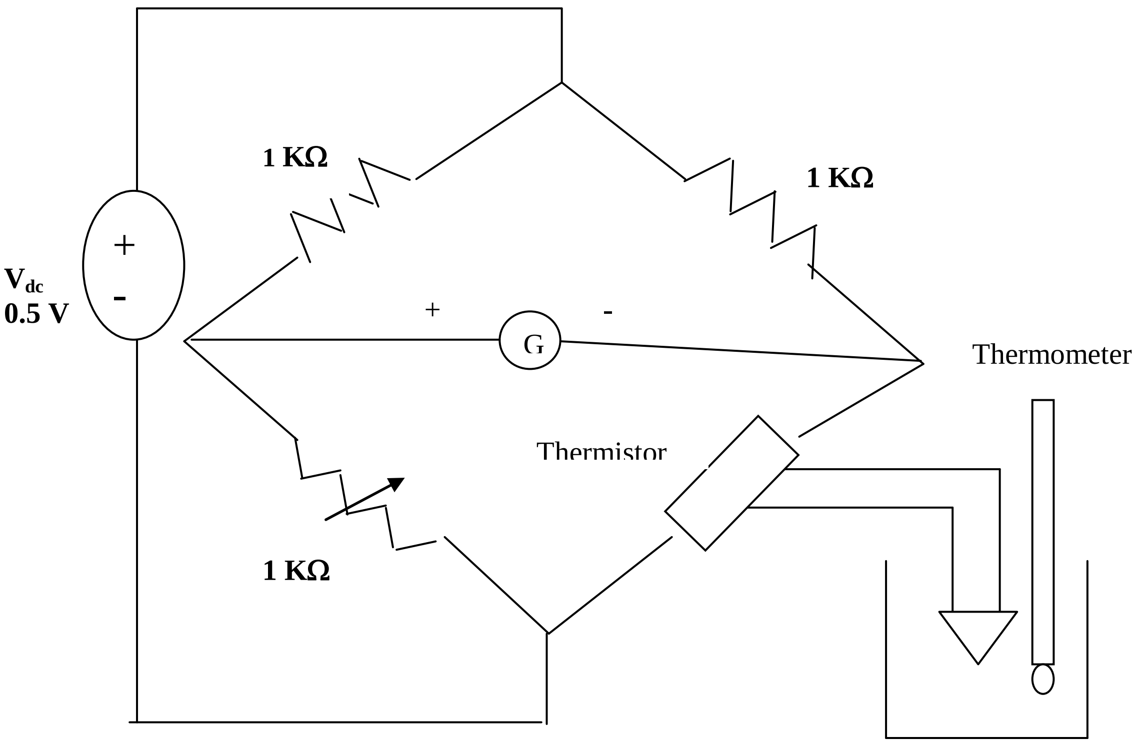
$$\boldsymbol{\alpha = \frac{R_2 - R_1}{R_1 T_2 - R_2 T_1}} /^0\mathrm{C}$$

Where R_1, R_2 are resistance

T_1, T_2 are temperatures

α = temperature coefficient of resistance

CIRCUIT DIAGRAM:



A thermistor is a temperature sensor consisting of semiconductor material that exhibits a large modification in resistance in proportion to a tiny low modification in temperature. Thermistors are inexpensive, rugged, and reliable which responds quickly. Because of these qualities thermistors are used to measure simple temperature measurements, but not for high temperatures. Thermistor is easy to use, cheap and durable which respond predictably to a change in temperature. Thermistors are mostly used in digital thermometers and home appliances such as refrigerator, ovens, and so on. Stability, sensitivity and time constant are the final properties of thermistor that create these thermistors sturdy, portable, cost-efficient, sensitive and best to measure single-point temperature. Thermistors are available in different shapes like rod, disc, bead, washer, etc. This article gives an overview of thermistor working principle and applications

The thermistor is connected in the fourth arm 'S' of the wheat stones bridge as shown in fig. In the above two arms resistances 1 KΩ each are placed and in the third arm a variable resistance box is connected. The thermistor is placed in an oil pot as shown.

PROCEDURE:

1. Connect the circuit as shown in figure. Yellow wires should be connected from kit to oil pot.

2. The bridge is balanced by adjusting the variable resistance box. The resistance in the third arm R gives the resistance of the thermistor at room temperature which is to be noted.

3. Switch ON the heater and turn off when the temperature reached to 80 ^{o}C.

4. The oil bath is allowed to cool and the resistance of the thermistor is noted at various temperatures when it is decreasing by adjusting the variable resistor at which the galvanometer reads to zero.

5. A graph is drawn taking the temperature (in ^{o}C) along X – axis and Resistance along Y-axis. The graph gives temperature characteristic of the thermistor.

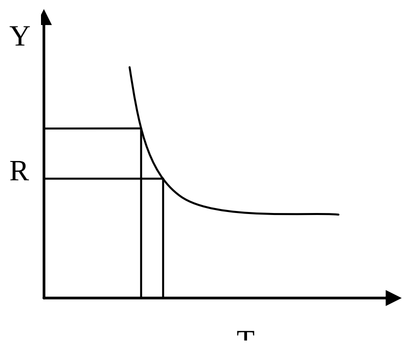
6. Draw the vertical tangent to the graph and find corresponding values of R_1 and R_2 for two different temperatures other than experimental values.

.

OBSERVATIONS

S.No.	Temperature in ^{o}C	Resistance of thermistor (Ω)
	70	
	65	
	60	
	55	
	50	
	45	
	40	
	35	
	30	

MODEL GRAPH



CALCULATIONS

PRECAUTIONS:

1. When the heater is ON, temperature should be observed carefully
2. Don’t allow very high temperatures
3. Observations should be taken carefully by adjusting the variable resistance gently

Result: The temperature characteristic graph of given thermistor is drawn and the negative temperature co-efficient of resistance is α =