VEMU INSTITUTE OF TECHNOLOGY

P.KOTHAKOTA, CHITTOOR DIST – 517 112

DEPARTMENT OF HUMANITIES & SCIENCES

ENGINEERING PHYSICS

LABORATORY MANUAL FOR I-Year B.Tech
(CE & ME)

DEPARTMENT OF HUMANITIES & SCIENCES

ENGINEERING PHYSICS LAB MANUAL

VEMU INSTITUTE OF TECHNOLOGY

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Name	
Register No.	
Branch/Section	
Academic year	

SYLLABUS

(CE & ME)

ENGINEERING PHYSICS LABORATORY: EXPERIMENTS

1. Determination of wavelength of Laser light using Diffraction Grating.

2. Determination of particle size by using Laser source.

3. Determination of spring constant of springs using Coupled oscillator.

4. Determination of Hall Voltage and Hall coefficient of a semiconductor using Hall Effect.

5. Determination of Dielectric constant using charging and discharging of a capacitor.

6. Determination of Magnetic field along the axis of a circular current carrying coil by Stewart and Gee's method.

7. Determination of Rigidity modulus by Wire-Dynamic method.

8. Determination of Hysteresis loss of a magnetic material by tracing B-H Curve.

9. Determination of Numerical aperture and acceptance angle of an optical fiber.

10. Determination of ultrasonic velocity in liquids.

11. Determination of pressure variation using strain gauge sensor.

12. Determination of temperature using strain gauge sensor.

CONTENTS

ENGINEERING PHYSICS LAB

LABORATORY INSTRUCTIONS

The following instructions must be followed by the students in their laboratory classes.

1. While entering the Laboratory, the students should wear shoes and lab uniform. Female students should tie their hair back.
2. The students should bring their observation note book, practical manual, record note book and calculator and necessary stationary items for the lab classes without which the students will not be allowed for doing the practical.
3. The student should not perform unauthorized experiments.
4. All the equipments should be handled with utmost care. Any damage will be charged.
5. At the end of practical class the apparatus should be arranged neatly.
6. Each experiment after completion should be written in the observation note book and should be corrected by the lab in charge on the same day of the practical class.
7. Each experiment should be written in the record note book only after getting signature from the lab in charge in the observation note book.
8. Record note book should be submitted in the following after completion of experiment.
9. 100% attendance should be maintained for the practical classes.

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ENGINEERING PHYSICS LAB-SCHEME OF EVALUATION

EXPT-1 **Date:**

DETERMINATION OF WAVELENGTH OF LASER LIGHT USING DIFFRACTION GRATING

Aim: To determine the wavelength of laser light using diffraction grating.

Apparatus: Laser source, diffraction grating, clamp stand, scale.

Formula:

$$\text{Sin } \theta = \frac{d}{\sqrt{D^2+d^2}} \quad \text{and} \quad \lambda = \frac{\sin\theta}{Nn} \text{ Å}$$

where θ = angle of diffraction

D = distance between grating and the screen

d = distance of diffraction spots from the central spot

n = order of the spot (1, 2, 3 -----)

N = number of lines per inch on the diffraction grating

λ = wavelength of given laser source.

Procedure:

1. Laser source is kept on the table. A grating plate is fixed vertically on a clamp stand such that the grating surface is perpendicular to the table so that the diffraction spots are seen on either side of the central spot at measurable distances.

2. The distance between the screen and the grating 'D' is measured with a scale. The distance of the diffracted spots (I order) on either side of the center spot are measured and their average value (d) is calculated.

3. The angle of diffraction 'θ' is calculated using the formula, $\text{Sin } \theta = \frac{d}{\sqrt{D^2+d^2}}$.

4. The wavelength of laser source (λ) is calculated by using the formula, $\lambda = \frac{\sin\theta}{Nn}$.

5. Similar calculation is made for the other orders (II and III) and the average value of λ can be calculated.

6. The experiment is repeated by changing the distance between the screen and the grating and wavelength of laser source is calculated.

<u>Precautions:</u>

1. Laser beam should not be seen with the necked eye directly which may cause blindness.

2. Don’t shine the laser toward anyone.

<u>Diagram:</u>

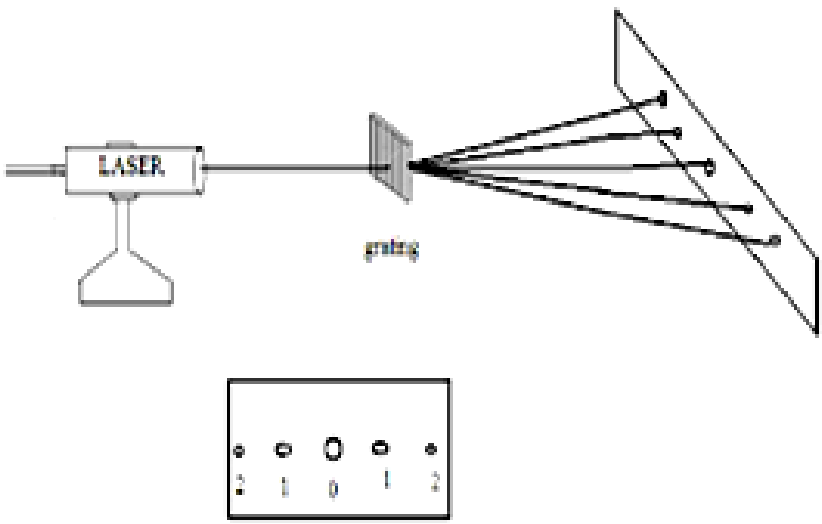


Fig.: laser- diffraction grating

<u>Table:</u>

S.No.	Distance between the grating and the screen D (cm)	Order of the spot (n)	Distance from the centre spot			Sin θ = $\frac{d}{\sqrt{D^2+d^2}}$	λ = $\frac{\sin\theta}{Nn}$ (Å)
			Left	Right	Average (d) cm		
1.							
2.							
3.							

Calculations:

Result: The wavelength of Laser light λ = -------------- Ǻ

EXPT-2 **Date:**

DETERMINATION OF PARTICLE SIZE BY USING LASER

Aim: To determine the size of a particle using a laser source by forming diffraction.

Apparatus: Optical bench, laser diode, screen, particle slide, meter scale.

Formula:

Size of the particle, $a = \frac{2m\lambda D}{x}$ µm

Where m = order of the bright ring

λ = wavelength of He-Ne laser

D = distance between the particle slide and the screen (cm)

x = diameter of m^{th} bright ring (mm)

Procedure:

1. Switch on the laser source and place the particle slide in between the laser source and the screen. Allow the laser beam to fall on a particle slide.

2. The slide consists of a large number of particles. When the light from a laser source is diffracted by the particle which is present in the slide, diffraction patterns are formed on the screen.

3. Once the diffraction pattern is formed due to particle on the screen to determine its size, fix its position and note the reading on the screen. For further readings vary the distance between the slit and the screen (D).

4. By varying D, measure 'x' for bright ring of order 'm' to determine the size of particle using the formula: $a = \frac{2m\lambda D}{x}$

5. Repeat the experiment for different orders of diffraction 'm' to determine the average size of the particle.

Diagram:

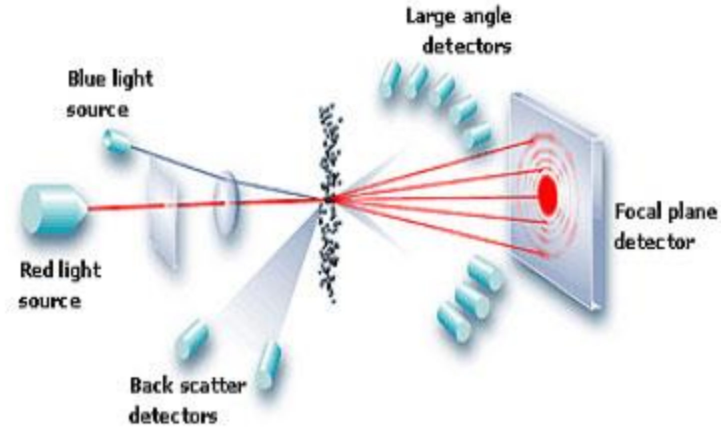


Fig. : Determination of particle size using Laser

Precautions:

1. Laser beam should not be seen with the nacked eye directly which may cause blindness.

2. Don’t shine the laser toward anyone.

3. The laser light should be operated at a constant voltage of 220 V.

Table:

S. No.	order of the bright ring (m)	Distance between the particle slide and the screen (D) cm	Diameter of m^{th} dark ring (x) (mm)	Size of the particle $a = \frac{2m\lambda D}{x}$ μm
1.				
2.				
3.				
4.				

Calculations:

Result:

The size of the particle a = ----------------- μm

EXPT-3 **Date:**

DETERMINATION OF SPRING CONSTANT OF SPRINGS USING COUPLED OSCILLATOR

Aim: To find the spring constant of a helical spring using coupled oscillator

Apparatus:

1. Light weight helical spring with a pointer attached at the lower end
2. A hook/ring for suspending it from a hanger (diameter of the spring may be about 1to1.5 cm inside or same as that in a spring balance of 100 g)
3. A rigid support
4. Hanger
5. Five slotted weights of 10 g each (in case the spring constant is of high value one may use slotted weight of 20 g)
6. Clamp stand
7. Balance
8. Measuring scale (15-30 cm)
9. Stop-watch (with least count of 0.1s).

Principle:

Spring constant (or force constant) of a spring is given by

$$\text{Spring constant, } K = \frac{Restoring\ Force}{extension}$$

Thus, spring constant is the restoring force per unit extension in the spring. Its value is determined by the elastic properties of the spring. A given object is attached to the free end of a spring which is suspended from a rigid point support (a nail fixed to a wall). If the object is pulled down and then released then it executes simple harmonic oscillations.

The time period (*T*) of oscillations of a helical spring of spring constant '*K*' is given by the relation '*T*',

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Where m is the load mass of the object.

Then spring constant is given by $K = 4\pi^2 \frac{m}{T^2}$

Procedure:

1. Suspend the helical spring (having pointer and the hanger at its free end), from a rigid support, as shown in figure.
2. Set the measuring scale, close to the spring vertically. Take care that the pointer moves freely over the scale without touching it.
3. Find out the least count of the measuring scale (It is usually 1mm or 0.1 cm).
4. Familiarize yourself with the working of the stop-watch and find its least count.

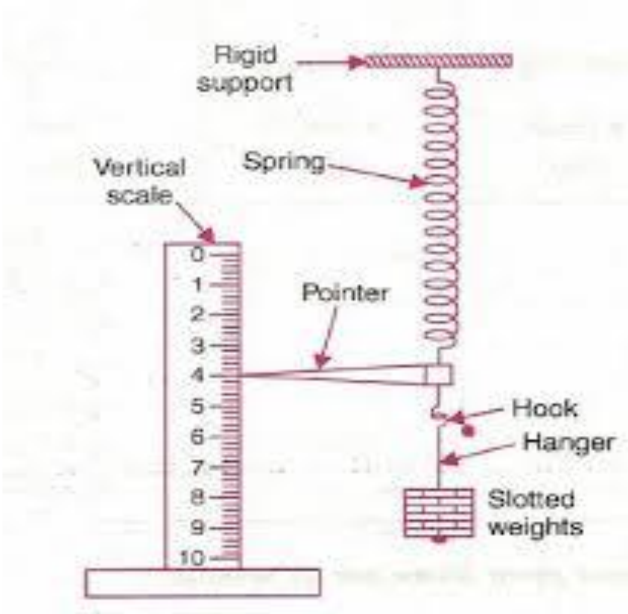


Fig: Determination of spring constant

5. Suspend the load or slotted weight with mass 'm_1' on the hanger gently. Wait till the pointer comes to rest. This is the equilibrium position for the given load. Pull the load slightly downwards and then release it gently, so that it is set into oscillations in a vertical plane about its rest (or equilibrium) position. The rest position (x) of the pointer on the scale is the reference or mean position for the given load. Start the stop-watch as the pointer just crosses its mean position (say from upwards to downwards) and simultaneously begin to count the oscillations.
6. Keep on counting the oscillations as the pointer crosses the mean position (x) in the same direction. Stop the watch after n (20) oscillations are complete. Note the time (t) taken by the oscillating load for n oscillations.
7. Repeat this observation at least thrice and in each occasion note the time taken for the same number (n) of oscillations. Find the mean time (t_1), for n oscillations and compute the time for one oscillation, i.e., the time period T_1 (= t_1/n) of oscillating helical spring with a load m_1.
8. Repeat steps 5 and 6 for m_2 & m_3 slotted weights.
9. Calculate time period of oscillation T = n for each weight and tabulate your observations.
10. Compute the value of spring constant (K_1, K_2, K_3) for each load and find out the mean value of spring constant K of the given helical spring.
11. The value of K can also be determined by plotting a graph of T^2 verses m with T^2 on y-axis and m on x-axis.

Precautions:

1. The spring should be light and flexible.

2. The pointer should be light and it should not touch the scale.

3. The number of oscillations should be large enough.

4. The weights added to the hanger must be within the elastic limit.

Observations:

Least count of the measuring scale = ---------- mm = -------- cm

Least count of the stop watch = -------- s

Mass of load 1, m_1 = -------- gm = ---------- kg

Mass of load 2, m_2 = -------- gm = ---------- kg

Mass of load 3, m_3 = -------- gm = ---------- kg

Table:

S. No.	Mass of the load(m)	Mean position of pointer(x) cm	Time for 20 oscillations (s)			Time period T = t/20 s
			Trial-1	Trial-2	Mean (t)s	
1.	m_1 =					
2.	m_2 =					
3.	m_3 =					

Substitute the values of m_1, m_2, m_3 and T_1, T_2, T_3 in Eq. (3)

$$K_1 = \frac{4\pi^2(m_1)}{T_1^2}$$

$$K_2 = \frac{4\pi^2(m_2)}{T_2^2}$$

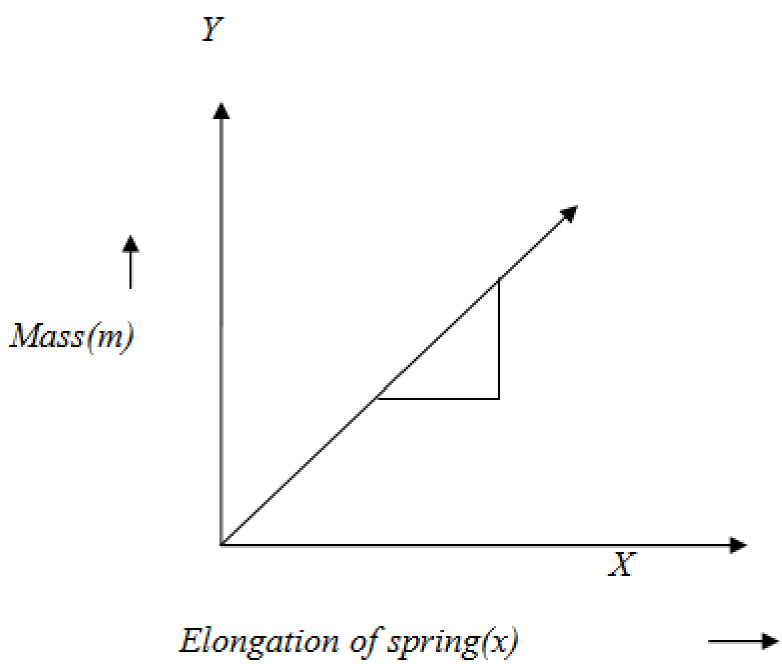
$$K_3 = \frac{4\pi^2(m_3)}{T_3^2}$$

Compute the values of K_1, K_2 and K_3 and find the mean value of spring constant K of the helical spring given by

$$K = \frac{K_1+K_2+K_3}{3}$$

Model Graph:

Alternately one can also find the spring constant of the spring from the graph between T^2 and m, which is expected to be a straight line as shown in Fig. The value of spring constant 'K' of the helical spring can be calculated from the slope m^1 of the straight line graph.



$$\text{Slope}(m^l) = \frac{\Delta m}{\Delta x}$$

Calculations:

Result: Spring constant of the given helical spring = **_____________** N/m

EXPT-4 **Date:**

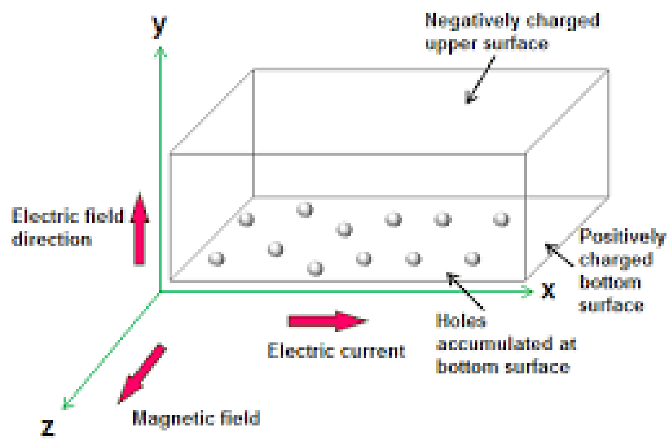
DETERMINATION OF HALL VOLTAGE AND HAL COEFFICIENT OF A SEMICONDUCTOR USING HALL EFFECT

Aim: To determine the Hall coefficient, the concentration of the majority charge carriers and the mobility of charge carriers in the material.

Apparatus: Extrinsic semiconductor material, constant current source, electro-magnets, voltmeter having high input impedance.

Introduction: If a magnetic field is applied along X-direction and current is applied along Y-direction, then the voltage will be developed perpendicular to the both current and magnetic field i.e. in Z- direction. This effect is known as Hall effect and developed voltage is called Hall voltage.

The schematic demonstration of Hall effect is shown in fig.



Hall Effect in P-type semiconductor

Theory:

Take a p-type semiconductor wafer of thickness 't' and area of cross section 'A'. It carries a current I is acted up by a transverse magnetic field B. The magnetic field deflects charge carriers in a semiconductor wafer towards the one of the faces leading to an accumulation of charge carriers. This will produce an electric field E_H in a direction which opposes the Lorentz force due to magnetic field. The electric field which builds will be exactly balances the magnetic field. The potential difference V_H arising due to E_H is given by

$$V_H = \frac{BI}{\rho e t} \quad \text{------------- (1)}$$

The ratio $\frac{I}{\rho e}$ is known as Hall coefficient R_H. Thus

$$R_H = \frac{I}{\rho e} \quad \text{-------------- (2)}$$

$$R_H = \frac{V_H}{BI} \quad \text{-------------- (3)}$$

If we know the thickness 't' of the semiconductor wafer, the magnetic field B and by measuring the Hall voltage V_H produced in the wafer for given current I, the Hall coefficient R_H, can be determine with the help of equation (3).

If we know the Hall coefficient, the concentration of charge carriers in the material can be determine with the help of equation

$$\rho = \frac{1}{R_H e}$$

$$\sigma = \frac{1}{\rho}$$

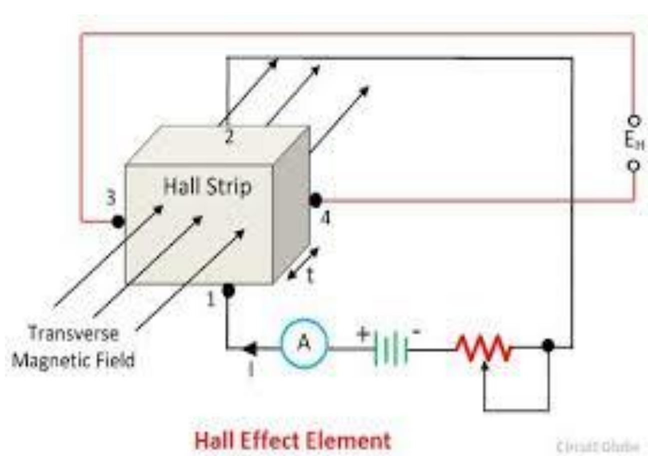
Knowing the conductivity σ of the semiconducting material, the mobility of charge carriers μ can be determine from following relation

$$\mu = \sigma R_H$$

<u>Description of experimental set up:</u>

The apparatus consist of a constant current source and digital panel meter. The current flowing through the semiconductor and voltage developed can be read with the help of current meter and volt meter. The semiconductor is taken in the form of a wafer and mounted on a strip. Four contacts were soldered on the wafer. An electro-magnet supplies uniform magnetic field. The magnetic field can be directly read from the panel meter located on the power supply unit. The strength of magnetic field can be varied with the help of potentiometer.

The circuit diagram for the measurement of Hall voltage is shown in figure.



Procedure:

1. The semiconductor is mounted on the probe strip and four electrical contacts are provided on the strip. The circuit is connected as shown in figure. The lengthwise contacts are connected to current meter and breadth wise contacts are connected to voltmeter.

2. The probe is placed in the gap of the electromagnets which provides magnetic field in direction perpendicular to the current direction and adjusts the magnetic field to a suitable value and keep constant.

3. The current through the semiconductor is adjusted to a suitable value with the help of constant current source and corresponding voltage and polarity can be noted.

4. For different current values, the corresponding Hall voltage developed can be noted down with the help of voltmeter and result s tabulated in table1.

5. Now keep the current value constant at a constant value (say 3mA) and the magnetic field is varied in steps of 500 Gauss. At each set of magnetic field note down the corresponding Hall voltage. The observations are tabulated in table2.

6. Using the above observations plot the graphs. In one graph plot the current versus voltage at a constant magnetic field. In second graph magnetic field versus Hall voltage. In both cases graphs will be straight lines.

Table1: **At constant magnetic field**

S.No.	**Current (I) (mA)**	**Hall voltage V_H (mV)**

Model graph 1:

Variation of Hall voltage with current

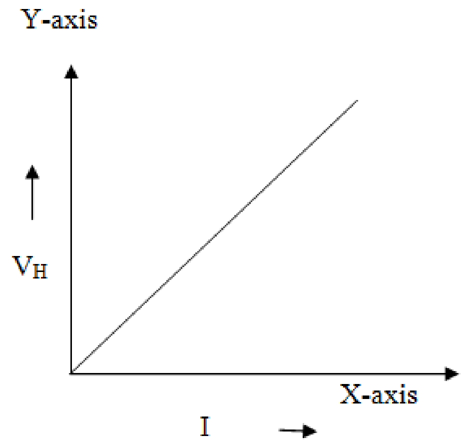


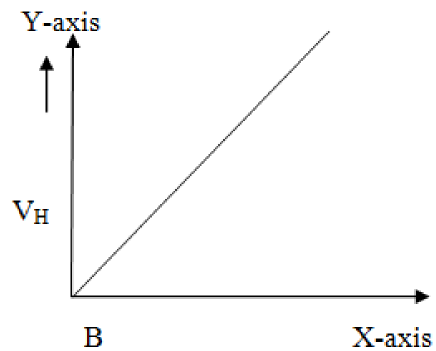
Table-2:

At constant current

S. No.	Magnetic field (Wb/m^2)	Hall voltage V_H (mV)

Model graph 2:

Variation of Hall voltage with Magnetic field



Precautions:

1. Care should be taken to limit the current through the probe to a value less than that of its capacity.

2. The probe should be properly centered and mounted in the magnetic field so that the maximum voltage is generated.

3. The potentiometer control of electro magnet is kept at a minimum value while switching on or off the power supply.

4. The potentiometer control of the current flow through probe is also brought to zero while on or off the current source.

5. Magnetic field should be varied gradually and slowly to avoid damage to the electromagnetic coil.

Formulae:

From the variation of current vs. voltage graph

(1) Slope = $\frac{V_H}{I}$

From the variation of magnetic field vs. voltage graph

Slope = $\frac{V_H}{B}$

R_{H1} = [slope $\frac{V_H}{I}$] x $\frac{t}{B}$ = ______________ m^3/C

R_{H2} = [slope $\frac{V_H}{B}$] x $\frac{t}{I}$ = ______________ m^3/C

Hall coefficient (Mean R_H) = $\frac{R_{H1}+R_{H2}}{2}$ = __________ m^3/C

(2) Majority carrier concentration

n (or) p = $\frac{1}{R_H e}$ = ______________ $/m^3$

(3) Mobility of charge carriers:

$\mu = \sigma R_H$ = _______ m^2/Vs

Calculations:

Results:

1. The Hall voltage measured =

2. The mobility of charge carriers =

3. The carrier concentration of charge carriers =

EXPT-5 **Date:**

DETERMINATION OF DIELECTRIC CONSTANT USING CHARGING AND DISCHARGING OF CAPACITOR

Aim: To determine the dielectric constant of the dielectric material of the given capacitor by the method of charging and discharging.

Apparatus: Power supply, capacitor, resistor, voltmeter etc.

Formula: Dielectric constant of the dielectric material

$$K=\frac{dT_{1/2}}{0.693\varepsilon_0 AR}$$

Where d = Thickness of dielectric material (m)

$T_{½}$ = Time require for 50% charge or discharge (s)

A = area of the dielectric material (m^2)

R = Resistance of resistor in series with the capacitor (W)

Procedure: The terminals of the capacitor are shorted using a wire to remove the charges that are already stored.

Charging mode: Circuit connections are made as shown in the figure. The voltage across the capacitor for time T=0 is noted as zero. The Toggle switch is closed to position ‘A’ to initiate charging of the capacitor and simultaneously a timer is started. The voltage (V) across the capacitor is noted for every 5 second until the voltage across the capacitor becomes almost constant. The readings are tabulated.

Discharging mode: The stop-clock is reset to zero. The voltage across the capacitor corresponding to time T=0 is noted. Now the toggle switch is closed to position ‘B’ to initiate discharging of the capacitor and simultaneously the timer is started. The voltage (V) across the capacitor is noted for every 5 second until the voltage across the capacitor becomes almost constant. The readings are tabulated.

Circuit Diagram:

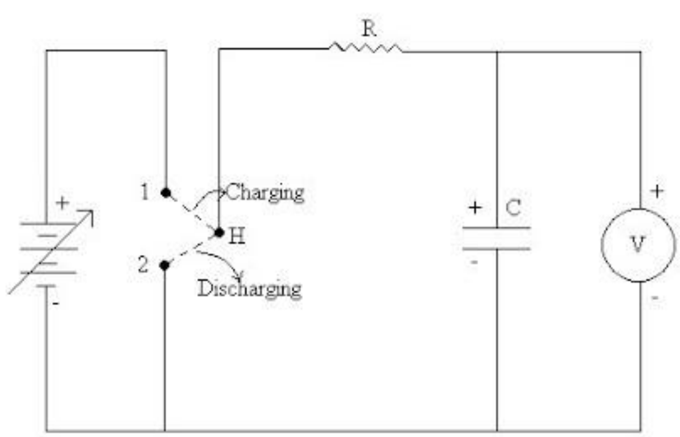
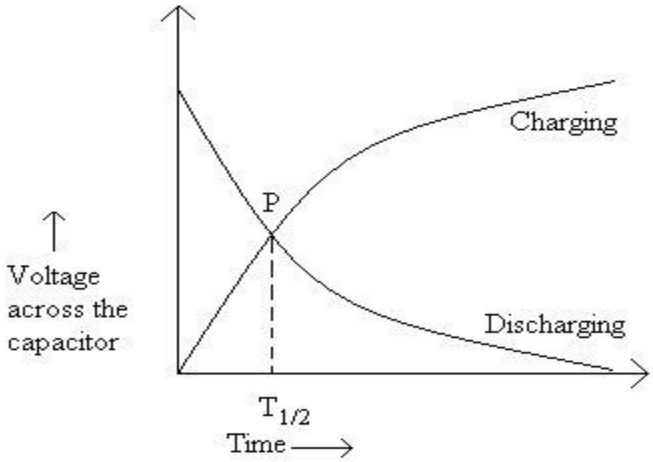


Figure 1

Model Graph:



A plot of Voltage (V) against Time (T) is made on the same graph for both charging and discharging of the capacitor. Two intersecting curves are obtained as shown in the figure. The time corresponding to the intersection of the curves called T½ is determined. It is the time required to charge a capacitor to a value half the maximum amount of charge. Given the length (l) and breadth (b) of the dielectric material the area (A) is calculated. Given its thickness (T), the dielectric constant of the material of the given capacitor is calculated using the formula

$$K= \frac{dT_{1/2}}{0.693\varepsilon_0 AR}$$

Table:

S.No	Time	R = ------ Ω, C= ------Mf Voltage across capacitor (V)	
		Charging	Discharging

Observations:

Length of the dielectric material, l = --------- m

Breadth of the dielectric material, b = --------- m

Thickness of the dielectric material, d = -------- m

Area of the dielectric material, A = lxb = -------- m^2

Permittivity of free space, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

From graph:

$T_{1/2}$ = --------- s

Calculations:

Dielectric constant of the dielectric material is given by $K = \frac{dT_{1/2}}{0.693\varepsilon_0 AR}$

Result: Dielectric constant of the dielectric material is, K = __________

EXPT-6 **Date:**

DETERMINATION OF MAGNETIC FIELD ALONG THE AXIS OF A CIRCULAR COIL CARRYING CURRENT

Aim: To study the variation of the intensity of magnetic field along the axis of a current carrying circular coil using Stewart & Gee's type of tangent galvanometer.

Apparatus:

1. Stewart & Gee's tangent galvanometer
2. Magnetic compass
3. Ammeter
4. Commutator
5. Battery eliminator
6. Rheostat
7. Plug key
8. Connecting wires

Formula:

1. The magnetic field along the axis of a current carrying coil is given by

$$B = \frac{2\pi n i r^2}{10(d^2+r^2)^{3/2}} \text{ Gauss}$$

Where n = no. of turns of the coil = 50

i = current flowing through the coil (Amp) = 0.2 A

r = Radius of the coil (cm) = 10.1 cm

d = distance of magnetic needle from the center of the coil towards east and west

2. At the center of the magnetometer the flux density 'B' due to the current in the coil and the horizontal component of the earth's flux density B_H act at right angles to each other, so that the deflection 'θ' is given by

$$B = B_H \tan\theta$$

Where B_H = horizontal component of the earth's magnetic field = 0.38 Gauss

θ = Average angle of deflection of the magnetic needle

Circuit Diagram:

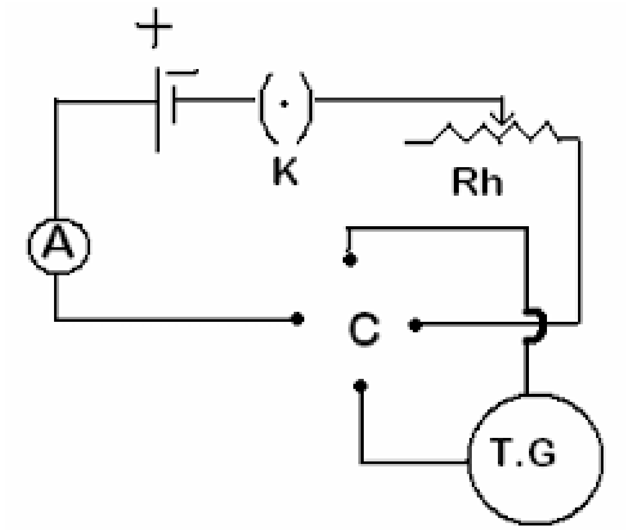


Fig.: Circuit diagram of Stewart & Gee's experiment

Graph : A graph is drawn between 'd' along x-axis and Tanθ along y-axis as shown in figure 2. It is symmetrical about the center of coil.

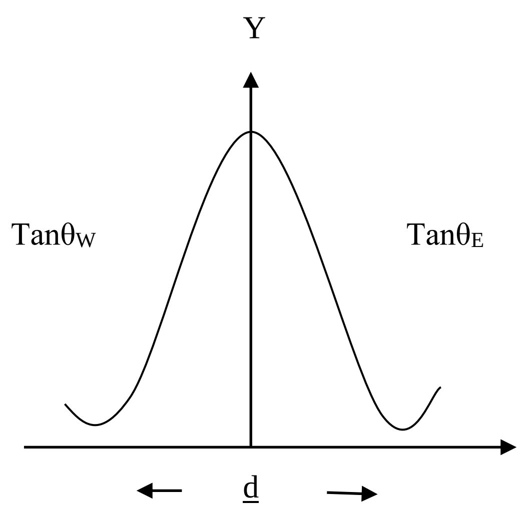


Diagram : Model graph

Procedure:

1. Orient the apparatus such that the coil is in the north-south plane as shown in the fig.

2. Adjust the leveling screws to make the base horizontal. Make sure that the compass is moving freely.

3. Connect the circuit as shown in the figure, selecting the number of turns (n) of the coil.

4. Keep the compass at the center of the coil and adjust the apparatus so that the pointers indicate 0-0 reading.

5. Close the plug keys (k) and commutator (C) (make sure that you are not shorting the power supply) and adjust the current with rheostat (Rh) so that the deflection is between 50 to 60 degrees. The current is noted by ammeter (A) and it will be kept fixed at this value for the rest of the experiment.

6. Note down the readings θ_1 and θ_2. Reverse the current by changing the commutator keys and note down θ_3 and θ_4.

7. Repeat the experiment at intervals of 2 cm along the axis towards East until the value of the field drops to 10 % of its value at the center of the coil.

8. Repeat the experiment on other sides of the coil towards West and note the deflections θ_5, θ_6, θ_7 and θ_8.

Precautions:

1. The coil and the magnetic needle are adjusted to be in magnetic meridian.
2. All the magnetic materials and current carrying conductor should be kept away from the apparatus.
3. The apparatus should be kept without any disturbance throughout the experiment.
4. Readings should be taken without parallax error.

Table:

S.No	d (cm)	Deflection in degrees								Avg.θ	Tanθ	B=B_H Tanθ	$B = \frac{2\pi n i r^2}{10(d^2 + r^2)^{3/2}}$
		Left arm				Right arm							
		θ1	θ2	θ3	θ4	θ5	θ6	θ7	θ8				
1.	0												
2.	2												
3.	4												
4.	6												
5.	8												
6.	10												

Calculations:

1. **For d = 0**

2. **For d = 2**

3. **For d = 4**

4. **For d = 6**

5. **For d = 8**

6. **<u>For d = 10</u>**

<u>Result:</u>

1. The magnetic fields along the axis of a current carrying coil have been computed and compared.

2. The variation of magnetic field along the axis of a current carrying coil have been studied with the help of a graph

EXPT-7 **Date:**

DETERMINATION OF RIGIDITY MODULUS BY WIRE-DYNAMIC METHOD

Aim: To determine the rigidity modulus of the material of the wire.

Apparatus: A circular disc provided with chuck nut (Torsional pendulum), steel wire, stop watch, screw gauge, vernier calipers.

Formula:

Rigidity Modulus of the material is given by

$$\eta = \frac{4\pi MR^2}{a^4}\left(\frac{l}{T^2}\right)$$

Where M = Mass of the disk

R =Radius of the disk

a = Radius of the wire

l =length of the wire,

T = Time period of oscillation

Procedure:

The circular metal disc is suspended to a wire of convenient length as shown in figure. A vertical pin (a small mark on the disk when it is in equilibrium) is placed in front of the disc. This will help to note the number of oscillations made by the disc. The disc is set to oscillate through small angles.

When the disc is rotating, the time for 20 oscillations is noted with help of a stop watch. This is repeated twice and the mean of two trials is taken. The time period (T) foe one oscillation is calculated.

This experiment is repeated for different lengths of the pendulum. The radius of the wire (a) is to be found accurately with screw gauge. The radius (R) of the disc is found with vernier calipers. The mass (M) of the disc is obtained by balance. The mean value of the (l/T^2) from the graph and then η is calculated.

Diagram:

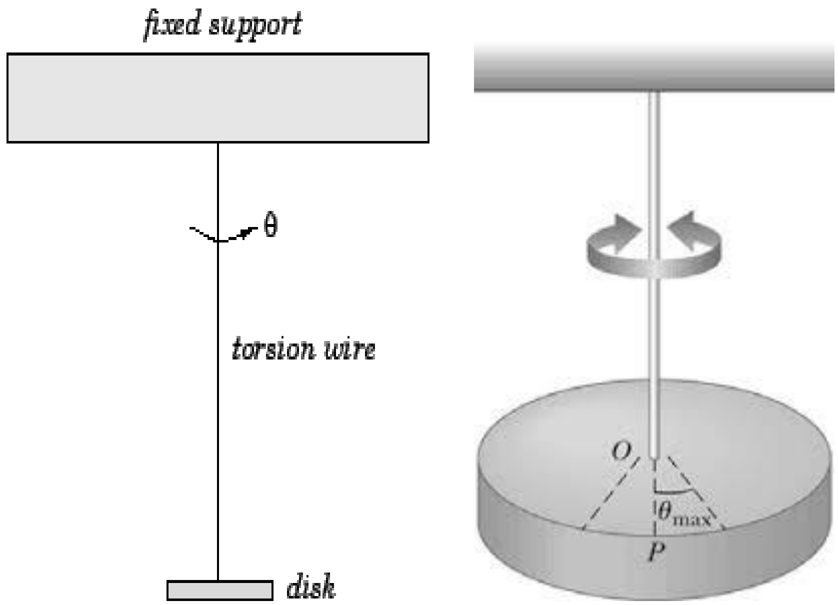
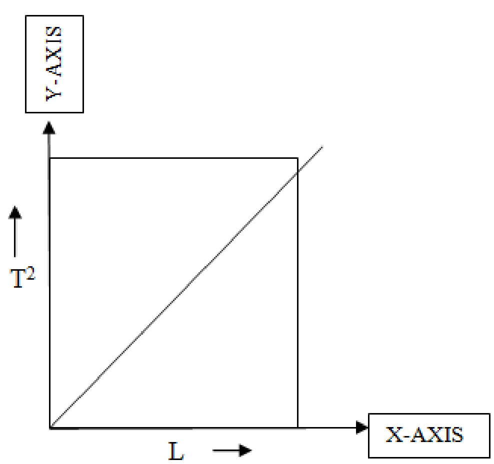


Figure: Torsional pendulam.

Model graph: A graph is drawn with l on x-axis and T^2 on y-axis. From the equation it should be linear as shown in figure. From the graph the value of T^2 for large l is noted and this value of (l/T^2) is substituted in the equation calculated the η.



Precautions:

1. There should be no kinks in the string.

2. The oscillations must be in a horizantal plane only.

3. The readings should be taken without any parallox error.

Table1:

S.No.	Length of the wire(l)	Time for 20 oscillations			Time period (T)=t/20	l/T^2
		Trial 1	Trial 2	Mean (t)		

Table2: To measure the radius of the disc with vernier calipers.

S.NO.	Main scale reading (MSR) (A)	Vernier coincidence (VC)	V.CX L.C=B	Radius=A+B

Table 3: **To measure the radius of the wire with screw gauge**

Least count=Pitch of the screw/Number of head scale readings.

Zero error= Zero correction=

S.NO.	Reading of the Pitch scale (P.S.R)(A)	Head scale reading(H.S.R)	Corrected Head scale reading (C.H.S.R)	C.H.R.SXL.C (B)	Diameter of the wire C=A+B

Calculations:

Result: The Rigidity Modulus of the material is = __________

EXPT-8 **Date:**

DETERMINATION OF HYSTERESIS LOSS BY TRACING B-H CURVE

Aim: To trace hysteresis curve of a transformer core using a CRO and find the energy loss per unit volume per cycle, coercivity and retentivity of the material core.

Apparatus: B-H Curve unit, ferrite core, CRO, translucent paper etc.

Formula:

The energy loss can be calculated by

(E.L) = $\frac{N_1}{N_2}$ X $\frac{R_2}{R_1}$ X $\frac{C}{AL}$ X S_v X s_H X CH_1 X CH_2 X area of the loop in j/cycle/volume

Where N_1 = No. of turns of primary coil

N_2 = No. of turns of secondary coil

R_2 = Resistance used in the experiment

R_1 = Resistance between terminals

C = Capacitance used in the circuit

L = length of specimen

A = Area of cross section of transformer

S_V = vertical sensitivity

S_H = Horizantal sensitivity

CH_1 = First channel voltage in CRO

CH_2 = Second channel voltage in CRO

Circuit :

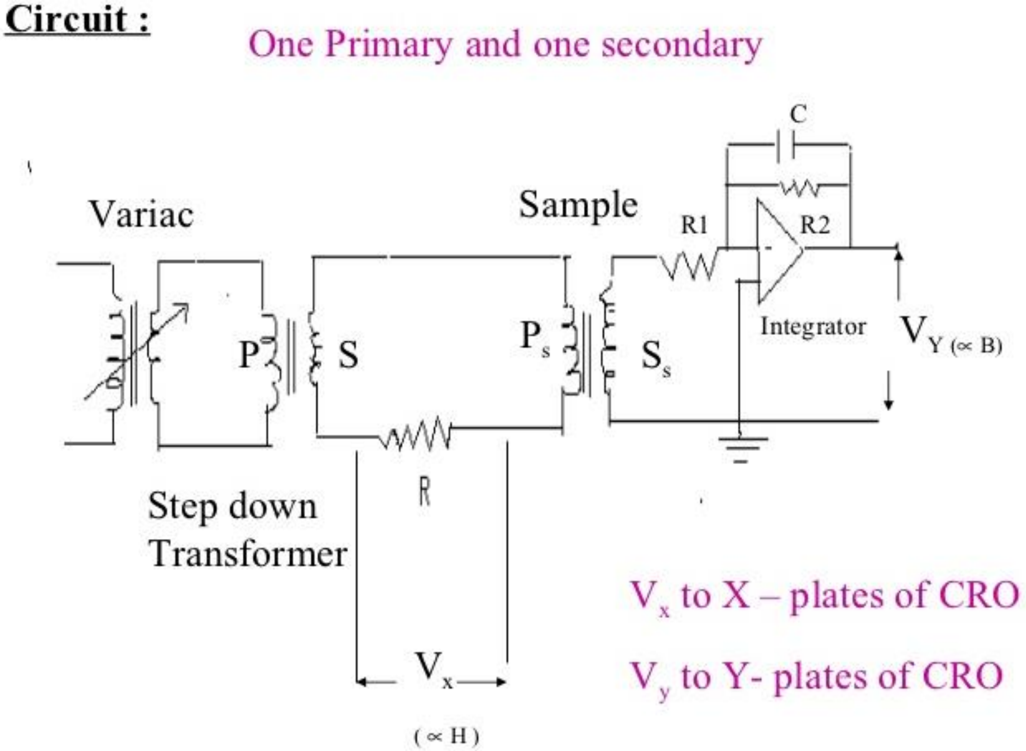


Fig 1: Circuit diagram of B-H curve

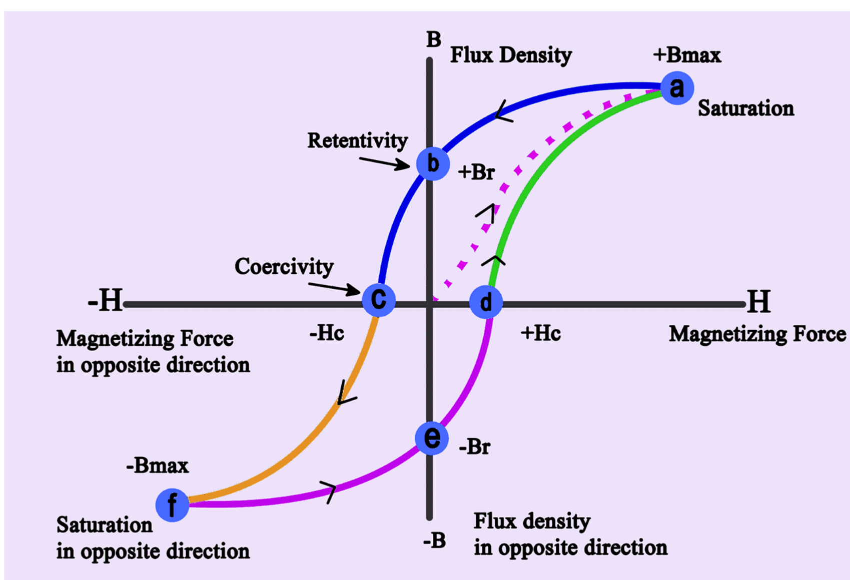


Fig 2: B-H curve

Procedure: The phenomenon by which the magnetic induction (B) lags behind the magnetizing field (H) is called hysteresis.

1. The hysteresis curve graph with H on X- axis & corresponding B on Y- axis (of the material) will be as shown in fig 2.
2. The area under the B-H curve gives the hysteresis loss per cycle that is the work done per unit volume per cycle. Ob gives the value of retentivity (B_r) that is the remanent induction even when the field H is removed. Oc gives the value of coercivity (H_c) that is the negative field to be applied to demagnetize the specimen completely.
3. The circuit diagram required for experiment is as shown in fig. Connect the primary terminals of the specimen to the' PRIMARY' and secondary to the 'SECONDARY' terminals. Adjust the CRO to work on external mode (the time base is switched off). Connect terminals "Vertical input" to CRO.
4. Connect terminal "Horizontal" CRO to the horizontal input of the CRO. Switch on the power supply of the unit. The hysteresis loop is formed. Adjust the horizontal and vertical gains such that the loop occupies maximum area on the screen of the CRO. Once this adjustment is made don't disturb the gain controls. The position of horizontal gain knob gives horizontal sensitivity S_H (Volts/m). Similarly the position of vertical gain knob gives vertical sensitivity S_v (Volt/m).
5. Trace the loop on a translucent sheet (butter paper) and reproduce the same on graph paper. Estimate area of loop in m^2.
6. The energy loss is given by

$$(E.L) = \frac{N_1}{N_2} \times \frac{R_2}{R_1} \times \frac{C}{AL} \times S_v \times s_H \times CH_1 \times CH_2 \times \text{area of the loop in j/cycle/volume}$$

Tabular Form:

S. No.	Resistance	CH_1	CH_2	S_V (m)	S_H (m)	Area of the loop (m^2)	Energy Loss
1.							
2.							
3.							
4.							

Precautions:

1. The current in the primary of solenoid should be quite large so as to magnetize the specimen sufficiently.
2. Handle CRO carefully.
3. Trace of BH curve should be taken as tracing paper and it should of suitable size.

Calculations:

Result:

1. The energy loss of hysteresis loop = ____________
2. The Retentivity of the core material =____________
3. The Coercivity of the core material =____________

EXPT-9 **Date:**

DETERMINATION OF NUMERICAL APERTURE AND ACCEPTANCE ANGLE OF AN OPTICAL FIBER

Aim: To determine the acceptance angle and numerical aperture of an optical fiber.

Apparatus:

1. Fiber optical light source
2. Optical fiber cables
3. Numerical aperture
4. Optical bench

Formula:

The Numerical aperture of an optical fiber is given by,

$$NA = \sin \alpha = \frac{W}{\sqrt{4L^2+W^2}}$$

Acceptance angle, $\alpha = \sin^{-1}$ (NA)

Where W = Diameter of the light falling on the screen

L = distance between the fiber end to circular image (cm)

Diagram:

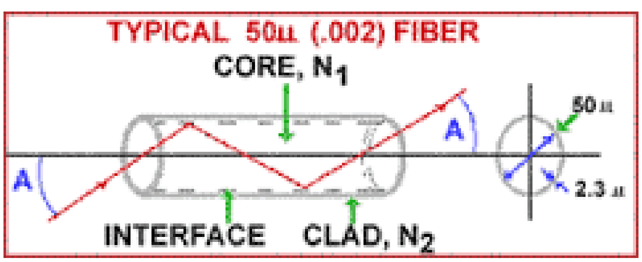


Fig.: Numerical aperture and acceptance angle of an optical fiber

Procedure:

1. One end of the optical fiber is connected to the power output of LED. And the other end of the fiber is connected to NA jig through the connector.

2. The A.C. mains is switched on. The light emitted by LED passes through the optical fiber cable to the other end. The set nob is adjusted such that, maximum intensity is observed on the screen and it should not be further disturbed.

3. A screen with concentric circles of known diameter is moved along the length of the NA jig to observe the circular spearing of light intensity on the screen.

4. The screen is adjusted such that, the first circle from the center of the screen is completely filled with the light. At this position, the distance (L) from the fiber end to the screen is noted on the NA jig.

5. The experiment is repeated for the subsequent circles by adjusting the length L along NA jig and the diameter of the rings (W) are noted in table.

6. By determining the values of ‘L’ and ‘W’, the NA and acceptance angle of the optical fiber can be calculated by using the above formulae.

Table:

S.No.	**Diameter of the circular ring W (mm)**	**Distance from fiber end to screen L (cm)**	**NA =** $\frac{W}{\sqrt{4L^2+W^2}}$	$\alpha = \sin^{-1}(NA)$
1.	5			
2.	10			
3.	15			
4.	20			
5.	25			
6.	30			

Precautions:

1. Surroundings should be perfectly dark.

2. Fiber should be coupled smoothly to the connector.

Calculations:

Result: Numerical aperture of the optical fiber NA = -------

Acceptance angle of the optical fiber α = -------

EXPT-10 **Date:**

DETERMINATION OF ULTRASONIC VELOCITY IN LIQUID

Aim: To determine velocity and wavelength of ultrasonic using ultrasonic diffractometer.

Apparatus: Quartz crystal (2 to 5 M Hz) mounted in between a pair of metal plates, a rectangular optically plane glass vessel (cell), liquid like kerosene or CCl_4, spectrometer, A.F oscillator etc.

Principle:

When a quartz crystal 'Q' placed between two metal plates in a liquid is sent into vibration using an A.F. oscillator then ultrasonics are produced. When these ultrasonics are reflected by a reflector, longitudinal stationary waves are produced in the liquid. As a result, alternate nodal planes the layers are crowded together (compressions and rarefactions) and density is maximum. At antinodal planes, layers are separated (rarefactions) and density is maximum. This set up of nodal planes and antinodal planes behave like slits and opaque spaces of a plane grating. Such an arrangement is called acoustic grating. Using this acoustic grating, velocity 'V' and wavelength' λ' can be determined.

A parallel beam of monochromatic light from a sodium vapor lamp is collimated and is allowed to fall normally on this acoustic grating. Diffraction takes place and diffracted beam is observed through the telescope of a spectrometer. On either side of the central maximum various orders of principle maxima are obtained. If θ is the angle of diffraction for a principle maximum, then

$$d\sin\theta = n\lambda \quad \text{-------------- (1)}$$

Where'd' is the distance between two consecutive nodal planes, n is the order of spectrum and λ is the wavelength of monochromatic light. D can be calculated from this grating equation.

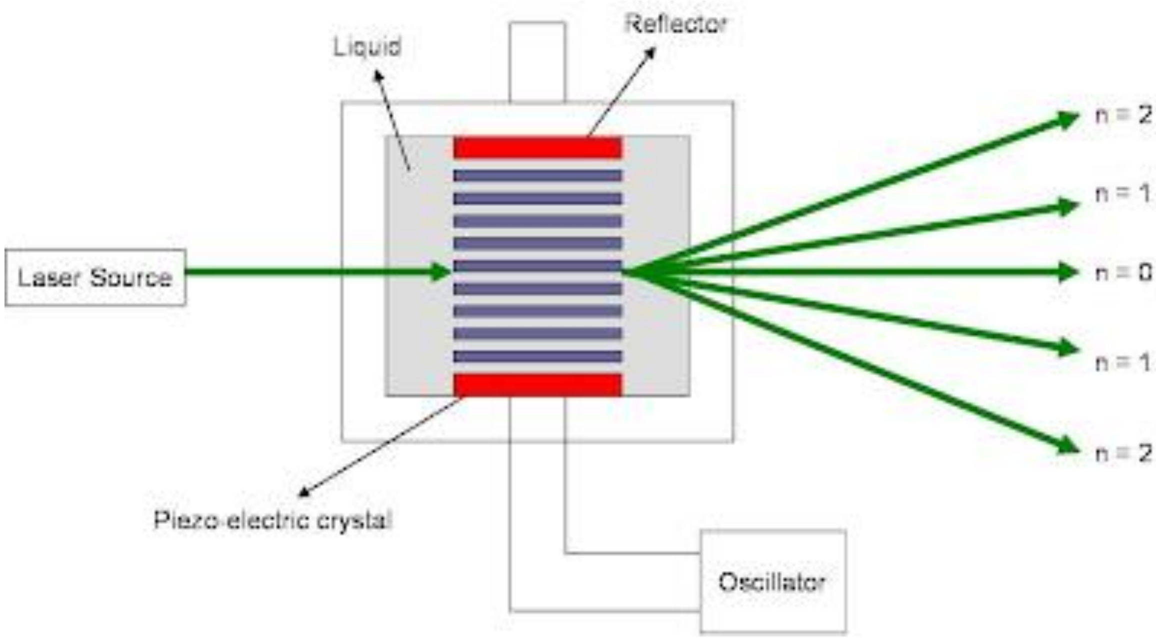
But $d = \frac{\lambda_a}{2}$ or $\lambda_a = 2d$ ------------------------------ (2)

Where λ_a is wave length of ultrasonic wave in the liquid.

But $V = \nu \lambda_a$ ----------------- (3)

Where ν is the frequency of oscillations of the crystal V is the velocity of ultrasonic wave in the liquid.

Diagram:



Description:

Ultrasonic diffractometer mainly consist of quartz crystal Q placed between two metal plates provided with connecting leads. The quartz crystal set up is claimed inside on one face of an optically plane rectangular glass cell filled with kerosene or CCl_4 so that the crystal is immersed completely in liquid. The cell is placed on the prism table of a spectrometer and it is illuminated by a beam of monochromatic light from a sodium vapor lamp. The quartz crystal can be subjected to vibrations from A.F. oscillator.

Procedure:

- The initial adjustment of spectrometer is made.
- The rectangular cell containing liquid is placed on the prism table perpendicular to the collimator.
- The quartz crystal Q together with metal plates and connection leads is clamped inside the liquid on another side of cell.
- A narrow beam of monochromatic light from collimator is allowe3d to fall normally on the cell. The direct image observed through the telescope.
- Now the A.F oscillator is switched on and the frequency of A.F oscillator is varied from 2 to 5 M Hz.
- The crystal is subjected to these oscillations and it begins to vibrate in resonance with the oscillator.

- As a result ultrasonic waves are produced in liquid. These waves get reflected from the opposite side of the cell producing longitudinal stationary waves in the form of compressions and rarefactions.
- This arrangement behaves like a grating and as a result ultrasonic waves are diffracted. On either side of the central maximum different orders of principle maxima are obtained.
- The telescope is turned so that the cross wires coincide with the spectral line of the first order on one side of the central maximum.
- The main scale reading and vernier scale reading are noted. Now the telescope is turned to the other side so that cross-wires coincide with the spectral line of first order.
- Main scale reading and vernier scale reading are noted. From these two sets of readings, 2θ for first order and hence θ are calculated.
- The distance 'd' between two consecutive nodes or antinodes is found out from the grating equation $d\sin\theta = n\lambda$ where λ is the wavelength of sodium light is known ($5893A^0$).
- λ_a, the wavelength of ultrasonics in liquid can be found out from $\lambda_a = 2d$. Knowing the frequency ν of oscillator, velocity v of ultrasonic in the liquid is calculated from the equation, $V = \nu\lambda_a$

Tabular Form:

S.No	vernier	Reading of diffracted image						$2\theta = X_2 - X_1$	θ	$d = \frac{N\lambda}{SIN\theta}$
		Left			right					
		MSR	VSR	TOTAL (X_1)	MSR	VSR	TOTAL (X_2)			

Mean d =__________________ m

Precautions:

1. The collimator and telescope must be coaxial.
2. Readings must be noted without parallax error.
3. The slit of the collimator must be narrow as possible.
4. The liquid must be free of impurities.

Observations:

Value of 1 MSD = _________

Number of vernier scale divisions (N) = _________

L.C = $\frac{1msd}{N}$ = ________

Frequency of oscillator ν = _______________

Order of spectrum (n) = _____________

Wavelength of light (λ) = ____________

Calculations:

Result:

1. Wavelength of ultrasonics in liquid λ_a = _______________ m

2. Velocity of ultrasonics in liquid V = ______________ m/s

EXPT NO. 11 **DATE:**

DETERMINATION OF PRESSURE VARIATION USING STRAIN GAUGE SENSOR

Aim: To determine the pressure variation using strain gauge sensor.

Apparatus: Pressure vessel, strain gauge sensor kit, pressure cell

Theory:

Transducers that measure force, torque or pressure usually contains an elastic member that converts the quantity to be measured to a deflection or strain. A deflection sensor or, alternatively, a set of strain gauges can be used to measure the quantity of interest (force, torque or pressure) indirectly. Characteristics of transducers, such as range, linearity and sensitivity are determined by the size and shape of the elastic member, the material used in its fabrication.

A wide variety of transducers are commercially available for measuring force. Torque and pressure the different elastic member employed in the design of these transducer include link, columns, rings, beams, cylinders, tubes, washers, diaphragms, shear webs and numerous other shapes of special purpose applications. Strain gauges are usually used as sensors; however linear variable differential transformers (LVDT) and linear potentiometers are some time used for static or quasistatic measurement.

Pressure Measurement (Pressure Cell)

Pressure cells are divisors that convert pressure into electrical signal through a measurement of either displacement strain or Piezoelectric response. Diaphragm type pressure transducers with strain gauges as sensor is used here for measurement of pressure.

This type of pressure transducers uses diaphragm as the elastic element. Diaphragms are used for low and middle pressure ranges. Strain gauges are bonded on the diaphragm and the pressure force is applied to the specimen the material gets elongated or compressed due to the force applied i.e., the material get strained. The strain incurred by the specimen depends on the material used and its elastic module. This strain is transferred to the strain gauges bonded on the material resulting in change in the resistance of the gauge. Since the strain gauges are connected in the form of whetstone's bridge any change in the resistance will imbalance the bridge. The imbalance in the bridge will intern gives out the output in mV proportional to the change in the resistance of the strain gauge.

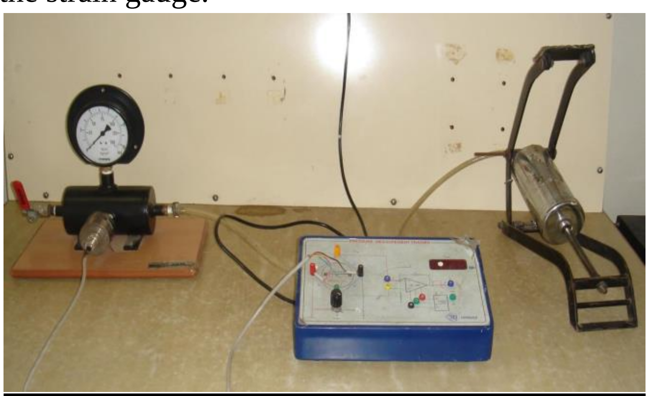


Fig: Pressure gauge sensor

Procedure:

- Check connection made and switch ON the instrument by rocker switch at the front panel.
- The display glows to indicate the instrument is ON. Allow the instrument in ON Position for 10 minutes for initial warm-up.
- Adjust the Potentiometer in the front panel till the display reads “000”.
- Apply pressure on the sensor using the loading arrangement provided.
- The instrument reads the pressure coming on the sensor and display through LED.
- Readings can be tabulated and % error of the instrument, linearity can be calculated.

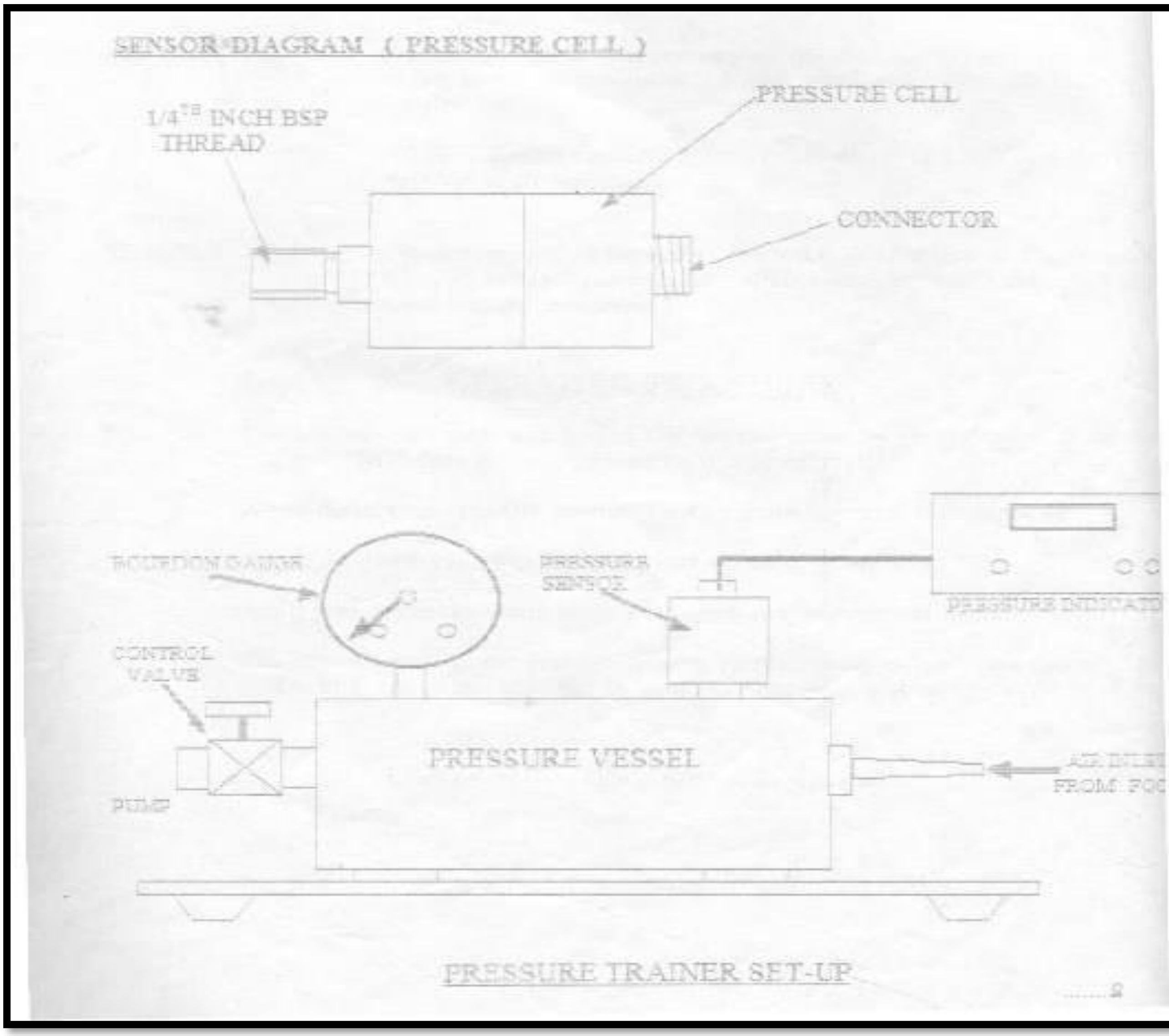


Table-1:

S.No.	Actual Pressure (P_A) kg/cm^2	Indicator Reading (P_I) kg/cm^2	Error (P_A- P_I)	Error (%)
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Calculations:

$$\text{Error} = \frac{\textbf{Error}}{\textbf{Max. Load}} \text{ x100 \%}$$

Specimen Readings

S.No.	Actual Pressure Kg/Cm^2	Indicator Reading Kg/Cm^2	Error	Error (%)
1	1.0	0.9	-0.1	
2	2.0	2.0	0	
3	3.0	3.0	0	
4	4.0	4.0	0	
5	5.0	5.1	0.1	
6	6.0	6.1	0.1	
7	7.0	7.1	0.1	

Calculations:

Result: Pressure variation using strain gauge sensor is =

EXPT NO:12 **DATE:**

DETERMINATION OF TEMPERATURE USING STRAIN GAUGE SENSOR

AIM: To determine the temperature variation using strain gauge sensor.

APPARATUS:

1. RTD
2. Thermometer
3. Resistances (100Ω, 39Ω)

THEORY:

The principle of operation of resistance temperature detectors is based on fact that electrical resistance many metals increases almost directly with temperature and is reproducible to high degree of accuracy. The term used to express these characteristics is coefficient at 0 degree by the appropriate formula. $R_t = R_0(1+\alpha t)$ Where α temperature coefficient of resistance for the metal clement in degree Celsius.

PROCEDURE:

1. Keep the switch in Temperature mode and connect 100 Ohm resistor between the input terminals. Now adjust the minimum knob to see zero on the display.
2. Connect 139 Ohm resistor and vary maximum knob to see 100 on the display.
3. Now keep 100Ohm resistor back and the display shows zero. If not follow steps 1 and 2 until display show zero for 100 ohm and 100 for 139 ohm resistors. Now the calibration is done.
4. Insert thermometer in the slot provided in the water bath. Place the water bath on the heater.
5. Connect the RTD – P_t100 at the input terminals. The resistance of RTD is around 100Ohms at 0^oC and 139 Ohms at 100^oC.
6. When room temperature is 25^oC as shown in the thermometer observe similar reading in the RTD display.
7. Switch on the heater and note down the temperature of RTD for the thermometer temperatures in the range of 25 to 70^oC. Then switch off the heater.
8. Turn the knob to resistance mode.
9. Replace the hot water with normal water to bring the temperature back the heater.
10. **Note:** Make sure the thermometer is not immediately inserted into the cold water. Allow in to come to normal temperature before immersing into the cold water.
11. For room temperature of 25^oC in the thermometer the RDT resistance value should be around 110 Ohms.
12. Now switch on the heater and note down the value of resistance in temperature range 25^oC to 70^oC.
13. Plot the graph between the RTD resistance and temperature.

CIRCUIT DIAGRAM:

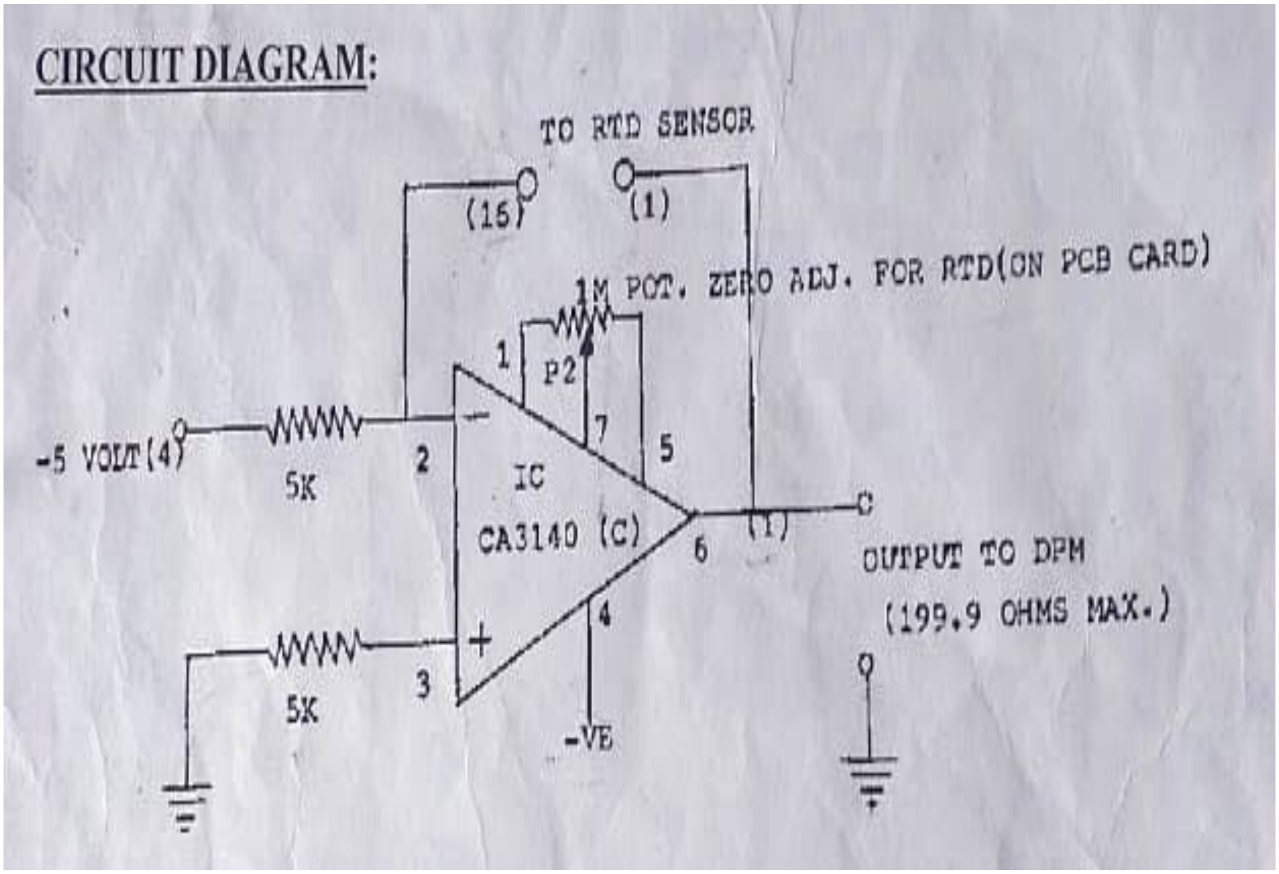
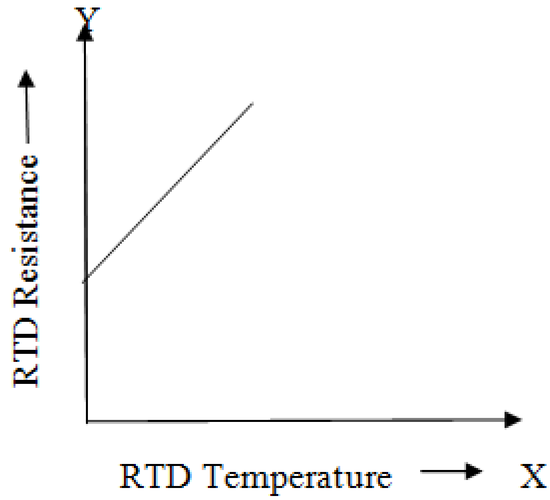


TABLE:

S. No	Thermometer temperature ^{0}c	RTD Temperature(Ω) ohm	RTD Resistance(Ω) ohm

MODEL GRAPH:



CALCULATIONS:

RESULT: Temperature variation using strain gauge sensor is determined.