

**DEPARTMENT OF PHYSICS**  
**RV COLLEGE OF ENGINEERING®**  
(AUTONOMOUS INSTITUTION AFFILIATED TO VTU, BELAGAVI)



**ENGINEERING PHYSICS**  
**PRACTICAL FILE**  
(MECHANICAL STREAM: ME/AS/IM/CH)

**COURSE CODE: 22PHY12B**

**2022-23**

**For the First Semester B.E**

<b>Name of the student</b>	
<b>Section, Batch</b>	
<b>Program</b>	
<b>Roll No. / USN</b>	
<b>Faculty In-charge</b>	<b>1.</b>
	<b>2.</b>

# **DEPARTMENT OF PHYSICS**

## **VISION**

TO ENABLE ENGINEERING GRADUATES TO UNDERSTAND, LEVERAGE AND APPRECIATE THE ROLE OF PHYSICS FOR THE DEVELOPMENT OF SUSTAINABLE AND INCLUSIVE TECHNOLOGY.

## **MISSION**

- EDUCATES THE STUDENTS WITH A PROGRAM CHARACTERIZED BY ART OF TEACHING WITH EXPERIMENTING SKILLS, PROJECT WORK/SEMINAR, SELF STUDY, EFFECTIVE COUNSELING AND AN ACTIVE INVOLVEMENT OF STUDENTS IN THEIR EXPERIENTIAL LEARNING.
- IMBIBE INQUISITIVENESS IN STUDENTS TO USE PHYSICS FOR ENGINEERING INNOVATION.
- EMPOWER THE FACULTY AND STUDENTS TO INVOLVE IN RESEARCH AND TO DEVELOP THE DEPARTMENT AS A KEY FACILITATOR FOR R&D TO ALL ENGINEERING PROGRAMS.

# RV COLLEGE OF ENGINEERING®

(An Autonomous Institution, Affiliated to V.T.U, Belagavi)

Mysuru Road, Bengaluru – 560059

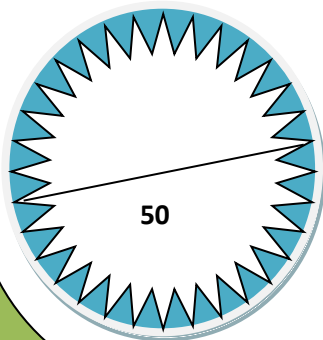
## DEPARTMENT OF PHYSICS

### CERTIFICATE

This is to certify that Mr./Ms..... has satisfactorily completed the course of experiments in **Physics practical (Mechanical stream)** prescribed by the department of Physics for the I semester of BE graduate programme during the year 2022 - 2023.

Signature of Head of the Department  
Date

Signature of the  
faculty in-charge



Name of the Candidate.....

Roll / U.S.N No.....

## PHYSICS FACULTY

<b>Sl. No.</b>	<b>Name</b>	<b>Designation</b>	<b>Initials</b>
01	Dr. Sudha Kamath M K	Associate Prof. & Head	SKMK
02	Dr. Bhuvanewara Babu T	Professor	TBB
03	Dr. Avadhani D N	Associate Professor	DNA
04	Dr. Shireesha G	Associate Professor	GHS
05	Dr. Shubha S	Assistant Professor	SHBS
06	Dr. Tribikram Gupta	Assistant Professor	TG
07	Dr. Rajesh B M	Assistant Professor	BMR
08	Dr. Ramya P	Assistant Professor	RAP
09	Dr. Karthik Shastry	Assistant Professor	KAS
10	Dr. Niranjana K M	Assistant Professor	NKM

## STAFF

<b>Sl. No.</b>	<b>Name</b>	<b>Designation</b>	<b>Initials</b>
01	Eshwarachari C	Assistant Instructor	EC
02	Satheesha KS	Attender	SKS
03	Shobha B	Peon	SB

## SCHEME OF EVALUATION

Particulars	Marks*
Data sheet + Experimental Set up	10
Conduction of Experiment	10
Calculation & Viva-Voce	10
Lab Internal	10
Experiential Learning	10
Total Marks	50

\* Tentative

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## MARKS SHEET

Name :

Sec/Batch :

USN/Roll No :

SLNO	SET NO.	LIST OF EXPERIMENTS	PAGE NO	DATE (EXPT SUBMITTED)	MARKS OBTAINED
1.	I	Single Cantilever/Uniform bending			
2.	II	Fermi Energy of Copper			
3.	III	Newton's Ring/ Air Wedge			
4.	IV	Spring Constant (EL-expEyes17)			
5.	V	Torsional Pendulum			
6.		Laser Diffraction			
7.	VI	Volume Resonator			
8.		Series LCR circuit (EL- expEyes17)			
		Average Marks (except EL)			/30
		Average marks for Experiential Learning (EL)			/10
Internal Marks					/10
Total Marks					/50
Signature of the faculty					



## GENERAL INSTRUCTIONS TO STUDENTS

1. Scan the QR code in each experiment to watch the video tutorial and read the procedure, come well prepare to the class.
2. Lab sub-batches will be allotted at the beginning of the semester.
3. Students will have to perform two experiments in one lab.
4. Every student has to perform the one/two experiments whichever is allotted to him /her, no change of experiments will be entertained.
5. While attending every laboratory session the student must bring the data sheets with all the relevant details written pertaining to the experiments.
6. **The data sheet must contain entries like *aim of the experiment, apparatus required, circuit diagram or the diagram of the experimental setup, tabular columns, the necessary formulae of the experiments as given in the in the practical file except the principle and procedure.***
7. Separate data sheets should be prepared for each experiment. *The procedure and principle of the experiment must be read by the student before coming to the laboratory and it should not be written on the data sheets.*
8. Students are required to obtain the signature (entry signature) of the faculty on the data sheet before proceeding to the experiment.
9. All calculations pertaining to the two experiments should be completed in the laboratory. *The results must be shown to the batch in charge faculty and must obtain the exit signature from batch teacher before he or she leaves the laboratory.*
10. Entries of observations should be made in data sheets with pen only.
11. Substitutions and calculations should be shown explicitly in the data sheet and the practical file.
12. Submission of practical file along with necessary data sheets (to be pasted to the particular experiment once readings are transferred to practical file) in every lab session for evaluation.
13. In the event the student is unable to complete the calculations in the regular lab session, with the permission of the lab in-charge, the student should complete calculations, transfer the readings to practical file and submit the file for evaluation in the next lab session. **(In case of any difficulty in calculation, the student can consult the batch teacher within two working days after the lab).**
14. Mobile phones are not allowed to the lab. The student should wear lab coat and also bring his/her own calculator, pen, pencil, eraser, etc.
15. The experiments are to be performed by the students in the given cyclic order. This will be made clear to the student in the instructions class. If for some reason a student is absent for a practical lab session/unable to perform experiments then the student must move on to the next set in the subsequent lab session. The experiment that he or she has missed will have to be performed by him or her in the repetition lab.
16. ***Please remember that practical file is evaluated during regular lab session. Therefore it is imperative that each student takes care to see that the experiments are well conducted, recorded and submitted for valuation regularly.***

17. There will be a continuous internal evaluation (CIE) in the laboratory. An internal test will be conducted at the end of the semester. The total internal assessment marks are for a maximum of 50.

Note: Stamp of rubrics for evaluation on the first page of data sheet is mandatory for each Experiment.

### RUBRICS FOR EVALUATION

Particulars	Maximum Marks*	Excellent	Very Good	Good	Satisfactory
Data sheet + Experimental Set up	05	05	04	03	02
Conduction of Experiment	10	10	08	06	04
Substitution, Calculation & Accuracy	05	05	04	03	02
Experiential Learning	20	20	16	12	8

*\*Tentative*

*All students are strictly required to adhere to the Do's and Don'ts in the laboratory:*

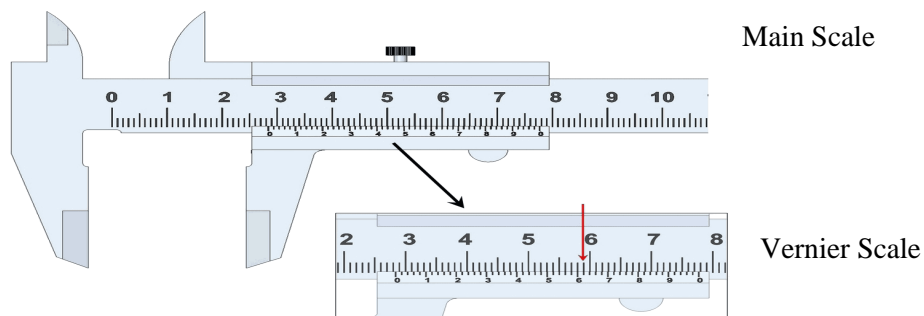
<p>✓ <b>Do's</b></p> <ul style="list-style-type: none"> <li>✓ Come prepared to the lab.</li> <li>✓ Wear lab coat in the lab.</li> <li>✓ Maintain discipline in the lab.</li> <li>✓ Handle the apparatus with care.</li> <li>✓ Confine to your table while doing the experiment.</li> <li>✓ Return the apparatus after completing the experiment.</li> <li>✓ Switch off the power supply after completing the experiment</li> <li>✓ Switch off the electrical circuit breaker if there is burning of insulation.</li> <li>✓ Utilize the First Aid box in emergency situation.</li> <li>✓ Keep the lab clean and neat.</li> </ul>	<p>✗ <b>Don'ts</b></p> <ul style="list-style-type: none"> <li>✗ Come late to the lab and leave the lab early.</li> <li>✗ Carry mobile phones to the lab</li> <li>✗ Touch un-insulated electrical wires.</li> <li>✗ Use switch if broken.</li> <li>✗ Overload the electrical meters.</li> <li>✗ Talk with other students in the lab.</li> <li>✗ Make the circuit connection when the power supply is on.</li> </ul>
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## MEASUREMENTS

To conduct various experiments in the Physics Laboratory, we need to learn measurement of dimensions and other physical quantities using instruments. Measurements of various dimensions of object using Vernier Calipers, Screw gauge, Multi metre etc are discussed here.

### Vernier Callipers

Vernier Callipers is used to measure dimensions like length, breadth, diameter of solid and hollow etc accurately.



### Least count of vernier calipers

The vernier caliper has two scales – main scale and vernier scale. The main scale is graduated in cm while the vernier scale has no units. The vernier scale is not marked with numerals, what is shown above is for the clarity only.

Least count (LC) of the vernier calipers is the ratio of the value of 1 main scale division (MSD) to the total number of vernier scale divisions (VSD).

Example:

Value of 10 main scale divisions (MSDs) = 1cm

Value of 1 MSD = 0.1cm

Total number of VSD = 10

Therefore  $LC = 0.1\text{cm}/10 = 0.01\text{cm}$

To take readings using the calipers

- (1) First see if the 0 of the vernier scale coincides with a main scale reading. If it coincides then the reading at the zero of the vernier is the main scale reading (MSR).
- (2) **If the 0 of the vernier scale does not coincide with any main scale division then the division just behind the zero of the vernier is the main scale reading (MSR).**
- (3) Then see which **vernier division** coincides with a **main scale division**. This division of the **vernier scale** is noted as the coinciding vernier scale division (CVD).
- (4) The total reading is given by  $TR = MSR + VSR$ ,  $TR = MSR + (CVD \times LC)$

Example:

If  $MSR = 1\text{cm}$ ,  $CVD = 6$ , then  $TR = MSR + (CVD \times LC) = 1\text{cm} + (6 \times 0.01)\text{cm} = 1.06\text{cm}$

## Screw gauge:

Screw gauge is used to find the dimensions of small objects and it has a pitch scale and a head scale. The pitch scale is graduated in mm while the head scale has no units.

The least count for this type of instruments is given by

$$\text{Least Count} = \frac{\text{pitch}}{\text{No. of head scale divisions}}$$

The pitch of the screw gauge is the distance moved on the pitch scale for one complete rotation of the head. To find pitch give some known number of rotations to the pitch scale and note the distance moved by the head scale.

**Pitch = distance moved on the pitch scale /No. of rotations given to head scale**

Usually the pitch is 1mm, the head scale is divided into 100 divisions.

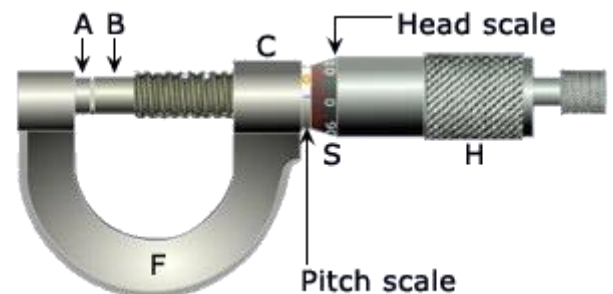
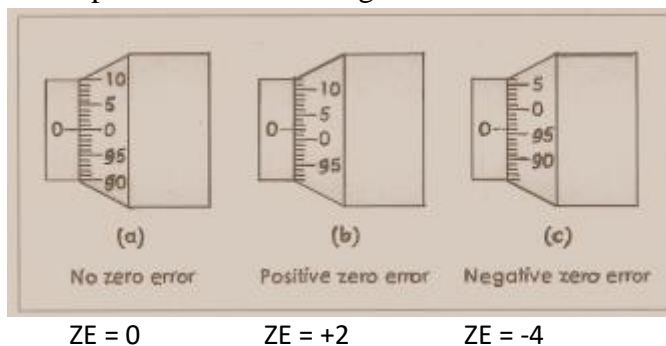
**LC = pitch /No. of head scale divisions = 1/100 mm =0.01mm**

In the screw gauge the head is rotated until the plane faces of metal plug A and screw head B touch each other. If the pitch scale reading is zero and the zero of the head scale coincides with the pitch line then there is no zero error, otherwise there is a zero error(ZE).

Determination of zero error is shown in the following figure.

If the pitch line is in the positive side of the HS then ZE is +ve

If the pitch line is in the negative side of the HS then ZE is -ve



Pitch scale reading PSR : The reading on the pitch scale, at the edge of the head scale or behind the edge of the head scale.

Head scale reading HSR : The reading on the head scale that coinciding with the pitch line i.e horizontal line on the pitch scale or below the pitch line

The total reading is calculated using the formula: **TR=PSR+{(HSD - ZE)×LC} mm**

## Travelling Microscope

### Least count of the travelling microscope (T.M)

The scales on the travelling microscope are similar to those in vernier callipers. The difference being that the value of 1 main scale reading is 0.05cm and the number of divisions on the vernier is 50.



Value of 1msd =  $1\text{cm}/20 = 0.05\text{cm}$

Number of VSDs = 50.

The least count (LC) of the instrument =  $1\text{MSD} / \text{Total number of vernier scale divisions}$

$\text{L.C} = 0.05\text{cm}/50 = 0.001\text{cm}$ .

The procedure for taking readings is the same as for vernier callipers.

- (1) First see if the 0 of the vernier scale coincides with a main scale reading. If it coincides then take it as the main scale reading (MSR).
- (2) **If the 0 of the vernier scale does not coincide with any main scale division then the division just behind the zero of the vernier is the main scale reading (MSR).**
- (3) Then see which **vernier division** coincides with a **main scale reading**. This division of the **vernier scale** is noted as the coinciding vernier scale division (CVD).
- (4) The total reading is given by  $\text{TR} = \text{MSR} + \text{VSR}$ ,  $\text{TR} = \text{MSR} + (\text{CVD} \times \text{LC})$

Example:

If  $\text{MSR} = 1.05\text{cm}$ ,  $\text{CVD} = 19$ , then  $\text{TR} = \text{MSR} + (\text{CVD} \times \text{LC}) = 1.05 + (19 \times 0.001) = 1.069\text{cm}$

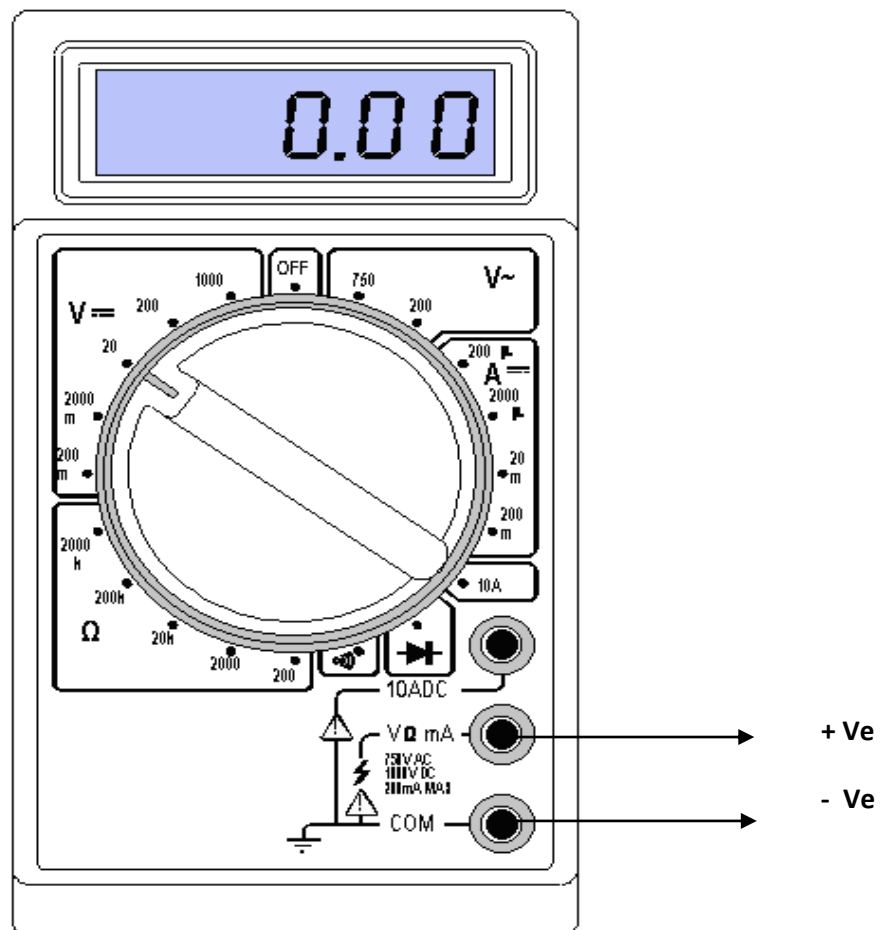
**NOTE. Ignore the numbering on the vernier scale and read the divisions from 0 to 50**

## Multi meter:

A multi meter is an instrument with many meters like ammeters, voltmeters (both AC and DC), ohmmeters etc., of various ranges built into it. By conveniently switching the rotatable knob of the multi meter, we can choose the electrical meter required for a particular measurement.

Note;

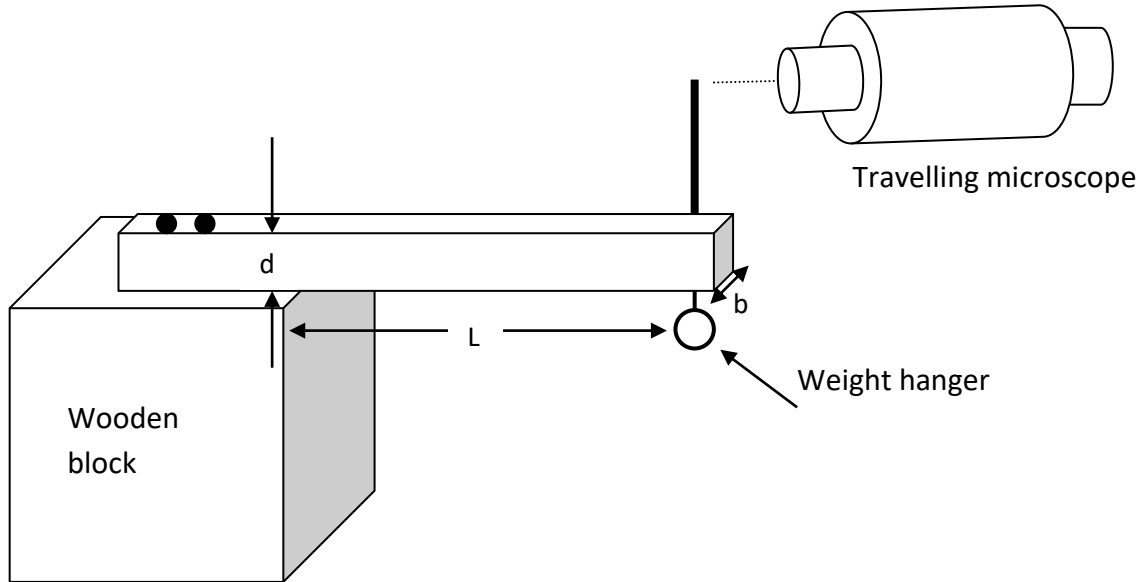
1. On the display if there is a numeral 1 at the extreme left the measured quantity is more than the maximum of the meter, move rotate the knob to the higher range .
2. If the display shows BAT the battery is low in power, ask for a different multi meter.



## SINGLE CANTILEVER

OBSERVATIONS:

**Experimental Setup:**



**Formula:**

The Young's modulus of the material of the cantilever is calculated using the formula;

$$q = \frac{4mgL^3}{bd^3\delta_{\text{mean}}} \text{ Nm}^{-2}$$

Where, m = mass for which depression produced is 0.04 kg (40 gm),

L is the length of the cantilever in metre

b is the breadth of the cantilever in metre

d is the thickness of the cantilevering metre

$\delta$  is the mean depression for 40g in metre

g is the acceleration due to gravity = 9.8 m/s

**Least count of the travelling microscope**

$$\text{L.C} = \frac{\text{Value of 1 main scale division}}{\text{Total number of vernier scale divisions}} = \text{---} = \text{---} \text{ c m}$$



Paste the data sheets here

## SINGLE CANTILEVER

Experiment No:

Date:

**Aim:** To determine the Young's modulus of the material of the given metal strip.

**Apparatus:** Thick rectangular metallic strip (cantilever), slotted weights with hanger, travelling microscope, screw gauge, Vernier callipers and metre scale etc.

**Principle:** Young's modulus, which is one of the elastic constants, is defined as the ratio of longitudinal stress to the longitudinal strain within elastic limit. For a given strip, the depression produced at the loaded end of the cantilever depends on the load and on the distance from the fixed end. This is measured to calculate the Young's modulus ( $q$ ) of the material.

**Formula:**

The Young's modulus of the material of the cantilever is calculated using the formula;

$$q = \frac{4mgL^3}{bd^3\delta_{\text{mean}}} \text{ Nm}^{-2}$$

Where,  $m$  = mass for which depression produced is 0.04 kg (40 gm),

$L$  is the length of the cantilever in metre

$b$  is the breadth of the cantilever in metre

$d$  is the thickness of the cantilevering metre

$\delta$  is the mean depression for 40g in metre

$g$  is the acceleration due to gravity = 9.8 m/s

**Procedure:**

- Suspend the weight hanger with mass  $W$ , at the bottom of the free end of the metallic strip (into a metal loop fixed below the pin).
- Adjust the vertical traverse of travelling microscope to focus the tip of the pin with the horizontal cross wire or the point of the intersection of cross wires.
- Note down the reading of the travelling microscope on the vertical scale when the load is  $W$  in table 1.
- Now add a mass of 10 g to the weight hanger and adjust the travelling microscope using the fine motion screw (vertical motion) to focus the tip of the pin with the point of intersection of cross wires. Note down the travelling microscope reading (for a load of  $W+10$ ).



**Table 1: Travelling microscope readings for the load increasing.**

Load (g)	MSR(cm)	CVD	TR= MSR + (CVD x LC) (cm)
W			
W + 10			
W + 20			
W + 30			
W + 40			
W + 50			
W + 60			
W + 70			

**Table 2: Travelling microscope readings for the load decreasing.**

Load (g)	MSR(cm)	CVD	TR= MSR + (CVD x LC) (cm)
W + 70			
W + 60			
W + 50			
W + 40			
W + 30			
W + 20			
W + 10			
W			

**Table 3: Mean depression and depression for a load of 40g (difference column)**

Load (g)	TM reading (cm)		Mean TMR $R_L = (R_1 + R_2)/2$	Load (g)	TM readings (cm)		Mean TMR $R_R = (R_3 + R_4)/2$	Depression $\delta$ for 40g ( $\delta = R_L - R_R$ ) cm
	Load increasing $R_1$	Load Decreasing $R_2$			Load Increasing $R_3$	Load decreasing $R_4$		
W				W + 40				
W + 10				W + 50				
W + 20				W + 60				
W + 30				W + 70				

**Mean depression for a load of 40 g =  $\delta$  = \_\_\_\_\_ cm.**

- Repeat the procedure by increasing the load in the weight hanger in steps of 10g up to a maximum load of W+70.
- Repeat the same by decreasing the load in steps of 10g and note down the readings for W+70, W+60 up to W and enter the readings in table 2.
- Tabulate the readings of increasing and decreasing loads in table 3. Compute the mean value of the reading corresponding to each load and find the depression ' $\delta$ ' for a load of 40 g ( m) by a difference column method.
- Measure the length ' $L$ ' of the cantilever from the edge of the wooden block to the position of the pin using a metre scale.
- Determine the breadth ' $b$ ' of the cantilever using vernier callipers at four different places on the metal strip and calculate the mean breadth.
- Determine the thickness ' $d$ ' of the cantilever using screw gauge at four different places on the metal strip and find the mean thickness.
- Compute the Young's modulus of the material of the cantilever by substituting the values of m, L, b, d and  $\delta$  in the given formula.

**Note:**

1. Level the travelling microscope using a spirit level.
2. Once you start the experiment do not shake or lean on the table, as this will disturb the focusing and affect the reading.
3. Add/ remove the weights gently on to/from the weight hanger
4. While performing the experiment care is to be taken to rotate the fine motion screw in only one direction so as to avoid backlash error.

Length of the cantilever,  $L = \underline{\hspace{2cm}}$  cm.

**Table 4: Breadth of the cantilever using vernier callipers**

$$L.C = \frac{\text{Value of 1 main scale division}}{\text{Total number of vernier scale divisions}} = \frac{\hspace{1cm}}{\hspace{1cm}} = \underline{\hspace{1cm}} \text{ cm}$$

Trial No.	MSR(cm)	CVD	TR = MSR + (CVD x LC) (cm)
1			
2			
3			
4			

Mean Breadth  $b = \underline{\hspace{2cm}}$  cm

**Table 5: Thickness (d) of the cantilever using screw gauge.**

**Least Count of Screw Gauge:**

$$\text{Pitch} = \frac{\text{Distance moved on the pitch scale}}{\text{Total number of rotations given to screwhead}} = \frac{\hspace{1cm}}{\hspace{1cm}} = \underline{\hspace{1cm}} \text{ mm}$$

$$L.C = \frac{\text{Pitch of the screw gauge}}{\text{Total number of head scale divisions}} = \frac{\hspace{1cm}}{\hspace{1cm}} = \underline{\hspace{1cm}} \text{ mm}$$

Zero error (ZE) =

Trial No.	PSR(mm)	HSD	TR= PSR + (HSD- ZE)LC (mm)
1			
2			
3			
4			

Mean thickness,  $d = \underline{\hspace{2cm}}$  mm

**Result:** Young's modulus of the given material is found to be  $\underline{\hspace{2cm}}$   $\text{N m}^{-2}$

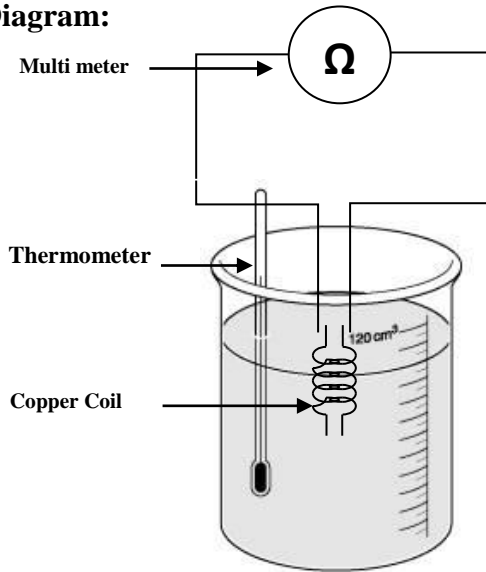
**CALCULATIONS:**

**Result:** Young's modulus of the given material is found to be \_\_\_\_\_ N m<sup>-2</sup>

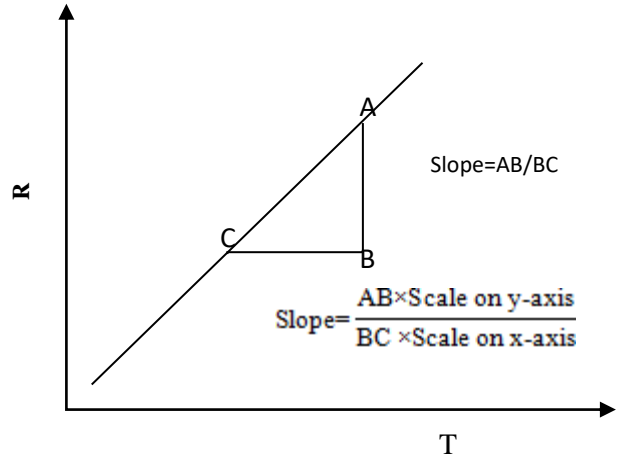
## FERMI ENERGY OF COPPER

OBSERVATIONS:

**Diagram:**



**Model Graph:**



**Formula:**

$$E_F = 1.36 \times 10^{-15} \sqrt{\frac{\rho A m}{l}} \text{ J}$$

$$E_F = \frac{1.36 \times 10^{-15} \sqrt{\frac{\rho A m}{l}} \text{ J}}{1.6 \times 10^{-19} \text{ C}} = \dots\dots\dots \text{ eV}$$

Where

$E_F$  is the Fermi energy (eV)

$T$  is the temperature of the coil in K

$A$  ( $\pi r^2$ ) is area of cross section of the given copper wire ( $\text{m}^2$ )

$l$  is the length of the copper wire (m)

Charge of the electron,  $e = 1.602 \times 10^{-19} \text{ C}$ .

$m$  is the slope of the straight line.

$\rho$  is the density of copper =  $8960 \text{ Kg/m}^3$

**Least Square Fit formula:**

$$\text{Slope} = m = \frac{n(\sum xy) - \sum x \sum y}{n(\sum x^2) - (\sum x)^2}$$

$$\text{Intercept} = c = \frac{(\sum y)(\sum x^2) - (\sum x)(\sum xy)}{n(\sum x^2) - (\sum x)^2}$$

## FERMI ENERGY OF COPPER

Experiment No:

Date:

**Aim:** To determine the Fermi energy of copper

**Apparatus:** Multi meter, Beaker, Thermometer and copper wire.

**Theory:** In a conductor, the electrons fill the available energy states starting from the lowest energy level. Therefore at 0K, all the levels with an energy  $E$  less than a certain value  $E_{F(0)}$  will be filled with electrons, whereas the levels with  $E$  greater than  $E_{F0}$  will remain vacant. The energy  $E_{F0}$  is known as Fermi energy at absolute zero and corresponding energy level is known as Fermi level. For temperature greater than zero Kelvin, Fermi energy is the average energy of the electrons participating in electrical conductivity. By measuring the resistance of the copper wire at different temperatures Fermi energy is calculated by the following formula.

$$E_F = 1.36 \times 10^{-15} \sqrt{\frac{\rho A m}{l}} \text{ J}$$

Where,  $E_F$  is the Fermi energy

$T$  is the reference temperature (K),

$A$  is area of cross section of the given copper wire ( $\text{m}^2$ )

$l$  is the length of the copper wire (m)

Charge of the electron,  $e = 1.602 \times 10^{-19} \text{ C}$ .

$\rho$  is the density of copper =  $8960 \text{ Kg/m}^3$

$m$  is the slope of the straight line obtained by plotting resistance of the metal against absolute temperature of the metal.

### Procedure:

- Connect the copper coil to the digital multi meter.
- Set the multi meter to  $200 \Omega$  mode.
- Immerse the copper coil in a beaker containing cold water, note down the resistance in multi meter and enter the readings in the tabular column.
- Immerse the copper coil in a beaker containing hot water at about  $90^\circ\text{C}$ .
- Note down the resistance in multi meter for every decrement of  $5^\circ\text{C}$  to about  $50^\circ\text{C}$  and enter the readings in the tabular column.
- Plot a graph of resistance along y-axis and temperature along x-axis and calculate the value of slope  $m$  of the resulting graph ( $m = AB/BC$ )
- Calculate the Fermi energy of the material by using the relevant formula.

**Table:**

Sl. No.	Temp °C		Temp K	R (Ω)
	Room Temp			
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Sl. No	T (x)	R (y)	$x^2$	xy
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
Sums	$\Sigma x =$	$\Sigma y =$	$\Sigma x^2 =$	$\Sigma xy =$

Sample Points:

x		
y		

$$y = mx + c$$

**Result:** The Fermi energy of copper is  $E_F =$  \_\_\_\_\_ J, \_\_\_\_\_ eV

Paste the data sheets here

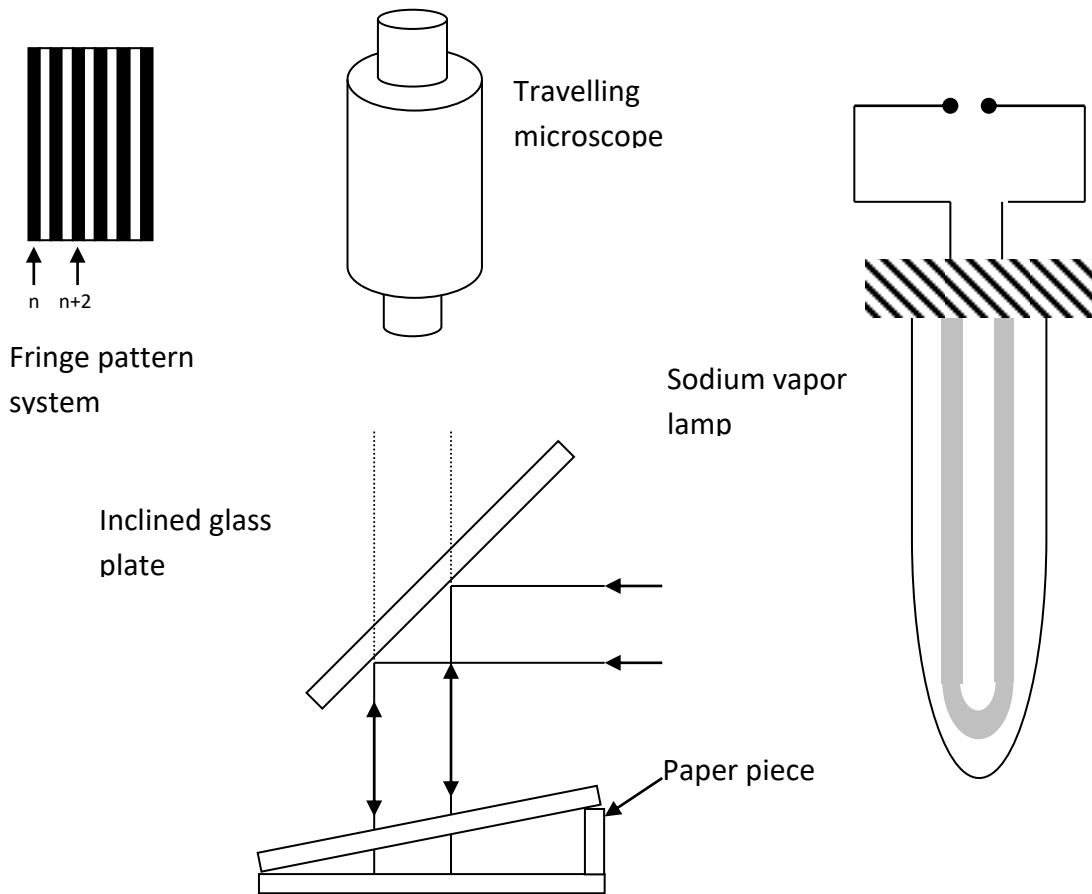
**CALCULATIONS:**

**Result:** The Fermi energy of copper is  $E_F =$  \_\_\_\_\_ J, \_\_\_\_\_ eV



## INTERFERENCE AT A WEDGE

### OBSERVATIONS



Least count of the travelling microscope

$$LC = \frac{\text{Value of 1 main scale division}}{\text{Total number of vernier scale divisions}} = \quad \text{cm}$$

#### Tabular column

Fringe number	TM readings, MSR + (CVD x LC)	Total reading (cm)
N		
n + 2		
n + 4		
n + 6		
n + 8		
n + 10		
n + 12		
n + 14		
n + 16		
n + 18		
n + 20		
n + 22		

## INTERFERENCE AT A WEDGE

Experiment No.

Date:

**Aim:** To determine the thickness of a thin paper piece by setting up interference fringes at an air wedge.

**Apparatus:** Two (optically flat) thick glass plates, sodium vapour lamp, travelling microscope (bridge type), a thin paper piece, reflecting glass plate, reading lens and a scale.

**Principle:** When a piece of paper is placed between two optically plane glass plates, a wedge shaped air film is formed between the two plates. If a parallel beam of monochromatic light is made to incident normally on the wedge (upper glass plate), the beam gets refracted through the upper glass plate. Two reflected rays from the upper and lower positions of the air film form two coherent sources. As the two portions in the reflected beam, are derived from the same incident beam and have path difference, they produce interference. The interference pattern, when viewed through a travelling microscope, appears as equally spaced alternate dark and bright straight fringes, parallel to the edge of the wedge.

### Procedure:

#### a) Experimental Setup

The given optically plane glass plates and the reflecting glass plate are cleaned well by using muslin cloth before starting the experiment. The optically plane glass plates are kept one above the other. A thin rectangular paper piece is inserted between the glass plates at one extreme end, such that the piece of paper is perpendicular to the length of the glass plate. Now a wedge shaped air film is formed in between the plates. The thickness of the air film gradually increases, from the point of contact of glass plate, till the inner edge of the paper piece.

Now illuminate the air wedge by a parallel beam of sodium light using reflecting glass plate by making an angle of inclination  $45^\circ$  to the horizontal as shown in the diagram. The whole setup is kept below the objective of the travelling microscope such that the illuminated portion of the air wedge comes under the field of view of travelling microscope. Then focus the travelling microscope using rack and pinion screw such that the alternate dark and bright interference fringes are clearly seen.

#### b) Measurement of fringe width

The least count of travelling microscope is determined by finding the ratio of the value of one main scale division to the total number of vernier scale divisions.

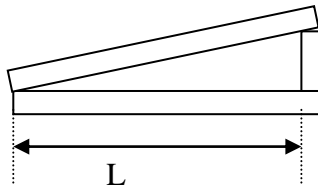
**Table 2:**

Fringe No.	TM Reading (cm)	Fringe No.	TM Reading (cm)	Width of 12 fringes (cm)
N		n + 12		
n + 2		n + 14		
n + 4		n + 16		
n + 6		n + 18		
n + 8		n + 20		
n + 10		n + 22		

Average width of 12 fringes,  $x =$  \_\_\_\_\_ m

The fringe width,  $\beta$ , is  $x/12 =$  \_\_\_\_\_ m.

**To measure the length, L, of the air wedge**



$L =$  \_\_\_\_\_ m

The thickness of the paper is calculated by using the formula

$$t = \frac{\lambda L}{2\beta} = \text{_____ m}$$

Here

t is the thickness of the paper ----- m

L is the length of the air wedge ----- m

$\lambda$  is the wavelength of sodium light = 589.3nm

$\beta$  is the fringe width -----m

The vertical cross wire is adjusted to be at the center of any one of the dark fringes. The reading on the main scale and the coinciding vernier scale division are noted. Let this fringe be the  $n^{\text{th}}$  dark fringe.

Next the reading corresponding to the dark fringes  $n+2$ ,  $n+4$ ,  $n+6$  up to  $n+22$  are noted. The microscope may be moved either to the left or the right side for this purpose.

The readings are tabulated in the observation column and the width of 12 dark fringes is calculated. The average width of 12 dark fringes and hence the fringe width,  $\beta$ , is calculated.

The length of the air wedge between the point of contact of the glass plates and the inner edge of the paper piece is measured using traveling microscope / scale.

The thickness of the given paper is calculated using the formula.

$$t = \frac{\lambda L}{2\beta} \text{ m}$$

**Result:**

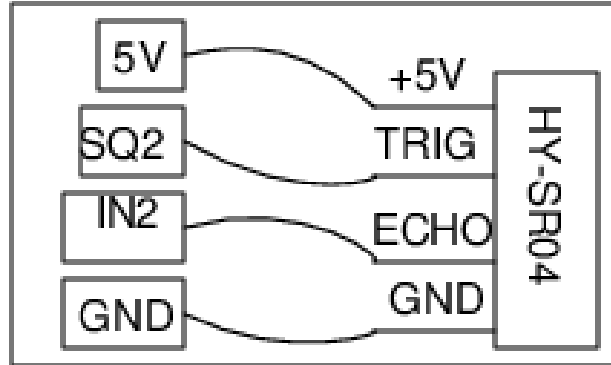
The thickness of the given paper = \_\_\_\_\_m.

## SPRING CONSTANT

### OBSERVATIONS



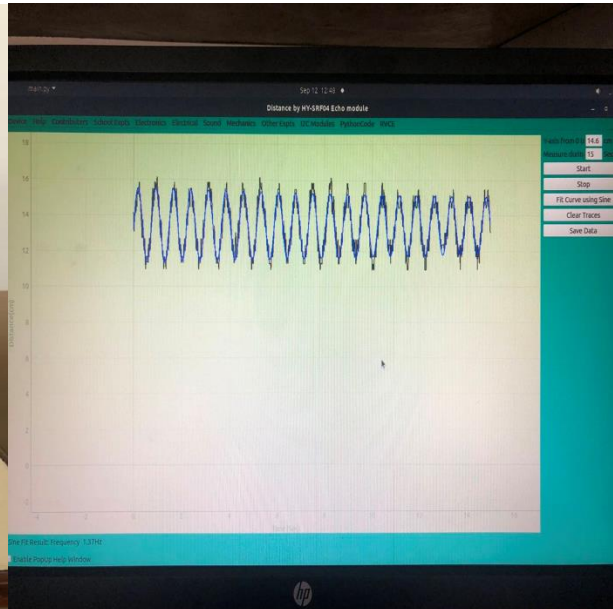
Ultrasonic sensor (HC-SR04)



Connections with Exp-eyes device



External setup



Output Sine Wave

**Formula:** Spring constant is given by

$$K = 4\pi^2 \frac{m}{T^2} \text{ N/m}$$

Where,  $m$  is the mass of the load in g.

$T$  is the time period in s and  $K$  is the spring constant in N/m.

## SPRING CONSTANT USING ULTRASONIC SENSOR

Experiment No:

Date:

**Aim:** Determine spring constant for the given spring using ultrasonic sensor.

**Apparatus:** springs, weight hanger, slotted weights, stop watch.

**Principle:** Spring constant (or force constant) of a spring is given by  $K = \frac{\text{Restoring Force}}{\text{Extension}}$  N/m

Spring constant is the restoring force per unit extension in the spring. Its value is determined by the elastic properties of the spring. Elastic materials are those which retain their original dimensions after the removal of deforming forces. When material is subjected to stress, strain is produced. The restoring force is always directed opposite to the displacement. When the mass is displaced through a small distance and then released, it undergoes simple harmonic motion.

The time period **T** of oscillations of a spring is given by the relation,

$$T = 2\pi \sqrt{\frac{m}{K}} \text{ s}$$

By finding the time period (T) spring constant K can be determined.

### Procedure:

1. Suspend one end of the given spring to a rigid support and add the slotted weights at the other end. And note down the mass of added slotted weights and weight hanger ( $m_1$ ).
2. Below the load, Place an ultrasonic sensor (HC-SR04) after making the connections with the expEYES-17 hardware.
3. Keep the distance between the ultrasonic sensor and the load as 6cm.
4. Interface the experimental circuit with the CPU and click on mechanics tab and select distance by HC-SR04 echo module experiment.
5. On the screen enter the y axis value as 10cm and time as 10 seconds.
6. Pull the load slightly downwards and then release it gently so that it is set into oscillations in a vertical plane about its mean position.
7. Click on the start button. The graph will be generated on the screen.
8. Click on the 'fit curve using sine' button to generate a sine curve on the existing graph.
9. Note down the frequency in Hz and find time period of the oscillation. And then compute the spring constant value ( $K_1$ ) for the load ( $m_1$ ).
10. Repeat the same procedure for another identical spring ( $K_2$ ) for the load ( $m_2$ )
11. Connect two springs in series combination and repeat the above activity and find  $K_S$  value. Calculate  $K_{\text{eff}}$  for series and compute the error.
12. Connect two springs in parallel combination and repeat the above activity and find  $K_P$  value. Calculate  $K_{\text{eff}}$  for parallel and compute the error

## SPRING CONSTANT

### OBSERVATIONS

**Table 1: Spring constant  $K_1$  for the given material**

(Mass of the hanger + Mass of the slotted weights) =  $m_1 =$  \_\_\_\_\_ Kg

Trial No	Frequency(Hz)	Time for one osc $T_1$ (s)	$T_1^2$	Spring constant $K_1 = 4\pi^2 \frac{m_1}{T_1^2}$ (N/m)
1				

**Table2: Spring constant  $K_2$  for the given material**

(Mass of the hanger + Mass of the slotted weights) =  $m_2 =$  \_\_\_\_\_ Kg

Trial No	Frequency(Hz)	Time for one osc $T_2$ (s)	$T_2^2$	Spring constant $K_2 = 4\pi^2 \frac{m_2}{T_2^2}$ (N/m)
1				

**Table 3: Spring constant  $K_s$  in series combination for the given material**

(Mass of the hanger + Mass of the slotted weights) =  $m_s =$  \_\_\_\_\_ Kg

Trial No	Frequency(Hz)	Time for one osc $T_s$ (s)	$T_s^2$	Spring constant $K_s = 4\pi^2 \frac{m_s}{T_s^2}$ (N/m)	$K_{\text{eff}} = \frac{K_1 K_2}{K_1 + K_2}$ (N/m)	Error = $K_{\text{eff}} \sim K_s$ (N/m)
1						

**Table 4: Spring constant  $K_p$  in parallel combination for the given material**

(Mass of the Scale + Mass of the hanger + Mass of the slotted weights) =  $m_p =$  \_\_\_\_\_ Kg

Trial No	Frequency(Hz)	Time for one osc $T_p$ (s)	$T_p^2$	Spring constant $K_p = 4\pi^2 \frac{m_p}{T_p^2}$ (N/m)	$K_p = K_1 + K_2$ (N/m)	Error = $K_{\text{eff}} \sim K_p$ (N/m)
1						

### Results:

a)	The spring constant for the given springs are	$K_1 =$ _____ N/m $K_2 =$ _____ N/m
b)	The spring constant in series combination is	$K_s =$ _____ N/m
c)	The spring constant in parallel combination is	$K_p =$ _____ N/m

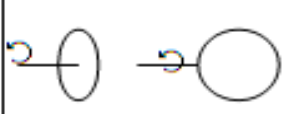

**About hardware and software:**

The circuit consists of a microcontroller system, an ultrasonic sensor, Expeyes hardware and a spring mass system. A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. An ultrasonic sensor measures the distance of an object using sound waves. The ultrasonic sensor consists of 4 pins (Voltage pin, Trigger Pin, ECHO pin, GND pin).Connections are made as shown in the figure, voltage pin is connected to +5V of the expEYES-17; the trig pin of the sensor is connected to the SQ2 of the expEYES-17; the echo pin is connected to the IN2; GND pin is connected to the GND of the expeyes-17. The expeyes-17 interfaced with CPU of the computer. It combines the real-time measurement capability of micro-controllers with the ease and flexibility of Python programming language for data analysis and visualization.

CALCULATIONS:



TORSION PENDULUM – OBSERVATIONS

Body	M (Kg)	Dimension (m)	Axis	Moment of Inertia I (Kgm <sup>2</sup> )	Time for 10 osc. (s)	Mean time 't' for 10 oscillation. (s)	Period T=t/10 (s)	$\frac{I}{T^2}$ (Kgm <sup>2</sup> s <sup>-2</sup> )
Circular plate		Radius =		$I_1 = \frac{MR^2}{2}$ =	1. 2. 3.		$T_1 =$	$\frac{I_1}{T_1^2} =$
				$I_3 = \frac{MR^2}{4}$ =	1. 2. 3.		$T_2 =$	$\frac{I_2}{T_2^2} =$
Rectangular plate		Length, L =		$I_3 = \frac{M(L^2 + B^2)}{12}$ =	1. 2. 3.		$T_3 =$	$\frac{I_3}{T_3^2} =$
				$I_4 = \frac{ML^2}{12}$ =	1. 2. 3.		$T_4 =$	$\frac{I_4}{T_4^2}$
				$I_5 = \frac{MB^2}{12}$ =	1. 2. 3.		$T_5 =$	$\frac{I_5}{T_5^2}$

$$\left(\frac{I}{T^2}\right)_{\text{mean}} = \text{_____ Kgm}^2\text{s}^{-2}$$

## TORSION PENDULUM

Experiment No:

Date:

**Aim:** To determine the moment of inertia of the given irregular body and Rigidity modulus of the material of the give wire.

**Apparatus and other materials required:** Rectangular, circular and irregularly shaped plates, steel or brass wire, chuck nuts, stop clock, pointer, metre scale, Screw gauge weight box.

### Principle:

Torsion pendulum is an angular harmonic oscillation. Moment of Inertia of a body is the reluctance to change its state of rest or uniform circular motion. A body whose moment of inertia  $I$  about an axis is known, is made to oscillate about the same axis, corresponding period  $T$  is noted. The ratio  $\frac{I}{T^2}$  is a constant for different bodies and different axes **as long as**

**the dimension of the suspension wire remains the same.** For a torsion pendulum  $T=2\pi\sqrt{\frac{I}{C}}$

where  $C$  is the couple per unit twist of the wire and it is a constant. Hence,  $I/T^2=C/4\pi^2$  is a constant and  $C=8\pi nr^4/2L$

### Formula:

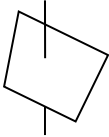
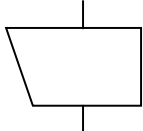
(a) Moment of inertia of irregular body about the axis through the CG and perpendicular to its plane,  $I'$

$$I_{\alpha} = \left( \frac{I}{T^2} \right)_{\text{mean}} \times T_{\alpha}^2 = \text{_____ Kgm}^2$$

(b) Moment of inertia of the irregular body about the axis through the CG and parallel to its plane

$$I_{\beta} = \left( \frac{I}{T^2} \right)_{\text{mean}} \times T_{\beta}^2 = \text{_____ Kgm}^2$$

(c) Rigidity modulus  $n = \left( \frac{8\pi L}{r^4} \right) \left( \frac{I}{T^2} \right)$  where  $r$  is the radius and  $L$  is the length of the wire.

Axis through CG	Time for 10 sec. (s)	Mean time(t) for 10 oscillations in s	Period $T=t/10$ s
	1. 2. 3.		$T_\alpha =$
	1. 2. 3.		$T_\beta =$

### Determination of Moment of Inertia of Irregular body

Formulae:

- (a) Moment of inertia of irregular body about the axis through the CG and perpendicular to its plane,  $I'$

$$I_\alpha = \left( \frac{I}{T^2} \right)_{\text{mean}} \times T_\alpha^2 \text{ Kgm}^2$$

- (b) Moment of inertia of the irregular body about the axis through the CG and parallel to its plane

$$I_\beta = \left( \frac{I}{T^2} \right)_{\text{mean}} \times T_\beta^2 \text{ Kgm}^2$$

### Determination of rigidity modulus of the material of the wire

Radius of the wire (r) using screw gauge.

$$\text{Pitch} = \frac{\text{Distance moved on the pitch scale}}{\text{Total number of rotations given to screwhead}} = \text{---} = \text{---} \text{ mm}$$

$$\text{L.C} = \frac{\text{Pitch of the screw gauge}}{\text{Total number of head scale divisions}} = \text{---} = \text{---} \text{ mm}$$

Zero error (ZE) = \_\_\_\_\_.



**Procedure:**

- Measure the dimensions of the given circular and rectangular discs.
- Clamp one end of the wire through the chuck nut to a regular disc and other end to the top end of the retard stand.
- Twist the wire through a small angle and then let free so that the body executes torsional oscillations (**The oscillations should be in a horizontal plane. Arrest the side ward movement or wobbling if any**).
- For each configuration of the pendulum, note down the time taken for 10 oscillations and repeat the process thrice. Tabulate this in table 1.
- Calculate mean time ( $t$ ) for 10 oscillations and hence the time period  $T$  then find  $\frac{I}{T^2}$  for each axis.
- Follow the same procedure for two different axes of the irregular body, determine the average period of oscillation for two different axes and tabulate values in table 2.
- Find out the moment of inertia of irregular body using given formulae.
- Measure the diameter of the wire using screw gauge and enter the readings in the tabular column.
- Calculate the average diameter and radius of the wire.
- Measure the length  $L$  of the wire between the check nuts.
- Calculate the rigidity modulus of the material of the wire using the given formula.

Trial No.	PSR(mm)	HSD	TR= PSR + (HSD- ZE)LC (mm)
1			
2			
3			
4			

Mean diameter of the wire,  $d = \underline{\hspace{2cm}} \text{mm} \underline{\hspace{2cm}} \text{m}$

Mean Radius of the wire,  $r = \underline{\hspace{2cm}} \text{m}$

Length of the wire,  $L = \underline{\hspace{2cm}} \text{m}$

Rigidity modulus  $n = \left( \frac{8\pi L}{r^4} \right) \left( \frac{I}{T^2} \right)$

**Result:**

1. The moment of inertia of irregular body about an axis perpendicular to the plane

$I_\alpha = \underline{\hspace{2cm}} \text{Kgm}^2.$

2. The moment of inertia of irregular body about an axis parallel to the plane

$I_\beta = \underline{\hspace{2cm}} \text{Kgm}^2.$

3. Rigidity modulus of the material of the wire 'n' =  $\underline{\hspace{2cm}} \text{N/m}^2$

## CALCULATIONS:

### Result:

1. The moment of inertia of irregular body about an axis perpendicular to the plane

$$I_{\alpha} = \text{_____ Kg m}^2.$$

2. The moment of inertia of irregular body about an axis parallel to the plane

$$I_{\beta} = \text{_____ Kg m}^2.$$

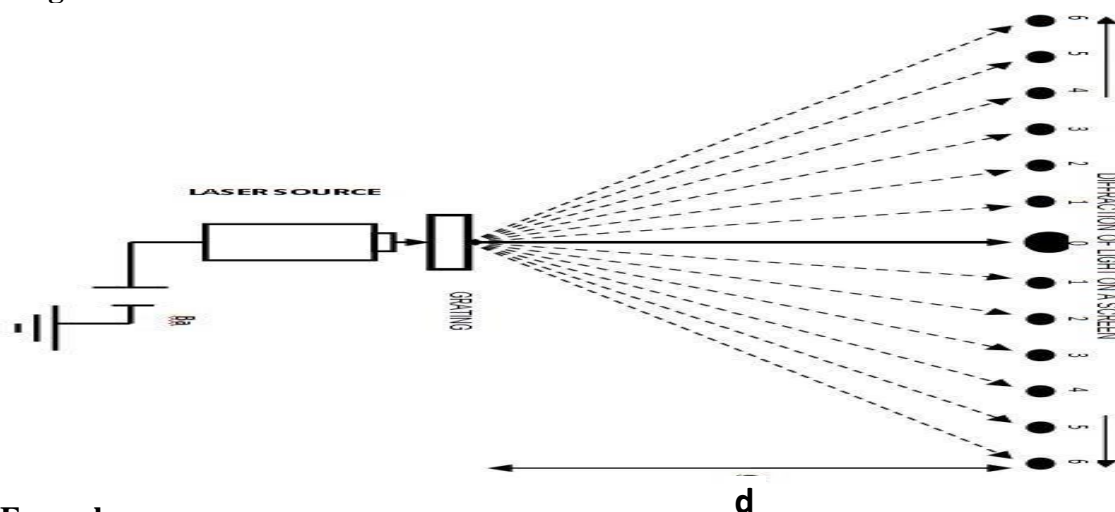
3. Rigidity modulus of the material of the wire 'n' = \_\_\_\_\_ N/m<sup>2</sup>

## LASER DIFFRACTION



OBSERVATIONS:

Diagram:



Formula:

$$\text{Wavelength of Laser source } \lambda = \frac{C \sin \theta_n}{n} \dots\dots m$$

Where C is the grating constant, n is the order of the maximum,  $\theta$  is the angle of diffraction

$$\text{Grating Constant: } C = \frac{1 \text{ inch}}{\text{No. of lines (N) per inch}} = \frac{2.54 \times 10^{-2} m}{500} = 5.08 \times 10^{-5} m$$

Distance between the grating and the screen,  $d = \text{_____} m$

Table:

Diffraction order (n)	Distance $2X_n(\text{cm})$	Distance $X_n(\text{cm})$	Diffraction angle ( $\theta_n$ ) $\theta_n = \tan^{-1} \left( \frac{X_n}{d} \right)$	Wavelength $\lambda$ (nm) $\lambda = \frac{C \sin \theta_n}{n}$
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

**CALCULATIONS:**

**Result:** The wavelength of laser light is found to be.....nm

Paste the data sheets here

## LASER DIFFRACTION

Experiment No:

Date:

**Aim:** To determine the wavelength of a given laser beam

**Apparatus and other required materials:**

Laser source, Grating, Optical bench with accessories and metre scale etc.,

**Principle:** laser is a device, which gives a strong beam of coherent photons by stimulated emissions. The laser beam is highly monochromatic, coherent, directional and intense. The directionality of a laser beam is expressed in terms of full angle beam divergence. Divergence of a laser beam is defined as its spread with distance.

**Formula:**

Wavelength of Laser source,  $\lambda = \frac{C \sin\theta_n}{n}$  ..... m

Where C is the grating constant: Distance between successive lines on the grating, n is the order of the maximum,  $\theta$  is the angle of diffraction,

**Procedure:**

- Mount the laser on an upright and fix the upright at one end of the optical bench. Mount a screen on another upright and fix it at the other end of the optical bench.
- Mark four quadrants on a graph with 'O' as the origin and fix the graph sheet on the screen using pins. Place a laser source in front of the grating and adjust the position of the graph sheet, so that the centre of the laser spot coincides with the origin.
- Mount the grating on the grating stand such that the length of the grating is on the grating stand and move the stand closer to the laser source. Adjust the grating plane such that the diffraction pattern is along the horizontal on the screen with the central maximum is at the origin. Note down the distance 'd' between grating and the screen.
- Mark the centres of the central maximum and secondary maxima on the graph sheet using pencil and remove the graph sheet from the stand. Measure the distance between the first order maxima on either side of the central maximum as  $2X_1$ , for the 2<sup>nd</sup> order maxima measure the distance as  $2X_2$ , continue this up to 4<sup>th</sup> order maxima.
- By using the grating constant C and the angle of diffraction  $\theta_n$ , calculate the wavelength of laser light for all the orders. Finally find the average value of wavelength.

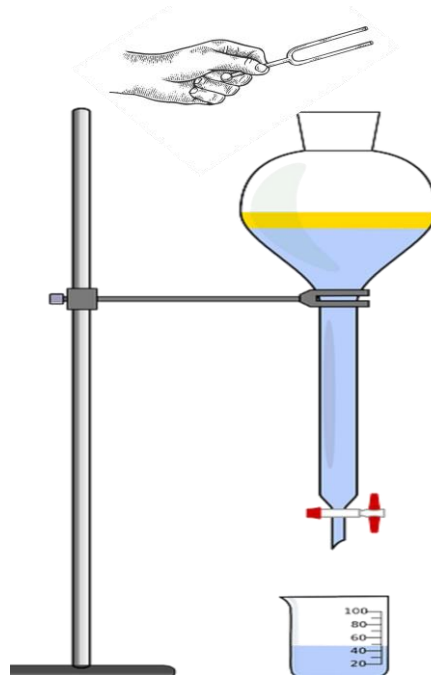
**Result:** The wavelength of laser light is found to be.....nm



## VOLUME RESONATOR

### OBSERVATIONS

#### Experimental setup:



Serial Number	Frequency of the tuning fork $f$ in $Hz$	Volume of resonating air ' $V$ ' in $m^3$			$f^2V$ in $m^3s^{-2}$	$(f^2V)_{avg}$
		Trial 1	Trial 2	Mean		
1.						
2.						
3.						
4.	Unknown			$V_x = \dots\dots$		

The unknown frequency of a tuning fork is given by,

$$f_x = \sqrt{\frac{(f^2V)_{avg}}{V_x}} = \dots\dots\dots Hz$$

Where,  $f_x$  = unknown frequency of the tuning fork,  $f$  = Known frequency of the tuning fork,  $V$  = volume of air resonating with the fork of known frequency,  $V_x$  = volume of air resonating with the fork of unknown frequency.

#### Calculations:

## VOLUME RESONATOR

Experiment No:

Date:

**Aim:** To determine the frequency of a tuning fork using volume resonator.

**Apparatus:** Aspirator bottle, tuning forks, rubber pad, beaker, measuring jar.

**Principle:** A resonator is a device used to analyse complex note of sound i.e. to determine particular frequencies present in the given note. The resonator is a large cylindrical vessel made of glass with a narrow neck through which a stream of air is set vibrating by running in and out of it. When a tuning fork of particular frequency is excited and held near the mouth of the resonator. The resonator exhibits a sharp resonance, when cavity of air with an opening which resonates at a natural frequency when the air is excited. The relationship of the resonate frequency to the volume of the cavity is given by the following equation.

$$f_x = \sqrt{\frac{(f^2V)_{avg}}{V_x}} \text{ Hz}$$

Where,  $f_x$  = unknown frequency of the tuning fork,  $f$  = Known frequency of the tuning fork,  $V$  = volume of air resonating with the fork of known frequency,  $V_x$  = volume of air resonating with the fork of unknown frequency.

**Procedure:** The aspirator bottle is filled with water. The tuning fork of known frequency is excited and it is held above the mouth of the aspirator bottle as shown in the figure. At the same time, water in the bottle is allowed to run out of aspirator bottle by opening the pinch cock attached to the out let tube. Water is allowed to flow out till the air in the resonator is in resonance with the tuning fork used. In the correct position of resonance, a note of maximum intensity will be heard. At the same moment the flow of water should be stopped using the pinch cock. The volume 'V' of water is collected in a beaker and measured using measuring jar. The volume is equal to the volume of air in the resonator, which is in resonance with the tuning fork, when vibrated. The experiment is repeated for the same tuning fork and the mean value of volume 'V' is found and hence  $f^2V$  is calculated.

The experiment is repeated for different tuning fork as above and average  $f^2V$  is calculated. The volume of air  $V_x$  is found out with the fork of unknown frequency  $f_x$  and unknown frequency of the tuning fork is calculated using the above formula.

**Formula:**  $f_x = \sqrt{\frac{(f^2V)_{avg}}{V_x}} \text{ Hz}$

Where,

$f_x$  = unknown frequency of the tuning fork,  $f$  = Known frequency of the tuning fork,

$V$  = volume of air resonating with the fork of known frequency,  $V_x$  = volume of air resonating with the fork of unknown frequency.

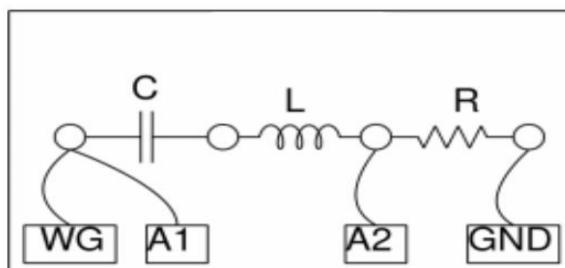
**Result:** The unknown frequency of given tuning fork = \_\_\_\_\_ Hz.

**Note:** Start the experiment by choosing higher frequency tuning fork and proceed the experiment in decreasing order of their frequencies.

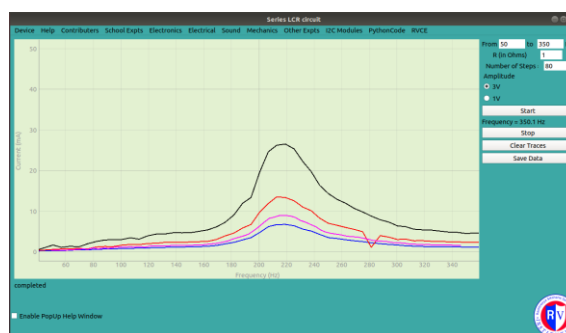
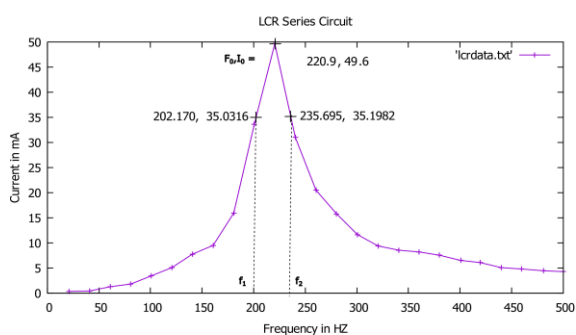
## SERIES L-C-R CIRCUIT

OBSERVATIONS:

**Circuit:**



**Model Graph:**



### Formulae

At resonance  $X_L = X_C$ ,

$$X_L = 2\pi f_0 L; X_C = 1/2\pi f_0 C; L = 1/4\pi^2 f_0^2 C$$

$$I_{\max} = \quad \text{mA}$$

$$I_{\text{rms}} = I_{\max}/\sqrt{2} = \quad \text{mA}$$

$$\text{Resonant Frequency } f_0 = \quad \text{Hz}$$

$$\text{Lower Cut off frequency } f_1 = \quad \text{Hz}$$

$$\text{Upper Cut off frequency } f_2 = \quad \text{Hz}$$

$$\text{Band width } \Delta f = f_2 - f_1 = \quad \text{Hz}$$

$$\text{Quality Factor } Q = f_0/\Delta f =$$

**Calculations:**

**Result:**

1.	Resonant frequency of the circuit $f_0$	_____ Hz
2.	Self-inductance of the given coil $L$	_____ H
3.	Quality factor from graph $Q$	_____
4.	Band width $\Delta f = f_2 - f_1$	_____ Hz

## SERIES L-C-R CIRCUIT

Experiment No:

Date:

**Aim:** To study the frequency response of LCR circuit and determination of a) Self-inductance of the given coil, b) Quality factor (Q- value) and c) Band-width

**Apparatus:** expEYES-17 kit, Resistance box, Capacitor, Inductor

**Principle:** In a series LCR circuit, as the frequency increases inductive reactance  $X_L$  of the circuit increases and capacitive reactance  $X_C$  decreases. At resonant frequency  $f_0$ . The inductive reactance and capacitive reactance are equal hence the total impedance of the circuit is minimum and there by the current is maximum. Therefore, at resonance  $X_L = X_C$ ,  
 $2\pi f_0 L = 1/2\pi f_0 C \rightarrow L = 1/4\pi^2 f_0^2 C$

Where  $f_0$  is the resonant frequency,  $L$  is the inductance of the coil and  $C$  is the value of capacitance.

The property of a reactive circuit to store energy is expressed in terms of quality factor or 'Q' factor. It is a figure of merit that enables us to compare different coils. It is defined as follows  
 $Q = \omega_0 \times \text{energy stored} / \text{average power dissipated}$ . [ $Q = f_0 / f_2 - f_1$ ]

The band width  $\Delta f$  is the difference in frequencies corresponding to current  $I_{\max}/\sqrt{2}$

### Procedure:

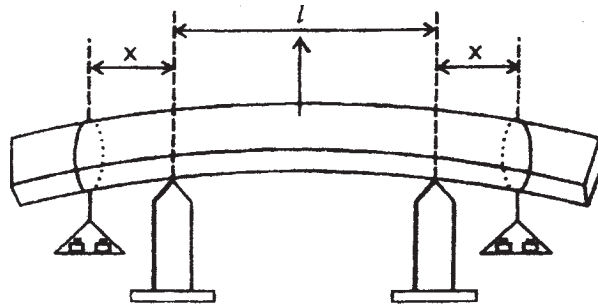
1. Make the connections as per the circuit diagram.
2. Select the frequency range in the right side of GUI window.
3. Enter the value of resistance in the box (keys unplugged in the resistance box).
4. Enter the frequency interval steps in the GUI window.
5. Click on START button to plot the current versus frequency.
6. Save the data by clicking on the Sava Data button.
7. A graph of frequency versus current is plotted using GNU PLOT software, this graph is called frequency response of the L C R circuit.
8. The frequency corresponding to maximum current  $I_{\max}$  is called resonant frequency and is denoted by  $f_0$ . Corresponding to a current  $I = I_{\max}/\sqrt{2}$  from the current axis, a horizontal line is drawn such that it cuts the graph at points A and B. From the points A and B vertical lines are drawn to cut the frequency axis at  $f_1$  and  $f_2$  respectively. These frequencies are lower cut off and upper cut off frequencies (or half power frequencies). The frequencies  $f_0$ ,  $f_1$  and  $f_2$  are noted. Self-inductance of the given coil, Quality factor and Band width  $df$  are calculated using the relevant formulae.



## YOUNG'S MODULUS BY UNIFORM BENDING

OBSERVATIONS:

Figure:



Least count of the travelling microscope

$$L.C = \frac{\text{Value of 1 main scale division}}{\text{Total number of vernier scale divisions}} = \frac{\quad}{\quad} = \underline{\quad} \text{ c m}$$

### TABULAR COLUMN

#### Travelling Microscope Readings:

Load Increasing Readings:

Mass in gm.	M.S.R.in cm	CVD	TR = MSR + (CVD x LC) in cm
50			
100			
150			
200			
250			
300			

Load Decreasing Readings:

Mass in gm.	M.S.R.in cm	CVD	TR = MSR + (CVD x LC) in cm
300			
250			
200			
150			
100			
50			

Calculation for elevation  $\delta$ :

Load in gms	TM Readings in cm			Load in gms	TM Readings in cm			Elevation ' $\delta$ ' for 150 gms in cm $\delta = (R_1 - R_2)$
	Load increasing	Load decreasing	Mean R1		Load increasing	Load decreasing	Mean R2	
0				150				
50				200				
100				250				
150				300				

Mean elevation  $\delta = \underline{\quad\quad\quad}$  cm

$= \underline{\quad\quad\quad} \times 10^{-2}$  m

## YOUNG'S MODULUS BY UNIFORM BENDING

Experiment No:

Date:

**Aim:** To determine the Young's modulus of the material of a bar by uniform bending method.

**Apparatus :** A uniform wooden bar about 1 meter long, two knife-edge, two weight hangers, travelling microscope, etc.,

FORMULA: The Young's modulus of the material of a bar is given by

$$q = \frac{3mg l^2 x}{2bd^3 \delta} \text{ N/m}^2$$

Where,

m = Mass for which the elevation is found in kg.

g = Acceleration due to gravity = 9.8 m/s<sup>2</sup>.

x = Distance between weight hanger and nearest knife-edge in m.

l = Distance between the two knife edges in m = 50 cm

b = Breadth of the bar in m.

d = Thickness of the bar in m.

$\delta$  = Mean value of elevation in m.

### Procedure:

1. The material of the given bar whose Young's modulus is to be determined is supported symmetrically on two knife edges separated by a distance (l = 50 cm).
2. The bar is loaded with m gm symmetrically at either end using weight hangers at distance x from the knife edges.
3. A pin is fixed at the midpoint of the beam. The Travelling Microscope (TM) is focussed on the pin and the reading is noted.
4. The load m in each of the scale pan is increased in steps of 50 gm, till a maximum load of 300 gm and the corresponding TM reading is noted in each case.
5. Step 4 is repeated while decreasing the load in steps of 50 gm starting from 300 gm.
6. Calculate the mean elevation for 150 gm
7. Young's modulus is calculated using the given formula

### Calculations

Distance between the two knife edges  $l = \underline{\hspace{2cm}} \times 10^{-2}$  m

Distance between weight hanger and the nearer knife edge  $x = \underline{\hspace{2cm}} \times 10^{-2}$  m

Mass for which elevation is found  $m = \underline{\hspace{2cm}} \times 10^{-3}$  kg

Breadth of the bar  $b = \underline{\hspace{2cm}} \times 10^{-2}$  m

Thickness of the bar  $d = \underline{\hspace{2cm}} \times 10^{-3}$  m

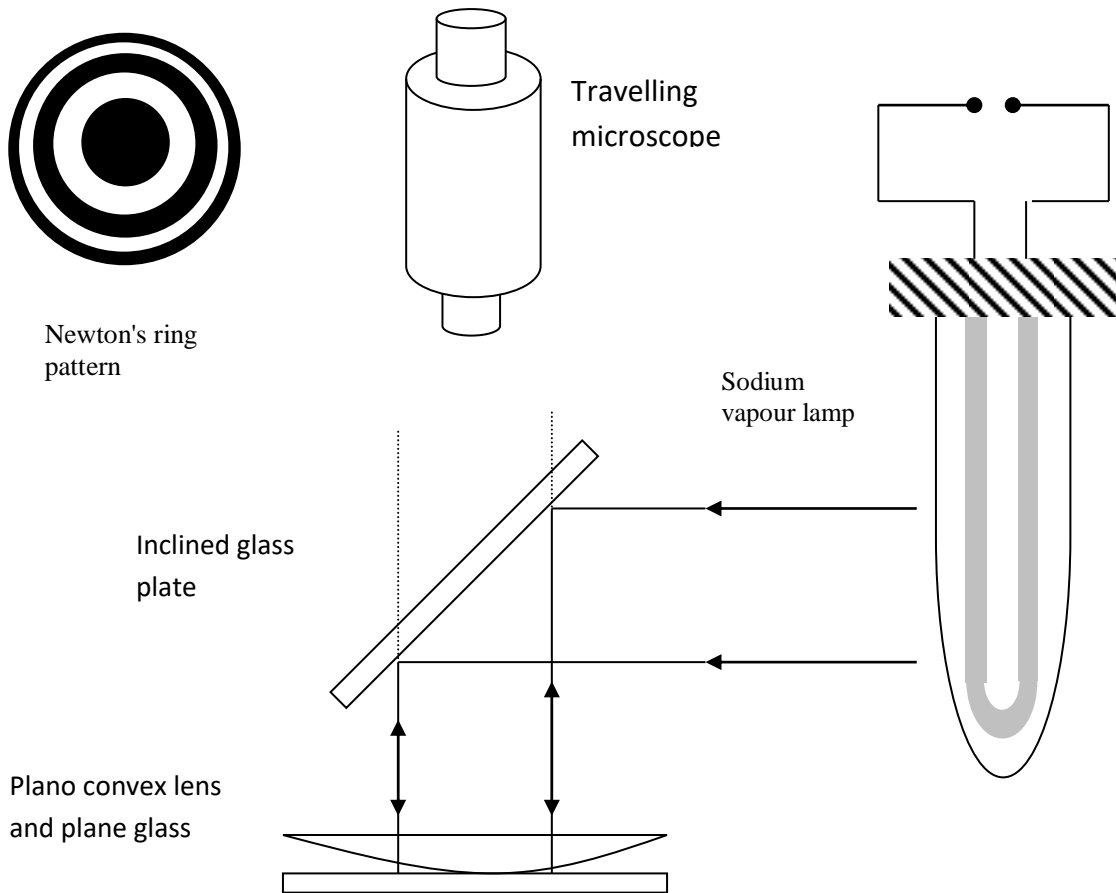
The Young's modulus of the material of a bar is given by

$$q = \frac{3mg l^2 x}{2bd^3 \delta} \text{ N/m}^2$$

**Result:** The Young's modulus of the material of the given bar =  $\underline{\hspace{2cm}}$  N/m<sup>2</sup>.

## NEWTON'S RINGS

OBSERVATIONS:



Least count of the traveling microscope

$$LC = \frac{\text{Value of 1 main scale division}}{\text{Total number of Vernier scale divisions}} = \quad \text{cm}$$

**Tabular column**

Left side reading (LSR)

Ring No.	MSR + (CVD x LC)	Total Reading (cm)
12		
10		
08		
06		
04		
02		

## NEWTON'S RINGS

Experiment No.

Date:

**Aim:** To determine the radius of curvature of a given plano-convex lens by setting up Newton's Rings.

**Apparatus:** Plano-convex lens of large radius of curvature, plane glass plate, reflecting glass plate, sodium-vapor lamp, travelling microscope (bridge type) and reading lens.

**Principle:** When a parallel beam of monochromatic light is incident normally on a convex lens kept on a plane glass plate then due to the phenomena of interference, a fringe pattern of alternate bright and dark concentric rings are formed. These rings are called Newton's rings.

**Identification of plane glass plate and convex lens:** When an object is seen through the lens, kept at different distances from the eye, there is a change in size of the object. When the same object is seen through a plane glass there is no change in size of the object.

**Procedure:** The given glass plate, convex lens and the inclined glass plate are cleaned well before starting the experiment. The convex surface of the plano-convex lens is placed on the glass plate. This setup is placed below an inclined glass plate. Then the whole setup is placed below the objective of the travelling microscope, such that the axis of the microscope passes through the center of the lens when viewed from the top. The travelling microscope unit is positioned properly to receive the light incident on to the inclined glass plate. The orientation of the inclined glass plate is changed slowly so that it makes an angle of  $45^\circ$  with respect to the direction of the incident light, at which time the field of view becomes bright in the microscope. The microscope is moved down by rack and pinion screw, at a certain height, the bright patch of light resolves itself into concentric alternate bright and dark rings. The horizontal cross wire is made to pass through the center of the ring pattern and the vertical cross wire is made tangential to the first dark ring. The cross wire of the traveling microscope is now moved to the 12<sup>th</sup> dark ring on left-hand side and the reading is noted down. Moving the microscope to the right, the readings corresponding to the 10<sup>th</sup>, 8<sup>th</sup>, 6<sup>th</sup>, 4<sup>th</sup> and 2<sup>nd</sup> dark rings of left side readings (LSR) are noted down. Continuing further and after crossing the central dark spot, the reading corresponding to 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup>, 10<sup>th</sup> and 12<sup>th</sup> dark ring of right side reading (RSR) are entered in the tabular column. The diameters of all the rings are calculated.

The radius of curvature of a given plano-convex lens is then calculated by using the formula

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

**RESULT:** The radius of curvature of the given plano-convex lens = \_\_\_\_\_ m



Right side reading (RSR)

Ring No.	MSR + (CVD x LC)	Total reading (cm)
02		
04		
06		
08		
10		
12		

The diameter ( $D_m$  or  $D_n$ ), for any ring is given by  $LSR \sim RSR$  for that ring

Ring No.	TM Reading (cm)		$D_m$ (cm)	$D_m^2$ (cm <sup>2</sup> )	Ring No.	TM Reading (cm)		$D_n$ (cm)	$D_n^2$ (cm <sup>2</sup> )	$D_m^2 - D_n^2$ (cm <sup>2</sup> )
	LSR	RSR				LSR	RSR			
12					6					
10					4					
8					2					

Mean  $D_m^2 - D_n^2 = \underline{\hspace{2cm}} \text{ cm}^2 = \underline{\hspace{2cm}} \times 10^{-4} \text{ m}^2$

**Calculation of radius of curvature**

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

Where

$D_m$  is the diameter of the  $m^{\text{th}}$  ring;  $D_n$  is the diameter of the  $n^{\text{th}}$  ring

Here  $m - n = 6$ ,  $\lambda$  is the wavelength of sodium light = 589.3nm

**RESULT:** The radius of curvature of the given plano-convex lens = \_\_\_\_\_ m

## ULTRASONIC INTERFEROMETER

### OBSERVATIONS

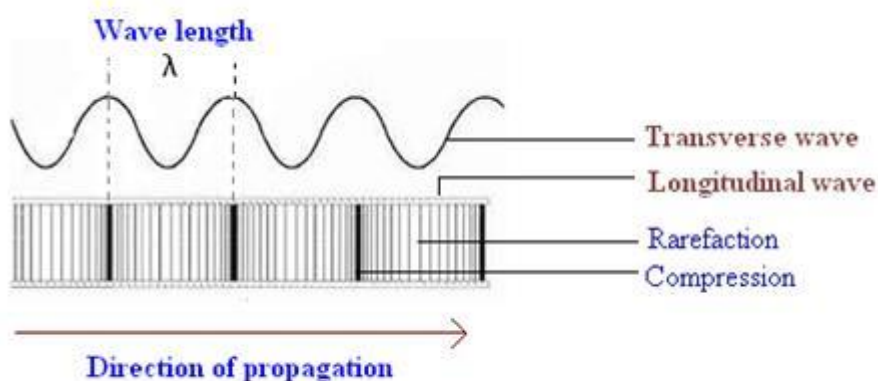
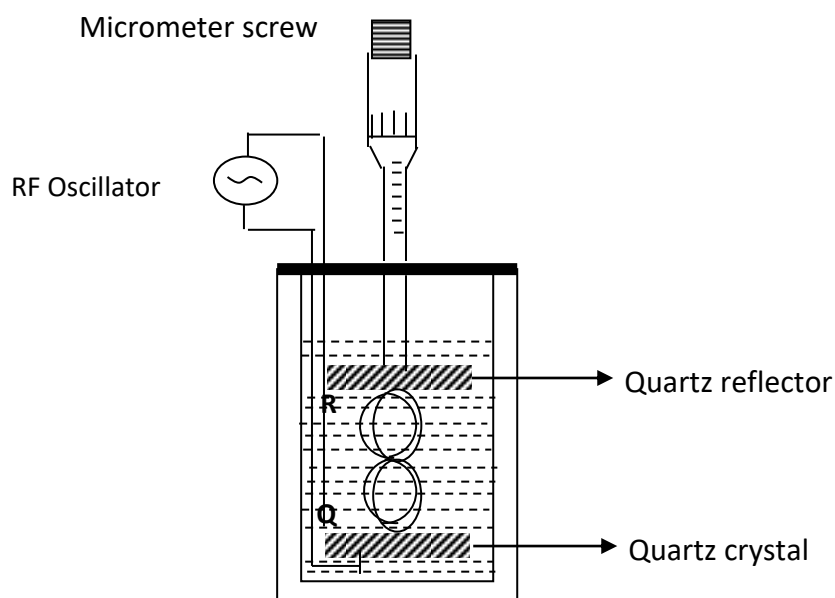
#### Least count of the Micrometer:

Pitch = distance moved on pitch scale/ no. of rotations given to screw head = \_\_\_\_mm

Total number of head scale divisions = -----

L.C = pitch / total no of divisions on the head scale = \_\_\_\_mm.

#### FIGURE:



## ULTRASONIC INTERFEROMETER

Experiment No:

Date:

**Aim:** To measure the velocity of ultrasonic waves in liquid and to calculate the compressibility of the given liquid.

**Apparatus:** A double walled cylindrical vessel containing liquid, RF power oscillator and a crystal (frequency = 2MHz), quartz crystal plate fitted with micrometer screw, an AC micro - ammeter.

**Formula:**

$$v = \lambda \times f \quad \text{m s}^{-1}$$

Where, 'λ' is the wavelength of ultrasonic wave in m.

'f' is the frequency of the given crystal f = 2 MHz.

'v' is the velocity ultrasonic waves in liquid.

**Compressibility**

$$\beta = 1 / \rho v^2$$

where, ρ is the density of the given liquid

v is the velocity of the ultrasonic wave in liquids

**Principle:** An Ultrasonic interferometer is a simple device to measure the ultrasonic velocity in liquid with high degree of accuracy. The principle used in the measurement of velocity is based on acoustic resonance. Ultrasonic waves of known frequency (f) are produced by a quartz crystal fixed at the bottom of the cell. These generated waves move up in the liquid column and are reflected by a movable similar crystal placed above and parallel to the first quartz crystal. Stationary waves are formed inside the liquid due to the superposition of the incident and reflected waves. If the separation between these plates is exactly integral multiple of half wavelength; standing waves are formed in the medium. This acoustic resonance gives rise to an electrical reaction on the generator driving the quartz crystal and the anode current of the generator becomes maximum. Velocity of ultrasonic waves can be calculated using the above formula.

Ultrasonic interferometer basically contains two units:

1. High frequency generator: which is designed to excite the quartz crystal fixed at the bottom of the measuring cell at its resonant frequency to generate ultrasonic waves in the experimental liquid.
2. Measuring cell: it is a specially designed doubled walled cell for maintaining the temperature of the experimental liquid constant throughout the experiment. A fine micrometer screw has been provided at the top, which can lower or raise the reflector plate in the liquid in the cell through a known distance.

**TABULAR COLUMN:**

Liquid used:-----				Room Temperature:-----° C				
Micro meter reading (mm)				Micro meter reading (mm)				Distance between 10 loops. D = X <sub>1</sub> ~X <sub>2</sub> (mm)
Serial No of loops	Main scale (mm)	Circular scale	TR(mm) X <sub>1</sub>	Serial No of loops	Main scale (mm)	Circular scale	TR(mm) X <sub>2</sub>	
N				n+10				
n+1				n+11				
n+2				n+12				
n+3				n+13				
n+4				n+14				
n+5				n+15				
n+6				n+16				
n+7				n+17				
n+8				n+18				
n+9				n+19				

Mean D = \_\_\_\_\_ X10<sup>-3</sup> m.

Width of single loop ( $\lambda/2$ ) = mean D/ 10 = d = \_\_\_\_\_ m

Hence the wavelength =  $\lambda = 2d = \text{-----}$  m.

The velocity of Ultrasonic waves in the given liquid can be calculated by using the formula

$$v = \lambda \times f \text{ ms}^{-1}$$

Where, 'λ' is the wavelength of ultrasonic wave in m  
 'f' is the frequency of the quartz crystal = 2MHz.  
 'v' is the ultrasonic velocity in liquid in ms<sup>-1</sup>

**Compressibility:**

$$\beta = \frac{1}{\rho v^2} m^2 / N$$

ρ is the density of the given liquid in kg m<sup>-3</sup>  
 v is the velocity of the ultrasonic wave in liquids in ms<sup>-1</sup>

## PROCEDURE:

1. Set up the apparatus as shown in the figure. Unscrew the knurled cap of cell and lift it away from double walled construction of the cell. In the middle portion of it pour experimental liquid and screw the knurled cap.
2. Insert the cell in the base socket and clamp it with the help of a screw provided on its side.[ Above two arrangements are made before the apparatus is given to the students.]
3. Connect the high frequency generator with cell by co-axial cable provided with the instrument.
4. For initial adjustment two knobs are provided on high frequency generator, one is marked with "ADJ" to adjust the position of the needle on the ammeter and the knob marked "GAIN" is used to increase the sensitivity of the instrument for greater deflection.
5. Move the micrometer for an initial reading of say 10mm . Now lower the micrometer slowly till the anode current in the ammeter on the high frequency generator shows a maximum current. Note down the reading on the micrometer. **Let this reading be for nth loop.**
6. Micrometer screw is further moved slowly in the **same direction** till the micrometer again shows the maximum reading for the loop n+1. The experiment is repeated up to the loop n+19. For each position the micrometer reading is noted and the readings are tabulated.
7. Determine velocity of ultrasonic waves ( $v$ ) by using the given formula.

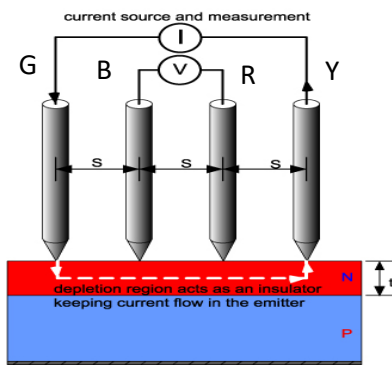
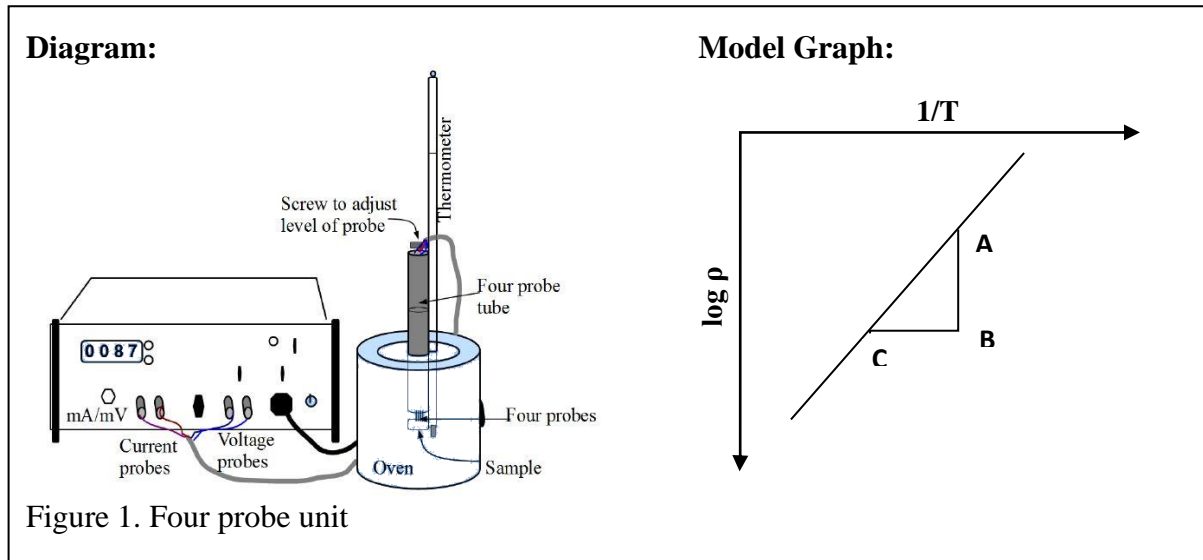
## Calculations:

**Result:** The ultrasonic velocity of a given liquid is \_\_\_\_\_  $\text{ms}^{-1}$

The compressibility of the liquid = -----  $\text{m}^{-2}/\text{N}$

## FOUR PROBE'S METHOD

### OBSERVATIONS



**Formula:**

Resistivity of a semiconductor  $\rho = \left(\frac{V}{I}\right) 2S \Omega m$

Where V is the voltage across two probes  
 I is the current across two probes  
 S is the inter probe spacing

Energy band gap of a semiconductor  $E_g = \frac{4.606 k m}{1.6 \times 10^{-19}} eV$

Where k is the Boltzmann constant =  $1.38 \times 10^{-23} J/K$   
 m is the slope of the graph

Figure 2. Arrangements of four probes

**Table 1:**

Probe spacing  $S = 0.2 \text{ cm}$ , Current (I) = ..... mA.

S.No	Temperature (°C)	Temperature T (K)	Voltage (mV)	Resistivity $\rho$ ( $\Omega \text{ cm}$ )	$\text{Log}_{10} \rho$	$1/T$ ( $\text{K}^{-1}$ )
1.	150					
2.	145					
3.	140					
4.						
5.						
6.						
7.						
8.						
9.						
10.						

**Result:**

1. The resistivity of a given material..... with decreasing temperature and hence the material is found to be.....
2. The energy band gap of the given semiconductor is .....eV

## Electrical resistivity by Four Probe's method

Experiment No:

Date:

**Aim:** To determine, a) The resistivity of Semiconductor, b) The energy band gap.

**Apparatus:** Four Probe arrangement, Oven, Semiconductor and thermometer

**Formula:** Resistivity of a semiconductor  $\rho = \left(\frac{V}{I}\right) 2S \Omega m$

Energy band gap of a semiconductor  $E_g = \frac{4.606 k m}{1.6 \times 10^{-19}} eV$

Where, V is the voltage across two probes, I is the current across two probes, S is the inter probe spacing, k is the Boltzmann constant =  $1.38 \times 10^{-23}$  J/K, m is the slope.

### Principle:

The two-probe method gives an average value of the resistivity. If the specimen ingots are of irregular shape, resistivity determination becomes difficult due to the difficulty in measurement of cross sectional area. The four probe method avoids the necessity of measurement of cross sectional area and is suitable for arbitrary shaped samples.

### Experimental Setup:

The four probe unit consists of four pointed pressure contacts which are equally spaced about 2mm apart. The four probes are loaded over the sample so that all the four probes which are of equal height make contact with the sample.

### Procedure:

1. Ensure that the specimen is placed on the base plate of the four probe arrangement.
2. Connect the pair of green and yellow leads to the constant current power supply and the black and red leads to the voltage terminals.
3. Place the four probe arrangement in the oven and place the thermometer in the oven through the hole provided.
4. Adjust the current to 5 mA and keep it constant throughout the experiment.
5. Switch on the oven and heat the sample up to 150 °C.
6. Unplug the oven connection from the four probe setup after reaches 150°C and note down the value of voltage for every 5° fall in temperature starting from 150 °C.
7. Plot a graph of  $\log_{10}\rho$  versus  $1/T$  and calculate its slope.
8. Energy gap of a given semiconductor is calculated by substituting the value of slope in the above formula.

### RESULT:

1. The resistivity of a given material..... with decreasing temperature and hence the material is found to be.....
2. The energy band gap of the given semiconductor is .....eV

### Precautions:

1. Do not apply pressure on the electrical contacts to the specimen as it is very brittle.



## VIVA VOCE

### SINGLE CANTILEVER

1. State Hooke's law of elasticity.  
Stress is proportional to strain within elastic limits.
2. Supposing the breadth, length and the thickness of the cantilever are altered, is there a variation in the Young's modulus?  
No, because it is a constant for a given material.
3. In the plot of stress versus strain, at a particular value of the applied force the material passes from an elastic state to the plastic state. What is this point called?  
Yield point.
4. What is stress?  
Restoring force per unit area
5. Does the modulus of elasticity change with increase in temperature?  
Yes
6. What is the dimension of strain?  
It is a dimensionless quantity
7. What is a cantilever?  
It is a homogenous beam whose length is more compared to its transverse dimensions.

### FERMI ENERGY

1. What is Fermi energy of a metal?  
It is the energy of the highest occupied level at absolute zero temperature..
2. What is meant by Fermi factor?  
It is the probability of occupation of given energy state by a charge carrier.
3. What is meant by Fermi temperature  $T_F$ ? What is the relation between  $E_F$  &  $T_F$ ?  
It is the temperature at which the average thermal energy of the free electrons in a solid becomes equal to the Fermi energy at  $0^\circ\text{K}$ .  $E_F = k_B T_F$
4. What is meant by Fermi velocity?  
It is the velocity of those electrons which occupy the Fermi level. It is given by
$$E_F = \frac{1}{2} m v_F^2$$
5. What is Fermi Dirac distribution?  
It gives distribution of electrons / fermions among the various available energy levels of a material under thermal equilibrium conditions.
6. What are the factors on which  $E_F$  depend?  
 $E_F$  depends on the material and the temperature.
7. How many electrons will be there in each energy level?  
According to Pauli's exclusion principle, there will be two electrons in each energy level.
8. State Pauli's exclusion principle?  
It states that no two electrons can have all the four quantum numbers same.
9. What is meant by free electron?  
Free electron is the electron which moves freely in the absence of external field. These electrons collide with each other and also with the lattice elastically and hence there is no loss in energy.

## INTERFERENCE AT A WEDGE

1. What is an air wedge?

When a monochromatic light is made to fall normally on the optical flat consisting of a thin paper piece between the two optical flats which forms an air film in wedge shape is called air wedge.

2. Name the phenomena on which this experiment is based.

Interference of Light.

3. Define Interference

Interference is the phenomenon of superposition of two or more light waves which are coherent in nature and coming from a monochromatic source (sodium vapour lamp).

4. What is the necessity of keeping the inclined glass plate at an angle  $45^\circ$ .

To make the light to fall normally on the air wedge apparatus. When the rays fall normally, the angle of incidence and angle of reflection are equal to zero. This done for the convenience of the experiment.

5. How are the straight fringes are formed?

Straight fringes are formed due to the interference in thin air film formed between the lower surface of the upper glass plate (optical flat) and upper surface of the lower glass plate (optical flat).

6. What are the applications of the air wedge experiment?

- i. It is used to determine the wavelength of the monochromatic source
- ii. it is used to determine the thickness of a thin paper.

## SPRING CONSTANT

1. What is Oscillatory motion?

When a body executes back and forth motion which repeats over and again about a mean position, then the body is said to have Vibrational/oscillatory motion.

2. What is Simple Harmonic Motion?

A body is said to be undergoing Simple Harmonic Motion (SHM) when the acceleration of the body is always proportional to its displacement and is directed towards its equilibrium or mean position.

3. What is time period?

The time taken by the particle executing simple harmonic motion to complete one oscillation is called the time period.

4. What is frequency?

The number of oscillations that a body completes in one second is called the frequency.

5. What is spring constant?

Spring constant is the restoring force per unit extension in the spring.

6. For what applications should parallel springs be used and why?

$K=K_1+K_2+\dots\dots\dots+K_n$ . This will ensure that the overall spring constant will be high, and therefore this configuration is used whenever we need a very high spring constant. (Good Shock absorbers in vehicles)

7. Why should springs be used in series?

$1/K = 1/K_1 + 1/K_2 + \dots + 1/K_n$ . This ensures that, the overall spring constant  $K$  is lower than each individual spring constant. This will increase the amplitude of oscillations. Which can be used in sensors.

8. What determines the value of the spring constant for a particular material?

It depends on the elastic properties of the material.

## TORSION PENDULUM

1. What is meant by Torsion Pendulum?

A pendulum in which the oscillations are due to the torsion in the suspension wire.

2. Describe Torsion pendulum?

It consists of a rigid body (disc, rod, etc.,) attached to the lower end of the wire, whose top end is fixed to the rigid support and it is subjected to rotational oscillations.

3. Define moment of inertia?

It is the opposition for the rotational motion. When rigid body rotates about an axis, it has tendency to oppose the change in its state of rest or of uniform rotation about its axis. This tendency is called moment of inertia of a body about the axis of rotation. Quantitatively it is the product of the mass and radius of gyration.

4. Define inertia of a body. What is the measure of the inertia of a body?

The property of a body by virtue of which every body tries to stay in its state of rest or uniform motion along a straight line unless compelled by an external force. Mass is the measure of the inertia of a body.

5. What are the factors on which moment of inertia of a body depend?

Moment of inertia depends on a) mass of the body b) The distribution of mass about the axis of rotation.

6. Why  $(I/T^2)$  is a constant for a given wire?

For a torsion pendulum, the period of torsion oscillation is  $T = 2\pi\sqrt{\frac{I}{C}}$  Where  $I$  = the moment of inertia about its axis,  $C$  = couple per unit twist of the suspended wire.

Rearranging  $(I/T^2) = (C)/(4\pi^2)$

Since "C" (couple per unit twist) is a constant for a given wire;  $I/T^2$  is a constant.

## LASER DIFFRACTION

1. What is meant by diffraction?

Bending of waves round the edges of an obstacle is called diffraction.

2. What is the condition for diffraction?

Size of the obstacle should be comparable with that of the wave length of the light source. Since grating constant and wave length are of the same order ( $10^{-6}$  metre), diffraction takes place within the grating.

3. Distinguish between diffraction and dispersion?

Diffraction: Bending of light round the edges of an obstacle is called diffraction. In this case lower the wave length lesser will be the deviation.

Dispersion: When white light passes through a prism it splits into its constituent colors. This phenomenon is called dispersion. In this case lower the wave length higher will be the deviation.

4. Distinguish between polychromatic & monochromatic source.  
Polychromatic source a source having different wave lengths. Ex. Mercury vapour lamp. Monochromatic source is a source having single wave length. Ex Sodium vapour lamp.
5. What does LASER stands for?  
The term LASER stands for Light Amplification by Stimulated Emission of Radiation.
6. What are the characteristics of laser radiation?  
Laser radiations have high intensity, high coherence, high monochromaticity and high directionality with less divergence.
7. What is population inversion?  
When the number of atoms are more in higher energy state than in the lower energy state, this condition is known as population inversion, it is essential for stimulated emission.
8. What is pumping in a laser?  
It is the process in which atoms are excited to higher energy states by continuously supplying energy.
9. What is meant by the term coherence?  
The state of vibration, same phase or constant phase difference is known as coherence.
10. What is an active medium?  
A solid, liquid, or gaseous medium in which population inversion can be achieved is called an active medium.
11. What is the action of an optical resonator?  
It gives the directionality to the laser beam and amplifies the laser beam.

### **VOLUME RESONATOR**

1. What type of waves are produced in the air column?  
Longitudinal or compressional stationary waves.
2. An open end is a node or antinode?  
An antinode.
3. Is there a node or antinode at the close end of water level?  
A node.
4. Where resonance is produced?  
In the air column.
5. What is an echo?  
Echo is the effect produced when sound wave is reflected on striking a solid obstacle like wall or rock.

### **SERIES RESONANCE (LCR)**

1. What is an Inductor?  
A non resistive coil of wire in which there will be an opposing emf when there is varying current is passing through it. It is a passive component used to store energy in the form of magnetic field.
2. What is Resistance?  
The resistance of a conductor is the opposition offered by the conductor to the flow of electric current through it. The opposition is due to the collision of electrons with ion cores of the conductor. It is independent of frequency.
3. What is Impedance?

Impedance measure the effective opposition to the flow of current due to the reactance and resistance. It is frequency dependent.

4. What is Inductive reactance?  
The opposition offered by the inductor to the flow of AC is called inductive reactance ( $X_L$ ).  $X_L = \omega_L = 2\pi fL$ .
5. What is capacitive reactance?  
The opposition offered by the capacitor to the flow of AC is called capacitive reactance ( $X_C$ ).  $X_C = 1/\omega_C = 1/C2\pi f$
6. What do you mean by resonance in LCR series circuit?  
The condition at which the current is maximum due to the matching of inductive and capacitive reactance's.
7. What is Quality factor? Explain the variation of quality factor with change in resistance of the circuit.  
It is defined as the ratio of resonant frequency to the bandwidth of the circuit. Quality factor measures the sharpness of resonance  $Q = 1/R (\text{sqrt}(L/C))$
8. The smaller the value of resistance, the greater is the current at resonance and the resonance curve is sharper. As the resistance is increased, the sharpness of resonance decreases and the circuit becomes less selective.
9. What is Bandwidth?  
It is the difference between upper and lower cut off frequencies. Bandwidth is the applicable range of frequencies.
10. What are the applications of LCR resonant circuits?  
They are used as tuning circuits in radio and television receivers.

