2.3.2

ICT ENABLED TEACHING SUPPORTIVE DOCUMENT

LAB MANUAL

DEPT OF PHYSICS (UG)

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SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (Autonomous), UJIRE - 574240

DEPARTMENT OF PHYSICS

KNOWLEDGE ENHANCEMENT THROUGH SKILL DEVELOPMENT

LABORATORY WORK BOOK

BSC –Ist SEMESTER

EXPERIMENTS

1. Helmholtz resonator
2. Fly wheel
3. Characteristics of Loudspeaker and Microphone
4. Thermo Couple
5. Specific heat of a liquid
6. Frequency of AC using sonometer
7. Torsion pendulum
8. Spiral spring
9. Thorem of moment of inertia - Perpendicular axis
10. Thorem of moment of inertia - Parallel axis

Name: Roll No:

INSTRUCTIONS AND SAFETY MEASURES

1. Come well prepared and do the experiment neatly.
2. Follow directions of the Staff Incharge, handle the equipments carefully.
3. Observe strict silence and be professional
4. Perform at least two trials and do the calculations independently
5. Report all injuries or breakages to the lab in-charge immediately. Also, report any equipment that you suspect is malfunctioning.
6. Be careful when working with apparatus that may be hot. When you pick it up, use tongs, a wet paper towel, or other appropriate holder.
7. Each time you use glassware, be sure to check it for chips and cracks. Inform Staff Incharge about any damaged glassware so that it can be properly disposed of.
8. Request the staff incharge to ensure all electrical circuits are proper before you turn on the power.
9. When working with electrical circuits, be sure that the current is turned off before making adjustments in the circuit.
10. During electronic experiments verify the values of resistors / capacitors to be used.
11. Switch off the circuit and multimeter when you finish the experiment
12. After finishing optical experiments switch off the sources.
13. While doing the LASER experiments avoid the beam targeting your eyes
14. Eating anything while working in the lab is prohibited
15. Always keep your work area neat and clean
16. Ensure that equipment remains in the same condition and place before you leave the laboratory

SCHEME OF PRACTICAL EXAMINATIONS

BSC Ist SEMESTER

Formula	3
Setup / Circuit / tabulation	4
Observation and number of trials	10
Knowledge about the experiment	5
Calculation and graph	5
Result and accuracy with units	3
Class records- Regularity in completing the experiments / Neatness / General impression	10
Internal assessment for practicals	10
Total Marks	50

Fundamental Physical Constants

Name	Symbol	Value
Speed of light	c	2.99792458×10^{x} m / s
Planck constant	h	$6.6260755 \times 10^{-34}$ J . s
Gravitation constant	G	6.67259×10^{-11} m^{3} . kg^{-1} - s^{-2}
Boltzmann constant	k	1.380658×10^{-23} J / K
Charge of electron	e	$1.60217733 \times 10^{-19}$ C
Mass of electron	m_e	$9.1093897 \times 10^{-31}$ kg
Avogadro’s number	N_A	6.0221367×10^{23} / mol
Stefan-Boltzmann constant	σ	5.67051×10^{-8} W / m^{2} . K^{4}
Standard atmosphere	atm	101325 Pa
Wien displacement constant	b	2.897756×10^{-3} m . K

COLOUR CODE OF RESISTORS

Color	Digit	Multiplier	Tolerance (%)
Black	0	10_0 (1)	
Brown	1	10_1	1
Red	2	10_2	2
Orange	3	10_3	
Yellow	4	10_4	
Green	5	10_5	0.5
Blue	6	10_6	0.25
Violet	7	10_7	0.1
Grey	8	10_8	
White	9	10_9	
Gold		10^{-1}	5
Sliver		10_{-2}	10
(none)			20

VALUES OF CERAMIC CAPACITORS

EIA Code	PF	KPF / N	UF	EIA Code	KPF / N	UF
102	1	1	0.001	403	40	0.4
103	10	10	0.01	471	0.47	0.00047
104	100	100	0.1	472	4.7	0.0047
202	2	2	0.002	473	47	0.047
203	20	20	0.02	442	4.4	0.0044
223	-	22	0.022	443	44	0.044
224	-	220	0.22	444	440	0.44

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DEPARTMENT OF PHYSICS

CERTIFICATE

This is to certify that ……………………………..……………

has satisfactorily completed the course of experiments in Practical Physics prescribed by the college for BSc Ist Semester in the Physics laboratory of this college during the year 20…........... 20….......….

Staff in charge of the Batch

Date :

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (Autonomous), UJIRE-574240

DEPARTMENT OF PHYSICS

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Expt No.	Name of the Experiment	Date	Page Number
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8.			
9.			

Signature & Name of the student

Experiment Number : Date :

HELMHOLTZ RESONATOR - DETERMINATION OF UNKNOWN FREQUENCY

Aim : To determine the frequency of a tuning fork by using helmholtz resonator.

Apparalus : Narrow necked bottle, measuring far, tuning forks, pinch cock, etc.

Theory : A resonator consists of narrow necked bottle with side tube at the bottom. It is filled with water upto a certain height leaving air cavity above it. When an excited tuning fork of frequency n is held above the neck of the bottle, the layer of air, in the neck is set into oscillations. This inturn, causes forced oscillations of the air cavity in the bottle. If the air in the cavity is in resonance it can be shown that n_2v = a constant, where V is the resonating volume of air If V_x is the volume correspending to the fork for frequency n_x we have $n^2_x = \frac{n^2V}{Vx}$ and $n_x = \sqrt{\frac{n^2V}{V_x}}$

If a graph is ploted connecting n_2 and $\frac{1}{V}$ a straight line is obtained.

This is used to find out the unknown frequency of a tuning fork by the method of interpolation (Frg.b)

Procedure : The resonance bottle is filled with water upto the neck. A tuning fork of known frequency n_1 is excited and held above the neck of the bottle. Water is allowed to flow out into a graduated jar til the maximum sound is heard. The volume of water collected in the jar is measured. This gives the volume of the air cavity in the bottle. The experiment is repeated and the mean volume V_1 of resonating air is determined. The product ($n_{12}V_1$) is calculated. The experiment is repeated for four more tuning forks, three of known frequencies. n_2, n_3, n_4 and the other of unknown frequency n_x. The mean value of (n^2V) as calculated. The unknwon frequency is got from the equation.

$$n_x = \sqrt{\frac{n^2V}{V_x}}$$

A graph is plotted connecting n_2 and 1/V. A straight line is obtained. Corresponding to $1/V_x$ the value of n_x^2 is determined from the graph. Hence n_x is calculated (V_x is the volume with unknown frequency n_x) figure (b)

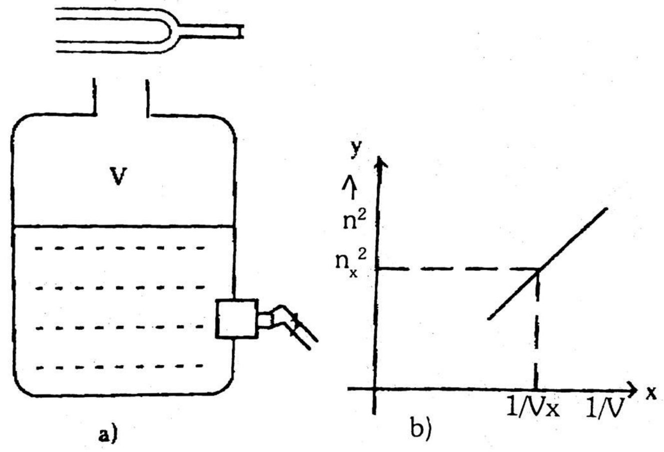
Result:

Frequency of the given tuning fork

i) By Calculation = Hz

ii) By Graph = Hz

Diagram



Observations:

Trial No.	Frequency of the tuning forks		Volume of air in resonance with vibrating fork (cc)			n_2V	1/V
	n (Hz)	n_2	1	2	Mean V		
1	n_1=						
2	n_2=						
3	n_3=						
4	n_4=						
5	n_x=						

Mean value of n_2V

=

Unknown frequency $n_x = \sqrt{\dfrac{n^2V}{V_x}} =$

from the graph n_x^2 =

$\therefore n_x$ =

Experiment Number : Date :

Flywheel

Aim : To determine the moment of inertia of flywheel about its axis of rotation and hence to estimate its mass and to perform the experiment by simulation.

Apparatus : Flywheel, stop watch, weight hanger, weights etc.

Description: The flywheel is a heavy wheel capable of rotation aboout a horizontal axle P is a peg fixed to the axle. (Fig a). A pointer fixed to the wheel support is useful in counting the number of rotations made by the wheel. One end of a string is attached to the peg. The string is wound over the axle without over lapping and a suitable load is suspended from the free end. When the load descends the wheel will rotate.

Principle : Let m be the load suspended and h be its height from the ground. Let v be the velocity of the load when its hits the ground and let W be the angular velocity of the flywheel at that instant. The loss in the potential energy of the load is equal to the kinetic energy gained by the load and flywheel

$\therefore mgh = {}^{1}/_{2}\, Iw^2 + {}^{1}/_{2}\, mv + nk \rightarrow (1)$

Where I is the M. I of the flywheel about its axis of rotation and nk represents the loss in energy due to friction, n is number of rotation made by the flywheel and h is workdone against friction in a rotation. Let N be the number of rotation made by the wheel after the load hits the ground. Hence $Nk = {}^{1}/_{2} Iw^2$. Substituting $k = Iw^2/2N$ and $V=r\omega$ in eqn (1)

We get $I = \frac{mN}{N+n} \times \left(\frac{2gh}{\omega^2} - r^2\right)$

Where r is radius of the axle of the wheel. Assuming the friction to be uniform, we have $w = 4 \pi N / t$ where t is the time for which the flywheel rotates after the load gets detached.

Procedure :

Part A (Direct Experiment)

A loop is made in a long string and it is slipped into the peg on the axle. The string is wound over the axle without over lapping and a load m is suspended from the free end. The height h of the load from the ground is measured. The length of the string is adjusted such that just when the load touched the ground the string slips from the peg. The number of rotations made by the wheel before the load touches the ground is given by $n = \frac{h}{2\pi r}$. The number of rotations made by the wheel after the load gets detached is counted with the help of the pointer. The time 't' taken by the flywheel to come to rest after the load touches the ground is measured using a stop watch. The radius of the axle is found by measuring the diameter using a vernier calipers. The circumference of the wheel is measured using a thread and radius R is calculated. The mass of the flywheel M is estimated using the formula $I = \frac{MR^2}{2}$. The experiment is repeated for different values of m and h.

Part B (by simulation)

Choose any desired environment by clicking on the 'combo box'.

1. Adjust the sliders to have suitable dimensions for flywheel arrangement.
2. Click on 'Release fly wheel' to start the experiment.
3. No of revolutions (N) of the flywheel, after the loop slips off from peg is indicated on the side of axle.
4. The time taken by flywheel to come to rest is noted from stop watch.
5. Repeat the experiment for different values of variables.

Result : Part A

The moment of inertia of the flywheel

about its axis of rotation = kg m^2

The mass of the flywheel = kg

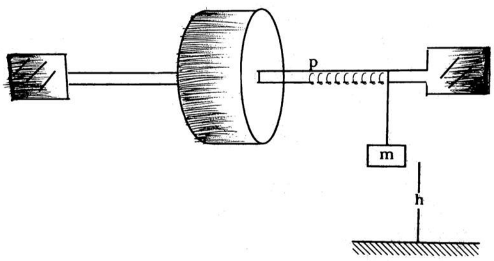
Part B

Environment details

Moment of inertia of the fly wheel =.........kgm^2

Observations :

Diagrams :



Tabulation :

Part A

a) To mesure the diameter of the axle using Vernier Calipers.

Least count of the Vernier = $\frac{\text{1 msd}}{\text{Number of vsd}}$ =

=

= cm

Trial No.	M. S. R. (cm)	V. S. R.	Diameter = MSR + (VSR x LC) (cm)
1.			
2.			
3.			

Mean Diameter =

Mean radius r =

Circumference of the flywheel, C =

Radius of the flywheel, = $\frac{C}{2\pi}$ =

b) To Determine I :

Trial No.	Mass Suspended m (kg)	Number of rotation N	Height h (m)	$n = \frac{h}{2\pi r}$	t	W = $\frac{4\pi N}{t}$ radian/s	Moment of Intrtia (kg m_2)
1.							
2.							
3.							
4.							
5.							
6.							

Part B

Mass suspended (m) x 10^{-3} kg	Height above the ground (h) x 10^{-2} m	No. of revolutions		Time of N revolution (t) S	Mean ang : vel : $\omega = 4 \pi n / t$	M. I. of the Flywheel (kgm^2)
		n	N			

Mean value of moment of inertia,I =.........kgm2

Result

Part A

Moment of Inertia,

Mean value of I = kgm2

Mass of the flywheel, M= $2I/R^2$ = kg

Psrt B

Environment details

Moment of inertia of the fly wheel =.........kgm^2

Experiment Number : Date :

CHARACTERISTICS OF LOUDSPEAKER AND MICROPHONE

AIM: To study the characteristics of a set of Loudspeaker and Microphone

APPARATUS: Audio frequency generator (AFO), mid- range speaker, V.T.V.M, microphone, patch cords, dual beam CRO

THEORY: Loudspeakers: Loudspeaker is a device which converts a varying electrical signal back into a proportional sound signal. It consists of a fairly large diaphragm of stiff paper or aluminium alloy which is mounted on a large size baffle board. The front side of the conical diaphragm gives out compression waves just when the rare side experiences rarefaction. The baffle board prevents intermixing of rare faction and compression.

The moving coil, also called as speech coil is wound around a light cylindrical former of cardboard, which is firmly fixed to the diaphragm. This coil can move in and out parallel to its axis in the strong radial field of the electromagnet. When the amplified output from microphone is made to pass through this coil, it experiences a mechanical force in accordance with Fleming's left hand rule. The magnitude of this mechanical force is proportional to the input varying current from the amplifier. This force makes the coil to vi-brate, which in turn produces vibrations of the diaphragm. This to-&-fro motion of the diaphragm produces sound waves proportional to the electrical signal fed by the amplifier.

Types of speakers: Depending upon the frequency of electrical signal and frequency produced by the diaphragm, there are 3 types of loudspeakers.

1. Woofer: When the frequency produced by the diaphragm is low frequency sound of range 60Hz to 500Hz, it is Woofer.
2. Speaker: When the frequency produced by diaphragm is medium frequency sound of range 500Hz to 3kHz, it is Speaker.
3. Tweeter: When the frequency produced by diaphragm is high frequency sound of range 3kHz to 15kHz, it is Tweeter.

Microphones: Microphone is a device which converts the variations of sound pressure in the form of compressions and rarefactions produced in the medium due to longitudinal waves, in a sound wave into corresponding electrical variations called as signal. These electrical signals are in the range 20Hz to 20kHZ and hence this range is called as audio frequency (AF) range. These sound signals are complex in nature. These electrical signals are very weak and hence need amplification for this purpose. AF amplifiers are employed. The power of these amplified audio signals is further boosted by power-amplifiers and lastly is fed to loudspeakers. The microphone is the first element in this process, which picks up to sound signal and coverts it into equivalent electrical signal.

General requirements:

1. The response of the microphone should be independent of frequency, i.e. the output should not vary much with frequency.
2. The shape or body of microphone should be such that, the frequency response is reasonably inde-pendent of angle of incidence of sound waves.
3. It should be free from harmonics.
4. The output of microphone should be high compared to the noise level.
5. It should remain unaffected by the adjacent electric and magnetic fields.
6. It should be robust for handling purpose.

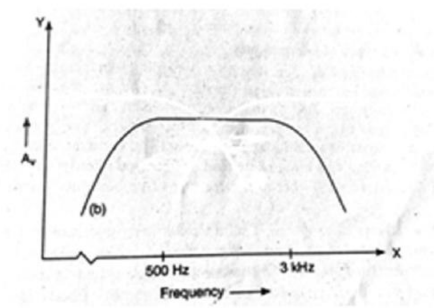
Both, loudspeaker and microphone hence are called transducers. The working principal of both is almost identical. The only difference is that the loudspeaker has a much larger diaphragm.

PROCEDURE:

i. Connect sine wave output of audio frequency signal generator(AFO) to the input of mid range speaker which is under study.
ii. The microphone under study is kept near the sounding speaker, in the direction of sound waves.
iii. Using dual trace CRO fix the input voltage to a constant value ,say 1 volt at frequency 500 Hz
iv. Note down the out put voltage Vout
v. Repeat the above steps for other frequencies up to 3KHz with the same fixed voltage.
vi. Plot frequency response curve taking frequency along X-axis and voltage gain along Y-axis.
vii. Repeat the experiment for another set of speaker and microphone.

RESULT : Speaker and microphone characteristic curves are as shown in the

graphs. **OBSERVATIONS**



Tabulation:

Input voltage V_i = 1 volt

input frequency in Hz	Set 1		Set 2	
	Out put voltage V_{out} in Volts	Gain=Vout/Vi	Out put voltage V_{out} in Volts	Gain=Vout/Vi
500				
600				
700				
800				
900				
1000				
1200				
1400				
1600				
1800				
2000				
2300				
2600				
2900				
3000				

RESULT : Speaker and microphone characteristic curves are as shown in the graphs.

Experiment Number : Date :

THERMO COUPLE

Aim: To determine (a) the thermo emf per unit temperature difference for the given thermocouple (b) the melting point of a solid using the thermocouple.

Apparatus: Thermocouple, potentiometer, battery, resistance box, galvanometer, thermometer, jock-ey etc.

Principle: A thermocouple consists of two dissimilar metals joined together to form two junctions. When the two junctions are at different temperatures an emf is produced in the thermocouple. This is called thermo emf. If Θθ is the temperature difference, thermo emf $e=a\theta + b\theta_2$ where 'a' and 'b' are constants. For small temperature difference $b\theta_2$ is negligible and the graph connecting e and θ is linear. Unknown tem-perature can be determined by interpolation of the graph. The slope of the straight line gives the thermo emf per unit temperature difference between the junctions.

The emf can be measured using a potentiometer calibrated for a p.d. of 1mV per metre length of the potentiometer wire. Let V be the emf of the source in the primary circuit, and let P be the resistance of potentiometer wire. If R is the resistance included in the primary circuit, the current in the circuit = v/(R+P). Hence the potential difference between terminals of the potentiometer = PV/(R+P). If potentiometer wire has a length 10m this should be 10mV at the rate of 1mVper meter

$$VP/(R+P) = 10mV= 0.01volt$$

$$R= (100V-1)\ P$$

Procedure: Circuit connections are made as shown in fig (a). A resistance R=(100V-1)P is unplugged in the resistance box so as to get a p.d. of 1mV per metre. One of the junctions of the thermocouple is kept in melting ice while the other is immersed in a water bath. The temperature of the bath is measure using a thermometer. The balancing point is determined. If 'l' is the balancing length in metre, the thermo emf=l mV. This is measured at different temperatures of the water bath. A graph is plotted taking thermo emf along Y-axis and the temperature difference between the junctions along X-axis. A straight line is obtained as in fig (b). The slope of the line gives the value of thermo emf per unit temperature difference between the junctions.

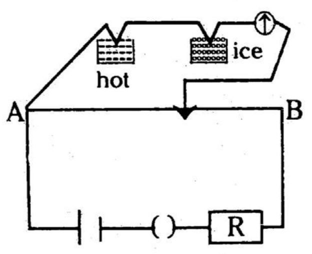
To find the melting point of a solid, the solid is taken in a test tube and the tube is dipped in the water bath. The temperature of the bath is slowly increased until the solid melts. When the solid is melting, the thermo emf is found out. The melting point can be determined using the graph.

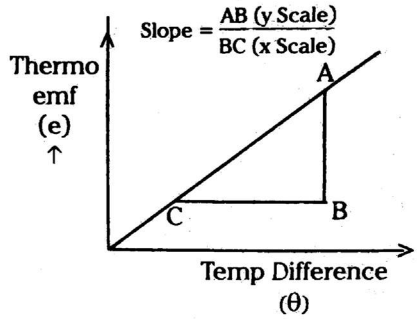
Result:

a) The thermo emf per unit temperature difference=-----------mV/K

b) The melting point of the solid=----------$_o$C

Diagrams:





Observations:

EMF of the cell V = ---------- V

Resistance of the potentiometer wire P = --------- ohm

Resistance in R for p.d. of 1mV/metre = (100V-1)P = ----------- ohm

Temperature of the cold junction = ---------- $_oC$

Tabulation:

Temperature of hot junction ($_oC$)	Temperature difference ($_oC$)	Balancing length (m)	Thermo emf (mV)

Result

The thermo emf per unit temperature difference = slope = -----------mV/K

= ------------μV/K

Melting point of the solid = -------------- $_oC$

Experiment Number : Date :

Specific heat of a liquid

Aim : To determine the specific heat of a liquid by the method of cooling.

Apparatus : Spherical calorimeter, thermometer, stop clock, etc.

Principle : This method is based on Newton's law of cooling which states that the rate of loss of heat by radiation from a hot body is directly preportional to the temperature difference between the body and its surroundings. The rate of cooling = mass x specific heat x fall in temperature per second.

Procedure : The mass of the empty colorimeter (w_1) is found using a physical balance. A certain volume of hot water. (at about 90ºC) is poured into the colorimeter. A thermometer is inserted into it. As the water cools time and temperature values are recorded. For example a stop clock may be started when the temperature is 75ºC and at intervals of 1ºc time shown by the stopclock may be noted. To get the cooling curve, temperature is plotted along Y axis and time along X axis. The calorimeter with water is weighed and the mass (m) of water in it is found out. The colorimeter is emptied and dried. Now the given liquid is heated about 90ºC. A volume of the hot liquid equal to that of water taken earlier poured into the colorimeter. As before the time and temperature readings are recorded for the some range of temperature and a cooling curve for the liquid is drawn on the same graph. The calorimeter with the liquid is weighed and the mass M of the liquid is found out. If t_1 is the time taken by the calorimeter and water in it to cool from θ_2ºc to θ_1ºc, the rate of cooling = $\frac{(w_1x + ms1)\ (\theta_2-\theta_1)}{t_1}$ where x is the specific heat of calorimeter and s_1 is the specific heat of water. If t_2 is the time taken by the caloraimeter and the liquid to coolfrom θ_1ºc to θ_2ºc the rate of cooling $\frac{(w_1\ x + ms1)\ (0_2\ -0_1)}{t_2}$ where S is the specific heat of the liquid and M is the mass of the liquid. The rate of cooling are equal in the two cases.

$$\therefore \frac{(W_1x+ms_1)(0_2-0_1)}{t_1} = \frac{(W_1x + MS)(0_2-0_1)}{t_2}$$

$$S = \frac{1}{M}\left((W_1x+ms_1)\frac{t_2}{t_1} - w_1x \right)$$

$\frac{t_2}{t_1}$ can be obtained from the graph.

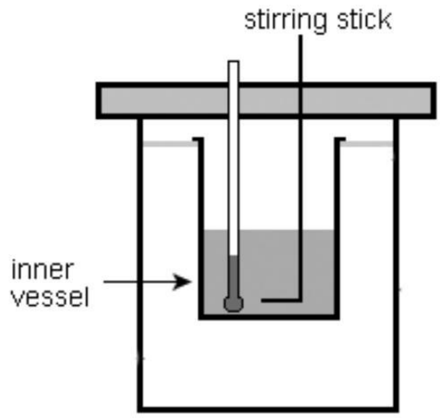
Result :

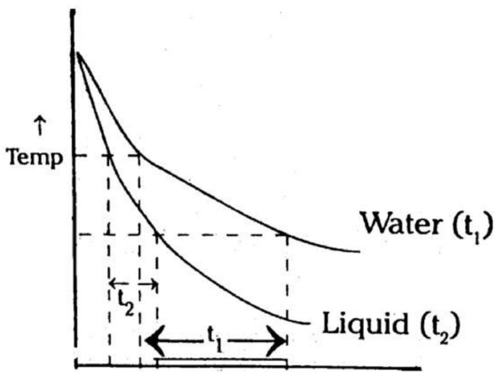
Specific heat of the given liquid

by calculation using graph h = J kg^{-1} k^{-1}

Observations :

Diagram:





Tabulation:

Time in minutes	0	2	4	6	8	10	12	14
Temperature of cooling water								
Temperature of cooling oil								

Calculation of t_2 / t_1 from the graph :

Trial No.	Temperature range ºC	Time of Cooling for		t_2 / t_1	Mean t_2 / t_1
		Water (t_1) (S)	Oil (t_2) (S)		
1.					
2.					

Mass of empty calorimeter W1 =

Specific heat of material of calorimeter x = 393J/kg/k Mass of

calorimeter and heater w_2 =

Mass of water $m = w_2 - w_1$ =

=

Specific heat of water $S_1 = 4200 Jkg^{-1} k^{-1}$

Mass of calorimeter and oil W_3 =

Mass of oil $M = W_3 - W_1$ =

=

Specific heat of liquid S_1

$$S = \frac{1}{M}\left((w_1 x + m s_1) \frac{t_2}{t_1} - w_1 x \right) J\,kg^{-1} k^{-1}$$

Experiment Number : Date :

Frequency of A. C. using Sonometer

Aim : To determine the frequency of A. C. using a sonometer.

Apparatus : Sonometer with a steel wire, step down transformer, iron core solenoid, weight hanger, etc.

Description : The Sonometer wire is made to vibrate by resonance, using an iron core solenoid whose terminals are connected to a 6 volt stepdown transformer. The solenoid is clamped in such a way that its iron core is about half a centimeter above the centre of vibrating segment of the sonometer wire.

Theory : When a wire, under tension T and fixed at two ends is made to vibrate, the fundamental frequency of vibrations of the wire is $n = \frac{1}{2L}\sqrt{\frac{T}{m}} \rightarrow (1)$

Where L = the length of the vibrating segment of the wire. m is the linear density (mass per unit length) of the wire. When the stretched wire is made to vibrate by the principle of resonance due to an A. C. passing through the iron-core solenoid, the frequency of vibrations of the wire is double the frequency of A. C. Therefore, frequency of A. C.

$$N = \frac{n}{2} = \frac{1}{4L}\sqrt{\frac{T}{m}} \rightarrow (2)$$

or

$$N = \sqrt{\frac{1}{16m}\frac{T}{L^2}} \rightarrow (3)$$

Procedure : A weight of 0.5 kg is suspended by the sonometer wire. The circuit is closed, and the bridges of the sonometer are adjusted until vibrating segment vibrates by resonance with maximum amplitude, forming a single loop. The length 'l' of the sonometer wire between the two bridges is measured. The tension T applied to the wire, is noted and the value of $T\backslash L_2$ is calculated. The experiment is repeated with different tensions applied to the same sonometer wire. The mean value of T/L_2 is determined. The mass per unit length 'm' of the sonometer wire is determined by weighing a known length of specimen wire. The frequency of the A. C. supply is calculated using equation (3).

Note : The density of the material of the sonometer wire can be calculated from the relation $\int = \frac{m}{\pi r^2}$ where ∫ is radius of the wire. If the frequency of A. C. supply is known, m and hence density of the wire can be estimated.

Result : Frequency of A. C. = Hz.

Linear density assuming frequency of A. C. = kg /m

Linear density by direct calculation = kg /m

Material density of the wire = kg/m_2

Observations :

To determine linear density ‘m’ of the sonometer wire.

Length of the sample wire = L cms =

Mass of the sample wire = W = gm = kg.

Linear density $m = \frac{W}{L} =$ kg /m

To determine T / L^2

Trial No.	Mass suspended m (kg)	Tension applied T- Mg (Newton)	Resonating length L metre	T / L^2
1. 2. 3. 4.				

Mean :

Frequency of A. C.

$$N = \sqrt{\frac{1}{16m} \text{ Mean } \frac{T}{L}}$$

= Hz

Calculation of Linear density assuming frequency A. C.

Frequency of A. C. = $N = \sqrt{\frac{1}{16m}\left(\frac{MeanT}{L^2}\right)}$ Hz

$m = \text{Mean}\left(\frac{T}{L^2}\right)\frac{1}{16N^2}$

= kg/m

Calculation of material density of wire.

Radius of the wire = m

Material density $\int = \frac{m}{\pi r^2}$ kg/m2

Experiment Number :   Date :

Torsion Pendulum

Aim : To determine (a) the moment of incrtia of the given irregular body and (b) the rigidity modulus of the material of the suspension wire of a torsion pendulum.

Apparatus : Circular disc, rectangular plate, irregular body, slopclock, screw guage etc.

Principle : The period of torsional oscillations of a rigid body suspended by a wire and oscillating with small amplitude is T = 2π $\sqrt{\frac{I}{C}} \rightarrow (1)$ Where I is the moment of incrtia of the oscillating body about the axis *of suspension and C is the couple for unit twist of the wire. Squaring and rearranging the terms we get* $\frac{I}{T^2} = \frac{C}{4\pi^2} =$ a constant. Different values of $\frac{I}{T^2}$ are found out for the given wire using bodies of regular shape like a circular disc and a rectangular plate. Finally the irregular body is suspended and period T_x is determined. If I_x is M. I. of the irregular body $\frac{I_x}{T_x^2} = \frac{I}{T^2}$ and $I_x = \frac{I}{T^2} T_x^2 \rightarrow (2)$

The couple per unit twist $C = \frac{\pi n r^4}{2L}$ where r is the radius and L is the length of the wire and n is the rigidily modulus of material. On substitution $C = 4\pi^2 \left(\frac{I}{T^2}\right)$, we get $n = \frac{8\pi l}{r^4} \left(\frac{I}{T^2}\right)$

The experiment can be repeated for difficult values of I

Procedure : The radius R of the circular disc, the length L and the Breadth B of the rectangular plate and their respective masses M_1 and M_2 are determined. The disc to suspended from a rigid support by a wire about an axis perpendicular to the plane and passing through the centre. The disc is rotated about the wire by a small angle and released. Then it executes torsional oscillations. The number of oscillations can be counted by making a mark on the disc and using a pointer as reference. When the mark crosses pointer a stop clock is started and the times at the completion of 5, 10, 15,20, 25 oscillations are noted. The period T1 is calculated by the method of differences. The M. I of circular disc about axis of suspension, $I_1 = \frac{M_1 R^2}{4}$ is found our and the value of $\frac{I_1}{T_1^2}$ is calculated.

Similarly, the disc is suspended along a diameter and the period T_2 is determined. The M. I. is given by $I_2 = \frac{M_1 R^2}{4}$ and $\frac{I_2}{T_2^2}$ is calculated.

The rectangular lamina is suspended by the same wire about an axis perpendicular to its plane and passing through its centre. The period T_3 is determined. The MI of the plate is found out using the relation $I_3 = \frac{M_2 (L^2 + B^2)}{12}$. The ratio I_3 / T_3^2 is calculated.

The plate is now suspended about an axis through the centre and parallel to the breadth. The period T_4 is determined. The M. I. is given by $I_4 = \frac{M_2 L^2}{12}$ Since the thickness D < < L I_4 / T_4^2 found out.

The Mean value of (I / T^2) is calculated. The irregular body is suspended from the same wire and the period T_x of torsional oscillations is determined as before. The M. I. of the irregular body $I_x = \frac{I}{T^2} T_x^2$. The length l of the wire is measured using a scale and diameter is measured using a screw guge. The radius is found out. Hence the rigidily modulus of the wire $n = \frac{8\pi l}{r^4}\left[\frac{I}{T^2}\right]$

Note : The expt can be repeated by changing the value of I and the mean value of n can be found out.

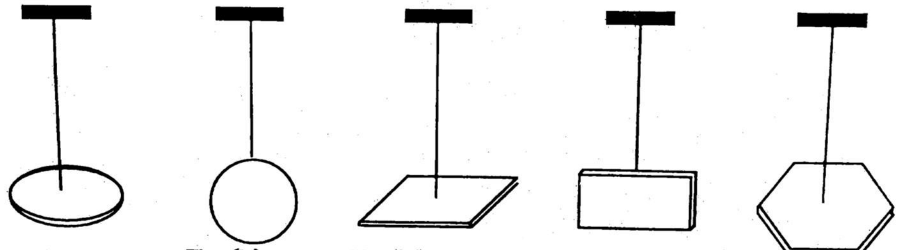
Result:

a) The M. I of the irregular body about the axis of suspension = kgm^2

b) The rigidily modulus of the material of the suspension wire = Nm^{-2}

Observations :

Diagrams :



Tabulation:

a) Circular disc (axis perpendicular to the plane):

No. of oscillations	Time (s)	No. of oscillations	Time (s)	Time for 15 oscillation (s)
		Mean value of (t) =		

Period T_1 = 9.6 5

Mass of circular disc M1 = kg

Diameter of the circular disc = m

Radius of circular disc R = m

M. I. of circular disc $I_1 = \frac{M_1 R_2}{= 2}$ kgm2

b) Circular disc (axis along a diameter)

No. of oscillations	Time (s)	No. of oscillations	Time (s)	Time for 15 oscillation (s)
		Mean value of (t) =		

Period T_2 =

M. I. of disc $I_2 = \frac{1}{2}$ = kgm2

c) Rectangular disc (Axis $\perp_r$ to plane through the centre)

No. of oscillations	Time (s)	No. of oscillations	Time (s)	Time for 15 oscillation (s)
Mean value of (t) =				

Period T_3 =

Mass of Rectangular disc M_2 = kg

Length of Rectangular plate L= m

Breadth of Rectangular plate B = m

M. I. of rectangular plate $I_3 = \frac{M_2\left(L^2 + B^2\right)}{12}$

= kgm^2

d) Rectangular plate (axis II to breadth)

No. of oscillations	Time (s)	No. of oscillations	Time (s)	Time for 15 oscillation (s)
Mean value of (t) =				

Period T_4 =

M. T. of Rectangular plate = $\frac{M_2 L^2}{12}$

Trial No.	Body suspended	Axis of suspension	MI (kgm^2)	Period T(s)	I/T^2
1. 2. 3. 4.					

Mean (I/T^2) =

To find the radius of the wire : using screw guage

Pitch of the screw guage = $\frac{\text{Distance uncovered}}{\text{Rotations given}}$

Least count = $\frac{\text{Pitch}}{\text{No. of divisions on HS}}$ =

Zero correction =

Trial No.	P.S. R. (mm)	H. S. R.	Corrected HSR	Diameter (mm)
1. 2. 3.				

Mean diameter =

Mean Radius r = =

Length of the suspenstion wire l =

$n = \frac{8\pi l}{r^4} \left({}^{I}\!/\!{}_{T^2} \right) Nm^{-2}$

e) Irregular body

No. of oscillation	Time (s)	No. of oscillation	Time (s)	Time for 15 oscillation

Period T_x =

M. I. of Irregular body Ix = $({}^{I}/T^2) T_x^2$ =

Experiment Number : Date :

Spiral Spring

Aim : To determine the acceleration due to gravity, unknown mass and to verify Hooke's loaw using a spiral spring.

Apparatus : Flat Spiral spring, stop watch, weight hanger, weight etc.

Principle : When a loaded Spiral spring is set into vertical oscillations of small amplitude the oscillations will be simple harmonic. If M is the load suspended from the spring, m is the mass of the spring and w is the load required to produce unit extension in the spring, the period of oscillation

$$T = 2\pi\sqrt{\frac{M + m/3}{wg}} \quad \text{or} \quad g = 4\pi^2 \frac{(M + m/3)}{T^2} \rightarrow (1)$$

According to Hooke's law, extension in the spring is directly proportional to the load suspended. Hence the load extension graph should be a straight line. The slope of line will be equal to ($^1/_w$)

Procedure : a) The mass of the spring is determined using a balance. The upper end of the spring is clamped to a stand and a weight hanger is suspended from the lower end as shown in fig. A reference pin is fixed horizontally to the spring at its loaded end. A metre scale is placed vertically near the spring in such a way that the pin moves over the graduations of the scale when it is stretched. The sprial spring is brought into the cyclic state by repeatedly increasing and decreasing the load suspended in regular steps. A suitable dead load (s) is suspended from the spring and the pointer reading is noted. The load is increased in regular steps (say, 50g) until a safe maximum load is reached and in every step the pointer reading is observed. The load is then decreased along the same steps and the observations are repeated. The extension of the spring for a definite load (say 200g) is found out by the method of differences. The load (w) required to produce unit extension is found out. A graph is plotted taking load along X-axis and extension along Y axis. A straight line is obtained. If 'S' is the slope of the line w = $^1/_S$

An unknown load can be determined as follows. It is suspended along with the dead load from the spring and the pointer reading is noted and the extension for the unknown load is found out. The value of the load is determined from the load extension graph.

b) A suitable load M is suspended from the spring the load is pulled down a little and let free. It executes oscillations in the vertical direction. Using a stop watch the time for 20 oscillations is measured and period T is calculated. (M + m/3)T_2 is calculated. The experiment is repeated for different values of M.

The mean value of $\left(M + \frac{m}{3}\right)/T^2$ is found out. Acceleration due to gravity is found our using equation (1)

Result :

a) Acceleration due to gravity =

b) Mass of the unknown load =

c) Justification of verification of Hooke's law.

Load - elevation graph is straight line. It justifies Hooke's law.

Observations

Diagrams :

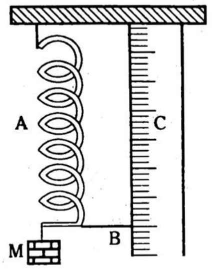


Fig. (a)

M - Load
A - Spiral spring
B - Pointer
C - Scale

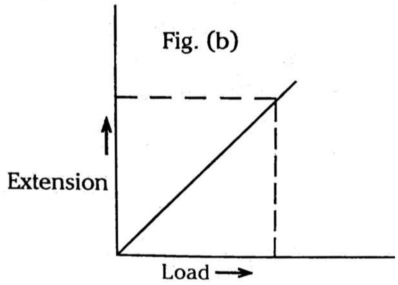


Fig. (b)

Tabulation :

a) To determine the mass per unit

externsion Mass of spring m =

Load (kg)	Pointer reading (cm)		Extension for 0.1 kg in (cm)	Extension produced for different load (cm)
	Load increasing	Load decreasing		

Mean extension for 0.1 kg =

Mass required for produce unit extension

$$W = \frac{\text{mass}}{\text{mean extension}} =$$

$= \qquad\qquad kgm^{-1}$

b) To determine period of oscillation:

Trial No.	Load attached (kg) M	Time for 20 oscillation (s)			Period T (s)	$\frac{M + m/3}{T^2}$
		1	2	Mean		
1.						
2.						
3.						
4.						
5.						

Mean value of $\frac{M + M/3}{T^2}$ =

$$g = \frac{4\pi^2}{w}\left(\frac{M + M/3}{T^2}\right) = \qquad \text{ms}^{-2}$$

Determination of unknown mass :

Reading corresponding to the dead load =

Reading corresponding to lead load with unknown load =

Extension for unknown mass =

Unknown mass (from graph) =

Experiment Number :   Date :

Verification of the theorem of M. I. - Part A

Aim : To Verify the theorems of perpendicular axes for moment of Inertia

Apparatus : Rectongular lamina, stop clock, etc.

Discription : The M. I. table is uniform rectangular wooden or melalic plate which can be suspended by a wire passing through its centre and perpendicular to its phone. The arrangement constitutes a torsion pendulum.

Principle : The theorem of perpendicular axis states that the sum of the M. I. of a rigid body about two a mutually perpendicular axis is equal to M. I of its body about an axis which is perpendicular to the two axes and passes through their point of intersection. If I_x and I_y are the M. I. of a rectangular lamina about the two axes passing through the centre and parallel to its length and breadth $I_z = I_x + I_y$, where I_x is the M.
I. about an axis passing through the centre and perpendicular to its plane. If T_x, T_y, T_z are the corresponding periods $T_x^2 = T_y^2 + T_z^2$. this can be experimentally tesified.

Procedure : A rectangular plate is suspended from a wire about an axis passing through its centre and parallel to its length. The period of oscrllations (T_x) is the determined by the method of differences Similarly the period T_y about an axis passing through the centre and parallel to the breadth and the period T_z about an axis passing through the centre and perpendicular to the plane of the lamina are determined. The expression $T_x^2 + T_y^2 = T_z^2$ is verified using these data.

Result :

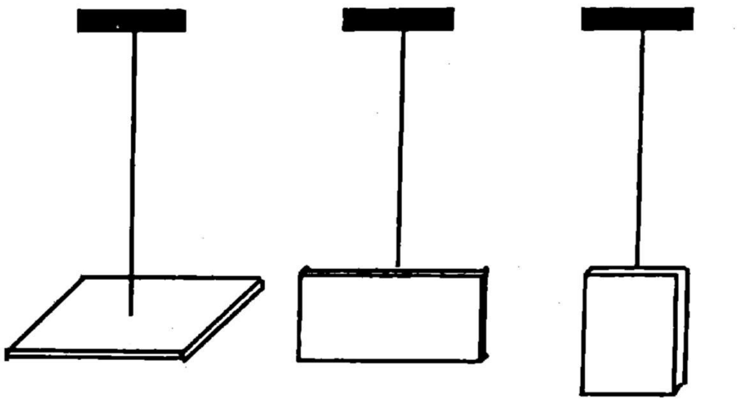
For perpendicular axes theorem :

a) Justification of the theorem $T_z^2 = T_x^2 + T_y^2$, verifies the theorem

b) Rigidily modulus n of the material of the suspension wire is = Nm^{-2}

Observation :

Diagrams :



Axis ⊥ to plane | Parallel to breadth | Parallel to length

Theorem of perpendicular axis :

To find T_x :

Rectangular lamina - Axis II' to length

Trial No.	Time for 10 oscillations	Mean time t_x (s)
1. 2. 3.		

Period $T_x \ \frac{t_x}{10}$ s =

To find T_y :

Rectangular lamina - Axis II' to breadth:

Trial No.	Time for 10 oscillations	Mean time t_y (s)
1. 2. 3.		

Period $T_y \ \frac{t_y}{10}$ s =

To find T_x :

Rectangular lamina - Axis $\perp_r$ to plane :

Trial No.	Time for 10 oscillations	Mean time t_y (s)
1. 2. 3.		

Period $T_z = \frac{t_x}{10} =$

=

$T_z^2 =$

Direct calculation of the rigidity modulus (n) of the suspension wire

Mass of rectangular lamina, M =

Length, L =

its Breadth, B =

M. I. of the lamina, $I_z = M \frac{L^2 + B^2}{12}$

length of the suspension wire = l =

To determine radius of suspension wire using screw gauge

Pitch of the screw guage = $\frac{\text{Distance uncovered}}{\text{Number of rotations given}}$ =

Least count = $\frac{\text{Pitch}}{\text{Number of head Scale divisions}}$ = mm

Zero correction =

Trial No.	PSR (mm)	HSR	CHSR	Diameter (mm)
1. 2. 3.				

Mean d = mm

radius of the wire, r = m

Rigidily modulus, $n = \frac{8\pi l}{r^4} \text{ x } \frac{I_z}{T_z^2}$

Experiment Number : Date :

Verification of the theorem of M. I. - Part B

Aim : To verify the theorem of parallel axis for moment of Inertia

Apparatus : M. I. table, two identical objects, rectangular lamina stop clock, etc.

Description: The M. I. table is a uniform rectangular wooden or metalic plate which can be suspended by a wire passing through its centre and perpendicular to its plane. The arrangement constitutes a torsion pendulum.

Principle: The theorem of parallel axis states that the M. I of a body about any axis is equal to the sum of the M. I. about a parallel axis passing through C. G of the body and the product of the mass of the body and the square of the distance between two axes. The square of the period of a torsion pendulum is directly proportional to the M. I. of the suspended body. If I_0 is the M. I. of the table and T_0 is the period T_0^2 x I_0

Let two identical bodies of mass M be placed on the table symmetrically with respect to the centre. According to the theorem, M. I. of one body about the axis of suspension - $i_0 + Mr_2$ where i_0 is the M. I. of the object about a vertical axis through its C. G and x is the distance between the centres of the table and the object. Hence M. I. of the suspended system is $I = I_0 + 2i_0 + 2Mx_2$ If T is the period of oscillation for the system $T_2 \alpha I$

$$\therefore \frac{T^2}{T_0^2} = \frac{I_0 + 2i_0 + 2Mx^2}{I_0}$$

$$\therefore T^2 = \frac{2I_0 + i_0}{I_0} T_0^2 + \frac{2MT_0^2}{I_0} x^2$$

A graph connecting T_2 and x_2 will be a straigh line with a slope $s = \frac{2MT_0^2}{I_0}$ and intercept $\frac{2I_0 + i_0}{I_0} T_0^2$

Procedure : The M. I. table is suspended from a rigid support using a long, thin wire. This is set into torsional oscillations and the time for 10 oscillations is determined. Hence the period T_0 is calculated. Two identical object of mass M each are placed on the table symmetrically with respect to the centre of the table. The distance or between the centres of the two objects is measured. The period of oscillation T is determined by measuring the time for 10 oscillations. The experiment is repeated for different values of x. A graph is plotted with T_2 along y axis and x_2 along X axis. A straight line is obtained. It s is the slope of the line. M. I. of the table $I_0 = \frac{2MT_0^2}{s}$ The M I. of the table by direct calculation is given by $I_0 = M_0 \frac{L_0^2 + B_0^2}{12}$ Where M_0 is the mass, L_0 is the length B_0 is the breadth of the table. From the intercept on the y axis, the M. I. of the object i_0 can also be determined.

Result : For parallel axis theorem

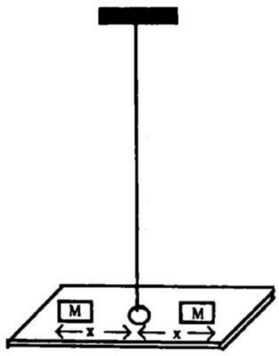
a) Justification of the theorem : The graph of T_2 verses x_2 is a straight line which verifies the theorem

b) M. I. of the table by experiment is kgm2

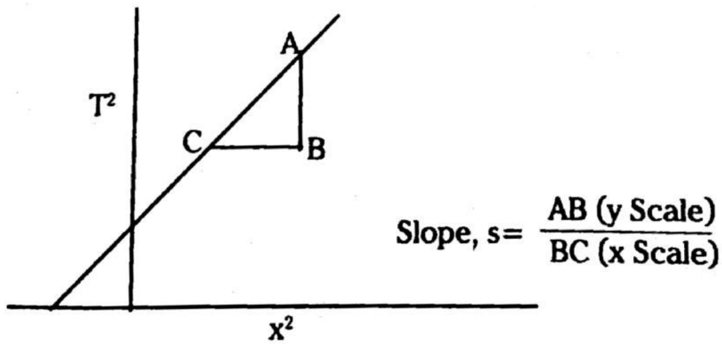
c) M. I. of the table by direct claculation is kg m2

Observation :

Diagram :



M. I. Table



Tabulation : Theorem of parallel axis

To find To

Trial No.	Time for 10 oscillation (s)	Mean time (s)
1. 2. 3. 4.		

Mean $T_0 = \frac{t_0}{10}\ (s) =$

To find T

Trial No.	Distance of mass x (m)	Time for Oscillation			Period T (s)	T^2	X^2
		1	2	Mean			
1.							
2.							
3.							
4.							
5.							

M. I. of table (I_0) :

Total mass of two objects placed on M. I. table = kg

∴ Average mass of object = M = kg

From the graph, slope = S =

M. I. table $I_0 = \frac{2MT_0^2}{S} =$

= kgm2

Direct calculation of I_0

Mass of M. I. table, M_0 = kg

Lengths of M.I. table, L_0 = m

Radius of M. I. table, B_0 = m

$$I_0 = M_0 \frac{L_0^2 + B_0^2}{12} =$$

= kgm2

SDM COLLEGE (AUTONOMOUS), UJIRE Department of Physics I

SEM BSc: Practical Questions

1. Determine the Moment of inertia of the given irregular body by using it as torsion pendulum (use two regular bodies for comparison). ertia.Also determine the rigidity modulus of the wire.

2. Verify parallel axes theorem of M.I. using M. I. table and two equal masses, by graphical method

3. Determine the frequency of AC by using sonometre . Compare the linear density of the material of the wire by direct calculation and assuming the frequency to be 50Hz.

4. Determine the M.I. of the given fly-wheel and hence estimate its mass (4 trials). perform the experiment by simulation method and find the mass of the fly wheel for another environmental condition.

5. Determine the specific heat of the given liquid by the method of cooling.

6. Find the frequency of the given tuning fork using a Helmholtz Resonator and four tuning forks of known frequency and by drawing the necessary graph. Verify it by direct calculation.

7. Determine the value of 'g' using spiral spring. (Period of oscillation of the spring is to be found for a minimum of 4 loads). Verify Hooke's law and determine the unknown mass of the given load.

8. Draw speaker and microphone characteristics using given apparatus.

9. Measure the thermo EMF developed using the given thermo couple set up

10. Verify perpendicular axis throrem of moment of inertia

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (Autonomous), UJIRE-574240

DEPARTMENT OF PHYSICS

CERTIFICATE

This is to certify that ....with Roll Number...................has satisfactorily completed the course of Experiments in Practical Physics prescribed by the College for BSc IInd Semester during the year 20…...-- 20…….

Lecturer in charge of the Batch

Submitted on.....

CONTENTS

Signature and Name of the student

Experiment Number : Date:

1. C-R CIRCUIT – CHARGING AND DISCHARGING

Aim: To study the charging and discharging of a capacitor in an RC circuit

Apparatus: Capacitor 1000 µF., resistor 100KΩ, voltmeter etc

Theory: When a resistor and a capacitor are connected in series to a source of voltage V_o as shown in fig (a). We have

$$V_c + V_R = V_o$$

V_c and V_R are the P.D. across C and R

$$\text{Now } V_c = q/C \;\&\; V_R = RI = R\frac{dq}{dt}$$

$$\frac{dt}{RC} = -\frac{dq}{V_oC - q}$$

$$\text{Integrating, } \ln(V_oC - q) + A = -t/RC$$

$$\text{When } t = 0,\ q = 0$$

$$+\ln V_oC + A = 0 \;\Rightarrow\; A = -\ln V_oC$$

On substitution and simplification $\ln\left(\frac{V_oC - q}{V_oC}\right) = \frac{-t}{RC} \;\Rightarrow\; q = -V_oC\ e^{-t/RC} + V_oC$

$$\Rightarrow q = V_oC\ (1 - e^{-t/RC})$$

$$\text{But } V_oC = q_o \quad \therefore\ q = q_o(1 - e^{-t/RC})$$

$$\text{P.D across capacitor } q/C = (q_o/C)(1 - e^{-t/RC})$$

$$\text{Or } V = V_o(1 - e^{-t/RC}) \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Thus the P.D. across the capacitor rises exponentially as in diagram (b)

$$\therefore \text{ Again from eqn (1) we have } V_o - V = V_o\, e^{-t/RC}$$

i.e., $V_o - V$ falls exponentially. i.e., in equal times $(V_o - V)$ falls by equal factors.

Considering the factor as 1/2 . Let,$(V_o - V) = ½ V_o$ when $t = T_{1/2}$

$$\text{Then, } e^{\frac{T_{1/2}}{RC}} = 2 \;\Rightarrow\; T_{1/2} = RC \log_e 2 \;= 0.69\ RC$$

Thus marking points on the P.D. axis corresponding to

$$(V_o - V) = ½ V_o\,,\quad ¼ V_o\,,\quad (1/8)V_o\,,\ \text{etc}$$

The corresponding times $T_{1/2}$ can be determined. The value can be verified by using the relation $T_{1/2} = 0.69$ RC.

The time constant of the circuit is given by $t = RC = \frac{T_{1/2}}{0.69}$.

Similarly it can be shown that the PD. across the capacitor during discharge is given by $V = V_o\, e^{-t/RC}$. The voltage 'V' versus time 't' graph will be as shown in diagram (c) which can be analysed as in the previous case.

Procedure : (A) Study of charging process:

The connections are done as shown in diagram (a) (with C = 100 µF & R = 1000 KΩ or C=1000 µF & R = 100 KΩ). The circuit is closed plugging gap G_1, starting a stop watch simultaneously. The voltmeter reading (V) are recorded every 30 seconds until a maximum value V_o is reached.

A graph is plotted connecting V and time. On the Y axis, points are marked corresponding to $V = (V_o - ½ V_o)$, $V = (V_o - ¼ V_o)$, $V = [V_o - (1/8)V_o]$ etc.

The corresponding times and interval $T_{1/2}$ is estimated. Then time constant is calculated. This is compared with the theoretical values.

(B) Study of discharging process

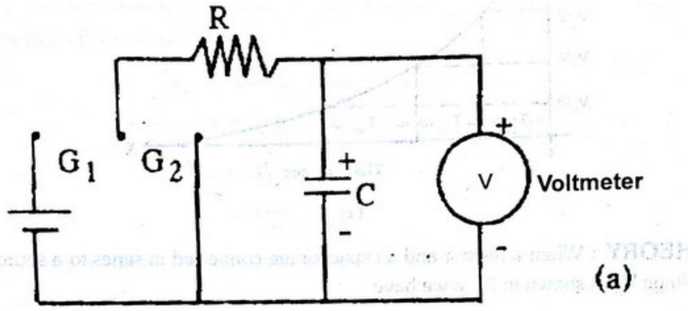
Gap G_1 is opened and G_2 is closed, after charging the capacitor to the peak value Vo. The capacitor discharges through R. The p.d. across the capacitor (V) is noted at intervals of 30 seconds. A graph is plotted with V vs time. In the V axis markings are made corresponding to $\frac{V_o}{2}, \frac{V_o}{4}, \frac{V_o}{8}$ etc. The corresponding values of time and hence the interval $T_{1/2}$ is found out. Then time constant is calculated. This is compared with the theoretical value.

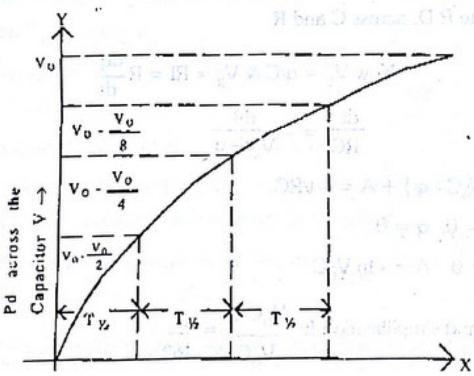
Result: The time constant of the CR circuit is found to be

1) t = ……… s from charging curve
2) t = ……… s from discharging curve
3) t = ………. s by direct calculation.

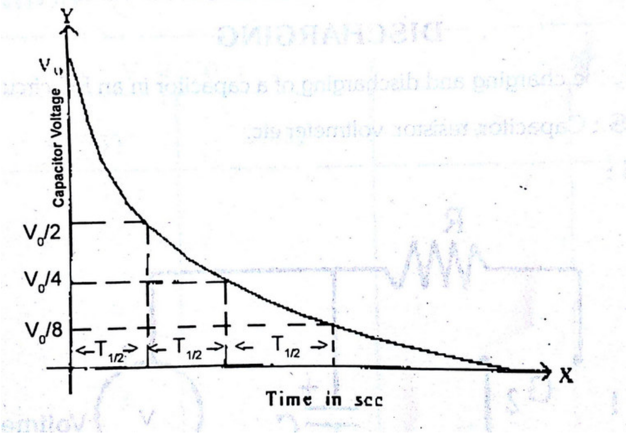
Observations

Circuit diagram





Charging (b)



Discharging (c)

While charging

R = 100Kohm C = 1000 μF

Time (in S)	0	5	10	20	30	60	90	120	150	180
Voltmeter Reading (V)										
Time (in S)	210	240	270	300	330	360	390	420	450	480
Voltmeter Reading (V)										

While discharging

Time (in S)	0	5	10	20	30	60	90	120	150	180
Voltmeter Reading (V)										
Time (in S)	210	240	270	300	330	360	390	420	450	480
Voltmeter Reading (V)										

Calculations:

From the charging curve, 1) $T_{1/2}$ = …………... s

2) $T_{1/2}$ = …………......s

3) $T_{1/2}$ = ……………..s

∴ Mean $T_{1/2}$ = …………….s

∴ Time constant of the circuit, $t = \frac{T_{1/2}}{0.69} =$ ……... s

From the discharging curve, 1) $T_{1/2}$ = ……….. s

2) $T_{1/2}$ = ……….. s

3) $T_{1/2}$ = ………… s

$\therefore$ Mean $T_{1/2}$ = ……….. s

$\therefore$ Time constant of the circuit, $t = \frac{T_{1/2}}{0.69} =$ ……… s

Direct calculation of time constant:

$R = 100\ K\Omega$, $C = 1000\ \mu F$

$\therefore$ Time constant, by direct calculation $t = RC = 100X1000X1000X10^{-6}$ s

=

Experiment Number : Date:

2. NETWORK THEOREMS

Aim: To verify Thevenin's and Norton's theorems for DC Circuits

Apparatus : Variable DC. Power supply, DC milliammeters and voltmeter.

Components: Resistors 100 ohm-2 numbers,150 ohms and resistance box.

Theory

Thevenin's theorem states that an electrical network consisting of energy sources and resistors can be replaced by a voltage source V_{Th} in series with a resistance R_{Th} where V_{Th} is the open circuit voltage measured between the output terminals of the network and R_{Th} is the resistance as seen between these terminals when all the energy sources within the network are replaced by their respective internal resistances.

For the circuit shown in fig (a) V_{Th} is the open circuit voltage between the terminals a and b. Using the voltage division rule we get,

$$V_{Th} = \frac{VR_3}{R_1+R_3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

The resistance R_{Th} as seen between the terminals a and b is

$$R_{Th} = R_2 + R_1 \parallel R_3 = R_2+\frac{R_1R_3}{R_1+R_3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\text{(2)}$$

(The source is assumed to have negligible internal resistance)

The circuit in fig (a) can be replaced by its Thevenin equivalent circuit shown in fig (b)

Norton's theorem states that an electrical network containing energy sources and resistors can be replaced by a single current source I_{sc} in parallel with a resistance R_N, where I_{sc} is the short circuit current that flows through the output terminals and R_N is the resistance as seen between these terminals when, all the energy sources are replaced by their internal resistances.

For the circuit in fig (a), the total current drawn by the source when the output terminals a and b are shorted is

$$I_T = \frac{V}{R_1+R_2||R_3} = \frac{V}{R_1+\frac{R_2R_3}{R_2+R_3}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\text{(3)}$$

The short circuit current through a and b is

$$I_{sc} = \frac{I_TR_3}{R_2+R_3} \quad \ldots\ldots\ldots\ldots\ldots\text{(4) (Using current division rule)}$$

Assuming that the source has negligible resistance, the resistance R_N as seen between the terminals a and b is given by the expression (2).

$$R_N = R_{Th} \text{ ………………..(5)}$$

The circuit in fig (c) is the Norton equivalent of the circuit in fig (a)

For the circuit shown in fig (d) V_{Th} and R_{Th} between the points a & b can be obtained by using source transformation technique twice and are given by

$$V_{Th} = \frac{V_1R_3}{R_1+R_3} - V_2 \text{ ………(6)}$$

$$R_{Th} = R_2 + \frac{R_1R_3}{R_1+R_3} \text{ …….(7)}$$

The Thevenin equivalent circuits as shown in fig (b). Its Norton equivalent shown in fig (c) can be obtained by source transformation.

$$I_{sc} = \frac{V_{Th}}{R_{Th}} \text{ …………… (8)}$$

$$R_N = R_{Th} \text{ …………… (9)}$$

Procedure:

A circuit is rigged up as in fig (a). The value of the resistance R_L is changed in suitable steps and the current in the circuit is noted in each case. Now V_{Th} and R_{Th} are calculated using equation (1) & (2). The network is now replaced by its Thevenin equivalent as in fig (b). Now R_L is changed in the same steps as before and the current in the circuit is noted in each case.

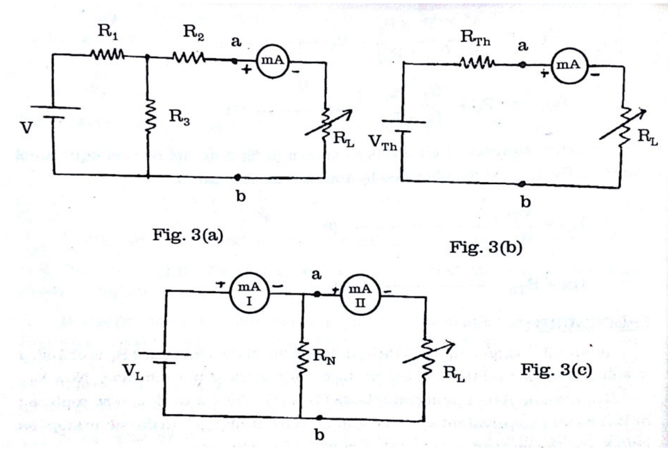
Now I_{sc} and R_N are calculated using equations (3), (4) & (5) and the network replaced by its Norton equivalent as in fig. The current for the same values of R_L are noted in milliammeter II, taking care to see that the milliammeter I always reads the short circuit current Isc (For this, voltage V_L is varied until milliammeter I reads I_{sc}).

Inference:

The current values for different load resistances are found to agree with each other for the original network and Thevenin & Norton equivalent circuits there by verifying Thevenin's and Norton's theorems.

Observations

Circuit diagram



Calculations

For the circuit in fig (a)

Supply voltage V = 10 volt

$R_1 =$ 100 ohm $R_2 =$ 150 ohm $R_3 =$ 100 ohm

$V_{Th} = \dfrac{VR_3}{R_1+R_3} =$ $R_{Th} = R_2+\dfrac{R_1R_3}{R_1+R_3} =$

$I_T = \dfrac{V}{R_1+\dfrac{R_2R_3}{R_2+R_3}} =$ $I_{sc} = \dfrac{I_TR_3}{R_2+R_3} = I_N =$

$R_N = R_{Th} =$

Tabulation

Load Resistance R_L (ohm)	Current in the circuit (mA)		
	For the original network	For the Thevenin equivalent	For the Norton equivalent
100			
200			
300			
400			
500			
600			

Experiment Number: Date:

3. RC LOW PASS AND HIGH PASS FILTERS

Aim: To construct RC low pass, high pass filters and to draw their frequency response curves.

Apparatus used: Oscillator, multimeter, Resistors 1K ohm,1.5Kohm.and Capacitors 0.1 μF .**Theory:**

The frequency sensitive circuit elements like capacitors and Inductors are used for filtering actions. The most common way of removing unwanted frequencies is by using simple RC filters. The filter circuits are grouped into four categories viz., (a) low pass filter (b) High pass filter (c) Band pass filter and (d) Band stop filter.

Low pass Filter

A low pass filter allows low frequencies and rejects high frequencies. A high pass filter allows high frequency components to pass through rejecting low frequency ones and a band pass filter is the one which allows a band of frequencies to pass through.

The rejected frequencies are those frequencies beyond the point at which the output signal is less than 70.7% of the input signal and this point is referred to as half power point. The frequency corresponding to this is called cut-off frequency or 3 dB frequency.

In the low pass filter shown in fig 1(a) the capacitor C_1 offers high resistance for low frequency signals. (the capacitive resistance $X_c \ \alpha \frac{1}{f}$). As a result, the output is high at low frequencies. When the input signal frequency increases the reactance of C_1 decreases causing the output to be increasingly attenuated.

High Pass Filter

In the high pass filter shown in fig 1 (b) the reactance Xc of the capacitor C is very high at low frequencies. So the output voltage will be very small. As the frequency increases Xc decreases and more voltage will be available at the output terminals.

Procedure: A low pass circuit is constructed as in fig 1 (a) with the designed values of R_1 and C_1. The input voltage is set to a suitable value (say 1 volt). The frequency is varied in suitable steps and the output voltage is noted using a AC Voltmeter. The observation is repeated for different frequencies. For all frequency settings, input voltage from the oscillator is maintained constant. A graph of output voltage Vs log f is plotted and the cutoff frequency is calculated from the graph. The designed and observed cut off frequencies are computed.

The above steps are repeated for the high pass filter.

Result

1. Low pass filter — a) Designed = ………………………….. Hz

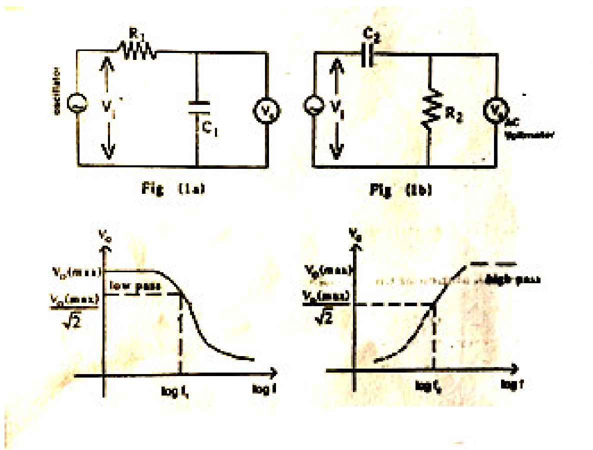
Cut off frequency f_1 — b) Observed = …………………………… Hz

2. High pass filter — a) Designed = …………………………… Hz

Cut off frequency f_2 — b) Observed = …………………………… Hz

Observations:

Circuit diagram



Design calculations:

I. To design a low pass filter value of R = 1.5 KΩ C = 0.1 μF

$\therefore$ Cut off frequency $f_1 = \dfrac{1}{2\pi R_1 C_1}$

$=$ Hz

II. To design a high pass filter R_2 = 1 KΩ C_2 = 0.1 μF

$\therefore$ Cut off frequency $f_2 = \dfrac{1}{2\pi R_2 C_2} =$

$=$ Hz

Input Voltage V_i = 1 Volt

Low pass filter			High pass filter		
Frequency Hz	log f	Output Voltage V_0 (volts)	Frequency (Hz)	log f	Output Voltage V_o (volts
100			100		
200			200		
300			300		
400			400		
500			500		
600			600		
700			700		
800			800		
1K			1K		
1.5K			1.5K		
2K			2K		
2.5K			2.5K		
3K			3K		
3.5K			3.5K		
4K			4K		
5K			5K		
			6K		
			7K		
			8K		
			9K		
			10K		

From the graphs, log f_1 = $\therefore$ f1 = ……………………….Hz

Log f_2 = $\therefore$ f_2 = ……………………….Hz

Experiment Number: Date:

4. SEARLE'S DOUBLE BAR

Aim: To determine the Young's modulus (q), Rigidity modulus (n) and Poisson's ratio (σ) of material of a wire by Searle's double bar method.

Apparatus: Searle's double bar, stop watch, screw gauge, etc.

Description:

The apparatus consists of a pair of identical uniform heavy bars (of circular or rectangular cross section) A and B. Each of the bars has chuck screw at its centre. The ends of the experimental wire are introduced into these chucks and tightly gripped.

Principle

The set up is as shown in fig(b). If the ends of the bars are brought close together and released, the experimental wire bends and unbends. The bars are set into oscillations about the suspension threads as axes.

The motion of each bar is simple harmonic and its period,

$T_1 = 2\pi\sqrt{\frac{2I\ell}{q\pi r^4}}$ where ℓ is the length r is the radius of the wire and I is the MI of the bar.

$I = W\left[\frac{L^2}{12}\right]$ where W & L represent the mass, and length of the bar.

$$\text{Hence } T_1^2 = \frac{8\pi I\ell}{qr^4} \quad \text{or } q = \frac{8\pi I\ell}{r^4 T_1^2} \quad \ldots\ldots\ldots\ldots (1)$$

In the second part of the experiment, (fig b) the wire is subjected to torsional oscillations by giving a small rotation to the bar about the wire as axis and releasing it.

The motion of the bar is simple harmonic and the period is

$$T_2 = 2\pi\sqrt{\frac{2I\ell}{n\pi r^4}}$$

$$\text{i.e., } T_2^2 = \frac{8\pi I\ell}{nr^4}$$

$$n = \frac{8\pi I\ell}{r^4 T_1^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Poison's ratio:

$$\frac{\text{Eqn}(1)}{\text{Eqn}(2)} \qquad \frac{q}{n} = \frac{T_2^2}{T_1^2}$$

$$\text{And} \qquad \sigma = \frac{q}{2n} - 1 = \frac{T_2^2}{2T_1^2} - 1 \text{ ………. (3)}$$

Procedure

In the first part of the experiment (flexural oscillations) both the bars are suspended from a rigid support by means of two strong threads of equal length. The strings are adjusted so that they are parallel and the bars lie in the same horizontal plane. The two ends of the bars are brought together so as to bend the wire in a circular arc and let go. They start vibrating in a horizontal plane about their centers. Using a stop watch the time for 10 oscillations is noted. This is repeated a number of times and the mean period T_1 is calculated.

For the second part of the experiment, (Torsional oscillations)one of the bars (say A) is clamped horizontally so that the other bar hangs freely from the suspension wire. The bar is set into torsional oscillations about its centre and the mean period T_2 is determined as before. The length 'ℓ' of the wire between the nuts is measured. Its radius r is determined using a screw gauge.

Both the bars are weighed together and the mean value of their mass W is determined. The mean length 'L' is determined. The values of q, n & σ are calculated using eqns. (1),(2) & (3) respectively.

Note

If the bars are of rectangular cross section with breadth B and length L, the moment of inertia of each bar about an axis passing through its C.G and parallel to its thickness is

$$I = W\left[\frac{L^2 + B^2}{12}\right] \quad \text{If } L >> B, \; I = \frac{WL^2}{12}$$

RESULT

1. Young's modulus (q) = … Nm^2
2. Rigidity modulus (n) = Nm^2
3. Poisson's ratio (σ) = ……………………………………

OBSERVATIONS :

DIAGRAMS :

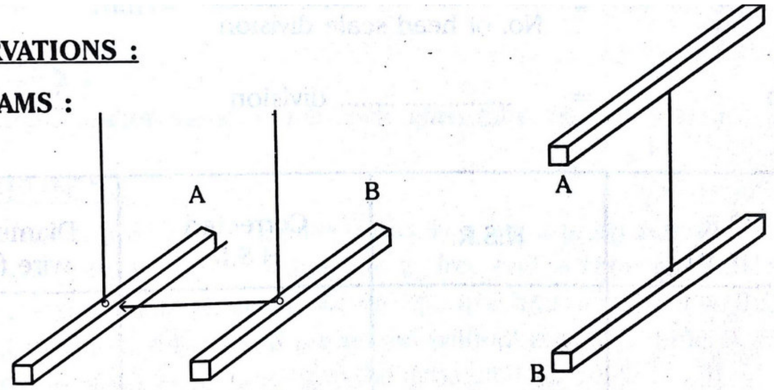


Fig. (a) Flexural oscillation Fig. (b) Torsional osillations

TABULATIONS

Part 1: **Flexural oscillations**

Tr.No.	Time for 10 oscillations t_1 (s)	Mean t_1 (s)	Period $T_1 = \frac{t_1}{10}$ (s)
1			
2			
3			
4			
5			
6			

Part 2: **Torsional oscillations**

Tr.No.	Time for 10 oscillations t_2 (s)	Mean t_2 (s)	Period $T_2 = \frac{t_2}{10}$ (s)
1			
2			
3			
4			
5			
6			

To determine radius of wire: using screw gauge.

Pitch of the screw gauge = $\dfrac{\text{Distance uncovered}}{\text{No. of rotation given}}$ =

Least count = $\dfrac{\text{Pitch}}{\text{No. of head scale division}}$ = mm

Zero error = HSD Zero correction = . HSD

Trial No.	P.S.R (mm)	H.S.R.	Corrected H.S.R.	Diameter of wire (mm)
1				
2				
3				

Mean diameter = ………………….mm

$\therefore$ Radius r = …………………. mm

Total mass of two bars W_1 = kg

Mean mass of one bar W = $\dfrac{W_1}{2}$ = kg

Mean length of one bar L = m

Moment of inertia of bar I = $\dfrac{WL^2}{12}$ kg m^2 = kg.m^2

Length of the wire, ℓ = ……………………… m

Young's modulus $q = \frac{8\pi I\ell}{r^4 T_1^2}$ Nm^{-2},

Rigidity Modulus $n = \frac{8\pi I\ell}{r^4 T_2^2}$ Nm^{-2},

Poisson's Ratio, $\sigma = \frac{T_2^2}{2T_1^2} - 1$

Experiment Number: Date:

5. STATIC TORSION

Aim: To determine the rigidity modulus (η) of the material of the given rod using static torsion apparatus.

Apparatus: Static torsion apparatus, weight hangers, Screw gauge etc

Description

In the static torsion apparatus, one end of the experimental rod is fixed firmly at A. The other end B of the rod is fixed firmly to a circular pulley. A cord is passed over the rim of the pulley. The free end of the cord is attached to a weight hanger. The twist at any point of the rod is noted by a pointer fixed to the rod. The pointer moves over a circular scale marked in degrees.

Principle: If a load M is suspended from the pulley and R is the radius of the pulley, moment of applied couple = M g R ………… (1)

If C is the couple per unit twist of the rod, the restoring couple developed for twist θ is $C\theta$

$$= \frac{\pi\eta r^4\theta}{2L} \quad \text{..............................} \; (2)$$

where r is the radius of the rod, L is distance of the pointer from the fixed end of the rod.

Equating equations (1) & (2)

$$\frac{\pi n r^4\theta}{2L} = MgR \quad \text{or} \quad n = \frac{2MgRL}{r^4\theta\pi} \quad \text{..........}(3)$$

If the twist is ϕ degrees, $\theta = \dfrac{\pi\phi}{180}$ radians

$$\eta = \frac{360\ MgRL}{\pi^2 r^4 \phi} \quad \text{......................................} \; (4)$$

Procedure: The rod is brought into cyclic state. For this, the cord is wound over the pulley in clockwise direction. The weights are added to the hanger in steps (say of 0.2 kg. or 0.5 kg.) till the maximum load is reached. The load is then decreased in similar steps. The cord is now wound in anticlockwise direction and the above procedure is repeated. The application of alternate clockwise and anticlockwise couples is repeated 4 times.

The position of the pointer is adjusted to keep L at a convenient value. The cord is wound over the pulley in the clockwise direction. With a dead load w in the weight hanger, the reading of the pointer is adjusted to zero. The load is increased in equal steps of 0.2 kg or 0.5 kg. and in each case the pointer reading is noted. After reaching the maximum load, it is decreased in similar steps and pointer readings are noted for each load.

The cord is now wound over the pulley in the anticlockwise direction. The initial reading of the pointer is set to zero. The readings of the pointer (for increase and decrease of load in equal steps) are noted. The radius of the rod is found out using a screw gauge. The radius of the pulley is calculated by measuring its circumference. The rigidity modulus of the material of the rod is determined using eqn. (4).

Result: Rigidity modulus of the material of the rod n =

Observations:

Diagram :

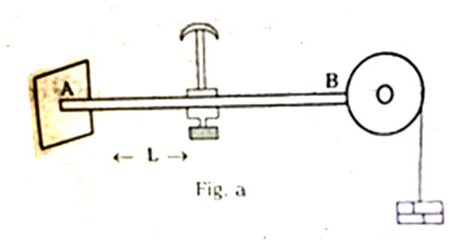


Fig. a

Tabulation:

Trail 1: Distance between the fixed end and the pointer, L_1 = ………… m

Load (kg)	Pointer reading in degrees				Mean pointer reading	Twist due to M= (1.5Kg) ϕ_1
	Clock wise couple		Anticlockwise couple			
	Load Increasing	Load decreasing	Load Increasing	Load decreasing		
W+0						
W+0.5						
W+1						
W+1.5						
W+2						
W+2.5						
W+3						

Mean ϕ_1 = …………………

$\frac{L_1 M}{\phi_1}$ = …………………………

Trail 2: Distance between the fixed end and the pointer, L_2 = …………………m

Load (kg)	Pointer reading in degrees				Mean pointer reading	Twist due to M =(1.5Kg) ϕ_2
	Clock wise couple		Anticlockwise couple			
	Load Increasing	Load decreasing	Load Increasing	Load decreasing		
W+0						
W+0.5						
W+1						
W+1.5						
W+2						
W+2.5						
W+3						

Mean ϕ_2 = …………………

$\frac{L_2 M}{\phi_2}$ = …………………………

To determine the radius of cross section of rod: using screw guage

Pitch = $\frac{\text{Distance uncovered}}{\text{Rotations given}}$ = = mm, Least count = $\frac{\text{Pitch}}{\text{No. of HSD}}$ = mm

Zero error = HSD Zero correction = HSD

Trial No.	Pitch scale reading (mm)	H.S.R.	Corrected H.S.R.	Diameter d (mm)
1				
2				
3				

Mean diameter = ………………… mm=……………..m

∴ Radius of the rod r = ………………… m

Circumference of the pulley = ……………….. m

Radius of the pulley R = $\dfrac{\text{Circumference}}{2\pi}$ =.......................m

Mean $\dfrac{LM}{\phi}$ = $\dfrac{1}{2}\left[\dfrac{L_1M}{\phi_2}+\dfrac{L_2M}{\phi_2}\right]$ =

Rigidity modulus η = $\dfrac{360\ gRL}{\pi^2 r^4}\left(\dfrac{LM}{\phi}\right)$ =...............................Nm^{-2}

Experiment Number: Date

6. CANTILEVER BENDING

Aim: To determine the Young's modulus 'q' of the material of a cantilever by measuring the depression of its loaded end.

Apparatus: Uniform bar, G clamp, weight hanger, travelling microscope, screw gauge, vernier calipers etc.

Principle: A thin uniform bar clamped horizontally at one end and loaded at the other end ,forms a cantilever. In the case of a light cantilever, the depression y of the loaded end for a weight W (= Mg) is

$$y = \frac{WL^3}{3qAK^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Ak^2 is the geometric moment of inertia of the bar. In the case of a bar of rectangular cross section,

$$Ak^2 = \frac{bt^3}{12}$$

where b is the breadth and t is the thickness of the bar.

$$\therefore\ y = \frac{4MgL^3}{qbt^3} \quad \text{Or} \quad q = \frac{4MgL^3}{bt^3y} \quad \ldots\ldots\ldots\ldots (2)$$

If a graph is plotted with depression against the load a straight line through the origin is obtained. The slope of the line

Is s = y/M from which 'q' can be obtained.

$$\text{Young's modulus } q = \frac{4gL^3M}{bt^3s} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Procedure

The given bar AB is fixed rigidly at one end using a G clamp so that it is perfectly horizontal. (The beam should project about 40 cm beyond the stand). A weight hanger is hung from the free end at the point B. At the same point, a pin is fixed (fig a). The load in the hanger is increased in equal steps until a maximum is reached. The load is now decreased in the same steps.

Field Code Changed

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A travelling microscope is focused horizontally on the pin until a clear image of its tip is seen in the field of view. The microscope is raised or lowered until the tip of the pin coincides with the intersection of the cross wires. The reading on the vertical scale is noted. The load in the hanger is increased in equal steps until a maximum is reached. For each load, the microscope reading is taken. The load is then decreased in the same steps till the dead load is reached (each time taking the readings). Employing the method of differences the mean depression y of the pin tip for M is determined. The length L of the cantilever i.e., the distance of B from the fixed end, is measured.

The breadth (b) and the thickness (t) of the cantilever are accurately measured using a vernier calipers and screw gauge respectively. The Young's modulus is calculated using   eqn. (2).

A graph is plotted with depression against the load (fig b). The slope of the straight line is calculated. The Young's modulus is estimated using the eqn. (3).

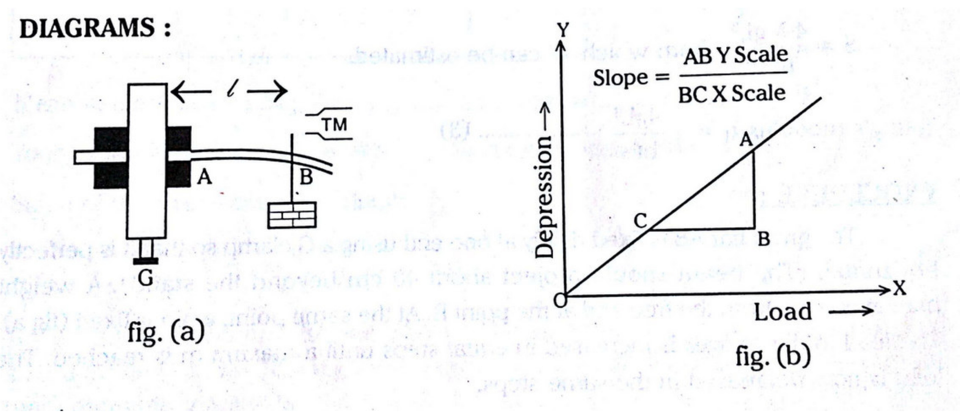
Result:

Young's modulus of the material of the bar

(a) By experiment (direct calculation) = ………………………… Nm^2

(b) By the graphical method =   ………………………………….Nm^2.

Observations:



Tabulation:

Length of the cantilever L = m

Least count of the travelling microscope = $\dfrac{1MSD}{\text{No.of vernier scale divisions}}$ = cm

Load (kg)	T.M readings (cm)			Depression for M=(0.15 kg) y (cm)	Depression for different loads (cm)
	Load increasing	Load decreasing	Mean		
W+0					
W+0.05					
W+0.1					
W+0.15					
W+0.2					
W+0.25					
W+0.3					

Mean y = cm = m

To determine thickness t : Using screw gauge

Pitch of the screw = $\dfrac{\text{Distance uncovered}}{\text{Rotations given}}$

Least count = $\dfrac{\text{Pitch}}{\text{No. of head scale divisions}}$ = mm

Zero correction =

Trial No	Pitch Scale reading (mm)	H.S.R	Corrected H.S..R	Total reading t (mm)
1				
2				
3				

Mean Thickness=t= mm

To determine breadth b: Using Vernier calipers

Least count of vernier = $\frac{1\text{MSD}}{\text{No.of H.S.D}}$ = ………………… cm

Trial No	M.S.R (cm)	CVSR	Total reading (cm) b
1			
2			
3			

Mean b = cm = m

Young's Modulus by direct calculation, $q = \frac{4MgL^3}{bt^3y}$ = ... Nm^{-2}

=

Young's Modulus by graphical method

Slope =

$$q = \frac{4gL^3}{bt^3}\left(\frac{1}{\text{slope}}\right) = \qquad Nm^{-2}$$

=

Experiment Number: Date

7. INTERFACIAL TENSION

AIM :

To determine the interfacial tension between water and kerosene by drop- weight method.

APPARATUS :

Funnel, beaker, pinch cock, physical balance, screw gauge etc.

PRINCIPLE :

The drops of a denser liquid of density d_1, are formed and detached inside another liquid of density d_2. ($d_2 < d_1$). The forces acting on a drop thus formed are,

1. Weight of the liquid drop, mg acting vertically downwards.
2. Up thrust = weight of the displaced liquid = $mg \frac{d_2}{d_1}$
3. Upward force due to surface tension=$2\pi r T$ where r is the outer radius of the tube and T is the interfacial tension between the liquids.
4. Downward force due to excess pressure inside the drop $= \pi r^2 T/r = \pi r T$.

For equilibrium. $mg + \pi rT = 2\pi rT + mg\left(\frac{d_2}{d_1}\right)$ or $\pi rT = \left(1 - \frac{d_2}{d_1}\right) mg$

Rayleigh gave an emperical relation for better results in which π is replaced by 3.8

$$\therefore T = \frac{mg}{3.8r}\left[1 - \frac{d_2}{d_1}\right] \quad \text{......................... (2)}$$

PROCEDURE :

Water (denser liquid, of density d_1) is made to flow in the form of drops at the end of the glass tube at a rate of 10 to 12 drops per minute. A clean dry beaker is filled with a sufficient quantity of kerosene (density d_2) and weighed. The beaker is placed below the tube such that the tube dips inside kerosene (fig a). Ten drops of water are now collected. The beaker is removed and weighed. The experiment is repeated by collecting 10 more drops of water in the same beaker. The external radius r of the glass tube is measured using a screw gauge.

Now average mass of one drop of water 'm' is determined.

To determine d_2/d_1

A clean dry beaker is weighed. Mass m_2 of 50 cc of kerosene oil is determined. Beaker is cleaned and mass m_1 of 50 cc of water is determined. Ratio of densities d2/d1 is found out using the formula

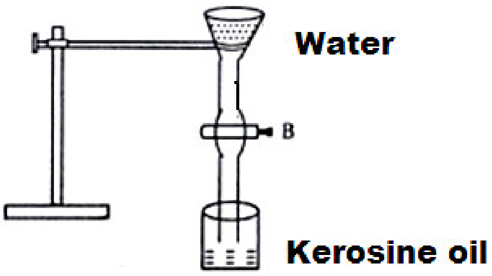
$$d_2/d_1 = m_2/m_1$$

Finally interfacial tension of water wrto kerosene oil is found out using eq no (2)

Result: Interfacial tension of water is= N/m

OBSERVATIONS :

DIAGRAM



Determination of mass of one drop of water

Object	Mass (grams)	Mass of 10 drops (grams)
Beaker +liquid		
Beaker +liquid+ 10 drops of water		
Beaker +liquid+ 20 drops of water		
Beaker +liquid+ 30 drops of water		
Beaker +liquid+ 40 drops of water		

Average mass of 10 drops of water = grams

Hence mass of 1 drop of water=m= grams= 10^{-3}Kg

To determine d_2/d_1

Object	Mass (grams)	Mass of 50 cc of Kerosine oil m_2 grams	Mass of 50 cc of water m_1 grams
Empty dry and clean beaker	M_1=		
Beaker +50 cc kerosene oil	M_2=	M_2-M_1=	M_3-M_1=
Beaker +50 cc of water	M_3=		

Hence ratio of densities $d_2/d_1 = m_2/m_1$

=

<u>To determine external radius of the tube</u>

$$\text{Pitch of the screw} = \frac{\text{Distance uncovered}}{\text{Rotations given}}$$

$$\text{Least count} = \frac{\text{Pitch}}{\text{No. of head scale divisions}} = \qquad \text{mm}$$

Zero error = Zero correction=

Trial No	Pitch Scale reading (mm)	H.S.R	Corrected H.S..R	diameter d (mm)
1				
2				
3				

Mean diameter d= mm mean Radius r= d/2= mm= $X10^{-3}$m

Interfacial Tension = T= mg[1-d2/d1]/3.8r

=

= N/m

Experiment Number: Date

8. OSTWALD'S VISCOMETER

AIM :

To compare the coefficients of viscosity of the given liquids using Ostwald's viscometer.

APPARATUS :

Ostwald's viscometer, given liquids, stop watch, Hare's apparatus etc.

DESCRIPTION :

Ostwald's viscometer consists of U shaped tube of unequal limbs with two bulbs A and B. The lower bulb has a funnel attached to it while the other ends with a capillary tube. The tube has a rubber tubings provided with a pinch cock (fig. a).

PRINCIPLE : If ρ_1 and ρ_2 are the densities of the liquids and h_1 and h_2 are the heights of the liquids in Hare's apparatus then $\left(\frac{\rho_1}{\rho_2}\right) = \left(\frac{h_2}{h_1}\right)$

Although the pressure head goes on changing continuously during the flow of the liquids, it is proportional to the density of the liquid at every part of the flow. If ρ_1 and ρ_2 are the densities, and P_1 and P_2 the average pressure heads we have from Poiseuille's relation.

$$Q_1 = \frac{\pi P_1 r^4}{8\eta_1 l} \text{ and } Q_2 = \frac{\pi P_2 r^4}{8\eta_2 l}$$

Where Q_1 and Q_2 are the rates of flow of the liquids. Since the volume of the liquids are the same the rate of flow is inversely proportional to the time for the flow and the pressure is proportional to the density of the liquid.

$$\text{Hence } Q_1/Q_2 = \frac{\rho_1}{\rho_2} \times \frac{\eta_2}{\eta_1} = \frac{t_2}{t_1} \text{ and } \frac{\eta_2}{\eta_1} = \frac{\rho_2 t_2}{\rho_1 t_1}$$

$$\frac{\eta_1}{\eta_2} = \left(\frac{\rho_1}{\rho_2}\right)\left(\frac{t_1}{t_2}\right) \text{or } \frac{\eta_1}{\eta_2} = \left(\frac{h_2}{h_1}\right)\left(\frac{t_1}{t_2}\right)$$

PROCEDURE :

The viscometer is first cleaned and dried. A fixed volume of the first liquid is introduced into the lower bulb (using a pipette). Air is sucked through the rubber tubing so that liquid rises to the mark M above B and the pinch cock is applied. The pinch cock is opened simultaneously starting stop clock. The time taken by the liquid in B to fall from mark M to the mark N below is found out. The liquid is once again drawn into B and the experiment is repeated four times. The liquid is poured out from the viscometer and it is then rinsed with the second liquid. The same volume of the second liquid is introduced into A. The experiment is done as before. The mean time taken by the liquids for falling through the same height is found out. The ratio of the densities of the liquids is found out using Hare's apparatus. If h_1 and h_2 are the heights of the liquid columns

$$\frac{\rho_1}{\rho_2} = \frac{h_2}{h_1}$$

The ratio of the coeffecients of viscosity

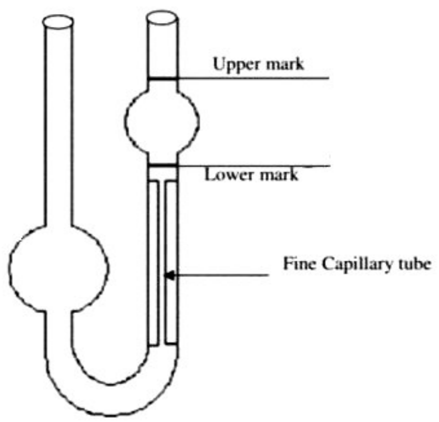
$$\frac{\eta_1}{\eta_2} = \frac{\rho_1 t_1}{\rho_2 t_2} = \left(\frac{h_2}{h_1}\right)\left(\frac{t_1}{t_2}\right)$$

RESULT :

The ratio of the coefficients of viscosity of the given liquids is =

OBSERVATIONS

OSTWLAD VISCOMETER



<u>Determination of Ratio of time of flow</u>

T.No	Time of Flow (s)		t_1/t_2
	Liquid 1 water t_1 (s)	Liquid 2 t_2 (s)	
1			
2			
3			
4			
5			

Mean t_1/t_2=

<u>Determination of h_2/h_1</u>

T.No	Liquid 1 water h_1	Liquid 2 h_2	h_2/h_1
1			
2			
3			

Mean h_2/h_1=

Coefficient of viscosities of the two liquids=

$$\frac{\eta_1}{\eta_2} = \left(\frac{h_2}{h_1}\right)\left(\frac{t_1}{t_2}\right)$$

$$=$$

SIMULATION EXPERIMENT

UNIFORM BENDING

Aim

To find Young's modulus of the given material bar by uniform bending using pin and microscope method by simulation method

Apparatus

Pin and Microscope arrangement, Scale ,Vernier calipers, Screw gauge, Weight hanger, Material bar or rod.

Theory

Young’s modulus is named after Thomas Young,19th century ,British scientist. In solid mechanics, Young’s modulus is defines as the ratio of the longitudinal stress over longitudinal strain, in the range of elasticity the Hook’s law holds (stress is directly proportional to strain). It is a measure of stiffness of elastic material.

If a wire of length L and area of cross-section 'a' be stretched by a force F and if a change (increase) of length 'l' is produced, then

$$Young's\ modulus = \frac{Normal\ stress}{Longitudinal\ strain} = \frac{F/a}{l/L}$$

Uniform Bending Using Pin and Microscope Method

In uniform Bending , the Young’s modulus of the material of the bar is given by

$$Y = \frac{mgpl^2}{8Ie} \qquad (1)$$

Where,

m - Mass at each end of the bar.

p - Distance between the point of suspension of the mass and nearer knife edge.

g - Acceleration due to gravity.

l is the length of the bar between the knife edges.

e - Elevation of the midpoint of the bar for a mass m at each end.

I - Geometrical moment of inertia.

For a bar of rectangular cross section,

$$I = \frac{bd^3}{12} \qquad (2)$$

Where b is the breadth and d is the thickness of the bar.

Substituting (2) in equation (1)

$$Y = \frac{3mgpl^2}{2bd^3e} \quad (3)$$

Applications

1. Thin film applications.

2.It helps to predict the directional and orientation properties of metals and has application in ceramics.

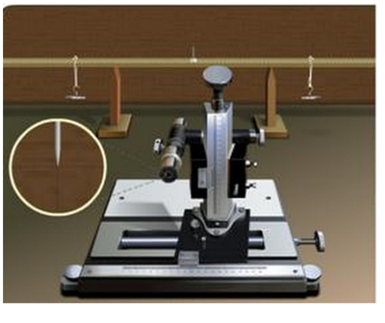
3. Measurement of soft tissues -early detection, elasticity imaging, etc.

4. It is used to test equipments like ultrasonic transducers, ultrasonic sensors.

Procedure for Simulation

1. Select the environment and material for doing experiment.
2. Adjust length, breadth and thickness of the material bar using sliders on the right side of the simulator .
3. Fix the distance between knife edges and weight hangers using sliders.
4. Focussing the microscope using focussing knob and adjusting the tip of the pin coincides with the point of intersection of the cross wires using left and top knobs on microscope respectively.
5. Readings are noted using the microscope reading for 0g. Zoomed part of microscope scale is available by clicking the centre part of the apparatus in the simulator. Total reading of microsope is MSR+VSR*LC. MSR is the value of main scale reading of the microsope which is coinciding exacle with the zero of vernier scale. One of the division in the vernier scale coincides exactly with the main scale is the value of VSR. LC is the least count.
6. Weights are added one by one say 50g, then pin moves downwards while viewing through microscope. Again adjust the pin such that it coincides exactly with the cross wire.
7. Note the microsope reading and repeat 7 and 8 by increasing the weights.
8. The readings are tabulated and Y is determined using equation (3).

Observations



Value of 1 m.s.d = 1/20 cm
Number of divisions on the vernier, n = 50
Least count of microscope = 1 m.s.d/n = 1/1000 = 0.001 cm

Young's modulus of the material bar , $Y = \frac{3mgpl^2}{2bd^3e}$ = ………………………..Nm^{-2}

Environmental condition, Earth, $g=9.8m/s^2$

Tabulations

Distance between weight hangers	40 cm
Distance between knife edges l	20 cm
Distance between point of suspension and nearest knife edge p	10 cm
Breadth in cm b	1 cm
thickness in mm d	4 mm

Observations	**Materials**	
	Wood	**Copper**
Reading for zero mass s_1	cm	cm
Mass suspended m	Kg	Kg
Reading for given mass s_2	Kg	Kg
Elevation s_1-s_2 e	cm	cm
Youngs modulus Y	N/m^2	N/m^2

1.Young's modulus of wood = ………………………… Nm^{-2}.

2.Young's modulus of copper = ………………………… Nm^{-2}.

II SEM :BSc : Practical Questions

1. Plot time –voltage graphs for a C-R circuit while charging and discharging. Hence obtain the time constant of the circuit in both cases. Verify by direct calculation.

2 Verify Thevenin's and Norton's theorems using the given circuit. (Take readings for 6 load resistances).

3. Draw the load - depression graph for the given cantilever. Use it to find the Young's modulus of the material of the cantilever, (six loads) by graphical method. Also verify the result by direct calculation.

4 Determine q, n and σ for the material for the given wire by Searle's double bar method.

5. Determine the rigidity modulus of the given rod by subjecting it to static torsion. Perform the experiment for two different lengths. (6 trials in each case)

6. With the given components (using C = 0.01 micro farad and R = 1 kΩ **Construct a Low filter** and using C = 0.01 micro farad R=1.5kohm **construct a High pass filter**),draw the frequency response curves and determine the cut off frequencies verify your answer by direct calculations.

7. Determine Interfacial tension of water with kerosene oil using the given setup.(four trials for mass of 10 drops of water and 3 trials for ratio of densities.)

8. Compare the coefficient of viscosities using Ostwald's viscometer. (Four trials for ratio of time of flow and three trials for ratio of densities)

UNITS OF MEASUREMENTS

FUNDAMENTAL UNITS		
Quantity	**Unit**	**Symbol**
1. Length	meter	m
2. Mass	kilogram	kg
3. Time	second	s
4. Electric Current	ampere	A
5. Temperature	kelvin	K
6. Luminious Intensity	candela	Cd
7. Amount of Substance	mole	mol
SUPPLEMENTARY UNITS		
Quantity	**Unit**	**Symbol**
1. Plane Angle	Radian	rad
2. Solid Angle	Steradian	Sr

DERIVED UNITS		
Quantity	**Unit**	**Symbol**
1. Area	square meter	m^2
2. Volume	cubic meter	m^3
3. Density	kilogram/ cubic meter	kg/m^3
4. Velocity	meter/second	m/s
5. Angular Velocity	radian/ second	r/s
6. Acceleration	meter/second square	m/s^2
7. Angular Accleration	radian/second square	rad/s^2
8. Frequency	hertz	Hz
9. Force	newton	N
10. Work energy	joule	J
11. Power	watt	W
12. Pressure	pascal	Pa
13. Electrical charge	coulomb	C
14. Potential difference	volt	V
15. Electrical resistance	ohm	Ω
16. Capacitance	farad	F
17. Inductance	henry	H
18. Magnetic field	telsa	T
19. Luminious flux	lumen	lm
20. Dynamic Viscocity	newton sec./ square meter	$N\text{-}s/m^2$

STANDARD PREFIXES IN MEASUREMENTS

Prefiks	Symbol	Multiplying factor
yotta	Y	$1\ 000\ 000\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{24}$
zetta	Z	$1\ 000\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{21}$
exa	E	$1\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{18}$
peta	P	$1\ 000\ 000\ 000\ 000\ 000 = 10^{15}$
tera	T	$1\ 000\ 000\ 000\ 000 = 10^{12}$
giga	G	$1\ 000\ 000\ 000 = 10^{9}$
mega	M	$1\ 000\ 000 = 10^{6}$
kilo	k	$1\ 000 = 10^{3}$
hecto	h	$100 = 10^{2}$
deka	da	$10 = 10^{1}$
deci	d	$0,1 = 10^{-1}$
centi	c	$0,01 = 10^{-2}$
milli	m	$0,001 = 10^{-3}$
mikro	µ	$0,000\ 001 = 10^{-6}$
nano	n	$0,000\ 000\ 001 = 10^{-9}$
piko	p	$0,000\ 000\ 000\ 001 = 10^{-12}$
femto	f	$0,000\ 000\ 000\ 000\ 001 = 10^{-15}$
atto	a	$0,000\ 000\ 000\ 000\ 000\ 001 = 10^{-18}$
zepto	z	$0,000\ 000\ 000\ 000\ 000\ 000\ 001 = 10^{-21}$
yocto	y	$0,000\ 000\ 000\ 000\ 000\ 000\ 000\ 001 = 10^{-24}$

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE
(Autonomous), UJIRE-574240
DEPARTMENT OF PHYSICS

CERTIFICATE

This is to certify that ....with Roll Number...................has satisfactorily completed the course of Experiments in Practical Physics prescribed by the College for BSc IIIrd Semester during the year 20…...- 20…….

Lecturer in charge of the Batch
Submitted on.....

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Signature and Name of the student

Experiment Number. Date

1. TRANSISTOR CHARACTERISTICS

AIM: To draw (a) input or Base characteristics (b) output or collector characteristic of a NPN transistor in common emitter configuration. Also to determine (i) DC current gain (ii) A C current gain (iii) Input resistance and (iv) output resistance of a transistor.

APPARATUS REQUIRED

DC regulated power supplies 0 -12 V_{DC} (variable), DC voltmeter, DC microammeter 0-100 μA, DC milliameter 0-25 mA, Multimeter, transistor BC 547, resistor 68 ohms, 100 K ohms ½ Watt each

DESCRIPTION:

A NPN transistor consists of a 'P' type of a semiconductor sandwiched between two N type materials. The three regions are called Emitter (E), Base (B) and Collector(C). The base is thinner and lightly doped compared to E and C. The junction between the emitter and base is called E- B junction and that between base and collector is called 'C- B' junction. Thus a transistor can be thought of as two p-n junction connected back to back. When the E - B junction is forward biased and C - B junction reverse biased, the transistor is said to operate in active region.

If both junctions are forward biased, the transistor is in saturation. However, if both junctions are reverse biased, the transistor is in cut off region. An input characteristic of a transistor is a curve showing the variation of input (base) current, I_B as a function of input voltage(base emitter voltage) $V_{BE,}$ when the output voltage
(collector emitter voltage) V_{CE} is kept constant,

The output characteristic is a curve showing the variations of output (collector) current Ic as function of output voltage V_{CE} when input (base) current I_B is kept constant.

THEORY

Design calculations

Let the maximum voltage power supply be V_{BB} = V_{CC}= 12V

Let V_{CE}(max) =10V

Max collector current allowed, $I_{C\,max} = \dfrac{P_{TOT}}{V_{CE}(\max)} = \dfrac{300\times10^{-3}}{10}$ = 30mA ----------(1)

$\therefore$ Minimum collector resistance $R_{cmin} = \dfrac{V_{CC}-V_{CE}(\max)}{I_C(\max)}$ -------------(2)

$= \dfrac{12-10}{30\times10^{-3}}$ = 67 ohm = 68 Ω

Maximum base current $I_{Bmax} = \dfrac{V_{CC}-I_{C\max}}{h_{FE}(\max)} = \dfrac{12-30\times10^{-3}}{220}$ = 136 μ A---(3 $\therefore$

Minimum base resistance $R_{Bmin} = \dfrac{V_{BB}-V_{BE}(\max)}{I_{B\max}} = \dfrac{12-0.7}{136\times10^{-6}}$ = 83Kohm = 100K Ω ....(4)

Transistor parameter from Input characteristics:

The AC input resistance h_{ie} = $\frac{\Delta V}{\Delta I_B}$ -------------------------- (5)

Transistor parameters from Output characteristics (for V_{CE} = 5V)

d.c current gain h_{FE1} = $\frac{I_{C1}}{I_{B1}}$ for $I_B = I_{B1}$ -----------(6)(a)

d c current gain h_{FE2} = $\frac{I_{C2}}{I_{B2}}$ for $I_B = I_{B2}$ -------(6) (b)

a c current gain h_{fe} = $\frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}}$ ------------------------------ (7)

output resistance of the transistor , $\gamma_0 = \frac{\Delta V}{\Delta I}$ ---------------------- (8)

PROCEDURE

All components are connected as shown in the figure(1)

Input characteristics:

Let V_{CE} = 0. For this, the collector connection is removed and shorted to emitter. V_{BB} is adjusted so that $I_B = 1\,\mu$ A. V_{BE} is noted. V_{BE} is noted for I_B = 2, 5,10,20,40,50 μA . A graph of I_B Verses V_{BE} is drawn . Choosing any two points on the raising part of the curve, the AC input resistance h_{ie} of transistor is determined. The collector is reconnected to the circuit. The experiment is repeated for V_{CE} =5V.

Output characteristics:

V_{BB} adjusted so as to get $I_B = 20\,\mu A$ (say) V_{CE} is adjusted to 0.2V, 0.4 V up to 10 volts.and in each case the collector current is noted. A graph of I_C verses V_{CE} is drawn. The DC current gain h_{FE} is calculated for different cases. The variation ΔI of collector current for a change ΔV of V_{CE} in the active region of transistor is noted. The AC current gain h_{FE} is calculated. The AC output resistance r_0, of transistor is calculated. The experiment is repeated for I_B is 40 μA and 60 μA .

NOTES:

1) The values of R_C and R_B depend on transistor used and maximum supply voltages V_{BB} and V_{CC}.

2) Voltage measurements are essentially done using voltmeter having high internal measurements.

RESULT:

V_{CE}(volts)	V_{CE}=0V	V_{CE}=5V
Input resistance h_{ie} (ohms)	$\frac{\Delta V}{\Delta IB}$ =	$\frac{\Delta V}{\Delta IB}$ =

I_B (μA)	20 μA	40 μA	60 μA
DC current gain h_{FE}	$\frac{I_{C1}}{I_{B1}} =$	$\frac{I_{C2}}{I_{B2}} =$	$\frac{I_{C3}}{I_{B3}} =$
Output resistance r_0 in ohms	$\delta V_{CE}/\delta I_C$ =	$\delta V_{CE}/\delta I_C$ =	$\delta V_{CE}/\delta I_C$ =

AC current gain h_{fe}	
$\frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}}$ =	$\frac{I_{C3} - I_{C2}}{I_{B3} - I_{B2}}$ =

OBSERVATIONS

Circuit diagram

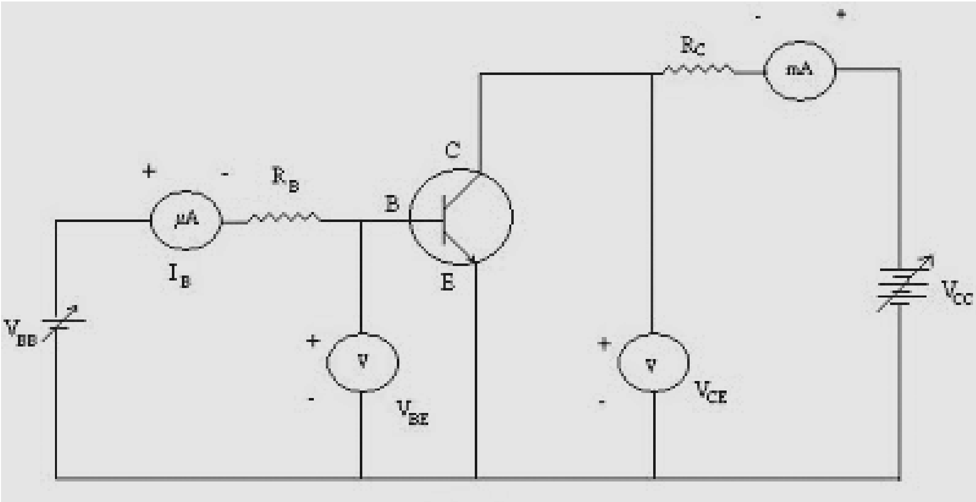
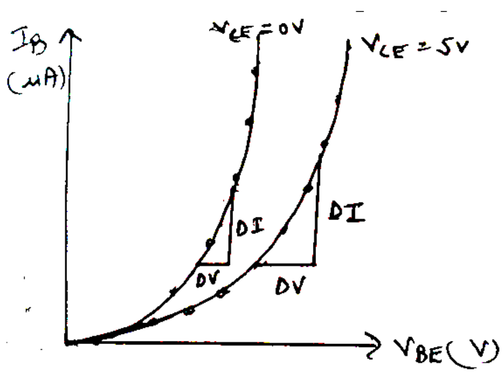
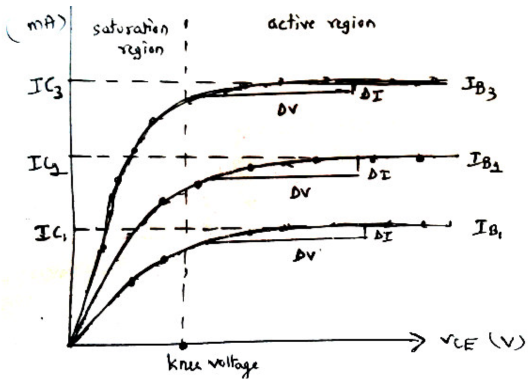
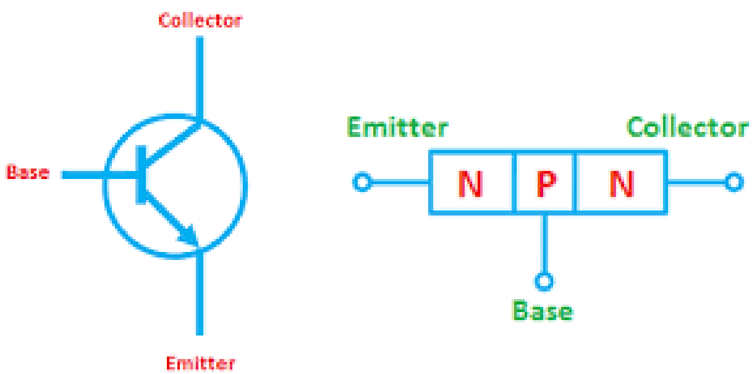


Figure 1







NPN transistor symbol

Tabulation

In put characteristics

V_{CE}=0V		V_{CE}=5V	
Base current I_B in μA	Base voltage V_{BE} in Volts	Base current I_B in μA	Base voltage V_{BE} in Volts
0		0	
1		1	
5		5	
10		10	
15		15	
20		20	
30		30	
40		40	
50		50	
60		60	

Out put characteristics

Base current 20 in μA		Base current 40 in μA		Base current 60 in μA	
V_{CE} in Volts	**I_C in mA**	**V_{CE} in Volts**	**I_C in mA**	**V_{CE} in Volts**	**I_C in mA**
0		**0**		**0**	
0.2		**0.2**		**0.2**	
0.5		**0.5**		**0.5**	
1		**1**		**1**	
1.5		**1.5**		**1.5**	
2		**2**		**2**	
3		**3**		**3**	
5		**5**		**5**	
6		**6**		**6**	
7		**7**		**7**	
8		**8**		**8**	
9		**9**		**9**	
10		**10**		**10**	

Calculations

From the input characteristics:

Input resistance h_{ie}

Case 1) For V_{CE}= 0V

$$h_{ie} = \frac{\Delta V}{\Delta IB} \qquad = \qquad \text{ohm}$$

Case 2) for V_{CE}= 5V,

$$h_{ie} = \frac{\Delta V}{\Delta IB} \qquad = \qquad \text{ohm}$$

From output characteristics

D.C current gain

1) $h_{FE} = \dfrac{I_{C1}}{I_{B1}} =$

2) $h_{FE} = \dfrac{I_{C2}}{I_{B2}} =$

3) $h_{FE} = \dfrac{I_{C3}}{I_{B3}} =$

AC Current gain for different cases

Case 1.) $h_{fe} = \dfrac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}} =$

Case 2) $h_{fe} = \dfrac{I_{C3} - I_{C2}}{I_{B3} - I_{B2}} =$

Output resistance for different cases

Case 1) $r_0 = \delta V_{CE}/\delta I_C$ =

Case 2) $r_0 = \delta V_{CE}/\delta I_C$ =

Case 3) $r_0 = \delta V_{CE}/\delta I_C$ =

RESULTS:

V_{CE}(volts)	**V_{CE}=0V**	**V_{CE}=0V**
Input resistance **h_{ie} (ohms)**	$\frac{\Delta V}{\Delta IB}$ =	$\frac{\Delta V}{\Delta IB}$ =

I_b (μA)	**20 μA**	**40 μA**	**60 μA**
DC current gain **h_{FE}**	$\frac{I_{C1}}{I_{B1}} =$	$\frac{I_{C2}}{I_{B2}} =$	$\frac{I_{C3}}{I_{B3}} =$
Output resistance **r_0 in ohms**	**$\delta V_{CE}/\delta I_C$** **=**	**$\delta V_{CE}/\delta I_C$** **=**	**$\delta V_{CE}/\delta I_C$** **=**

AC current gain h_{fe}	
$\frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}}$ =	$\frac{I_{C3} - I_{C2}}{I_{B3} - I_{B2}}$ =

Experiment Number. Date

2. NEWTON'S RINGS -DETERMINATION OF RADIUS OF CURVATURE

AIM: To determine the radius of curvature of a convex lens surface by forming Newton's rings.

APPARATUS: Travelling microscope, optically plane glass plate, lens, sodium light, reading lens etc.

EXPERIMENTAL SETUP: Light from a monochromatic source is reflected by a glass plate P, kept at an angle of 45^o to the horizontal. This falls over the lens placed over the glass plate G. The travelling microscope over plate P can be focussed to see the alternate bright and dark concentric rings. These are the Newton's rings.

THEORY:

Interference takes place between the light reflected from the lower surface of the lens and upper surface of plate G, the path difference at a point A

$$= 2\mu t\cos r$$

where t = thickness of air film at point A. Now $\mu = 1$ for air and r = 0 for normal incidence. Hence the path difference = 2t.

Due to the reflection of the light at the surface at G an additional path difference of $\lambda/2$ (where λ is the wavelenghth of monochromatic source) is introduced. The total path difference thus becomes (2t + $\lambda/2$). If this point is nλ, point A will be on the bright ring. A is on dark ring if (2t+$\lambda/2$) is equal to (2n+λ/2). Since the thickness of air film is uniform along a circle with the point of contact as centre, there will be dark (or a bright) ring at all points where the condition (2t+$\lambda/2$) = (2n+1) $\lambda/2$ or nλ is satisfied. The central spot will be dark. If $\mathbf{R}_n$ is the radius of nth dark ring, (ref diagram b), R is the radius of curvature of lens

$$\frac{r_n^2}{R} = 2t = n\lambda \text{ ---(1)}$$

for m^{th} dark ring

$$\frac{r_m^2}{R} = m\lambda \text{ --(2)}$$

Eqn (2) – Eqn (1) gives $r_m^2 - r_n^2 = R\lambda(m-n)$

$$\text{or } \lambda = \frac{r_m^2 - r_n^2}{R(m-n)} \text{ --(3)}$$

If diameters are considered,

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

PROCEDURE:

The travelling microscope is focussed to observe the rings clearly with the dark spot at the centre. The cross wires are adjusted so that one of them is tangential to the ring and the other is tangential to the diameter of rings. Counting the central dark spot as zero, the cross wire is made tangential to the 20^{th} dark ring on one side and vernier reading of TM is taken. Then the cross wire is made tangential to 5^{th}, 10^{th}, 15^{th} and the readings of microscope after each setup is taken. After crossing the centre of the ring system the reading of 5^{th}, 10^{th}, 15^{th}, 20^{th} dark rings on the other side are taken. The diameters of the rings are calculated.

The radius of curvature R of lens surface in contact with the glass plate can be calculated from (eqn 4).

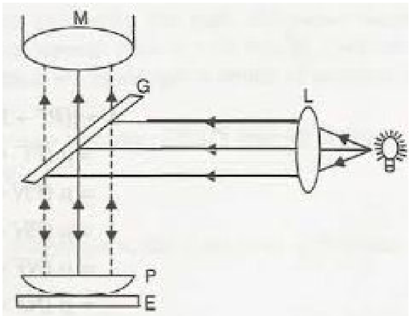
RESULT: Radius of curvature of lens by Newton's ring method = m.

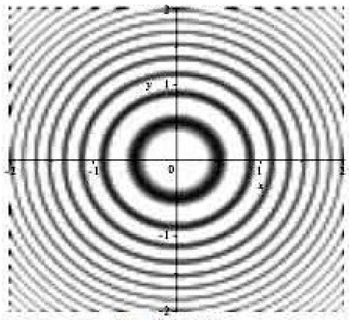
OBSERVATIONS

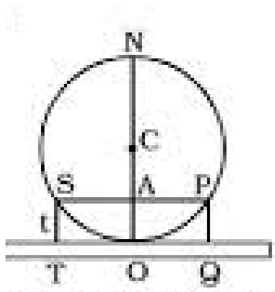
Least count of the Travelling microscope is

=Length of 1 msd/no of divisions on Head scale=S/N

=0.1cm/100=0.001 cm







Tabulations

Ring Number	Microscope reading in cm		Diameter D=(b-a) cm	D^2 (cm^2)	$D^2_m - D^2_n$ (cm^2)
	Left (a)	Right (b)			
20					
15					
10					
5					

m-n=10

Radius of curvature of the lens is = $R = \dfrac{D_m^2 - D_n^2}{4(m-n)\lambda}$

= m

Experiment Number. Date

3. DETERMINATION OF PLANCK'S CONSTANT USING LEDs

AIM: To determine the value of Planck's constant by measuring activation voltages of different LEDs

APPARATUS REQUIRED: 0-5 V power supply, milliammeter, voltmeter, 1K ohm resistor and different LED's

DESCRIPTION

Planck's constant (h), a physical constant was introduced by German physicist named Max Planck in 1900. The significance of Planck's constant is that 'quanta' (small packets of energy) can be determined by frequency of radiation and Planck's constant. It describes the behavior of particle and waves at atomic level as well as the particle nature of light. The value of Plancks constant can be determined by using LEDs of different activation voltages

LEDs are produced by the junction of two 'doped' semiconductor materials, one of which has an excess of electrons (n-type) and the other a lack of electrons – also designated as holes (p-type). When an electrical current is injected through this so-called 'p-n' junction, the recombination of electrons and holes releases energy in the form of photons.

The colour of the light emitted from an LED is determined by the energy of the photons, which can be tailored by changing the chemical composition of the semiconductor materials. LEDs are most commonly made from alloys of gallium, arsenic and aluminium, and changing the proportion of these constituents can produce LEDs that emit light in specific colours – such as red and green in the visible region of the electromagnetic spectrum, or beyond into the ultraviolet and infrared regions.

As with any light, it is the wavelength that determines its colour. The human eye is sensitive to light with wavelengths from about 390 to 700 nanometres (0.00039–0.0007 mm). We see the shortest wavelengths as violet and the longest as red, and each in between corresponds to a particular colour in the spectrum. For example, green-emitting LEDs typically produce light with a wavelength of around 567 nanometres.

We use LEDs in this experiment because each colour of LED has a different threshold voltage at which electrons start being produced. Measuring this voltage, together with known values for the emission wavelengths, provides a path to finding a value for the Planck constant.

THEORY

In the unbiased condition a potential barrier is developed across the p-n junction of the LED. When we connect the LED to an external voltage in the forward biased direction, the height of potential barrier across the p-n junction is reduced. At a particular voltage the height of potential barrier becomes very low and the LED starts glowing, i.e., in the forward biased condition electrons crossing the junction are excited, and when they return to their normal state, energy is emitted. This particular voltage is called the **knee voltage** or the **threshold voltage or activation voltage**. Once the knee voltage is reached, the current may increase but the voltage does not change.

The light energy emitted during forward biasing is given as ,

$$E = \frac{hc}{\lambda} \qquad (1)$$

Where

c -velocity of light.
h -Planck's constant.
λ -wavelength of light.

If V is the forward voltage applied across the LED when it begins to emit light and e is charge on the electron (the knee voltage), the energy given to electrons crossing the junction is,

$$E = eV \qquad (2)$$

Equating (1) and (2), we get

$$eV = \frac{hc}{\lambda} \qquad (3)$$

The knee voltage V can be measured for LED's with different values of λ

$$V = \frac{hc}{e}\left(\frac{1}{\lambda}\right) \qquad (4)$$

The equation shows that a plot of V against 1/ λ is a straight line as shown with slope

$$s = \frac{hc}{e} \qquad (5)$$

From which Planck's constant h, is given by

$$h = \frac{e}{c}s \qquad (6)$$

Where $C=3 \times 10^{8}$ m/s is the velocity of light and $e= 1.6022 \times 10^{-19}$ C is the electronic charge , Alternatively, we can write equation (3) as

$$h = \frac{e}{c}\lambda V$$

h is calculated for each diode and average value is found out

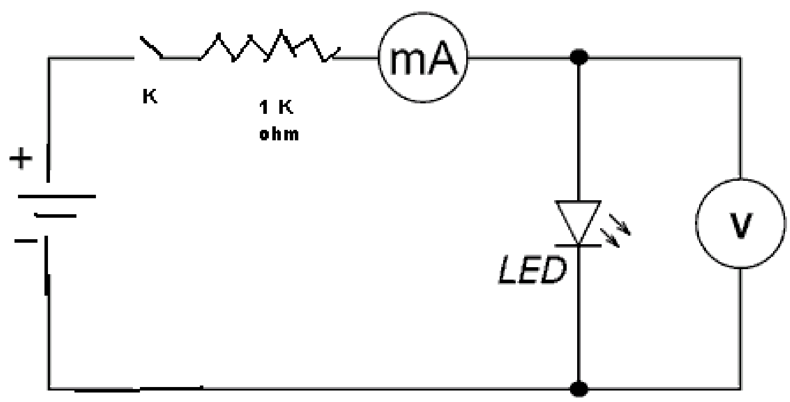
PROCEDURE

1. Set up the circuit as shown in the diagram. Connect the ammeter in series with the LED to measure the current through it, and connect the voltmeter in parallel to the LED to measure the voltage across it. The applied voltage can be changed by using variable power supply.
2. Change the voltage in steps of 0.5 V from 0 V to 3 V, and measure the resulting electrical current. Note that when the current flowing through the LED is small, the LED might not light up, but the ammeter can still measure the current.
3. For each LED, plot a graph of current against voltage,. On each graph, find the straight line of 'best fit' to join up the points that slope up from the *x*-axis. If the points lie close to the line, this shows that a linear relationship holds between the applied voltage and the current in this region of the graph
4. Finally, determine the activation voltage (V_a) from the collected data. This is the point at which the current begins to increase linearly with voltage. It can be read off the graph by extrapolating the straight line representing the linear response region backwards until it intercepts the *x*-axis.
5. Experiment is repeated for different diodes and the values are tabulated.
6. A graph is plotted taking activation voltage along y axis and reciprocal of wavelength along x axis. Slope (s) of the graph is calculated and using equation (6) value of Planck's constant is determined.
7. The value is verified by direct calculation.

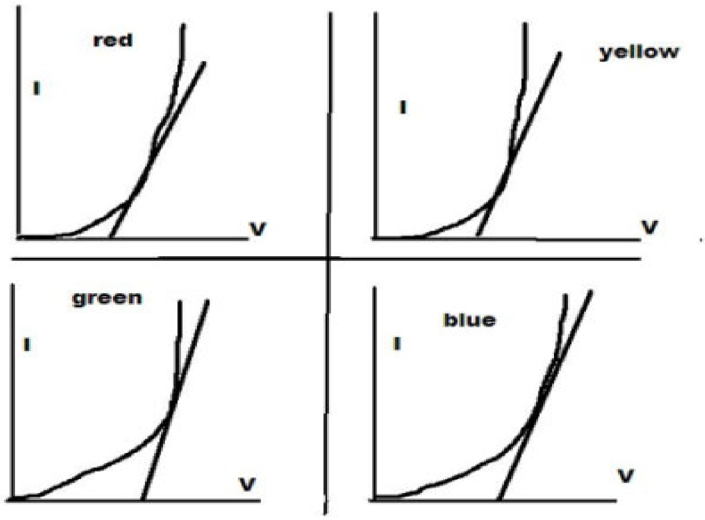
RESULT

1. Value of Planck's constant by graphical method=
2. Value of Planck's constant by direct method=

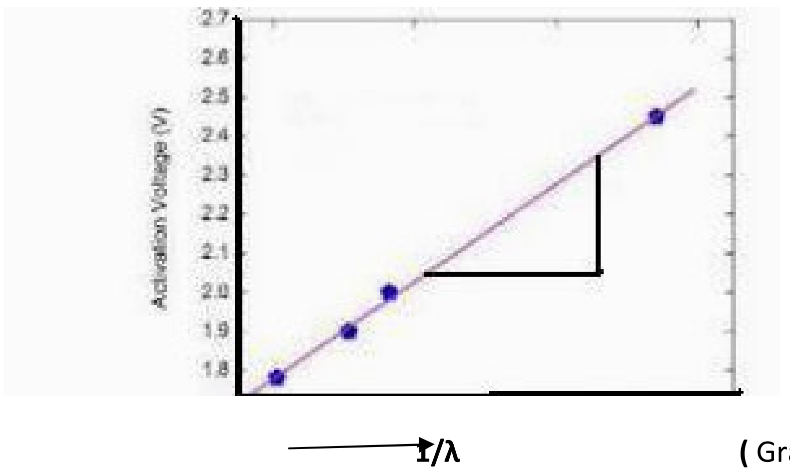
Observations



Circuit diagram



Graph I/V for different LEDs (graph 1)



(Graph 2)

To determine activation voltage

Diode current In mA	Voltage in Volts			
	RED	YELLOW	GREEN	BLUE
0				
0.5				
1				
1.5				
2				
2.5				
3				
3.5				
4				
4.5				
5				
5.5				
6				

To determine Planck's constant

LED colour	Wavelength λ (m)	1/ λ	Activation voltage Va (in V)	$h=\frac{e}{c}\lambda V$ **(Js)**
Red	$660X10^{-9}$			
Yellow	$589\ X10^{-9}$			
Green	$525\ X10^{-9}$			
Blue	$450\ X10^{-9}$			

Average value of h =

By Direct method $h= e\ s/c$,where s is the slope of the line in graph 2

= Js

RESULT

1. Value of Planck's constant by graphical method= Js
2. Value of Planck's constant by direct method Js

Experiment Number. Date

4. ZENER DIODE AS A VOLTAGE REGULATOR

AIM: To study zener diode as voltage regulator

APPARATUS REQUIRED: Zener diode, Resistors, Power supply, Multi meter, and rheostat

THEORY

Zener diode is a P-N junction diode specially designed to operate in the reverse biased mode. It is acting as normal diode while forward biasing. It has a particular voltage known as break down voltage, at which the diode break downs while reverse biased. In the case of normal diodes, the diode damages at the break down voltage. But Zener diode is specially designed to operate in the reverse breakdown region.

The basic principle of Zener diode is the Zener breakdown. When a diode is heavily doped, it's depletion region will be narrow. When a high reverse voltage is applied across the junction, there will be very strong electric field at the junction. And the electron hole pair generation takes place. Thus heavy current flows. This is known as Zener break down. So a Zener diode, in a forward biased condition acts as a normal diode. In reverse biased mode, after the break down of junction current through diode increases sharply. But the voltage across it remains constant. This principle is used in voltage regulator using Zener diodes

The figure shows the zener voltage regulator, it consists of a current limiting resistor R connected in series with the input voltage Vs and zener diode is connected in parallel with the load R_L in reverse biased condition. The output voltage is always selected with a breakdown voltage Vz of the diode.

The input source current, $I_S = I_Z + I_L$............ . (1)

The drop across the series resistance, $R_s = V_{in} – V_Z$........ (2)

And current flowing through it, $I_s = (Vin – V_Z) / R_S$ .... (3)

From equation (1) and (2), we get, $(Vin - Vz)/R_s = I_z + I_L$ .... (4)

Regulation with a varying input voltage (line regulation):

It is defined as the change in regulated voltage with respect to variation in line voltage. It is denoted by 'LR'. In this, input voltage varies but load resistance remains constant hence, the load current remains constant. As the input voltage increases, form equation (3) Is also varies accordingly. Therefore, zener current I_z will increase. The extra voltage is dropped across the R_S. Since, increased I_z will still have a constant V_z and V_z is equal to V_{out}. The output voltage will remain constant. If there is decrease in V_{in}, I_z decreases as load current remains constant and voltage drop across R_s is reduced. But even though I_z may change, V_z remains constant hence, output voltage remains constant.

Regulation with the varying load (load regulation):

It is defined as change in load voltage with respect to variations in load current. To calculate this regulation, input voltage is constant and output voltage varies due to change in the load resistance value. Consider output voltage is increased due to increasing in the load current. The left side of the equation (4) is constant as input voltage V_{in}, I_S and R_s is constant.

Then as load current changes, the zener current I_z will also change but in opposite way such that the sum of I_z and I_L will remain constant. Thus, the load current increases, the zener current decreases and sum remain constant. From reverse bias characteristics even I_z changes, V_z remains same and hence output voltage remains fairly constant

PROCEDURE:-

Line Regulation:

1. Make the connections as shown in figure
2. Keep load resistance fixed value; vary DC input voltage from 6V to 10.5V.
3. Note down output voltage as a load voltage with high line voltage 'V_{HL}' and as a load voltage with low line voltage 'V_{LL}'.
4. Using formula, % Line Regulation = $(V_{HL}-V_{LL})/ V_{NOM}$ x100, where V_{NOM} = av value of inputs under the typical operating conditions.
5. A graph is plotted between output and input voltage

Load Regulation:

1. For finding load regulation, make connections as shown in figure
2. Keep input voltage constant say 10V, vary load resistance value.
3. Note down no load voltage 'V_{NL}' for maximum load resistance value and full load voltage 'VFL' for minimum load resistance value.
4. Calculate load regulation using, % load regulation = $(V_{NL}-V_{FL})/ V_{FL}$ x100
5. A graph is plotted between output voltage and load resistance

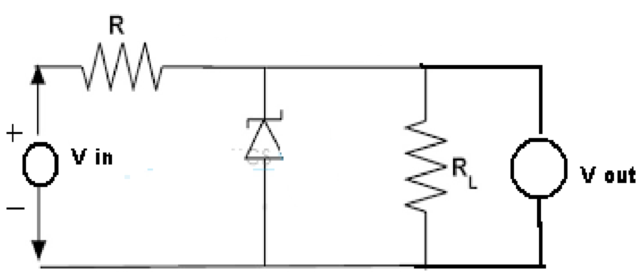
RESULT

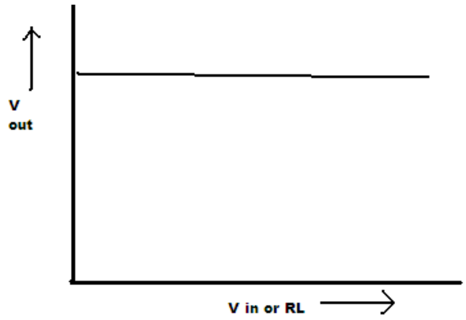
1.Variation of output voltage with input voltage and variation of output voltage with load resistance are as shown in the graphs

2 Line Regulation = ------------ %

3. Load regulation = ----------%

OBSERVATIONS





Circuit diagram **graph**

Line regulation

sl no	input voltage (V)	V_{out} in volts	
		Load=2 k ohm	Load= 5 k ohm
1	6	V_{LL}=	V_{LL}=
2	6.5		
3	7		
4	7.5		
5	8		
6	8.5		
7	9		
8	9.5		
9	10		
10	10.5	V_{HL}=	V_{HL}=

Load regulation

sl no	Load in ohms	Vout in volts	
		input =5 volts	input =7 volts
1	750	V_{FL}=	V_{FL}=
2	1000		
3	1.25K		
4	1.5K		
5	2K		
6	3K		
7	4K		
8	5K		
9	6K		
10	7K	V_{NL}=	V_{NL}=

Result

1.Variation of output voltage with input voltage and variation of output voltage with load resistance are as shown in the graphs

2.Average Line Regulation = ------------ %

3.Average Load regulation = ----------%

5. DETERMINATION OF CAUCHY'S CONSTANTS

AIM : To determine the Cauchy's Constants of the material of a prism by

1) Graphical method 2) Direct calculation

APPARATUS : Spectrometer, prism, mercury lamp, spirit level etc.

THEORY : The variation of refractive index μ with wavelength λ is given by Cauchy's eqn.

$$\mu = A + \frac{B}{\lambda^2} \text{ ---------------(1)}$$

where A & B are constants. If a graph is drawn between μ and $1/\lambda^2$ it will be a straight line. The intercept of this line on the Y – axis gives the constant A and slope gives B.

The value of B can also be verified by the equation.

$$B = \frac{\mu_1 - \mu_2}{\frac{1}{\lambda_1^2} - \frac{1}{\lambda_2^2}} \text{ -------------(2)}$$

Substituting the value of B in eqn. (1) the value of A can be estimated.

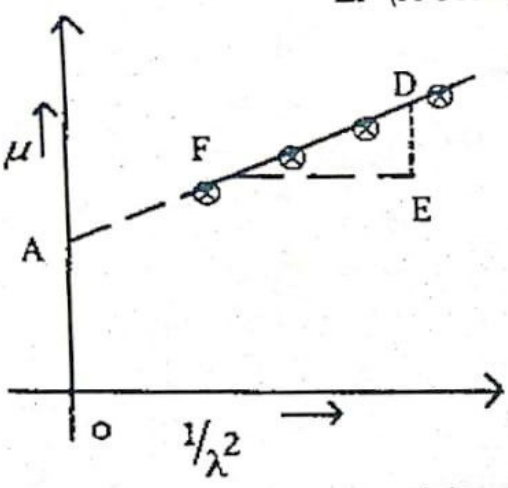
μ for various wavelenths is determined using a prism and spectrometer from the formula.

$$\mu = \frac{\sin\left(\frac{A' + D}{2}\right)}{\sin\left(A'/2\right)} \text{ – (3)}$$

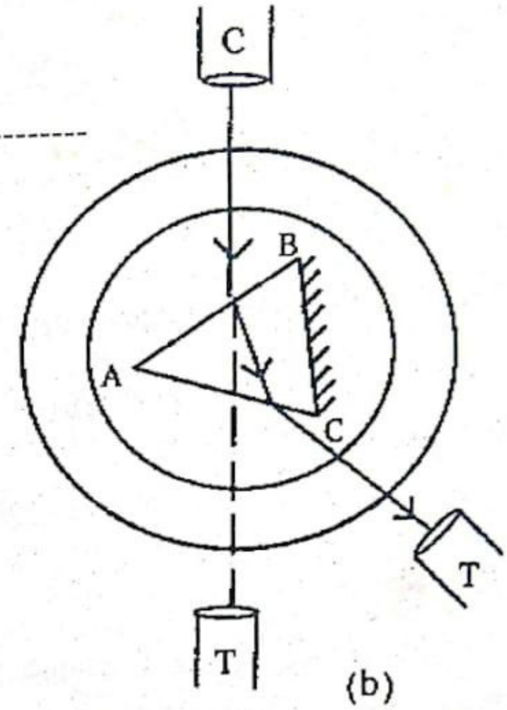
where A' is the angle of the prism and D is the angle of minimum deviation.

DIAGRAMS :

$$\text{Slope } B = \frac{DE \text{ (Y Scale)}}{EF \text{ (X Scale)}} = \text{-----------------}$$



(a)



(b)

PROCEDURE : The following adjustments of the spectrometer are made.

i) The telescope of the spectrometer is directed to a white wall. Looking through the eyepiece, its position is adjusted until the cross wires are clearly seen.

ii) The telescope is directed to a distant object and working on the focussing screw, the distance between the objective and eyepiece is adjusted to get a clear image (there should not be parallax between the crosswire and the image of distant object). Now telescope is adjusted for parallel rays.

iii) The spectrometer is arranged such that the slit of the collimator points to a mercury lamp. The telescope is made to face the collimator. The image of the slit is observed through the telescope. Looking through the telescope, the distance between the slit and the lens of the collimator is adjusted until the clear image of the slit is seen, side by side with the cross - wire, without parallax. Now the rays focussed by the telescope are rendered parallel by the collimator.

iv) The prism table is levelled using a spirit level by means of the levelling screws.

To find the angle of minimum deviation :

The prism is placed on the prism table such that the rays from the collimator are incident on the face AB of the prism. The refracted ray coming out of the face AC is observed through the telescope. Looking at the yellow line, the prism table is rotated in such a direction that the angle of deviation decreases (i.e. the refracted rays moves towards the axis of the collimator). The rotation of the prism table is continued, until the image of the slit appears stationary for a while and then begins to turn back. Where it just turns back is the position of minimum deviation. The prism table and the telescope are fixed in this position. Working the tangential screw, the cross wire is made to coincide with the image. Reading of the scale and vernier are taken. Similarly the readings for minimum deviations for the green, blue and violet lines are noted. Then the prism is removed and the direct reading of the slit is taken. The difference between the minimum deviation and direct readings gives the angle of minimum deviation (D).

The refractive indices of the material of the prism for different lines are calculated using the relation (3). A graph is drawn with the reciprocals of the squares of the wavelengths of the spectral lines along x-axis and corresponding value of 'μ' along the y-axis,

RESULT : Cauchy's constants (1) By direct calculation A =

B =

(2) By graphical method A =

B =

OBSERVATIONS : L.C. of the vernier of the spectrometer

$$= \frac{1 \text{ m.s.d.}}{\text{No. of divisions on vernier}} =$$

Angle of the prism $\angle A' = 60^\circ$

To determine D :

Spectral line	Wave length nm λ	$1/\lambda^2$ in m^{-2}	Reading of Spectrometer			Refractive Index μ
			Deviated ray (X)	Direct ray (Y)	Angle of m in. deviation (D=X~Y)	
Yellow	578.0	2.993×10^{12}				
Green	546.1	3.353×10^{12}				
Blue	435.8	5.265×10^{12}				
Violet	404.7	6.103×10^{12}				

CALCULATION :

$$\mu = \frac{\sin (A'+D)/_2}{\sin (A'/_2)}$$

$$B = \frac{\mu_1 - \mu_2}{\frac{1}{\lambda_1^2} - \frac{1}{\lambda_2^2}} = \text{--------------}$$

$$\text{From graph Slope B} = \frac{\text{DE (Y Scale)}}{\text{EF (X Scale)}} = \text{-----------------}$$

$$A = \mu - \frac{B}{\lambda^2}$$

Intercept A = -----------

Experiment Number .. Date

6.AIR WEDGE.

AIM : To determine the thickness of the given paper sheet by interference at an air wedge.

APPARATUS: Travelling microscope, piece of paper, optically plane glass plates, sodium lamp, reading lens, etc.

EXPERIMENTAL SETUP: An air wedge is formed by placing a paper at one end of a combination of two plane glass plates perpendicular to their length (fig a) Monochromatic light from a source is made to fall normally on this arrangement. Alternate bright and dark interference fringes can be seen with reflected light.

THEORY : Interference taken place here between the light of wavelength λ reflected at the upper and lower surface of the air film formed between the glass plates.

For n^{th} dark fringe at p path difference.

$$= 2\ \mu\, t \text{ Cos } r = n\lambda$$

Where μ = 1 for air, t_1 is thickness of the air film at P. n is an integer, and r = 0 for normal incidence.

$$\therefore \text{ Path difference} = 2t_1 = n\lambda$$

For (n + 1) the dark fringe at Q, $2t_2 = (n+1)\lambda$

$$\text{Subtracting } 2(t_2 - t_1) = \lambda \text{ or } t_2 - t_1 = \frac{\lambda}{2} \text{ ------------- (1)}$$

$$\text{Now } \tan\alpha \approx \frac{t_2 - t_1}{PQ} \text{ -------------}$$

$$\text{Or } \tan\alpha = \alpha \text{ (since } \alpha \text{ is small } = \frac{\lambda}{2(pq)} \text{ using (1)}$$

$$\text{Or } \alpha = \frac{\lambda}{2\beta} \text{ where } \beta = PQ \text{ fringe width .}$$

From (figb) $\alpha = \frac{d}{\ell}$ where d = diameter of the wire ℓ = distance between the wire and closed end of the edge. $\therefore$ d = $\frac{\lambda l}{2\beta}$ ------(2)

PROCEDURE:

The Optically plane rectangular glass plates are placed one over the other. The paper piece is introduced between the plates, perpendicular to their length, at one end. The glass plate G is adjusted to have an inclination of about 45º, with horizontal so that the monochromatic light falls on the air wedge. The travelling microscope is set to get clear, alternate bright and dark fringes.

Starting from a bright fringe at one end, the readings of the 5th, 10th ----- fringes are taken. Two band widths β is calculated by the method of difference. The distance ℓ between the line of contact of glass plates and the paper piece is measured Thickness of the paper piece is calculated using equation(2).thickness of the paper piece is verified using screw gauge.

RESULT:

Thickness of the piece of paper

By experiment = m

By direct measurement = m

OBSERVATIONS

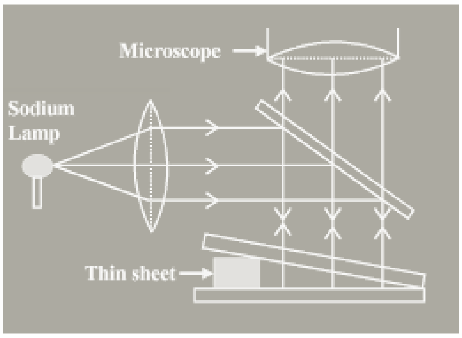


Fig 1

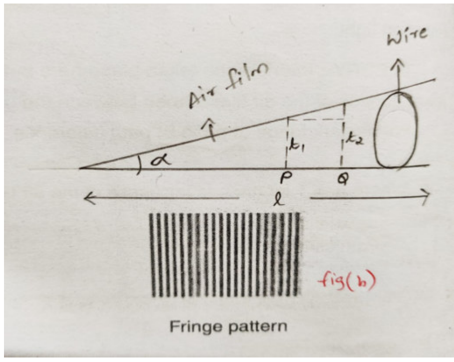


Fig 2

Wavelength of Sodium light=589.3nm

Distance l= cm

Least count of the travelling microscope=S/N = 0.1cm/100=0.001 cm

No of fringe	TM Reading cm	No of Fringe	TM Reading cm	Width of 20 fringes cm
0		20		
5		25		
10		30		
15		35		

Mean 20 β= cm, fringe width β= cm = m

There fore thickness of the paper = $\frac{\lambda l}{2\beta}$

= m

To find the thickness of the paper by using screw gauge

Pitch of the screw gauge=no of divisions uncovered/no of rotations given

=S/N= = 1 mm

No of divisions on head scale = 100

Least count of the screw gauge=Pitch/no of divisions on Head scale

= 1mm/100

=0.01 mm

Zero error= zero correction=

T No	PSR mm	HSD	CHSR	Thickness of 8 fold paper PSR+CHSRXLC (mm)
1				
2				
3				

Mean thickness of 8 fold paper=

Thickness of paper=

RESULT:

Thickness of the piece of paper

By experiment = m

By direct measurement = m

Experiment Number. Date

7.BIPRISM

AIM : To determine the wavelength of the given monochromatic radiation using Fresnel's biprism.

APPARATUS: optical bench, sodium vapour lamp, Fresnel's biprism convex lens etc.

DESCRIPTION:

The apparatus consists of an optical bench on which are mounted, a number of movable uprights. The bench is graduated in an and the uprights are provided with verniers. On the first upright. a slit s, of adjustable width, is mounted vertically, it is illuminated by the monochromatic source . On the second upright is mounted, the biprism with its edge A vertical angle nearly = 180^0. The upright is provided with tangential screws so that the slit and edge A of the prism can be made exactly parallel. On the third upright, an eyepiece with a micrometer, which can be made to move laterally, is mounted.

THEORY:

When monochromatic light from the slit falls on the biprism two virtual images S_1, and S_2 of the source are formed. These two form coherent sources of light, emitting wave trains of equal length and amplitude, in the same phase and with same period. Interference bands are obtained on the screen with in the area where the two cones of light from S_1 an S_2 are superimposed.

The bands can be seen using the micrometer eye piece. The distance between any two consecutive bright bands (or the width of a fringe) is

$$\beta = \frac{D}{d}\lambda \text{ ------(1)}$$

Where D is distance of focal plane of eyepiece from source S, d is the distance between two virtual sources $S_1$and S_2 and λ is the wavelength of monochromatic light. The focal plane of the eyepiece may not coincide with the zero of vernier attached to upright. Hence D may not be accurately known. Let the band width be β_1 for $D=D_1$ and B_2 for $D=D_2$ then,

$$\beta_1 = \frac{D_1}{d}\lambda \text{ and } \beta_2 = \frac{D_2}{d}\lambda \text{ ------ (2)}$$

$$(\beta_2 - \beta_1) = \left[\frac{D_2 - D_1}{d}\right]\lambda$$

$$\therefore \lambda = \left[\frac{\beta_2 - \beta_1}{D_2 - D_1}\right] d \text{ ------ (3)}$$

Now, let the distance between the source and the eyepiece be greater than four times the focal length of convex lens. The distance d_1 and d_2 between the images of S_1 and S_2 for conjugate positions of lens are measured.

Then $d = \sqrt{d_1 d_2}$ ----- (4)

PROCEDURE: To find β

The micrometer eyepiece is focused on the cross wire.The cross wire is made vertical. Te height of the slit. The biprism and the eyepiece are adjusted to be the same. The slit is illuminated by sodium lamp whose wavelength λ is to be determined The biprism is fixed at a distance of about 12 cm, from the slit. The refracting edge A of the biprism is made parallel to slit by the means of tangential screws. The plane of the biprism is kept normal to length of optic bench.

To obtain clear fringes, slit should be made narrow. By suitable adjustments of slit and the biprim, a system of clear interference fringes is obtained in the field of view . The eyepiece is fixed at distance of about 0.3 m from slit (D1 cm) Bandwidth β1 is determined by noting the positions of alternate fringes. The eyepiece is moved back by 0.35 m (distance D2 m from the slit) and band width β_2 is determined.

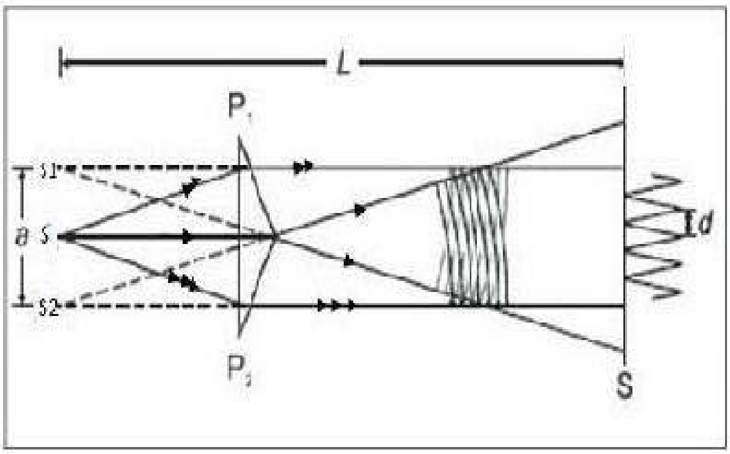
To find d

The eyepiece is fixed at distance four times the focal length of a short focus convex lens (f$\cong$15 cm). The lens is moved vertically on an upright between the eyepiece and biprism. Its height is adjusted to be the same as that of eyepiece. The lens is moved towards biprism, till two enlarged images of slit and clearly seen in field of view. Using the micrometer screw the distance d1 between them is determined. The less is moved towards the eyepiece, till two diminished images of slit are clearly seen in field of view. The distance cl2 between them is determined. The experiment is repeated by slightly altering position of eyepiece. The actual distance between two virtual images of slit is calculated using eq (4). The wavelength of source is calculated using eqn (3)

RESULT :

Weave length of Sodium light =   nm.

OBSERVATIONS



Tabulations

Least count of the micrometer screw=0.001 cm

To determine β_1 position of eye piece $=D_1=$

No of fringes	Micrometer reading (cm)	No of fringes	Micrometer reading (cm)	Width of 6 fringes (cm)
0		6		
2		8		
4		10		

Average 6 $\beta_1=$

$\beta_1=$ cm

To determine β_2 position of eye piece $=D_2=$

No of fringes	Micrometer reading (cm)	No of fringes	Micrometer reading (cm)	Width of 6 fringes (cm)
0		6		
2		8		
4		10		

Average 6 $\beta_2=$

$\beta_2=$ cm

To determine d

Trial No	Micrometer reading in cm						$d=\sqrt{d_1 d_2}$ cm
	Enlarged image			Diminished image			
	slit 1 R_1	slit 2 R_2	Distance $d_1=R_1-R_2$	slit 1 R_1	slit 2 R_2	distance $d_2=R_1-R_2$	
1							
2							

Mead d=

$\therefore$ wave length of monochromatic light $= \lambda = \left[\dfrac{\beta_2-\beta_1}{D_2-D_1}\right] d$

=

=

RESULT :

Wave length of Sodium light = nm.

Experiment Number. Date

8. TRANSISTOR AS A SWITCH

Aim: To study the action of a transistor as a switch

Apparatus required :NPN Transistor, 2.2Kohm,33kohm resistors,LED,Signal generator ,5V Power supply,bread board, connecting wires,multimeter etc,

Theory :A transistor is a three terminal semiconductor device formed by sandwiching one type of semiconductor between a pair of other type, accordingly there are two types namely NPN and PNP

Transistor Action:

For the proper action of a transistor, its emitter base junction is to be forward biased, and base-collector junction is to be reversed biased. Therefore more number of current carriers are diffused into the base region resulting in large conventional emitter current I_E. Since the base collector region is reverse biased , current carriers flow towards the collector region resulting in conventional collector current Ic. However few current carriers combine with the holes in the P region resulting in small conventional base current I_B as shown.

Thus due to the external biasing condition in the transistor, current carriers flow from a region of low resistance to a region of high resistance. This is called transistor action. This action makes it useful as an amplifier

The Transistor as a Switch

A bipolar transistor can be operated as “ON/OFF” type electronic switch by giving AC voltage of low frequency to the base.

Cut-off Region

When no voltage is given to the base, collector current (I_C) becomes zero, thus no current flows through the device. Therefore the transistor is switched “Fully-OFF”, Which results in high collector voltage. This is called cut off region

Saturation Region

When high voltage is given to the base, large collector current flows through the device. Therefore the transistor is switched “Fully-ON”,voltage drop across the collector resistor will be large and the collector voltage will be low. This is called saturation region.

Procedure:

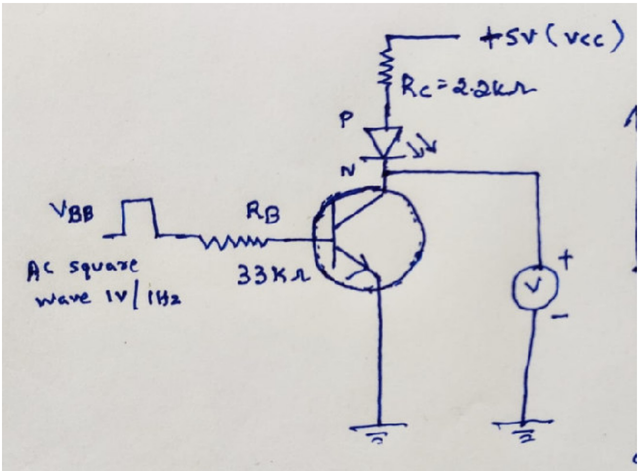
1. Construct the circuit as shown in figure.
2. Apply 1 Hz square wave signal to the base and ground from function generator.
3. Apply 5V to collector and ground.
4. Observe the indication of LED, and measure Maximum and minimum collector voltage

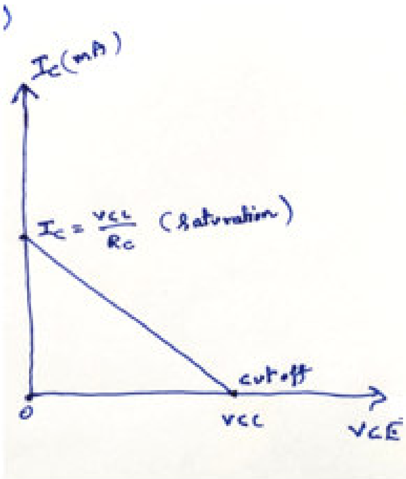
Under the application of the square wave, When input is high, the transistor is turned on and works in saturation region. So maximum current I_C flows through transistor as well as through LED. Hence LED emits the light. When input is low the transistor remains cutoff and LED goes off.

5.Load line of the transistor is drawn by taking $I_{C\ Max}$=50 mA along Y axis and max V_{CE} =5V along X axis.

Inference

Under the application of the square wave, transistor switches between cut off and saturation region with the frequency of the square wave. This explains the action of a transistor as a switch.





Circuit diagram Graph

Design calculations

V_{cc}=5V,V_{BE}=0.7 Volt, $V_{applied}$ = 1volt,β=227

R_c(assumed)=2.2kΏ

Now Ic= V_{CC}/R_c
=5/2.2k
= 2.27mA

$I_B=I_C/\ \beta$=2.27mA/227=10 µA

$R_B=(V_{BB}-V_{BE)}/I_B$
=(1-0.7)/10 µA
=33KΏ

Base voltage(V)	LED	Collector current mA	Collector voltage (V)	Transistor state	Transistor switch
0	Off	0	V_{max}=	cut off	Off
5	on	2.27	V_{min}=	saturated	on

8. Simulation Experiment
Transistor characteristics

Aim : To draw input and output characteristic curves of a NPN Transistor by simulation method

Procedure

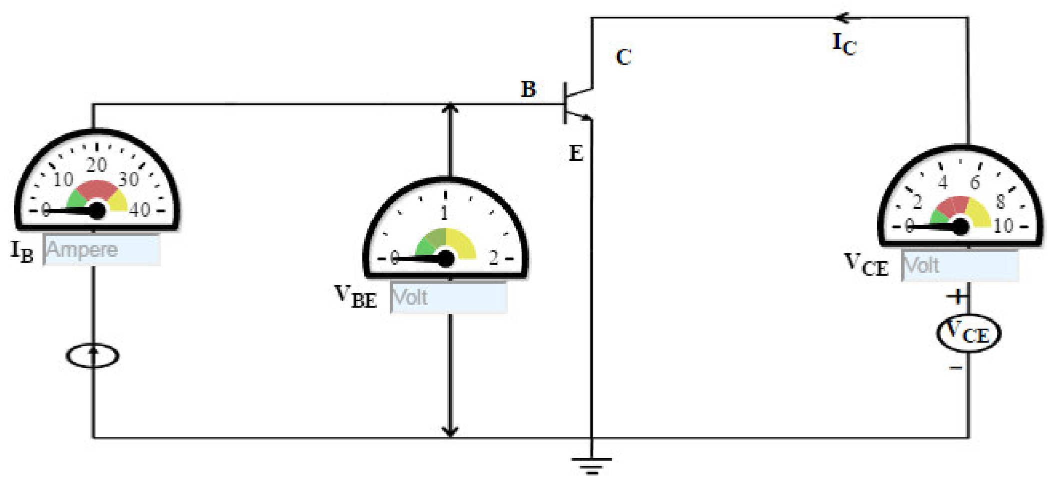
I. Input Characteristics

1. Take NPN transistor.
2. Set the Collector-Emitter Voltage(V_{CE}) to 1 V
3. Vary the Base Emitter Voltage(V_{BE})0.3 to 0.65 with interval 0.01.
4. Note the reading of Base current(I_B).
5. Click on 'Clear' button to take another sets of readings
6. Now set the Collector-Emitter Voltage(V_{CE}) to 5 V
7. Repeat step 3 to 4.
8. Record the values in the tabular column and draw the graphs

II. Output Characteristics

1. Take NPN transistor.
2. Set the Base current(I_B)20μA
3. Vary the Collector-Emitter Voltage(V_{CE})0 to 1 with interval 0.0005.
4. Note the reading of Collector current(I_C).
5. Click on 'Clear' button to take another sets of readings
6. Now set the Base Current(I_B) to 40 μA
7. Repeat step 3 to 4.
8. Record the values in the tabular column and draw the graphs

Result : Transistor characteristic curves are as shown



Observations

In put characteristics

V_{CE}=0V		V_{CE}=5V	
Base emitter voltage in V	Base Current in μA	Base emitter voltage in V	Base Current in μA

Output characteristics

Base current = μA		Base current = μA		Base current = μA	
V_{CE} in Volts	I_C in mA	V_{CE} in Volts	I_C in mA	V_{CE} in Volts	I_C in mA

Result : Transistor characteristic curves are as shown

III SEM BSc: Practical Questions

1. Measure the thickness of a paper strip forming an air wedge (5 trials) . Verify your answer using screw gauge. (wavelength of the source=589.3nm)

2. Determine the radius of curvature of one surface of the given lens by forming Newton's rings. Measure the Diameters of the 4 different rings.
(wavelength of the source=589.3nm)

3. Find out the values of Cauchy's constant by determining the refractive indices of different colours using a prism of angle A'=60^o.Compare the values by graphical method

4. Draw the *input characteristics* for the given transistor for two values of collector – emitter voltages and *output characteristics* for three base currents, hence calculate the ac and dc current gains and the input and output resistances for transistor in CE configuration. Value of current limiting resistors to be calculated.

5.Use the given zener diode as a voltage regulator .study the line regulation for two load resistances and load regulation for two inputs voltages,hence determine percentage of load and line regulations. (8 trials each) Draw relevant graphs.

6. Determine Planck's constant by measuring cut in voltages of given LEDs by direct method and graphical method.(assume the wavelength for red colour=643.8nm,yellow colour=589nm,green colour=508.5nm and blue colour=479.9nm)

7. Study the given NPN Transistor as a switch and determine the collector voltages at two extreme conditions

8. Determine the wavelength of the given monochromatic light using biprism . Measure fringe width for two different distances.

UNITS OF MEASUREMENTS

FUNDAMENTAL UNITS		
Quantity	**Unit**	**Symbol**
1. Length	meter	m
2. Mass	kilogram	kg
3. Time	second	s
4. Electric Current	ampere	A
5. Temperature	kelvin	K
6. Luminious Intensity	candela	Cd
7. Amount of Substance	mole	mol
SUPPLEMENTARY UNITS		
Quantity	**Unit**	**Symbol**
1. Plane Angle	Radian	rad
2. Solid Angle	Steradian	Sr

DERIVED UNITS		
Quantity	**Unit**	**Symbol**
1. Area	square meter	m^2
2. Volume	cubic meter	m^3
3. Density	kilogram/ cubic meter	kg/m^3
4. Velocity	meter/second	m/s
5. Angular Velocity	radian/ second	r/s
6. Acceleration	meter/second square	m/s^2
7. Angular Accleration	radian/second square	rad/s^2
8. Frequency	hertz	Hz
9. Force	newton	N
10. Work energy	joule	J
11. Power	watt	W
12. Pressure	pascal	Pa
13. Electrical charge	coulomb	C
14. Potential difference	volt	V
15. Electrical resistance	ohm	Ω
16. Capacitance	farad	F
17. Inductance	henry	H
18. Magnetic field	telsa	T
19. Luminious flux	lumen	lm
20. Dynamic Viscocity	newton sec./ square meter	$N\text{-}s/m^2$

STANDARD PREFIXES IN MEASUREMENTS

Prefiks	Symbol	Multiplying factor
yotta	Y	1 000 000 000 000 000 000 000 000 = 10^{24}
zetta	Z	1 000 000 000 000 000 000 000 = 10^{21}
exa	E	1 000 000 000 000 000 000 = 10^{18}
peta	P	1 000 000 000 000 000 = 10^{15}
tera	T	1 000 000 000 000 = 10^{12}
giga	G	1 000 000 000 = 10^{9}
mega	M	1 000 000 = 10^{6}
kilo	k	1 000 = 10^{3}
hecto	h	100 = 10^{2}
deka	da	10 = 10^{1}
deci	d	0,1 = 10^{-1}
centi	c	0,01 = 10^{-2}
milli	m	0,001 = 10^{-3}
mikro	µ	0,000 001 = 10^{-6}
nano	n	0,000 000 001 = 10^{-9}
piko	p	0,000 000 000 001 = 10^{-12}
femto	f	0,000 000 000 000 001 = 10^{-15}
atto	a	0,000 000 000 000 000 001 = 10^{-18}
zepto	z	0,000 000 000 000 000 000 001 = 10^{-21}
yocto	y	0,000 000 000 000 000 000 000 001 = 10^{-24}

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (Autonomous), UJIRE-574240

DEPARTMENT OF PHYSICS

KNOWLEDGE ENHANCEMENT THROUGH SKILL DEVELOPMENT

(LABORATORY WORK BOOK)

BSC -IVth SEMESTER

EXPERIMENTS

1. **Diffraction Grating-Minimum Deviation Method**
2. **Diffraction at a Straight Wire**
3. **Particle Size using LASER**
4. **Polarimeter-Specific Rotation of Sugar Solution**
5. **Full Wave Rectifier**
6. **Series resonance**
7. **Stefan Boltzmann Law**
8. **Solar cell Characteristics**
    - **Simulation experiment**

Name: **Roll No:**

INSTRUCTIONS AND SAFETY MEASURES

1. Come well prepared and do the experiment neatly.
2. Follow directions of the Staff In-charge and handle the equipments carefully.
3. Observe strict silence and be Professional
4. Perform at least two trials and do the calculations independently
5. Report all injuries or breakages to the lab in-charge immediately. Also, report any equipment that you suspect is malfunctioning.
6. Be careful when working with apparatus that may be hot. When you pick it up, use tongs, a wet paper towel, or other appropriate holder.
7. Each time you use glassware, be sure to check it for chips and cracks. Inform Staff In-charge about any damaged glassware so that it can be properly disposed of.
8. Request the staff in-charge to ensure all electrical circuits are proper before you turn on the power.
9. When working with electrical circuits, be sure that the current is turned off before making adjustments in the circuit.
10. During electronic experiments, verify the values of resistors / capacitors to be used.
11. Switch off the circuit and multimeter when you finish the experiment
12. After finishing optical experiments switch off the sources.
13. While doing the LASER experiments avoid the beam targeting your eyes
14. Eating anything while working in the lab is prohibited
15. Always keep your work area neat and clean
16. Ensure that equipment remains in the same condition and place before you leave the laboratory

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (Autonomous), UJIRE-574240

DEPARTMENT OF PHYSICS

CERTIFICATE

This is to certify that ....with Roll Number...................has satisfactorily completed the course of Experiments in Practical Physics prescribed by the College for BSc IVth Semester during the year 20……-- 20…….

Lecturer in charge of the Batch

Submitted on.....

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Expt No	Name of the Experiment	Date	Page Number
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3			
4			
5			
6			
7			
8			
9			

Signature and Name of the student

Experiment Number. Date

1. Diffraction Grating – Minimum Deviation Method

Aim:

To determine the wavelength of the prominent lines in the mercury spectrum using diffraction grating by minimum deviation method.

Apparatus:

Spectrometer, Diffraction grating, Mercury lamp, Spirit level, etc.

Description:

A grating consists of a plane glass plate on which a large number of close parallel rulingsare made at equal distance. When a light passes through the rulings, the diffraction plane will be observed in the transmitted light. The grating used in the laboratory are exact replicas of the original grating on a celluloid film. The celluloid film is kept in between two optically plane glass plates.

Theory:

Parallel rays of wavelength are incident on the grating surface making an angle 'i' with the grating normal.After diffraction the rays pass parallel to each other, inclined at an angle 'θ' with grating normal.

The total deviation D=i+θ. The deviation D varies as the angle of distance i. when D is minimum, $\frac{dD}{di} = 0$ which gives dΘ = -di. Now the path difference between rays passing through A and C to form n^{th}order spectrum.

=PA+AQ

=AC(sin i + sin θ)

= (a + b)(sin i + sin θ)

Where (a + b) is called grating constant. Differentiating and substituting dθ = -di, we get θ= i. Therefore at the position of minimum deviation, the path difference = 2(a+b) sin θ. The condition for maximum intensity in this direction is 2(a+b)sinθ = nλ. Sinceθ = i and D = i+θ we have $\theta = \frac{D}{2}$. Hence for diffraction maximum we have 2 (a+b) sin$\frac{D}{2}$ = nλ.

If there are N lines/unit length on grating

(a+b) = $\frac{1}{N}$ i.e. $\frac{2}{N}$sin $\frac{D}{2}$ = nλ

or 2 sin $\frac{D}{2}$ = Nnλ or $\lambda = \frac{2\sin\frac{D}{2}}{Nn}$

For the I order spectrum , n = 1

$\lambda = \frac{2\sin\frac{D}{2}}{N}$ ……………………. (1)

Procedure: The initial adjustments of the spectrometer are made. The grating is fixed with the rulings vertical on the prism table. The collimator slit is illuminated with the light from the mercury lamp so that the light passes axially through the collimator. The first order spectrum (n=1) is viewed directly and then observed through the telescope. Viewing a particular line (say green line) the prism table is turned till the line is in the minimum position. The reading of the vernier and the scale are taken.The procedure is repeated for the other lines. Finally the light from the collimator is viewed directly and the reading is taken when the image coincides with cross wire. By findings the difference between the direct reading and the minimum deviation reading, the angle of minimum deviation (D) is calculated for yellow, green, blue & violet lines.

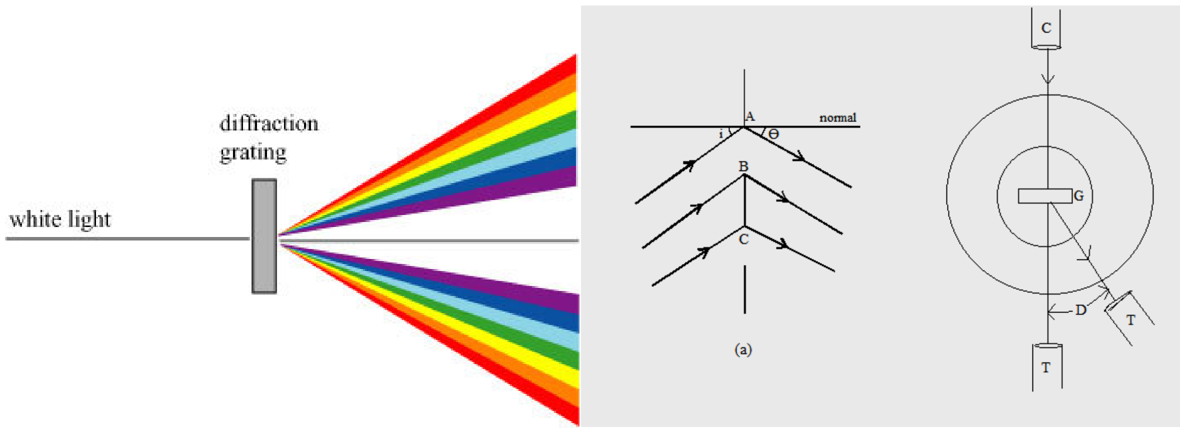
NOTE: Assuming the wave length of the green light as 546.1nm, N can be calculated using the formula

$$N = \frac{2\sin\left(\frac{Dg}{2}\right)}{n\lambda g}$$

Result:

1) Wavelength of yellow line = ……………… nm
2) Wavelength of blue line = ……………… nm
3) Wavelength of violet line = ………………. Nm

Observations



Order of the Spectrum n = 1

$$\text{Least count of the vernier } = \frac{1 \text{ m.s.d}}{\text{No. of division on vernier scale}}$$

$$\text{No. of lines per meter on grating N} = \frac{2\sin\frac{Dg}{2}}{n\lambda g}$$

λg = 546.1 nm

Wave length is $\lambda = \frac{2\sin D/2}{Nn}$ nm

Where D = Total deviation

To find the wavelength:

Colour of the line	**Vernier**	**Reading of the telescope in the minimum deviation Position X in Degrees**	**Direct reading Y in Degrees**	**Deviation D (X – Y) in Degrees**	**Mean D in Degrees**	Wavelength $\lambda = \frac{2\sin D/2}{Nn}$ nm
Yellow	A					
	B					
Green	A					$\lambda g = 546.1$
	B					
Blue	A					
	B					
Violet	A					
	B					

Result:

1) Wavelength of yellow line = ……………… nm
2) Wavelength of blue line = ……………… nm
3) Wavelength of violet line = ………………. nm

Experiment Number. Date

2. Diffraction at a Straight Wire

Aim:

To determine the diameter of the wire using the interference fringes formed within the geometric shadow, of the wire.

Apparatus:

Optic bench, given wire, sodium lamp, etc.

Theory:

Let AB represent the thin wire placed in front of linear slit illuminated by monochromatic light of wavelength λ. Let EF represent the cylindrical wave front just when it touches the wire so that the bright edges A & B become two independent sources of light sending out waves of the same wavelength and amplitude and the same phase. Let O be the midpoint of the shadow and C be the another point at distance X from O. the point C will be the bright or dark according as the path difference = BC – AC = nλ or (2n+1)$\frac{\lambda}{2}$. But the path difference = BC – AC =$\left(\frac{d}{D}\right)$x, where, d = diameter AB of the wire & D = distance between the wire & screen.

For C to be bright

$$\left(\frac{d}{D}\right)x = n\lambda, x = \left(\frac{d}{D}\right)n\lambda.$$

For the next bright fringe

$$\left(\frac{d}{D}\right)x' = (n+1)\lambda$$

$$\text{or } x' = \left(\frac{D}{d}\right)(n+1)\lambda$$

Therefore the fringe width

$$\beta = x - x' = \left(\frac{D}{d}\right)\lambda \text{ .... (1)}$$

If β_1&$\beta_2$are the fringe widths corresponding to distances D_1&D_2, we have,

$$\beta_1 = \frac{D_1\lambda}{d} \& \beta_2 = \frac{D_2\lambda}{d}$$

$$\text{or } \beta_2 - \beta_1 = \frac{(D_2 - D_1)\lambda}{d}$$

$$\text{Hence, } d = \frac{(D_2-D_1)\lambda}{(\beta_2-\beta_1)} \text{ ....(2)}$$

Procedure:

The wire is mounted vertically on one of the uprights on the optic bench. The heights of the uprightson the optic bench are adjusted such that the horizontal axis of the eyepiece, when produced, passes through the wire and the slit. The slit is illuminated by sodium light. The wire is made parallel to slit by adjusting the tangential screw which rotates the wire in its own plane. Toobtain the clear fringes, the slit should be made narrow. Thus by suitable adjustments of slit and the wire, a system of interference fringes are obtained in the field of view inside the geometric shadow. The eyepiece is fixed at a definite position D on the optic bench. At this position, by working the micrometer screw of the eyepiece, readings are taken on a number of fringes and band width is determined.

To eliminate the error associated with the measurements of D, the experiment is performed for three distances $D_1, D_2, \& D_3$ and the fringe width $\beta_1, \beta_2, \& \beta_3$ are calculated. The diameter d is calculated.

Result:

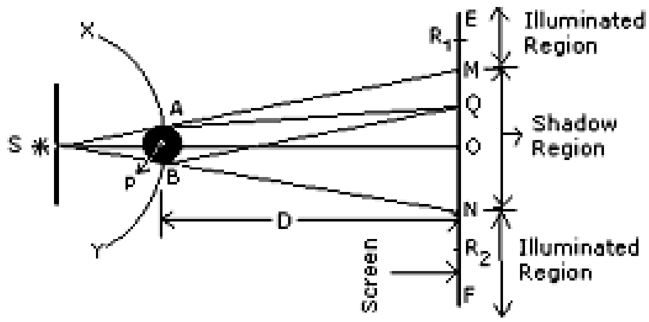
Diameter of the given wire

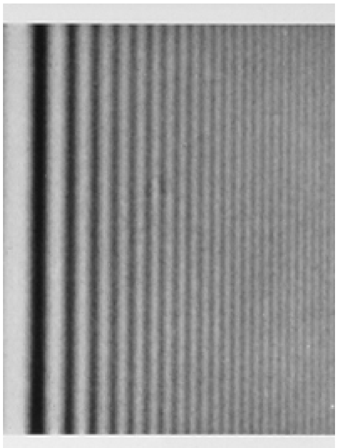
a)By experimental method = m

b)By Direct Calculation d= m

Observations:

Diagram





To find LC of the scale:-

Pitch = ………………… mm

No. of head scale divisions = ……………

LC = …………………… mm

Formula:

$$d = \frac{(D_2 - D_1)\lambda}{(\beta_2 - \beta_1)}$$

Where, d = diameter AB of the wire,

D = distance between the wire and screen

λ = wavelength of monochromatic light

β = fringe width

To determine the band width:

a) To determine Fringe width β_1: Position of eyepiece D_1 = ……………… m

No. of fringes	Micrometer reading cm	No. of fringes	Micrometer reading cm	Width of 3 bands cm	Mean width of 3 bands width (cm)
0		3			
1		4			
2		5			

fringe width β_1 = …………………..

b) To determineFringe width β_2: Position of eyepiece D_2 = ……………… m

No. of fringes	Micrometer reading cm	No. of fringes	Micrometer reading cm	Width of 3 bands cm	Mean width of 3 bands width (cm)
0		3			
1		4			
2		5			

fringe width β_2 = ………………….. m

c) To determineFringe width β_3: Position of eyepiece D_3 = ……………… m

No. of fringes	Micrometer reading cm	No. of fringes	Micrometer reading cm	Width of 3 bands cm	Mean width of 3 bands width (cm))
0		3			
1		4			
2		5			

fringe width β_3 = ………………….. m

Wave length of lightλ=589.6X10^{-9} m

Calculations:

1) $d = \frac{(D_2 - D_1)\lambda}{(\beta_2 - \beta_1)}$ = ……………….. m

2) $d = \frac{(D_3 - D_2)\lambda}{(\beta_3 - \beta_2)}$ = ……………….. m

3) $d = \frac{(D_3 - D_1)\lambda}{(\beta_3 - \beta_1)}$ = ……………….. m

Mean diameter of the wire d = …………………….. m

Diameter of the wire by direct method

$$\text{Pitch of the screw} = \frac{\text{Distance uncovered}}{\text{Rotations given}}$$

$$\text{Least count} = \frac{\text{Pitch}}{\text{No. of head scale divisions}} = \qquad = \qquad \text{mm}$$

Zero error = zero correction=

Trial No	Pitch Scale reading (mm)	H.S.R	Corrected H.S..R	Total reading d (mm)
1				
2				
3				

Mean diameter of the wire=

Result:

Diameter of the given wire

a) By Experimental method = m

b) By Direct Calculation d= m

Experiment Number. Date

3. Particle Size using Laser

Aim:

To measure the diameter of Lycopodium powder particle using laser beam

Apparatus:

Laser source, Glass plate, Lycopodium powder, Screen, etc.

Theory:

Measurement of particle size using laser is based on the Debye scherrer – hill diffraction of X – rays. This method assumes that the crystals in the powdered sample are oriented randomly . This results in the atomic planes positioned in every possible orientation. Diffracted rays go out from individual crystallite which happens to be oriented with planes making an angle θ with the beam satisfying Bragg's condition 2d sin θ = nλ, where n is the order of diffraction & λ is the wavelength of light, d is the distance between the atomic plaens&θ is the diffraction angle.

This principle can be extended to micro particle diffraction of visible laser beam since the particle size is comparable to that of visible wavelength of light within the size of laser beam there will be hundreds of particle, each oriented in different directions and the diffraction ring produced will be a function of size and the shape of the average particle.

A detailed mathematical analysis shows that the intensity is given by,

$$I = I_o\left[\frac{I_1(V)}{V}\right]^2$$

Where, V = $\frac{2\pi}{\lambda}$ $a\sin\Theta\,\Theta$, 'a' being the radius of the particle and 'θ' the angle of diffraction. The function of I_1(V) which occur at V = 3.833, 5.136, ...

Thus, the first dark ring appears when,

$$\text{Sin } \theta = \frac{3.833\lambda}{2\pi a} = \frac{1.22\lambda}{d}$$

Where 2a = d ,diameter of Lycopodium powder.

For small angle of diffraction $\sin\theta$can be replaced by $\tan\theta$ and from the figure

$$\tan\theta = \frac{\gamma}{D}$$

$$\frac{r}{D} = \frac{1.22\,\lambda}{d}$$

$$\text{or particle size, } d = \frac{1.22\lambda D}{r} \dots\dots\dots\dots\dots\dots\dots (1)$$

Where, 'λ' is the wavelength of the Laser radiation used. A graph of r v/s D is plotted. Slope of the of straight line is calculated and diameter of Lycopodium power is obtained using the formula,

$$d = \frac{1.22\,\lambda}{\text{slope}} \dots\dots\dots\dots\dots\dots\dots\dots (2)$$

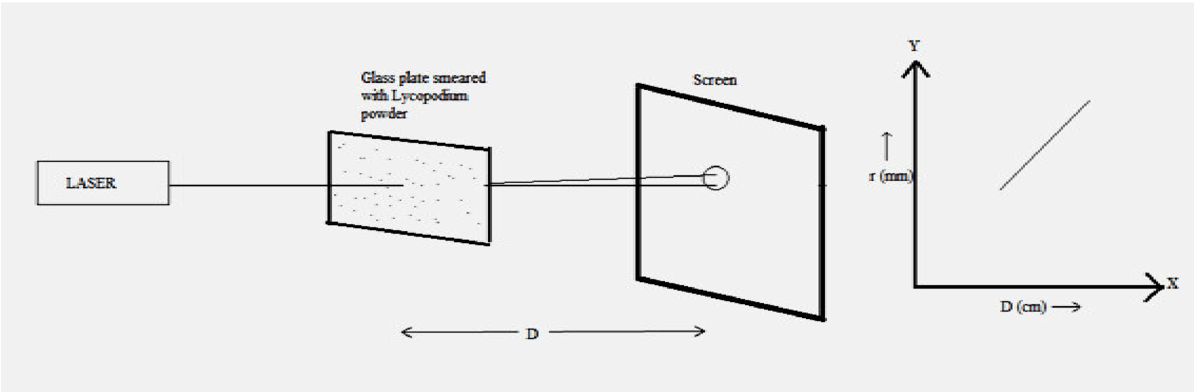
Procedure:

Lycopodium powder is smeared on a clean, dry glass plate and this glass plate is kept in front of the laser source as shown in the figure. 'D' is the distance between the glass plate and the screen. The radii of the ring obtained is measured using the scale. The experiment is repeated for different values of D.A graph of r v/s D is plotted which is a straight line . From the slope of the graph, diameter of the Lycopodium power is calculated using the equation (2).

Result:

Diameter of Lycopodium powder = ___________________m

Diagram:



Tabulation:

Trial Number	Distance between glass plate & screen D (m)	Radius of the ring =R (m)
1		
2		
3		
4		
5		
6		
7		
8		
9		

From graph, slope =__________________________

Diameter of the Lycopodium powder, d = $\frac{1.22\,\lambda}{\text{slope}}$=

= m

Result: Diameter of Lycopodium powder = ___________________m

Experiment Number. Date

4. Polarimeter – Specific Rotation of Sugar Solution

Aim:

To find the specific rotatory power of cane sugar solution using a polarimeter

Apparatus:

Laurent's Polarimeter, source of light, cane sugar etc.

Theory:

When plane polarized light is passed through certain substances like quartz or cane sugar solution which are optically active, it is found that the plane of polarization is rotated. Biot's study of optical activity led to the following laws:-

1.The angle of rotation of plane of polarization is directly proportional to the length 'l' of the solution traversed by light (or thickness of the substance).
2.The angle of rotation is directly proportional to the concentration of the solution (or density of the substance).
3.The angle of rotation is inversely proportional to the square of the wavelength of the light used.
4.It depends on the nature and temperature of the substance. Therefore at a given temperature, the Angle of rotation.

$$\theta \alpha \frac{LC}{\lambda^2}$$

The specific rotatory power or specific rotation is defined as the angle of rotation (in radians) of the plane of polarization produced by a solution of unit length and unit concentration at a given temperature for the given wave length of light. If 'L' is the length and 'C' is the concentration (in kg/m^3) angle of rotation.

$$\theta = SLC \text{ or } S = \theta/LC$$

Description of Laurent's Polarimeter:

It consists of a slit S, illuminated from a source of light. The rays are rendered parallel by the convex lens L. These rays pass through the Polarimeter P and are rendered plane polarized. The plane polarized light then passes through the biquartz (BQ). The biquartz is helpful in determining the angle of rotation of the plane of polarization very accurately. When a biquartz is employed, white light can be used to illuminate the slit. Otherwise the monochromatic source is to be used. T is a glass tube closed at both ends. The given solution can be taken in this. A is the analyzer which can be rotated about its axis. The amount of the rotation can be read on the circular scale. E is the eyepiece for observation.

Procedure:

The length L of the glass tube T is measured. The glass tube is then filled with distilled water and placed in its position. A bright source of yellowlight is placed in front of the Polarimeter in such a way that the axis of the Polarimeter passes through the center of the source of light. The analyser is rotated in its own plane and is adjusted for the tint of passage, when the whole field of view is of the same colour. The position of the analyser on the circular scale θ_1 is noted.

A solution of cane sugar is prepared by dissolving 0.01 kg. of cane sugar in 50 cc ($50 \times 10^{-6}\mathrm{m}^3$)of distilled water. The glass tube T is filled with the solution and is replaced in its position. Now the two halves of the field of view of the eyepiece which were matched earlier are found to be differently colored. The analyzer is again rotated till it is set to the tint of passage position. The reading corresponding to this position (θ_2^0) is noted.

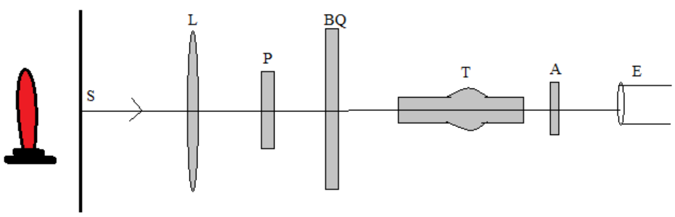
The difference between these two reading ($\theta_2^0 - \theta_1^0$) gives the angle in degrees through which the plane of polarization has been rotated. The experiment is repeated for different concentrations. The specific rotary power 'S' of the sugar solution is calculated using the relation S = $\frac{\theta}{\mathrm{CL}}$ where Θ is in radian measure given by Θ = $\frac{\pi}{180}(\theta_2^0 - \theta_1^0)$.

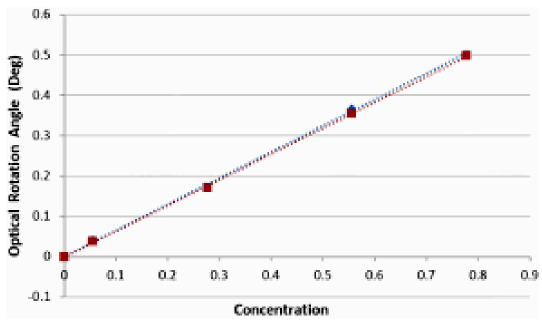
A graph of concentration versus angle of rotation of the plane of polarization is drawn. This is found to be straight line.

Note: Using the Θ vs C graph the angle rotation can be determined for any unknown concentration.

Result:

The specific rotary power of cane sugar solution = ___________ rad $\mathrm{m}^2\mathrm{kg}^{-1}$





Observations:

Least count of the vernier of the Polarimeter = $\frac{1\ \mathrm{m.s.d}}{\mathrm{No.of\ div.on\ vernier}}$

Length of the tube which contains the liquid l = _________ m

Reading for the tint off passage with distilled water θ_1^0 =

Formula:

$$S = \frac{\theta}{\mathrm{CL}}$$

Where, S =The specific rotatory power or specific rotation,

l = length of the tube which contains the liquid and

C = concentration (in kg/m^3) , θ = angle of rotation.

Tr. No.	Concentration C Kgm^{-3}	Reading for Tint off passage with sugar solution θ_2 degrees	Angle of rotation $\theta = \theta_2 - \theta_1$ in degrees	Angle of rotation in Radians $\frac{\pi \times \theta}{180}$	$S = \frac{\theta}{CL}$ rad m^2kg^{-1}
1	200				
2	100				
3	50				
4	25				

Result:

The specific rotatory power of cane sugar solution = ___________ rad m^2kg^{-1}

Experiment Number. Date

5.Full Wave Rectifier

Aim:

To construct a full wave bridge rectifier with (a) capacitor filter (b) choke input or LC filter and (c) π filter ,and to study the variations of output dc voltage and ripple factor with load current.

Apparatus:

Voltmeter, DC miliammeter 0-100 mA, Rheostat 500Ω 500mA, transformer 9V -500mA, diodes IN4001, Inductor, capacitors 2200μF-25V, 1000μF-25V.

Description:

The process of conversion of AC into DC (unidirectional current)is called rectificationA four-diode bridge is most commonly used to obtain full wave rectification. The AC pulses present in the output are filtered off using filters.To reduce the mains voltage to low value , a step down transformer is used.

Theory:

The fig (a) shows a full wave bridge rectifier with four diodes $D_1, D_2, D_3 \& D_4$connected in the form a bridge to provide full wave rectification. During a half cycle of the input , when A is positive with respect to B,.$diodes$ $D_1 \& D_3$ conduct while, during the next half cycle $D_2 \& D_4$ conduct. Therefore , the current, in the external circuit always flows in the same direction with changing magnitude.This out put of the rectifier is DC with fluctuations or ripples.

The filters are used to reduce fluctuations in the rectified voltage. When a large capacitor is connected across the output terminals of the rectifier, It get charged to the peak voltage V_m, during the first quarter cycle. During the rest of the cycle, the capacitor loses very little charge (the time constant is large). Thus, until the rectifier output catches up again, the filtered output had decreased very little from the peak value. A shunt capacitor reduces the voltage fluctuations. DC output is very nearly the peak voltage V_m.

When an inductor is in series with the load, it opposes the changes in the current through it. Or it opposes the fluctuations and the output remains almost constant.In Pie filter one more shunt capacitor is connected which smoothens the out putfurther.Regulating action is estimated using the formula

$$\text{Percentage of voltage regulation} = \frac{V_{\text{no load}} - V_{\text{full load}}}{V_{\text{no load}}} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where, $V_{\text{no load}}$ = DC output voltage with no load current $(I_L = 0)$&

$V_{\text{full load}}$= DC output voltage with maximum load current $(I_L = \text{maximum})$

Procedure:

1.**No Filter**:The circuit is made as shown in the fig (a) without any filter. The DC & AC voltages across the load are noted by setting the load current I_L =0, 50,60,70,80 90 mA.. The ripple factor r = $\frac{V_{ac}}{V_{dc}}$ are calculated. Graphs are drawn connecting I_L&V_{dc} and I_L&γ. The percentage of voltage regulation is calculated using equation(1).

2.C Filter: A capacitor of high value 1000 µF is connected across the load.The DC & AC voltages are measured under no load conditions and for different load currents. The ripple factor is calculated and the graphs are drawn .

3.LC Filter: An inductor of high value (>0.5H) is connected in series with the load. The whole experiment is done as detailed earlier.

4.**Π Filter:** Capacitors of high value is connected across the load as shown. The experiment is done as described earlier and graphs are drawn.

Result: Following table summarizes the result

Particulars	No filter	C filter	LC filter	Π filter
Percentage of regulation				
Variation of V_{dc} with I_L				
Variation of ripple factor withI_L				

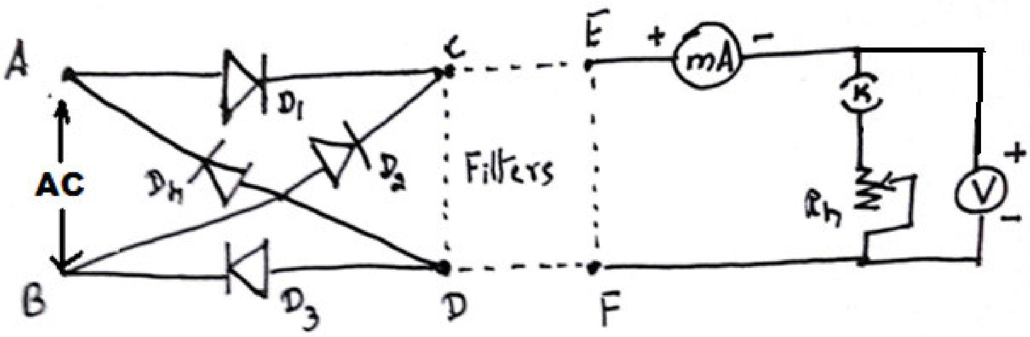
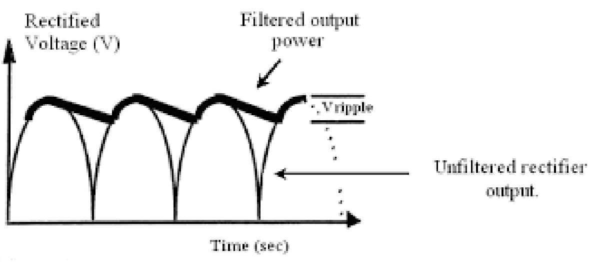
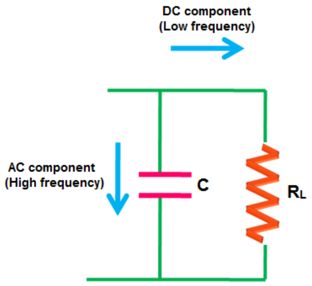
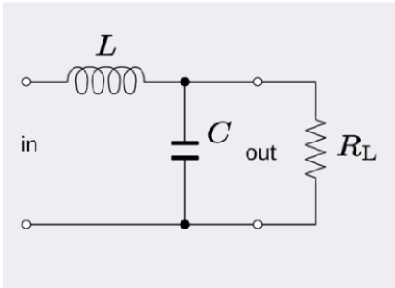


Fig a

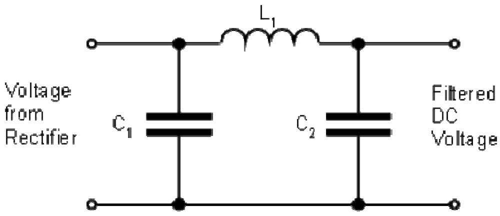


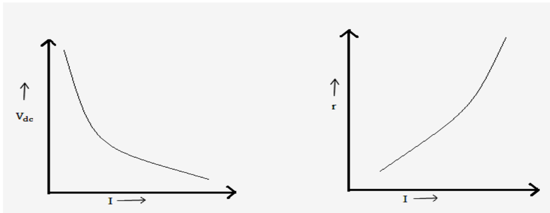
Rectifier Output





C Filter   LC Filter





∏ Filter

Graphs

Tabulation: Transformer output = … . V

Load current mA	No filter			C filter			LC filter			π filter		
	Voltage across the load(V)		Ripple factor $\gamma = \frac{V_{ac}}{V_{dc}}$	V_{dc}	V_{ac}	Ripple factor $\gamma = \frac{V_{ac}}{V_{dc}}$	V_{dc}	V_{ac}	Ripple factor $\gamma = \frac{V_{ac}}{V_{dc}}$	V_{dc}	V_{ac}	Ripple factor $\gamma = \frac{V_{ac}}{V_{dc}}$
	V_{dc}	V_{ac}										
0												
Percentage Regulation												

6. Series Resonance

AIM :

To study the frequency response of a series RLC circuit and to determine (a) the resonant frequency and (b) the quality factor of the circuit.

APPARATUS :

AF sine wave generator, VTVM or FET VOM meter, a.c. milliammeter (rectifier type) of range 0-5 mA, resistance box, capacitor, fluorescent lamp choke or any inductance coil etc.

THEORY :

A circuit with capacitance C, inductance L and resistance R, connected in series with an a.c source forms a series resonant circuit. When a constant voltage of varying frequency is applied to such a circuit, the current shows a resonant increase at a frequency called the resonant frequency f_o.

For $f << f_o$, the capacitive reactance $X_c = \frac{1}{2\pi fC}$ of the circuit is much larger than the inductive reactance $X_L = 2\pi fL$. Most of the voltage drop is across the capacitor. The current in the circuit is small and leads the applied voltage. For $f >> f_o$, the inductive reactance is large compared to capacitive reactance. The current in the circuit is small and lags behind the applied voltage. At resonant frequency, the capacitive and inductive reactances are exactly equal. Consequently, the impedence in the circuit is minimum and is equal to the resistance in the circuit. Thus the current in the circuit is maximum and is in phase with the applied voltage.

[The resistance R in the circuit (fig 1a) is the equivalent series resistance in the circuit, taking into account all the energy losses in the circuit. It includes losses due to ohmic resistance of the inductance coil, hysterisis loss and eddy currents in its core, and any additional resistance connected].

At resonance, inductive reactance X_{L_o} = capacitive reactance X_{C_o}

$$2\pi f_o L = \frac{1}{2\pi f_o C} \quad \text{or} \quad f_o = \frac{1}{2\pi\sqrt{LC}} \quad \text{------------------} \quad (1)$$

The resonant frequency is independent of the resistance R in the circuit. The current at resonance,

$$i_o = \frac{V}{R} \quad \text{--------------------} \quad (2)$$

QUALITY FACTOR :

In the circuit under consideration, the capacitance stores energy in the electric field while the inductance returns energy in its magnetic field and vice versa. Thus, the reactive power is exchanged between the inductance and capacitance, while the resistance dissipates power.

At resonance, the reactive powers of inductance and capacitance being equal, the source has to supply only the active power required by the resistance of the circuit. The ratio of reactive power of inductance (or capacitor) at resonance to the active power of the resonant circuit is called the quality factor or Q of the circuit.

$$Q = \frac{i^2 X_{L_o}}{i^2 R} = \frac{i^2 X_{C_o}}{i^2 R}$$

$$\therefore \quad Q = \frac{2\pi f_o L}{R} \quad \text{-------------} \ (3)$$

$$\text{Also } Q = \frac{1}{2\pi f_o C R} \quad \text{----------------} \ (4)$$

Now, the voltage across the capacitor, at resonance is $V_c = i_o \ X_{C_o}$

using eqn. (2) $V_c = \frac{V}{R} \cdot \frac{1}{2\pi f_o C} = \frac{V}{2\pi f_o C R}$

using eqn (4) $V_c = QV$ and $Q = \frac{V_c}{V}$ ------------------ (5)

Thus, there is a resonant rise of voltage across the capacitor.

BAND WIDTH :

A resonant circuit selects a band of frequencies. To estimate the width of this band, two frequencies f_1 and f_2 which differ from f_o by $\frac{1}{2Q}$ are located. Then the bandwidth

$$B = \frac{f_o}{Q} \quad \text{----------------} \ (6)$$

Q measures the sharpness of resonance.

Further, at f_1 and f_2, the current in the circuit reduces to $\frac{i_o}{\sqrt{2}}$ so that bandwidth $B = f_2 - f_1$ ------------------- (7)

PROCEDURE :

The circuit is made as in fig 1(a) with C = 0.1 μF. R_1 is made zero.

The frequency of the source is set at $100 H_z$. The voltage V across the RLC series is adjusted, say, to 1 volt. The current i in the circuit is noted. The current is noted for frequencies 200 Hz, 300 Hz . . . etc., keeping V constant, throughout. The resonant frequency f_o is located. The frequency is fixed at f_o. The current i_o and the voltage V_c across the capacitor are noted. A graph with f along X axis and current i along Y axis is drawn. The inductance of the coil (eqn.1), the resistance R in the circuit (eqn.2), the quality factor (eqns. 4 & 5) and the bandwidth B (eqns. 6 & 7) are calculated.

The whole experiment is repeated for R_1 = 1K ohm

Results

Particulars		Resistance included in ohms	
		R_1=0 ohms	R_1=1000 ohms
Resonance frequency f_0 in Hz			
Quality factor	Theoretical		
	Experimental		
Band width in Hz	Theoretical		
	Experimental		

Circuit diagram

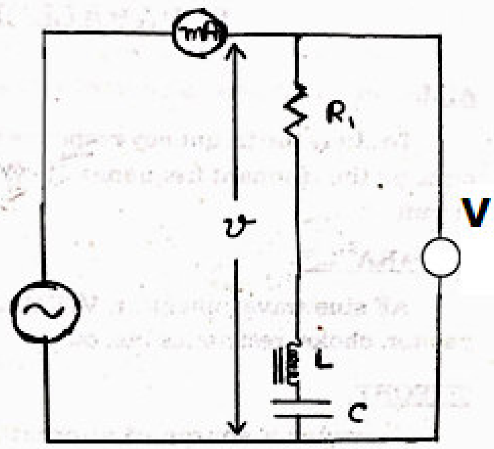
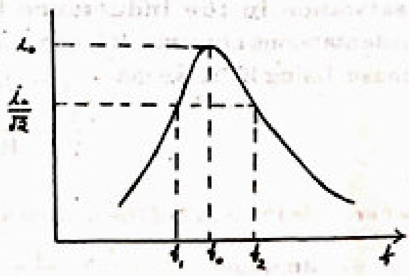


Fig. 1 (a)



Capacitance of the Capacitor=0.1 μF
Input voltage=V=1 volt

Tabulations

Frequency in Hz	**Current in the circuit in mA**	
	R_1=0	**R_1=1000K**
100		
200		
300		
400		
450		
500		
550		
600		
700		
800		
900		
1000		
1100		
Resonance frequency f_0		
Max Current I_0		
Resistance in the circuit at resonance $R=V/I_0$ ohms		
Voltage across C at f_0 Volts		

Particulars		**R_1=0 ohms**	**R_1=1000 ohms**
Quality factor	Theoretical $Q=1/2\prod_{f0}CR$		
	Experimental $Q=V_0/V$ at f_0		
Band width in Hz	Theoretical $B=f_0/Q$		
	Experimental $B=f_2-f_1$		

Results

<table>
<tr><td colspan="2" rowspan="2">Particulars</td><td colspan="2">Resistance included in ohms</td></tr>
<tr><td>R_1=0 ohms</td><td>R_1=1000 ohms</td></tr>
<tr><td colspan="2">Resonance frequency f_0 in Hz</td><td></td><td></td></tr>
<tr><td rowspan="2">Quality factor</td><td>Theoretical</td><td></td><td></td></tr>
<tr><td>Experimental</td><td></td><td></td></tr>
<tr><td rowspan="2">Band width in Hz</td><td>Theoretical</td><td></td><td></td></tr>
<tr><td>Experimental</td><td></td><td></td></tr>
</table>

Experiment Number : Date :

7.Stefan - Boltzmann Law

AIM :

To verify the Stefan - Boltzmann fourth power law.

APPARATUS :

Method 1 : 6V-300 mA bulb, 12V DC source, resistance boxes : 0 - 1000 ohm, 0-50 ohm, d.c milliammeter 0-500 mA, galvanometer, rheostat (1 amp rating)

Method 2 : 6V-300 mA bulb, 12V DC source, standard resistance of 2 of 5 ohm, 0-500 mA milliammeter, potentiometer galvanometer, rheostat etc.

THEORY :

Stefan - Boltzmann law states that the rate of radiation of energy from a black body varies directly as the fourth power of the absolute temperature T of the body.

$$\frac{dE}{dt} \propto T^4 \quad \text{.............. (1)}$$

Let the filament of a low voltage bulb be treated as a black body. Then, if the temperature of the filament is large compared to room temperature, loss of energy due to convection and conduction can be neglected. Thus, we can assume that the energy dissipated by the filament is mainly due to radiation.

$$\therefore \frac{dE}{dt} = I^2R \propto AT^n \quad \text{.............. (2)}$$

where I is the current through the filament, R its resistance. A is a constant and n = 4 according to the Stefan-Boltzmann law.

The resistance variation of tungsten (filament material) with temperature shows that $R \propto T^{1.25}$ .... (3) between 300°K and 2300°K

$$\therefore I^2R = B R^{\frac{n}{1.25}} \quad \text{where B is a constant.}$$

$$\text{or } \log(I^2R) = \frac{n}{1.25} \log R + B \quad \text{.............. (4)}$$

A graph of log I^2R along Y axis and log R along X axis gives a straight line wit! slope

$$s_1 = \frac{n}{1.25} \quad \therefore n = (1.25)\, s_1 \quad \text{.................. (5)}$$

. Also, $I^2 = B R^{(\frac{n}{1.25} - 1)}$

Taking log. $$2 \log I = \left(\frac{n}{1.25} - 1\right) \log R + \log B$$

or $$\log I = \left(\frac{n}{2.5} - 0.5\right) \log R + \log B \quad .... (6)$$

A graph of log R along X axis and log I along Y axis gives a slope

$s_2 = \left(\frac{n}{2.5} - 0.5\right)$. The Value of n can be determined using relation

$$n = (s_2 + 0.5)\, 2.5 \quad .... (7)$$

PROCEDURE :

The connections are made as in fig 8a. A low voltage bulb (6V 0.3A) can be used for the experiment . Let S = 10 ohm (10W) and P = 100 ohm

The rheostat is adjusted to get a current I = 100mA through the filament. A minute or two is allowed for the temperature to stabilize. The bridge is balanced by adjusting Q. The resistance of the filament (plus that of ammeter coil)

$$R = \frac{Q}{P} S = \text{...........} \ \Omega$$

The experiment is repeated for I = 120, 140, ... 240mA. A graph of log I^2R against log R is drawn. The radiation index n is calculated from the slope (fig 8b) (eqn. 5). A graph of log I against log R is drawn. The value of n is calculated from the slope (fig 8c) (eqn. 6). P, Q, & S should have a rating of at least one ampere so that they do not get heated during the experiment.

NOTES :

(1) The filament of the bulb is not an ideal black body. Thus the value of n, obtained in the experiment, is only approximate.

(2) The filament resistance is of the order of 10 ohm, while the milliammeter coil has a resistance of a fraction of an ohm. Thus the value of R can be treated as that of the filament for all practical purposes.

RESULT :

The radiation index n = which is approximately 4. Hence Stefan - Boltzmann fourth power law is verified.

Observations :

Bulb used : 6V 0.3Amp. P = 100 ohm.,Q=100 ohms

Diagrams :

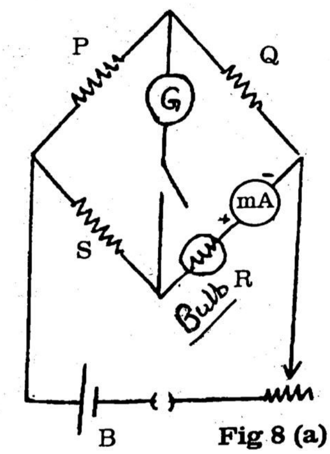


Fig 8 (a)

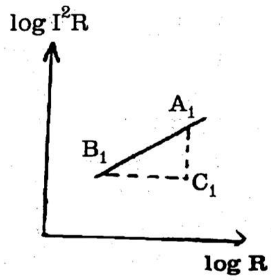


Fig 8 (b)

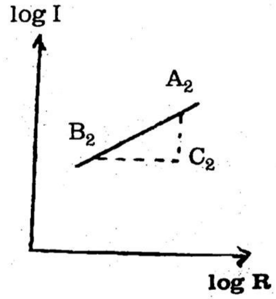


Fig 8 (c)

Tabulations

T.no	Current I after balance (A)	Log I	Balancing resistance S ohms	Filament resistance ohms $R = \frac{QS}{P}$	Log R	I^2R	$\log I^2R$

Calculations :

Graph I :

Slope S_1=

$$S_1 = \frac{n}{1.25}$$

Radiation index n = 1.25 S_1 =

Graph II :

Slope S_2=

$$S_2 = \frac{n}{2.5} - 0.5$$

Radiation index n = 2.5 (S_2 + 0.5) =

Average n=

Experiment Number. Date

8.SOLAR CELL CHARACTERISTICS

Aim:To determine solar cell characteristics of the given solar cell, it's Maximum power point power,efficiency,and Fill factor

Apparatus required: Solar cell experiment set up consisting of digital DC ammeter of range 0-2A,digital DC milli Voltmeter of range 0-200mV,,Light source ((50W),solar cell (5 cm radius),AC power supply 12V,5A, a variable resistant box and connecting wires.

Description:Here I-V Characteristic curves of monocrystalline silicon solar cell are studied using standard 50W MR 16 type halogen lamp.solar cells are special semiconductor devices which produce electric voltage across its terminals by absorbing sunlight.The light photons are converted into voltage hence the process is called photovoltaic effect.A solar cell looks like fragile wafer as shown.Solar cells are cascaded in series or parallel to obtail solar cell module for commercial use.

The photons absorbed by the solar cell create hole-electron pair inside the crystal.accumulation of such pairs give rise to potential across the terminals of the solar cell.

The solar cell equivalent circuit consists of constant current source producing photo current $I_{ph}$and a diode parallel to it as shown.The photo current IPH is directly proportional to the incident light energy.The diode represents p-n transition area of the solar cell.

Applying Kirchhoff law

$$I_{PH}=I_D + I$$

Where I_{PH} is photo current,I_D is the current through diode and I is the output current.

$$I=I_{PH}-I_D$$

Diode current at room temperature is

$$I_D=I_S(e^{40V}-1)$$

Where $I_S$is reverse saturation current and V is the voltage across output terminal.therefore

$$I=I_{PH}-I_S(e^{40V}-1)\ldots\ldots\ldots\ldots\ldots\ldots.(1)$$

represents IV characteristics of solar cell

Solar cell parameters

Maximum power point Power(P_{MPP})

As per the maximum power transfer theorem,the cell delivers maximum power to the load,when its internal resistance becomes equal to the external load.Internal resistance varies with incident energy and attains a a minimum value at maximum intensity.At this saturation value powerout put is maximum.this maximum power output is termed as maximum power point power(P_{MPP})At this point maximum power transfer takes placeand is given by

$$P_{MPP}=V.I$$

Short circuit current(I_{SC}): When the solar terminals are shorted,(RL=0),Current flowing is called short circuit current.

Open circuit voltage (V_{OC}): It is the voltage measured across the terminals of solar cell .when load terminals are open.

At both cases of open or short circuit the power dissipated is zero.

Efficiency: In a solar cell light energy is converted into electrical energy.All input light is not converted into electrical energy.The conversion efficiency in percentage is given by

$$\eta = \frac{p_{mpp}}{S \cdot E} \text{..........(2)}$$

Where S is the surface area of solar cell and E is the light intensity $W1/d^2$ here d is the distance of the solar cell from the light source

$S=\pi r^2$......................(3) where r is the radius of the cell

$$E = \frac{W1}{d^2} \text{....................(4)}$$

Fill Factor (FF):It is the measure of individual photo junctions inside the solar cell which is effectively contributing to the photo current.in general 75 % to 80 % of the cells contribute.It is also the measure of the perfectness of characteristic curves. If the graph resembles a square then FF is 100 percent.

Fill factor is given by

$$FF = \frac{\eta \cdot S \cdot E}{I_{sc} V_{oc}} \text{................(5)}$$

Procedure:

1. The circuit connections are made as shown in the fig. The solar cell illuminator power supply is switched on.Cooling fan is switched on
2. Solar cell is placed under the halogen lamp at a convenient distance (d m)
3. The variable resistance is shorted (R=0),and short circuit current(I_{SC}) is noted.
4. Both the terminals of the variable resistance are disconnected.(R=∞).The open circuit voltage (V_{0C}) is noted.
5. The rheostat is reconnected and it is adjusted to have a convenient voltage value in the voltmeter. The corresponding current is noted.Experiment is repeated for other convenient voltages.
6. All values are tabulated and Power in each case is determined and maximum power (P_{MPP}) is noted.
7. Area of cross section of the cell A,Power of the source E are calculated using the equations (3) and (4) respectively.
8. Conversion efficiency (▪) and fill factor (FF) are calculated using equation (1) and (5) respectively.
9. Experiment is repeated by keeping the solar cell at another from the source and Solar cell parameters are estimated.
10. IV characteristics of solar cell and power variation graph for both cases are plotted. Maximum power point power (P_{MPP}) from each graph is estimated

Note:

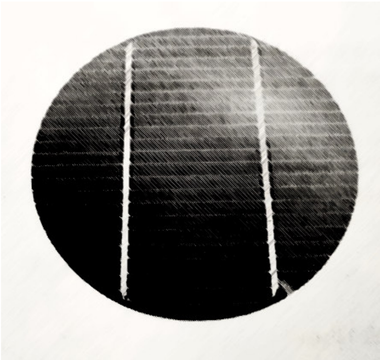
- For a given solar cell Maximum power point power is constant.
- All parameters are temperature dependent

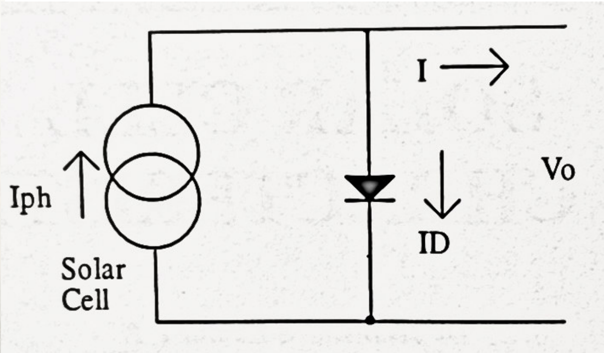
Result: 1) VI characteristics of the solar cell are as shown in the graphs

2) Solar cell parameters are as given below.

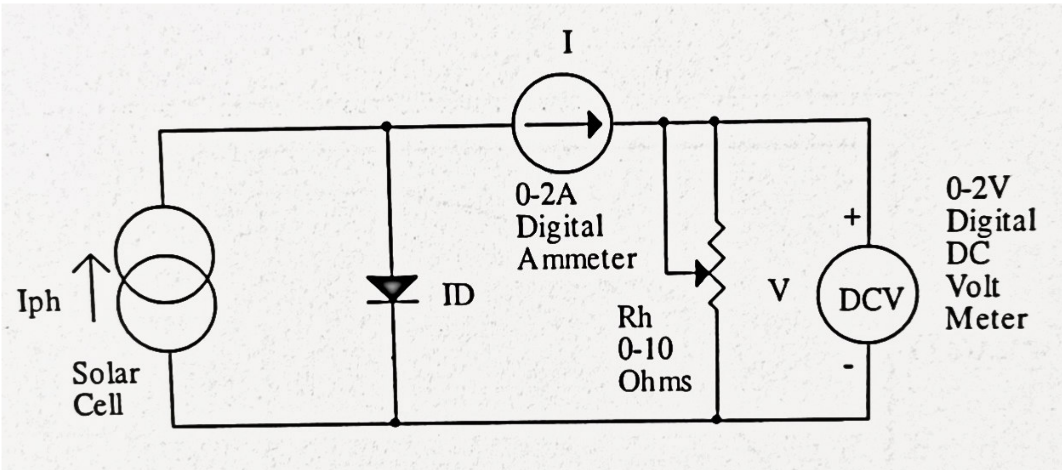
Parameter	**Distance d=**	**Distance d=**
Max power point power $\mathbf{P_{MPP}}$ **in Watts**		
Max power point power $\mathbf{P_{MPP}}$ **in Watts** from graph		
Efficiency (▪)		
Fill factor (FF) %		

Figures and circuit diagrams

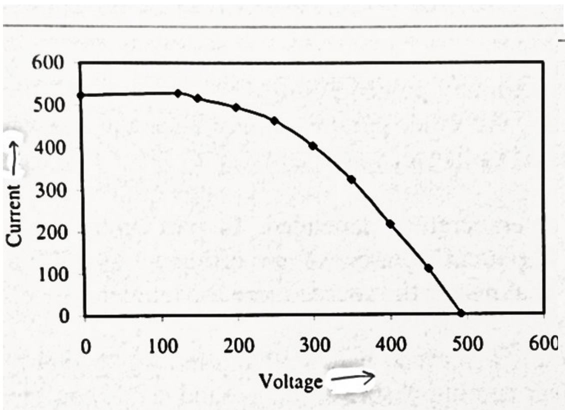


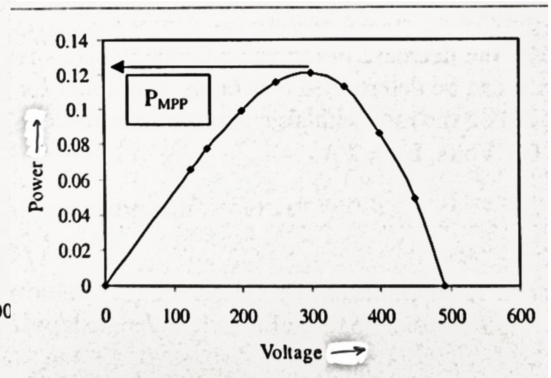


Solar cell **Equivalent circuit**



Circuit diagram





VI Characteristics **Power variation**

Observations :

T no	Voltage V in V	**Distance d= m**			Voltage V in V	**Distance d= m**		
		Current I in A	Power W =VI Watts	P_{MPP} Watts		Current I in A	Power W =VI Watts	P_{MPP} Watts
1	0	Isc=	0		0	Isc=	0	
2								
3								
4								
5								
6								
7								
8								
9								
10	V_{OC}=	0	0		V_{OC}=	0	0	

Source Power W1=50 watts

Radius of the solar cell =5 X 10^{-2} m

Parameters	**Distance d= m**	**Distance d=m**
Area $S=\pi r^2$ in m^2		
Light intensity $E=W1/d^2$		
Max power point power **P_{MPP} in Watts**		
Max power point power **P_{MPP} in Watts** from graph		
Efficiency (▪) $\eta = \frac{p_{mpp}}{S \cdot E}$		
Fill factor $FF = \frac{\eta \cdot S \cdot E}{I_{sc} V_{oc}}$ **%**		

Experiment Number. Date

9. SIMULATION EXPERIMENT

FULL WAVE RECTIFIER

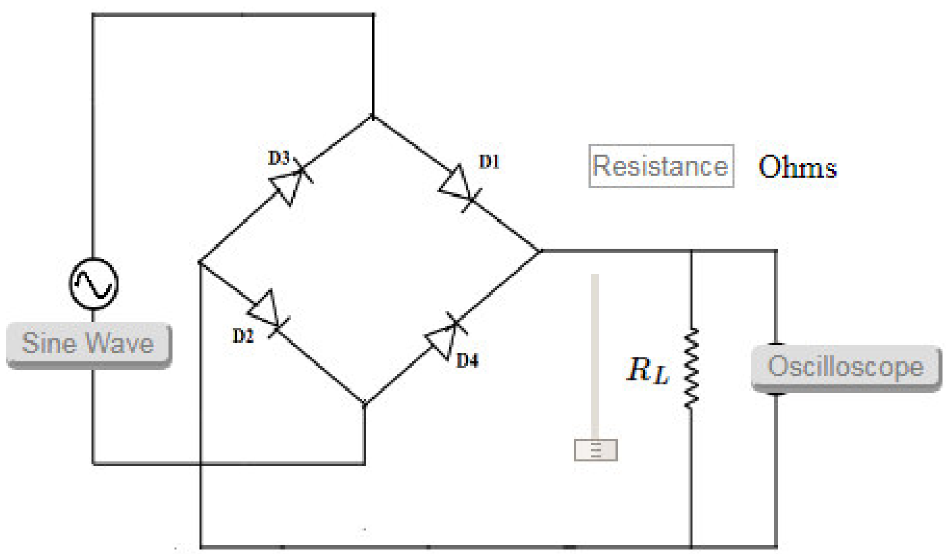
Aim: To study the working of a full wave bridge rectifier by simulation experiment and to calculate the ripple factor

Procedure: Set the load resistor $R_L$to a particular value.say 500 ohms.

1. Click on 'ON' button to start the experiment.
2. Click on 'Sine Wave' button to generate input waveform
3. Click on 'Oscilloscope' button to get the rectified output.
4. Vary the Amplitude, Frequency, volt/div using the controllers.
5. Click on "Dual" button to observe both the waveform.
6. Channel 1 shows the input sine waveform, Channel 2 shows the output rectified waveform.
7. Measure peak value Vm and hence V rms
8. Calculate Vdc
9. Calculate the Ripple Factor.
10. Repeat the experiment for different values of load resistors

Result: Average ripple factor of the full wave bridge rectifier is =

Circuit diagram



Tabulation

Value of Load resistance selected=500ohms
Amplitude of the input wave=2000Hz

Input voltage Volts	**output Peak Value** ***V_m volts***	***V_{rms}*****= $V_m/\sqrt{2}$ volts**	V_{rms}^2	***V_{dc}*****= $2V_m/\pi$ volts**	***V^2dc***	Ripple factor $\gamma = \sqrt{\frac{V^2\mathrm{rms}}{V^2dc}} - 1$

Average ripple factor of the full wave bridge rectifier is =

BSC Practicals- IV Semester -PRACTICAL QUESTIONS

1. Determine the wavelengths of violet, blue and yellow lines of mercury spectrum using plane diffraction grating and spectrometer by minimum deviation method.Assume the wavelength of Green line of mercury spectrum to be 546.8nm, to determine the grating constant.

2. Determine the diameter of the given wire by diffraction at a straight wire method forming 6 diffraction bands in the shadow region. Measure the band width for two different distances. Verify the answer using screw gauge.

3. Prepare sugar solutions of concentrations 200 Kg m^{-3} ,100 Kg m^{-3},50 Kg m^{-3} , 25 Kg m^{-3} ,measure the angle of rotation and hence calculate the specific rotations. Verify your answer drawing the necessary graph .

4. Determine the diameter of Lycopodium powder particles by laser Diffraction method.

5. Construct a full wave bridge rectifier circuit and find out the ripple factor for NO filter,C filter and LC filter for 6 different loads. Draw ripple factor verses load current and Vdc verses load current graphs in each case. find the percentage regulation

6. Using given components construct a series resonance circuit and study frequency response curve, Determine resonance frequency, quality factor, Band width for two resistances. compare experimental values with theoretical values

7. Verify Stefan Boltzmann law by using by using incandescent bulb as a heat radiater.Draw the necessary graphs.(Minimum 6 trials)

8. Draw solar cell characteristics of the given solar cell hence determine Maximum power point power, efficiency, and Fill factor for two different distances of the solar cell from light source.

UNITS OF MEASUREMENTS

FUNDAMENTAL UNITS		
Quantity	**Unit**	**Symbol**
1. Length	meter	m
2. Mass	kilogram	kg
3. Time	second	s
4. Electric Current	ampere	A
5. Temperature	kelvin	K
6. Luminious Intensity	candela	Cd
7. Amount of Substance	mole	mol
SUPPLEMENTARY UNITS		
Quantity	**Unit**	**Symbol**
1. Plane Angle	Radian	rad
2. Solid Angle	Steradian	Sr

DERIVED UNITS		
Quantity	**Unit**	**Symbol**
1. Area	square meter	m^2
2. Volume	cubic meter	m^3
3. Density	kilogram/ cubic meter	kg/m^3
4. Velocity	meter/second	m/s
5. Angular Velocity	radian/ second	r/s
6. Acceleration	meter/second square	m/s^2
7. Angular Accleration	radian/second square	rad/s^2
8. Frequency	hertz	Hz
9. Force	newton	N
10. Work energy	joule	J
11. Power	watt	W
12. Pressure	pascal	Pa
13. Electrical charge	coulomb	C
14. Potential difference	volt	V
15. Electrical resistance	ohm	Ω
16. Capacitance	farad	F
17. Inductance	henry	H
18. Magnetic field	telsa	T
19. Luminious flux	lumen	lm
20. Dynamic Viscocity	newton sec./ square meter	$N\text{-}s/m^2$

SCHEME FOR PRACTICAL EXAMINATIONS

BSC IVth SEMESTER

Particulars	Marks
Formula	3
Setup / Circuit / tabulation	4
Observation and number of trials	10
Knowledge about the experiment	5
Calculation and graph	5
Result and accuracy with units	3
Class records- Regularity in completing the experiments/ Neatness / General impression	10
Internal assessment for Practicals	10
Total	50

Fundamental Physical Constants

Constant	Symbol	Value
Avogadro's number	N_A	$6.022\ 141\ 29 \times 10^{23}$/mol
Boltzmann's constant	k	$1.380\ 6488 \times 10^{-23}$ J/K
Elementary charge	e	$1.602\ 176\ 565 \times 10^{-19}$ C
Electron mass	m_e	$9.109\ 382\ 91 \times 10^{-31}$ kg
Neutron mass	m_n	$1.674\ 927\ 351 \times 10^{-27}$ kg
Proton mass	m_p	$1.672\ 621\ 777 \times 10^{-27}$ kg
Speed of light in vacuum	c	2.99 792 458 m/s (exact)
Universal gravitation constant	G	$6.673\ 84 \times 10^{-11}$ N · m^2/kg^2
Universal gas constant	R	8.314 4621 J/(mol · K)
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ N/A
Permittivity of free space	ε_0	$8.854\ 187\ 817 \times 10^{-12}$ C^2/(N · m^2)
Plank's constant	h	$6.626\ 068\ 57 \times 10^{-34}$ J · s

COLOUR CODE OF RESISTORS

Color	Color Name	1st digit 1st stripe	2nd digit 2nd stripe	Multiplier 3rd stripe	Tolerance 4th stripe
	Black	0	0	x1	-
	Brown	1	1	x10	1%
	Red	2	2	x100	2%
	Orange	3	3	x1,000	3%
	Yellow	4	4	x10,000	4%
	Green	5	5	x100,000	-
	Blue	6	6	x1,000,000	-
	Violet	7	7	-	-
	Grey	8	8	-	-
	White	9	9	-	-
	Gold	-	-	x0,1	5%
	Silver	-	-	x0,01	10%

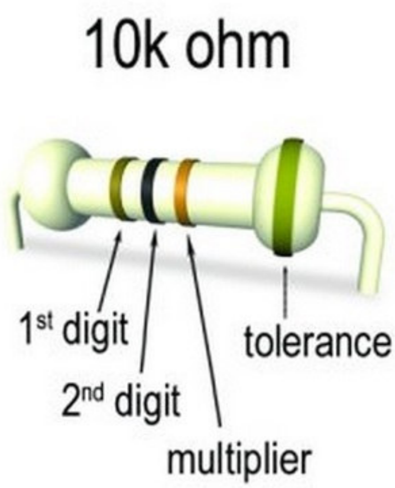


TABLE OF CAPACITOR CODES

Picofarad (pF)	Nanofarad (nF)	Microfarad (uF)	Code	Picofarad (pF)	Nanofarad (nF)	Microfarad (uF)	Code
10	0.01	0.00001	100	4700	4.7	0.0047	472
15	0.015	0.000015	150	5000	5.0	0.005	502
22	0.022	0.000022	220	5600	5.6	0.0056	562
33	0.033	0.000033	330	6800	6.8	0.0068	682
47	0.047	0.000047	470	10000	10	0.01	103
100	0.1	0.0001	101	15000	15	0.015	153
120	0.12	0.00012	121	22000	22	0.022	223
130	0.13	0.00013	131	33000	33	0.033	333
150	0.15	0.00015	151	47000	47	0.047	473
180	0.18	0.00018	181	68000	68	0.068	683
220	0.22	0.00022	221	100000	100	0.1	104
330	0.33	0.00033	331	150000	150	0.15	154
470	0.47	0.00047	471	200000	200	0.2	254
560	0.56	0.00056	561	220000	220	0.22	224
680	0.68	0.00068	681	330000	330	0.33	334
750	0.75	0.00075	751	470000	470	0.47	474
820	0.82	0.00082	821	680000	680	0.68	684
1000	1.0	0.001	102	1000000	1000	1.0	105
1500	1.5	0.0015	152	1500000	1500	1.5	155
2000	2.0	0.002	202	2000000	2000	2.0	205
2200	2.2	0.0022	222	2200000	2200	2.2	225
3300	3.3	0.0033	332	3300000	3300	3.3	335

STANDARD PREFIXES IN MEASUREMENTS

Prefiks	Symbol	Multiplying factor
yotta	Y	1 000 000 000 000 000 000 000 000 = 10^{24}
zetta	Z	1 000 000 000 000 000 000 000 = 10^{21}
exa	E	1 000 000 000 000 000 000 = 10^{18}
peta	P	1 000 000 000 000 000 = 10^{15}
tera	T	1 000 000 000 000 = 10^{12}
giga	G	1 000 000 000 = 10^{9}
mega	M	1 000 000 = 10^{6}
kilo	k	1 000 = 10^{3}
hecto	h	100 = 10^{2}
deka	da	10 = 10^{1}
deci	d	0,1 = 10^{-1}
centi	c	0,01 = 10^{-2}
milli	m	0,001 = 10^{-3}
mikro	µ	0,000 001 = 10^{-6}
nano	n	0,000 000 001 = 10^{-9}
piko	p	0,000 000 000 001 = 10^{-12}
femto	f	0,000 000 000 000 001 = 10^{-15}
atto	a	0,000 000 000 000 000 001 = 10^{-18}
zepto	z	0,000 000 000 000 000 000 001 = 10^{-21}
yocto	y	0,000 000 000 000 000 000 000 001 = 10^{-24}

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (Autonomous), UJIRE - 574240

DEPARTMENT OF PHYSICS

CERTIFICATE

This is to certify that …………………………..…………….has satisfactorily completed the course of experiments in Practical Physics prescribed by the college for BSc V th Semester in the Physics laboratory of this college during the year 20…............ 20…..........

Staff in charge of the Batch

Date :

CONTENTS

Expt No	Name of the Experiment	Date	Page Number
1			
2			
3			
4			
5			
6			
7			
8			
9			

Signature and Name of the student

Experiment Number : Date :

1.Stefan - Boltzmann Law

AIM :

To verify the Stefan - Boltzmann fourth power law.

APPARATUS :

Method 1 : 6V-300 mA bulb, 12V DC source, resistance boxes : 0 - 1000 ohm, 0-50 ohm, d.c milliammeter 0-500 mA, galvanometer, rheostat (1 amp rating)

Method 2 : 6V-300 mA bulb, 12V DC source, standard resistance of 2 of 5 ohm, 0-500 mA milliammeter, potentiometer galvanometer, rheostat etc.

THEORY :

Stefan - Boltzmann law states that the rate of radiation of energy from a black body varies directly as the fourth power of the absolute temperature T of the body.

$$\frac{dE}{dt} \propto T^4 \quad \text{.............. (1)}$$

Let the filament of a low voltage bulb be treated as a black body. Then, if the temperature of the filament is large compared to room temperature, loss of energy due to convection and conduction can be neglected. Thus, we can assume that the energy dissipated by the filament is mainly due to radiation.

$$\therefore \frac{dE}{dt} = I^2R \propto AT^n \quad \text{.............. (2)}$$

where I is the current through the filament, R its resistance, A is a constant and n = 4 according to the Stefan-Boltzmann law.

The resistance variation of tungsten (filament material) with temperature shows that $R \propto T^{1.25}$ .... (3) between 300^0K and 2300^0K

$$\therefore I^2R = B R^{\frac{n}{1.25}} \quad \text{where B is a constant.}$$

$$\text{or } \log (I^2R) = \frac{n}{1.25} \log R + B \quad \text{.............. (4)}$$

A graph of log I^2R along Y axis and log R along X axis gives a straight line wit! slope

$$s_1 = \frac{n}{1.25} \quad \therefore n = (1.25)\, s_1 \quad \text{.................. (5)}$$

Also, $I^2 = B R^{(\frac{n}{1.25} - 1)}$

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Taking log, $2 \log I = (\frac{n}{1.25} - 1) \log R + \log B$

or $\log I = (\frac{n}{2.5} - 0.5) \log R + \log B$ .... (6)

A graph of log R along X axis and log I along Y axis gives a slope $s_2 = (\frac{n}{2.5} - 0.5)$. The Value of n can be determined using relation

$$n = (s_2 + 0.5)\, 2.5 \quad .... (7)$$

PROCEDURE :

The connections are made as in fig 8a. A low voltage bulb (6V 0.3A) can be used for the experiment . Let S = 10 ohm (10W) and P = 100 ohm

The rheostat is adjusted to get a current I = 100mA through the filament. A minute or two is allowed for the temperature to stabilize. The bridge is balanced by adjusting Q. The resistance of the filament (plus that of ammeter coil)

$$R = \frac{Q}{P} S = ... \Omega$$

The experiment is repeated for I = 120, 140, ... 240mA. A graph of log I^2R against log R is drawn. The radiation index n is calculated from the slope (fig 8b) (eqn. 5). A graph of log I against log R is drawn. The value of n is calculated from the slope (fig 8c) (eqn. 6). P, Q, & S should have a rating of at least one ampere so that they do not get heated during the experiment.

NOTES :

(1) The filament of the bulb is not an ideal black body. Thus the value of n, obtained in the experiment, is only approximate.

(2) The filament resistance is of the order of 10 ohm, while the milliammeter coil has a resistance of a fraction of an ohm. Thus the value of R can be treated as that of the filament for all practical purposes.

RESULT :

The radiation index n = which is approximately 4. Hence Stefan - Boltzmann fourth power law is verified.

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Observations :

Bulb used : 6V 0.3Amp. P = 100 ohm.

Diagrams :

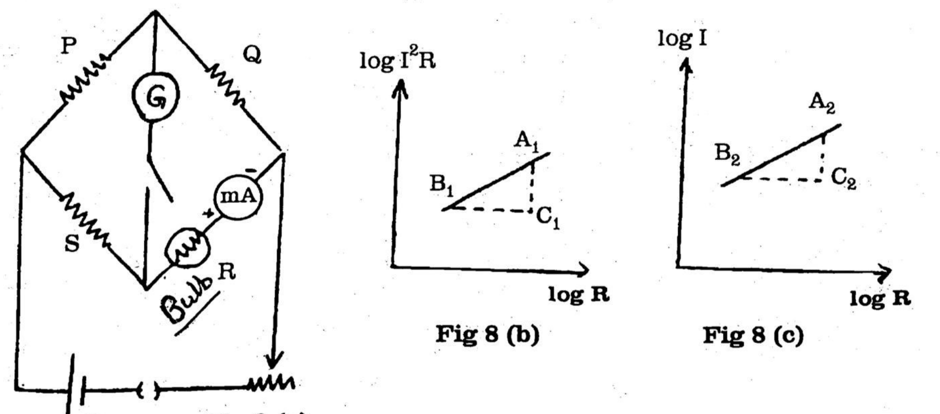


Fig 8 (a) Fig 8 (b) Fig 8 (c)

Tabulations

T no	Current I (A) After balance	Balancing Resistance S (ohm)	Filament Resistance $R = \frac{Q}{P} S$ (Ohm)	log R	log I	log I^2R

Calculations :

Graph I :

$$\text{Slope } S_1 = \frac{A_I C_I \text{ X yscale}}{B_I C_I \text{ X x scale}}$$

$$S_1 = \frac{n}{1.25}$$

Radiation index n = 1.25 S_1 =

Graph II :

$$Slope = \frac{A_2C_2 \ . \ Y \text{ Scale}}{B_2C_2 \ . \ X \text{ Scale}} =$$

$$S_2 = \frac{n}{2.5} - 0.5$$

Radiation index $n = 2.5 (S_2 + 0.5) =$

Experiment Number : Date :

2.Temperature response of a Thermistor

AIM:

To study the temperature response of a thermistor and hence to estimate its energy gap.

APPARATUS :

Thermistor, metre bridge, battery, table galvanometer, water bath etc.

THEORY:

The resistance R of a thermistor is given by

$R = ae^{b/T}$ ------------------- (1)

where a is a constant and $b = E_g / 2k$. T is the temperature on the kelvin scale, k the Boltzmann constant and E_g the energy gap. $\frac{dR}{dT} = ae^{b/T}\left(-\frac{b}{T^2}\right) = R\left(-\frac{b}{T^2}\right)$ $\left(\frac{1}{R}\frac{dR}{dT}\right)$ gives the temperature coefficient of resistance α. Thus $\alpha = -\frac{b}{T^2}$

Further from equation (1)

we have $\log_e R = \log_e a + \frac{b}{T}$. or $\log_{10} R = \log_{10} a + \frac{1}{2.303}\frac{b}{T}$

IF a graph is drawn connecting $\log_{10} R$ with $\left(\frac{1}{T}\right)$ a straight line with a slope $s = \frac{b}{2.303}$ is got. Hence b = (2.303) x slope of the straight line. Knowing 'b' the value of the temp coefficient can be estimated at any temperature.

The energy gap of the thermistor is given by $Eg = 2kb$. ------ (2)

PROCEDURE :

The connections are made as shown in Fig 10(a). The commutator keys are so plugged that the resistance box S is in the left gap (gaps 2 and 3 are shorted). The resistance in the box is so chosen that the balance point is near the middle of the bridge wire. The balancing length l_1 is measured from the left end of the bridge. The resistance of the thermistor is calculated using the relation $R_1 = S(100-l_1)/l_1$. By shorting gaps 1 and 4 the resisstance of the thermistor and the box are interchanged and balancing length l_2 is measured from the same (left) end. The resistance of thethermistor is calculated using the relation $R_2 = \frac{Sl_2}{(100-l_2)}$ The mean resistance R is calculated.

. The temperature T of the water bath in which the thermistor is immersed is observed. The temperature of the bath is increased and at intervals of 10K the resistance is determined as before. A graph is drawn connecting $\log_{10}R$ and $^{1}/T_{2}$

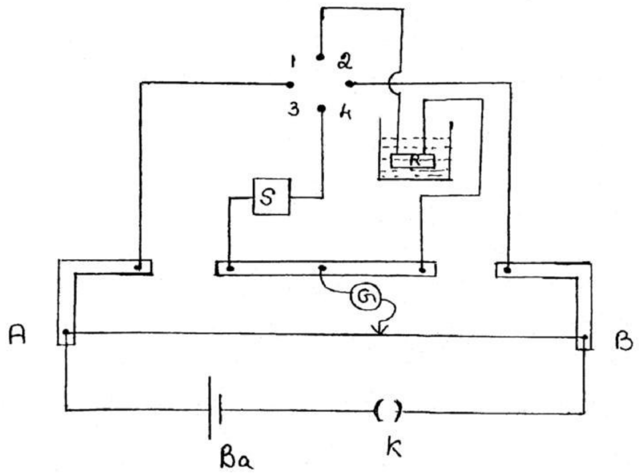
The slope 's' of the straight line is found out. Hence the values of b, temperature coefficient of resistance and the energy gap of the themistor can be estimated using the relation E_g = 2Kb.

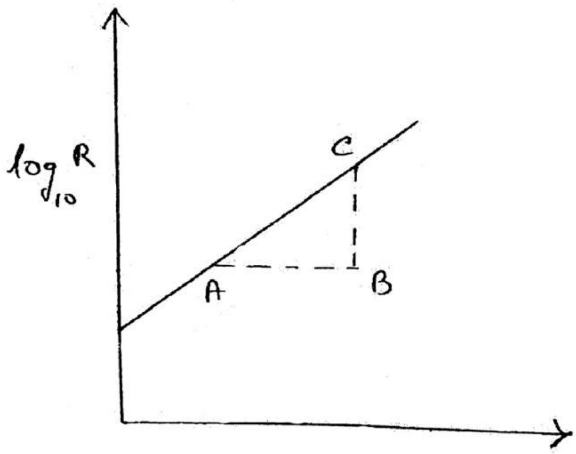
Result : i) The temperature coefficient of resistance of the thermistor is found to decrease with temperature.

ii) The energy gap between the valence and conduction bands of the thermistor is found to be eV.

Observations :

Diagrams





Tabulation :

Resistance unplugged S= ohms

Temp in T in K	1/T	Balancing length in cm		Resistance of thermistor in ohms			log R
		plug gap 2 &3 (l_1)	plug gap 1 &4 (l_2)	$R_1 = \frac{S(100-l_1)}{l_1}$	$R_2 = \frac{Sl_2}{(100-l_2)}$	Mean R	

Calculations :

$$\text{Slope} \quad S = \frac{BC \times \text{yscale}}{AC \times \text{x scale}}$$

$b = 2.303\ (\text{Slope}) =$

α at lab temp $= -b/T_1^2$

α at boiling temp temp $= -b/T_2^2$

Energy gap $E_g = 2Kb =$

$=$ ev

Experiment Number : Date :

3.Specific charge of the Electron

AIM :

To determine the specific charge, e/m of electron by Thomson's method.

APPARATUS :

Cathode ray tube (CRT) with power supply, short bar magnets, vibration magnetometer etc.

DESCRIPTION :

A cathode ray tube consists of a highly evacuated funnel shaped glass bulb inside which are contained an electron gun, deflecting plates and a fluorescent screen. (fig. 9a).

Electrons are emitted by a hot cathode K. They pass through a control grid G which controls the number of electrons getting past it. These electrons are accelerated towards the anodes A_1 and A_2. Through the central fine apertures of the anodes, a narrow beam of cathode ray. emerges. This beam is allowed to pass between two sets of plates X_1 & X_2 and Y_1 & Y_2. A potential difference between Y_1 and Y_2 causes the beam to deflect in the vertical plane. The beam finally strikes the fluorescent screen S and a bright spot is seen. The deflection of the beam can also be achieved by applying a magnetic field. This deflection, however, is normal to the field.

THEORY :

Consider the path of an electron of mass m, charge e and velocity v. Now, if a uniform horizontal magnetic field (induction) B is applied at right angles to the electron path, the force on the electron is Bev $\perp^r$ to B and $\perp^r$ to V. The path of the electron is, therefore circular (fig 8 b) of radius r.

Then, $$Bev = \frac{mv^2}{r} \qquad \text{.............} (1)$$

If l is the length of the region where the magnetic field is present and y is the vertical deflection of the electron, from fig 9b,

$$\theta = \frac{l}{r} = \frac{y}{\frac{1}{2}} \qquad \text{if } \theta \text{ is small}$$

$$\therefore \quad \theta = \frac{l}{r} = \frac{2y}{l^2} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Thus from eqn. (1) $\frac{e}{m} = \frac{v}{B} \cdot \frac{2y}{l^2}$ .... (3)

Now if an electric field E is applied vertically and adjusted so as to neutralise the deflection produced by the magnetic field.

$$Bev = eE = \frac{eV}{t}$$

$$\therefore \quad v = \frac{V}{Bt} \quad \ldots\ldots\ldots\ldots (4)$$

where V is the potential difference between plates Y_1 and Y_2 separated by a distance t

Using eqn. (4), we get $\frac{e}{m} = \frac{2}{l^2 t} \cdot \frac{V}{B^2} y$ .... (5)

If Y is the shift of the spot observed on the screen, $Y \propto y$

$$\therefore \quad \frac{e}{m} = K \frac{V}{B^2} Y \quad \ldots\ldots\ldots (6)$$

Where K is the constant of the apparatus.

$K = 1.79 \times 10^4$ for the CRT type 70 CIP 31.

Magnetic field :

The magnetic field B is produced by two short bar magnets (fig 9c) kept with their axial lines collinear, in the horizontal plane, normal to the axis of the CRT. The magnetic fields produced by the magnets at the site of electron path are

$$B_1 = \frac{\mu_0}{4\pi} \cdot \frac{2M_1}{d^3} \quad \text{and } B_2 = \frac{\mu_0}{4\pi} \quad \frac{2M_2}{d^3} \quad \ldots\ldots\ldots (7)$$

where M_1 and M_2 are the magnetic moments of the magnets, d is the distance of each magnet from the CRT axis and μ_0 is the permeability of vacuum $= 4\pi \times 10^{-7}$ henry. metre^{-1}.

$B = B_1 + B_2 \ldots . (8)$

The magnetic moments are obtained by the deflection magnetometer method (say, in Tan A position).

If the mean deflections are Θ_1 and Θ_2 respectively when the magnets are placed at distance d from the pivoted needle,

$$\frac{\mu_0}{4\pi} \cdot \frac{2M_1}{d^3} = B_H \tan\Theta_1 \text{ and } \ldots\ldots \frac{\mu_0}{4\pi} \cdot \frac{2M_2}{d^3} = B_H \tan\Theta_2 \quad \ldots\ldots\ldots (9)$$

where B_H is the horizontal component of earth's field.

$$\text{Then, } M_1 = \frac{4\pi}{\mu_0} \frac{B_H d^3}{2} \tan\Theta_1 \text{ and } \ldots\ldots \quad M_2 = \frac{4\pi}{\mu_0} \frac{B_H d^3}{2} \tan\Theta_2 \quad \ldots\ldots\ldots (10)$$

PROCEDURE :

The direction of magnetic meridian is drawn using a compass needle. The CRT is placed with its axis along this direction. Now, the earth's magnetic field, being parallel to the electron path, does not cause any deflection of the spot on the fluorescent screen. The CRT power supply is switched on and a warm up time of 5 to 10 minutes is allowed. The bar magnets are placed symmetrically (fig 9c) (i) with N-poles toward east (or west) (ii) in the horizontal plane at the height of CRT axis (iii) with the axial lines of the magnets collinear and normal to CRT axis. (iv) the distance d of the mid point of the magnets from the CRT axis being large compared to magnetic lengths. The shift Y of the luminous spot on the screen from the zero position is noted. A potential difference between plates Y_1 and Y_2 is applied. Its value V is adjusted until the spot comes back to zero position. The observations are repeated by varying the value of d.

A deflection magnetometer is set in Tan A position. Magnet I is placed at a distance d and the mean deflection Θ_1 is determined. Magnet I is now replaced by magnet II and deflectlion Θ_2 is determined. The observation is repeated for another value of d. M_1 and M_2 are calculated using eqn.(10). The value of B is then obtained from eqns. (7) and (8). The graph of B^2/V along X axis and Y long Y axis is drawn (fig 9d). The straight line obtained has a slope = $\frac{1}{K}\left(\frac{e}{m}\right)$. The specific charge of the electron can hence be calculated from $\frac{e}{m}$ = K slope.

NOTES :

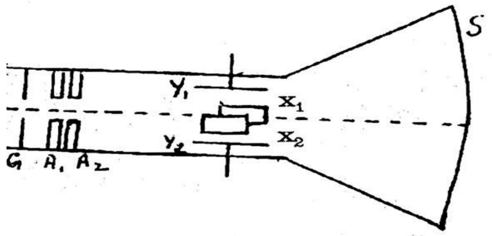
(1) The assumption of uniform magnetic field B is not strictly true.

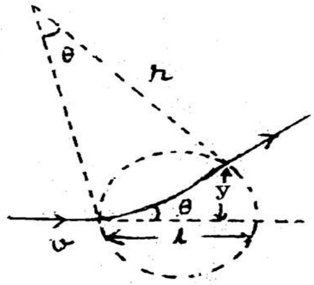
(2) If the application of electrostatic field increases the deflection of the spot, the p.d. applied between Y_1 and Y_2 should be reversed.

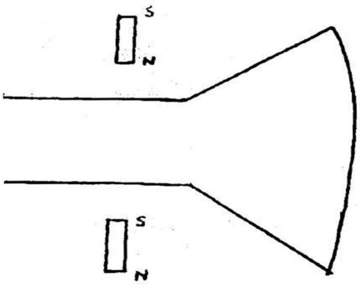
Result :

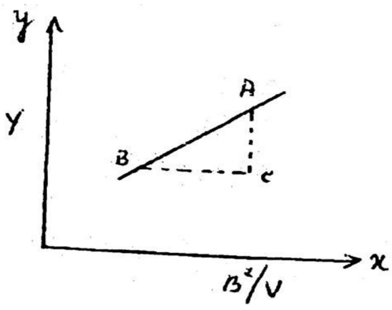
Specific charge of electron e/m = C/Kg

Observations









Given B_H = 3.8×10^{-5} Tesla

	Distance of the magnet d (m)	Deflections									$d^3 \tan\theta$	Mean ($d^3 \tan\theta$)
		1	2	3	4	5	6	7	8	Mean θ		
Magnet I												
Magnet II												

$$M_1 = \frac{2\pi}{\mu_0} B_H \left(d^3 \tan\theta\right)$$

$=$

$=$ Henry /m

$$M_2 = \frac{2\pi}{\mu_0} B_H \left(d^3 \tan\theta\right)$$

$=$

$=$ Henry / m

$M_1 + M_2 =$

Zero position of the spot on the screen R_0 (mm) =

Distance of mid points of magnets from CRT axis d(cm)	Position of the spotoh the screen R (MM)	Deflection of the spot Y (MM) $R_o + R$	Voltge applied for Zero deflection V(Volts)	Magnetic field B $= \frac{\mu_0}{2\pi} \frac{(M_1+M_2)}{d^3}$ (Tesla)	B^2/V

Calculations

$$\text{Slope} = \frac{AC}{BC} \times \frac{\text{Y Scale}}{\text{X Scale}}$$

=

=

Specific charge of election e/m = K (Slope) =

= C / Kg

Experiment Number: Date:

4.GM Tube Characteristics

Aim

To study the variations of count rate with applied voltage and thereby determine the plateau, the operating voltage and the slope of the plateau.

Equipment / Accessories required

- **a.** G.M. Counting System GC601A / GC602A with A.C. main chord.
- **b.** G.M Detector (End window) stand (or) G.M Detector/source holder bench (optical bench).
- **c.** G.M. Detector (in PVC cylindrical enclosure) with connecting cable.

Description

Geiger-Muller radiation counter tubes (G.M.Tubes) are intended to detect alpha particles, beta particles, gamma or X-radiation.A G.M. tube is a gas-filled device which reacts to individual ionizing events, thus enabling them to be counted. The Tube consists of basically an electrode at a positive potential (anode) surrounded by a metal cylinder at a negative potential (cathode). The cathode forms part of the envelope or is enclosed in a glass envelope. Ionizing events are initiated by quanta or particles, entering the tube either through the window or through the cathode and colliding with the gas molecules.The gas filling consists of a mixture of one or more rare gases and a quenching agent. Quenching is the termination of the ionization current pulse in a G.M.tube. Effective quenching in G.M. Tube is determined by the combination of the quenching gas properties and the value of the anode resistor.

Operating characteristics:

Starting Voltage (V_s):

This is the lowest voltage applied to a G.M. Tube at which pulses just appear across the anode resistor and unit starts counting.

Plateau:

This is the section of the GM characteristic curve constructed with counting rate versus applied voltage (With constant irradiation) over which the counting rate is substantially independent of the applied voltage. Unless otherwise stated, the plateau is measured at a counting rate of a approximately 100 counts.

Plateau threshold voltage (V_1) :

This is the lowest applied voltage which corresponds to the start of the plateau for the stated sensitivity of the measuring circuit.

Plateau length :

This is the range of applied voltage over which the plateau region extends. Upper Threshold voltage (V_2) :

This is the higher voltage up to which plateau extends, beyond which count rate increases with increase in applied voltage.

Plateau Slope:

This is the change in counting rate over the plateau length, expressed in % per volt

Recommended Supply Voltage : (Operating Voltage)

This is the supply voltage at which the G.M.Tube should preferably be used. This voltage is normally chosen to be in the middle of the plateau.

Background : (BG)

This is the counting rate measured in the absence of the radiation source. The BG is due to cosmic rays and any active sources in the experimental room.

Procedure

a. Make the connection between counting system to G.M. Detector by MHV to UHF co-axial cable. Also connect the mains chord from the counting system to 230V A.C. Power

b. Place a Gamma or Beta source facing the end window of the detector, in the source holder of G.M. stand or optical bench at about 2 cms (for Gamma source) or 4 cms (for Beta source) approximately, from the end window of the detector. (For Beta source ensure that countrate is less than 200 CPS at 500V)

c. Now power up the unit and select menu options to PROGRAM on the keypad of the G.M. Counting System and select 30sec preset time typically (It can be in the range of 30 to 60 sec.) [For all command button functions, refer to G.M. Counting System GC601A / GC602A user manual.]

d. Now press - "START" button to record the counts and gradually increase the HV by rotating the HV knob till such time, the unit just starts counting. Now, press "STOP" button.

e. Now take a fresh reading at this point (STARTING VOLTAGE) and record the observations in the format as given in Table 1.

f. Also record for each HV setting, corresponding background counts without keeping the source.

g. Continue to take these readings in steps of 30V and for the same preset time, keep observing counts & tabulate the data, with and without source.

h. Initially within 2 to 3 readings, counts will steeply increase and thereafter remain constant with marginal increase (may be within 10%). After few readings, one will find a steep increase as one enters the discharge region. Take just one or two readings in this region and reduce the HV bias to 0 volts. It is important to note that operating the G.M detector in discharge region for longer time can reduce the life of tube or can result into permanent damage of the detector.

Now tabulate the readings and plot a graph of voltage against counts (corrected counts). This graph should look as shown in Fig. 6.

Identify from the graph / tabulated data

- Starting Voltage
- Lower threshold voltage (V_1)
- Upper threshold voltage (V_2). It is called Breakdown threshold voltage
- Discharge region.

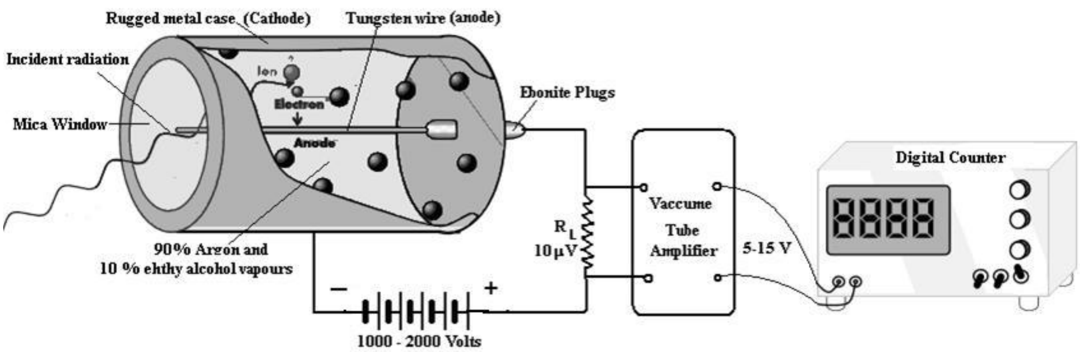
Calculate plateau, percentage slope, and plateau length, operating voltage, etc.

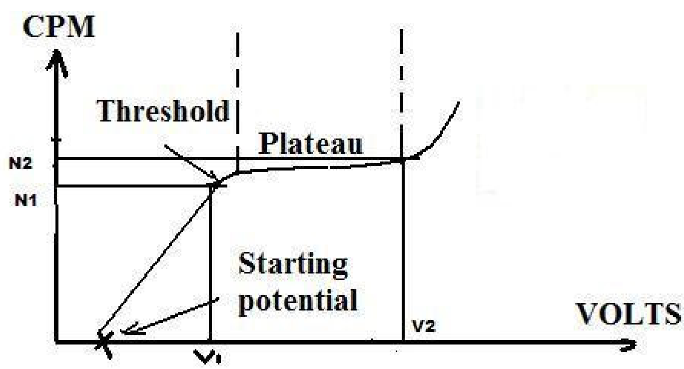
Repeat the experiment with the source by keeping the source slightly away from the end window when compared to gamma source and tabulate the data. Calculate slope, plateau length etc

Inference

1. From the plateau, it can be noticed that mid point of the characteristics of the GM tube is defined as operating voltage and is to be used for counting applications. The tube is operated at this voltage when used in Radiation Monitors for measurements.
2. Different parameters of the GM Tube are as shown in the table

Observations





Case 1,d= Case 2,d=

S.No.	EHT (Volts)	Counts N 120 sec		Background Counts N_b 120 sec		Corrected Counts Nc = $(N-N_b)$	
		case1	case2	case1	case2	case1	case2
1							
2							
3							
4							
5							
6							
7							
8							

CASE 1		CASE2	
Starting voltage of plateau	V_1=	Starting voltage of plateau	V_1=
Upper threshold of the plateau	V_2=	Upper threshold of the plateau	V_2=
Plateau length	V2 - V1=	Plateau length	V2 - V1=
Operating voltage V_0	(V2+V1)/2 =	Operating voltage V_0	(V2+V1)/2 =
Slope of the plateau %	$\frac{(N2-N1)X100X100}{N1(V2-V1)}$ =	Slope of the plateau %	$\frac{(N2-N1)X100X100}{N1(V2-V1)}$ =

Where N1 and N2 are the count rates at the lower and the upper limits of the plateau and V1 and V2 are the corresponding voltages.

Experiment Number: Date:

5. Regulated Power supply using IC Three Pin Regulator

AIM : To construct a regulated power supply using three pin regulator and to study its regulating action hence to find out line and load regulation

Apparatus required: unregulated power supply,7805IC,220µF/25V,22µF/25V,1000µF/25V.and 470 µF/25 capacitors, resistance box and connecting wires.

Description: A regulated power supply is very much essential for several electronic devices due to the semiconductor material employed in them have a fixed rate of current as well as voltage. The device may get damaged if there is any deviation from the fixed rate. By the help of a DC voltage regulator, unregulated output will be fixed to a constant voltage.

Preamble

7805 IC Regulator: Most generally used IC Regulator is IC 7805 and gives a constant output of 5V. This IC is very flexible and is widely employed in all types of circuits like a voltage regulator. It is a three terminal device..it consists of op amp,transistors and zenar diode and other components. It comes with provision to add heat sink. it is connected in series with the unregulated power supply along with two shunt capacitors. Pin diagram of the IC 7805 is shown in the figure

Regulation with a varying input voltage (line regulation):

It is defined as the change in regulated voltage with respect to variation in line voltage. It is denoted by 'LR'. In this, input voltage varies but load resistance remains constant hence, the load current remains constant. Due to regulating action of IC The output voltage will remain constant.

Regulation with the varying load (load regulation):

It is defined as change in load voltage with respect to variations in load current. To study load regulation, input voltage is kept constant and the load resistance is varied. due to regulating action of IC, output voltage remains constant

PROCEDURE:-

A) Line Regulation:

1. Make the connections as shown in figure .take C_1= 220µF , C_2= 22µF
2. Keep load resistance at a fixed value say at 500 ohms.; vary DC input voltage from 6V to 15V and note down the output voltage
3. Note down output voltage as a load voltage with high line voltage 'VHL' and as a load voltage with low line voltage 'VLL'.

4. Using the formula, % Line Regulation = [(V_{HL}-V_{LL})/ $V_{av(input)}$]x100, where V_{ave}= average of the two
5. A graph is plotted between output and input voltage

B) Load Regulation:

1. For finding load regulation, make connections as shown in figure

2. Keep input voltage constant say at 6V, vary load resistance value and note down the output voltage for different load resistances
3. Note down no load voltage ‘VNL’ for maximum load resistance value and full load voltage ‘VFL’ for minimum load resistance value.
4. Calculate load regulation using the formula , % load regulation = [(V_{NL}-V_{FL})/ V_{FL}]x100
5. A graph is plotted between output voltage and load resistance

C.)Experiment is repeated for **C_1=1000**µF **,C_2=** 470µF

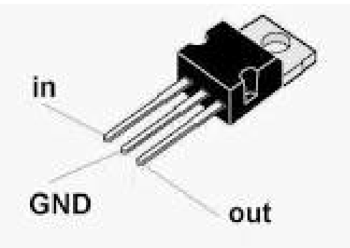
Result

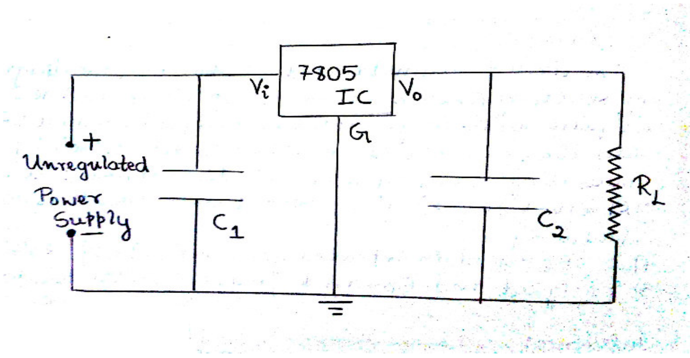
1. Variation of output voltage with input voltage and variation of output voltage with load resistance for different cases is as shown in the graphs.

2. Percentage of regulations is as shown below

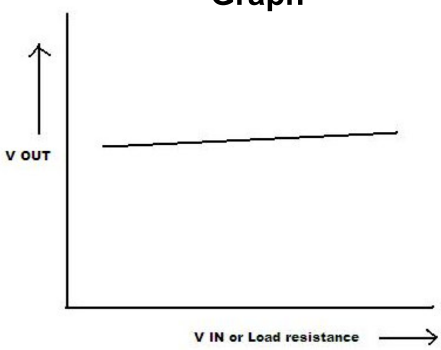
Regulation	Case1	Case2
% line regulation		
% load regulation		

OBSERVATIONS.





Graph



Line regulation

Value of the load resistance = 500 ohms

sl no	Input voltage (V)	Output voltage (V)	
		Case1	Case2
		C_1= 220 µF C_2=22 µF	C_1=1000 µF C_2=470µF
1	(VLL)=6		
2			
3			
4			
5			
6			
7			
8			
9			
10	(VHL)=		
Percentage regulation			

Percentage regulation

1. $[(V_{HL}-V_{LL})/ V_{ave(input)}]$ x100=

2.$[(V_{HL}-V_{LL})/ V_{ave(input)}]$ x100=

Load regulation

Constant input voltage = 6 volts

sl no	load resistance in ohms	Output voltage (V)	
		Case 1	Case2
		C1= 220 µF C2=22 µF	C1=1000 µF C2=470 µF
1	500(VFL)		
2	600		
3	700		
4	800		
5	900		
6	950		
7	1000		
8	1200		
9	1400		
10	1500 (VNL)		
Percentage regulation			

% load regulation

1. $[(V_{NL}-V_{FL})/ V_{FL}]$ x100=

2. $[(V_{NL}-V_{FL})/ V_{FL}]$x100=

Average Regulation	Case1	Case2
% line regulation		
% load regulation		

6. Common Emitter Amplifier

Aim:

To construct common emitter amplifier using the given components, to study its frequency response and to determine (a) mid band gain (b) lower cut off frequency (c) input resistance and (d) output resistance of the amplifier.

Apparatus:

D.C. regulated power supply +12 V, Cathode ray oscilloscope, sine wave generator, decade resistance box, Transistor BC 547, $\frac{1}{2}$ watt resistors 820 Ω, 2.7 K, 12 K & 47 K, capacitors 47 µF, 12 V; 4.7µF, 6 V.

Description:

A common emitter (CE) configuration has the emitter, common to input & output. The input is fed between the base and the emitter while the output is taken in between the collector and emitter.

A CE amplifier is characterized by high voltage gain, high output resistance & medium input resistance.

An amplifier does not amplify signals of all frequencies. Below a 'lower cut off frequency' and above a 'higher cut off frequency' the gain of the amplifier rapidly decreases. The lower cut off frequency depends on the input capacitor C_1, output capacitor C_2 and bypass capacitor C_E. The higher cut off frequency depends on the internal capacitance of the transistor and stray wiring capacitances.

Procedure:

Given: Transistor BC 547, $V_{CC} = +12\ V$

$$R_C = 2.7\ K\Omega = R_L = R_E = 820\Omega, K\Omega, R_1 = 47\ K\Omega, R_2 = 12\ K\Omega$$

$$C_1 = 47\ \mu F, 12\ V,\ C_2 = 47\ \mu F, 12\ V,\ C_E = 4.7\ \mu F, 6\ V$$

Using these components, circuit is constructed (fig a). the circuit layout is given in fig 6b. Before the signal generator is connected, the d.c. voltages at the collector, base, & emitter are measured. (Designed values $V_C = 6.6V, V_B = 2.34V, V_E = 1.64V$).

<u>Frequency response</u>: the signal generator is connected to the circuit. The frequency is set at 200 Hz. A CRO is connected across its terminals and the voltage (input V_i to the amplifier) is adjusted to 20 mV peak to peak (p-p). The output V_o of the amplifier is measured using the CRO. The observations are repeated for frequencies 600 Hz, 1K Hz, ………. 5kHz, keeping V_i constant throughout.

At each frequency, the voltage gain $A = \frac{V_o}{V_i}$ is calculated. A graph log f vs gain is drawn (fig c). The mid band gain A_o is noted. The frequency at which the gain is $A = \frac{V_o}{\sqrt{2}}$ gives the lower cut off frequency f_c.

Input resistance: A decade resistance box (initially with zero resistance in it) is introduced between the signal generator and input capacitor C_1. The frequency is set at mid band (say 1 K Hz). The generator output is adjusted so that the amplifier output is 1 volt. The resistance R in the box is adjusted until, the output reduces to 0.5 V.(half the original value). R gives the input resistance of the amplifier.

Output resistance: A resistance box is considered (initially with infinite resistance in it) parallel to R_L. The frequency is set at mid band. The input voltage is given to the amplifier is adjusted so that the output V_o of the amplifier is 1 volt. The resistance R in the box is now reduced until the output reduces to 0.5 volt (half the original value). This resistance R gives the output resistance of the amplifier.

NOTE:

1) The input and output voltages of the amplifier are initially measured using CRO, because it measures the voltages while indicating the wave forms. Any distortion or noise can easily be detected. It will also be observed that the input and the output waveforms are out of phase by π.
2) The input given to the amplifier must be small because, the above theory holds good for only small signals. If the input exceeds certain limits, the output waveform gets destroyed.
3) When an electrolytic capacitor is used in the circuit, its polarity should be properly connected .

Result:

		Designed	Measured
Mid band voltage gain	A_o	100	
Lower cut off frequency	f_c	500 Hz	
Input resistance	R_1'	3.0 K Ω	
Output resistance	R_o	1.35 K Ω	

. **Observations:**

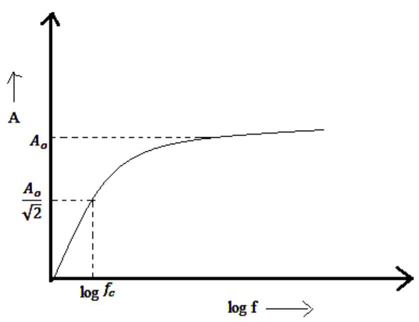


Fig (b)

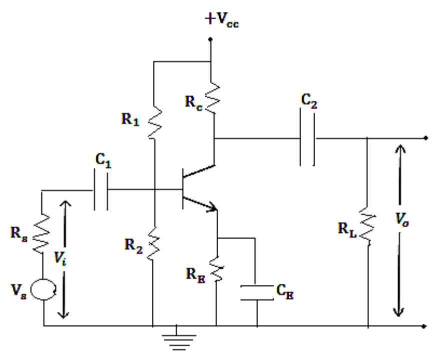


Fig (a)

	Designed	Observed
DC voltage at E	**1.64 V**	
DC voltage at B	**2.34 V**	
DC voltage at C	**6.6 V**	

Input voltage=………. V

Frequency (Hz)	**log f**	**Output Voltage V_0 (V)**	**Voltage gain** $A = \frac{V_o}{V_i}$
200			
300			
400			
500			
600			
700			
800			
900			
1K			
1.5K			
2K			
2.5K			
3K			
3.5K			
4K			
4.5K			
5K			

Input resistance = …………….. …………….Ω

Output resistance = …………………………..Ω

From the graph log f_c = ………………………

Therefore cut off frequency, f_c = ……………..

Result:

		Designed	**Measured**
Mid band voltage gain	A_o	100	
Lower cut off frequency	f_c	500 Hz	
Input resistance	R_i'	3.0 K Ω	
Output resistance	R_o	1.35 K Ω	

Experiment Number. Date

7.Wien Bridge Oscillator

Aim:

To construct and study a Wien – Bridge Oscillator.

Apparatus:

`DC power supply (-12V – 0 – 12V), OP – AMP 741IC, resistors, capacitors, CRO, etc.

Principle:

The circuit of Wien Bridge oscillator is as shown in the figure .The Wien Bridge circuit is connected between the amplifiers input terminals and the output terminals. Basically the circuit is Wheatstone bridge with series of RC network in one arm & a parallel RC network in adjoining arm and the resistors R_1 &R_2 are in other two arms.

The oscillations will occur only when the bridge is balanced (at resonance). For the oscillations to occur, Barkhausen Criterion is to be satisfied which is given by,

$$A_v\beta = 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, A_v = closed loop voltage gain of the amplifier

β = feed back factor

The voltage gain amplifier is given by

$$A_v = 1 + \frac{R_F}{R_1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

It can be shown that $\beta = \frac{1}{3}$

$$\therefore\ A_v = \frac{1}{\beta} = 3$$

On substituting in equation (2)

$$3 = 1 + \frac{R_F}{R_1}$$

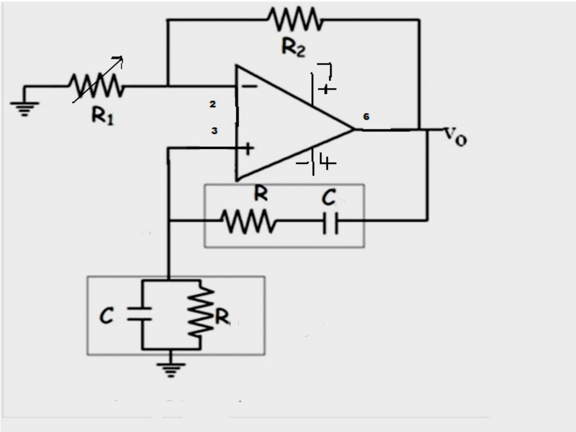
$$R_F = 2R_1 \ldots\ldots\ldots\ldots\ldots (3)$$

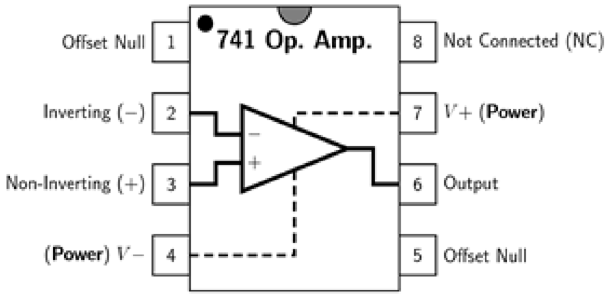
The frequency of oscillations can be given by

$$f = \frac{1}{2\pi RC} \ldots\ldots\ldots\ldots\ldots (4)$$

Procedure: The circuit is perfectly designed and constructed as shown in the figure. The power supply is switched on. A CRO is used to observe the output waveform. A potentiometer (0 – 20 KΩ) is used as R_F. It is adjusted slowly to get the sinusoidal waveform in CRO. The period (T) of the wave is measured using the CRO and hence the frequency $(f = \frac{1}{T})$ is calculated. The experiment is repeated for different value of the resistor R. theoretical and observed frequencies are compared in each case.

Result: The frequency of the oscillator is as shown in the tabular column. The theorotical and observed frequencies agree with each other with in the experimental limitations.





Circuit diagram **Pin Diagram of 741 IC**

Observations:

Design Calculations:

By Barkhausen Criterion, $A_v \beta = 1$

$\therefore \quad R_F = 2R_1$

Let R_1 = 10 KΩ

Then, R_F 10 K × 2 = 20 KΩ

Formula:

$$f = \frac{1}{2\pi RC}$$

Where, f = frequency of oscillations

R = Resistance (KΩ)

Capacitance of the capacitor used is C = µF

Trail no.	Resistance R (Ω)	Period T	Frequency of the oscillator (Hz)	
			Observed 1/T	Theoretical $f = \frac{1}{2\pi RC}$
1				
2				
3				
4				

8.Anderson's bridge

AIM :

To determine the self-inductance of a given coil by Anderson's bridge method.

APPARATUS :

Resistance boxes 0-5000 ohm, capacitor, Leclanche cell, Audio oscillator, head phone, galvanometer, inductance coil etc.

THEORY :

Consider the circuit given in fig. 6b. Let i_1, i_2 and i_3 be the instantaneous currents through P,C and R respectively. When the bridge is balanced, current through the head- phone is zero.

Then, we have,

$$i_1 p + (i_2 + i_1)Q = i_3 \ (R + S + jwL) \quad \text{-------------- (1)}$$

$$i_1 p = i_2 \ (r + \frac{1}{jwC}) \quad \text{-------------- (2)}$$

and $$\frac{i_2}{jwC} = i_3 R \quad \text{-------------- (3)}$$

where S is the total resistance in the arm ED, $w = 2\pi f$, f being the frequency of the oscillator and $j = \sqrt{-1}$

From these equations, we get

$$L = C\,[\,RQ + r\ (R+S)\,] \quad \text{-------------- (4)}$$

where $$S = \frac{RQ}{P} \quad \text{-------------- (5)}$$

In the above equation if P=Q then S=R and (4) reduces to

$$\mathbf{L=CR(P+2r)}$$

i) **To Find S :**

Connections are made as shown in figure 6(a). Since the capacitance offers infinite resistance for direct current, the circuit works as a Wheatstone's net work. Initially resistance in r and S' are made zero. Q is set at, say 50Ω & P = 50Ω. The resistance in R is adjusted to get correct D.C. balance. The experiment is repeated for another value of P, say 100Ω. Different sets of values are obtained by keeping S' = 50Ω, 100Ω etc. The resistance in Q, R & S, for DC balance are found. In each trial the resistance of the fourth branch of the net work S is calculated using the relation $S = \frac{RQ}{P}$. S includes the resistance in S' as well as the resistance of the coil.

ii) **To Find r :**

The circuit is made as in Fig 6(b). The galvanometer is replaced by a head phone, and the battery by an oscillator. One set of values in P, Q, R & S for which the bridge was balanced is chosen. The resistance in r is adjusted so that the sound heard in the head phone is a minimum. The inductance L of the coil is calculated using equation (4). The experiment is repeated for different sets of values obtained in the first part of the experiment. The mean value for L is calculated.

NOTES:

(1) It is evident from equation (4), that the choice of C, R and Q should be such that, $\boxed{L > CRQ}$, so as to get a positive value of r. Thus, it is desirable to know the approximate value of L beforehand.

(2) The bridge is most sensitive when the impedences or resistances of all the arms of the bridge are of the same order of magnitude.

(3) If an iron-cored coil is used for inductance, its a.c. and d.c. resistances are not equal. While, only the ohmic resistance contributes to d.c. resistance, the hysterisis loss of the core provides an additional contribution to a.c. resistance.

(4) If L is known, the value of capacitance C can be estimated using the formula.

$$C = \frac{L}{RQ + r\ (R + S)}$$

RESULT :

Self inductance of the coil L = ... mH.

OBSERVATIONS :

DIAGRAMS :

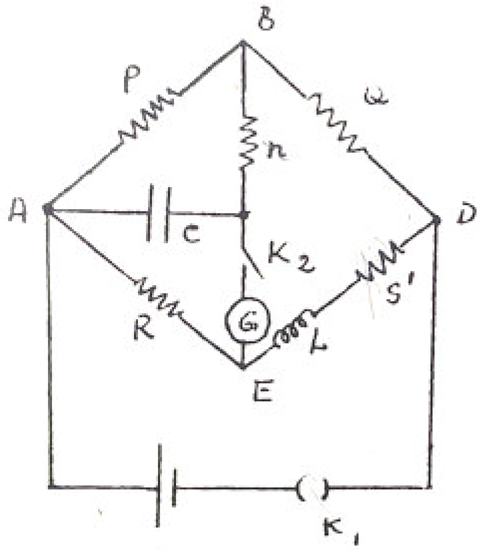


Fig. 6(a)

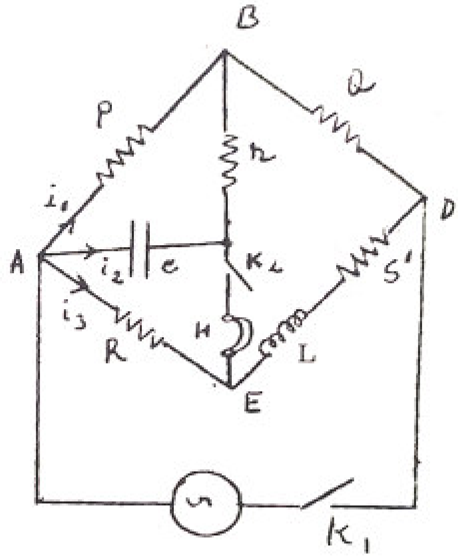


Fig. 6(b)

Tabulation

Capacitance used C= μF

T no	Resistances in ohms					r in Ω	Inductance L Henries L=CR(P+2r)
	P=Q		S′	R	S=QR/P		
1.			0				
2.			50				
3.			100				
4.			150				
5.			200				
6.			250				

Mean inductance of the coil= H

SIMULATION EXPERIMENT

MILLIKANS OIL DROP

Aim

1. To experimentally demonstrate the concept of Millikan's oil drop experiment.
2. To find the terminal velocity of the drop.
3. To find the charge on a drop.

Apparatus

Millikan's oil drop apparatus,oil, Dc supply.

Construction

Oil drop experiment was performed originally by the American physicist Robert A. Millikan in 1909. It measures the size of charge on a single electron.

Apparatus consist of an atomizer, which helps to spray tiny droplets. By means of a short focal distance telescope, the droplets can be viewed. There are two plates, one positive and the other negative above and below the bottom chamber.dc supply is attached to the plates. Some of the oil drops fall through the hole in the upper plate.

Using X-rays the bottom chamber is illuminated causing the air to ionize. As the droplets traverses through the air, electrons accumulate over the droplets and negative charge is acquired. With the help of dc supply a voltage is applied. Speed of its motion can be controlled by altering the voltage applied on the plates. By adjusting the voltage applied, drop can be suspended in air. Millikan observed one drop after another, varying the voltage and noting the effect. After many repetitions he concluded that charge could assume only certain fixed values.

He repeated the experiment for many droplets and confirmed that the charges were all multiples of some fundamental value and calculated it to be 1.5924(17) $\times 10^{-19}$ C, within one percent of the currently accepted value of 1.602176487(40) $\times 10^{-19}$ C. He proposed that this was the charge of a single electron.

Theory

Initially the oil drops are allowed to fall between the plates in the absence of electric field. Due to gravity they accelerate first, but gradually slowdown because of air resistance.

The terminal velocity v_1 in the absence of an electric field is calculated as

$$v_1 = \frac{l_1}{t_1}$$

where 'l_1' is the distance travelled by the oil drop and 't_1' is the time taken.

The drag force acting upon the drop is calculated from stokes's law and is given as

$$F_v = 6\pi\eta r v_1$$

The apparent weight (true weight minus up thrust) for a perfectly spherical body is given by,

$$F_G = \frac{4}{3}\pi r^3 g(\rho - \rho_{air})$$

At terminal velocity the oil drop is not accelerating, so the total force acting on it must be zero

$$F_V - F_G = 0.$$

i.e.,

$$F_V = F_G$$

$$r^2 = \frac{9\eta v_1}{2g(\rho - \rho_{air})}$$

r-radius of oil drop,η-viscosity of air,V_1-terminal velocity,g-acceleration due to gravity,ρ-density of liquid
ρ_{air}-density of air

Now a field is produced in the bottom chamber with the supply voltage. A likely looking drop is selected and kept in the middle of the field of view by adjusting the voltage.

If the electric forces F_e, balances the gravitational force F_G, the drop suspends in the air.
Then,

$$F_e = F_G$$

$$qE = mg$$

$$\frac{qV}{d} = mg$$

where V is the balancing potential and d is the distance between the plates.

If the applied electric force F_e is greater than the downward forces, some of the drops (the charged ones) will start to rise. Now the electric force will act upwards,gravity and viscous forces acts downwards.
Corresponding terminal velocity v_2 is calculated as,

$$v_2 = \frac{l_2}{t_2}$$

where l_2 is the distance travelled by the oil drop and t_2 the time taken.
Now the total force acting on drop is $F_e - F'_v - F_G = 0$.

$$F_e = F'_v + F_G$$

F'_V is the new viscous force under the action of electric field.

$$qE = 6\pi\eta r v_2 + 6\pi\eta r v_1$$

$$\frac{qV}{d} = 6\pi\eta r(v_1 + v_2)$$

$$q = 6\pi\eta r(v_1 + v_2)\frac{d}{V}$$

Millikan repeated the experiment no. of times, each time varying the strength of X-rays ionizing the air. As a result no. of electrons attaching to the oil drop varied. Then he obtained various values for q, and is found to be a multiple of 1.6 x 10^{-19}C.

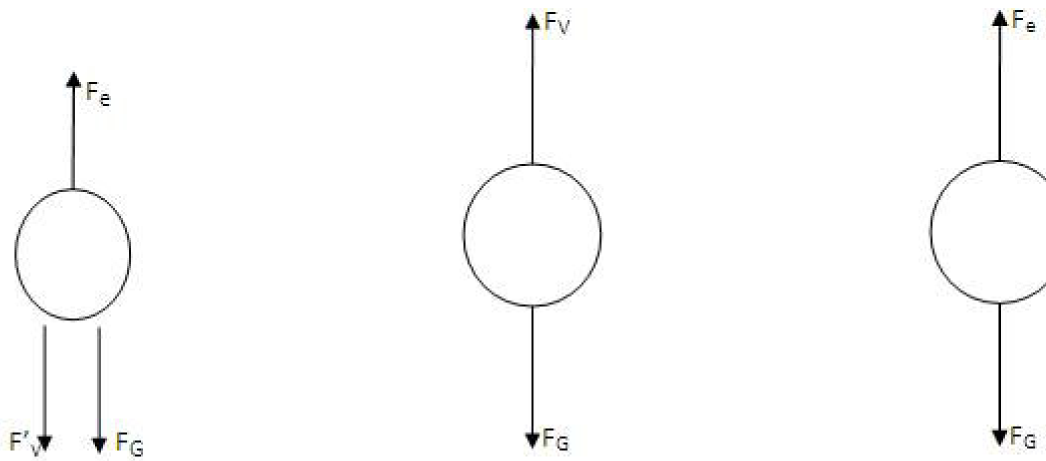
Procedure for Simulation:

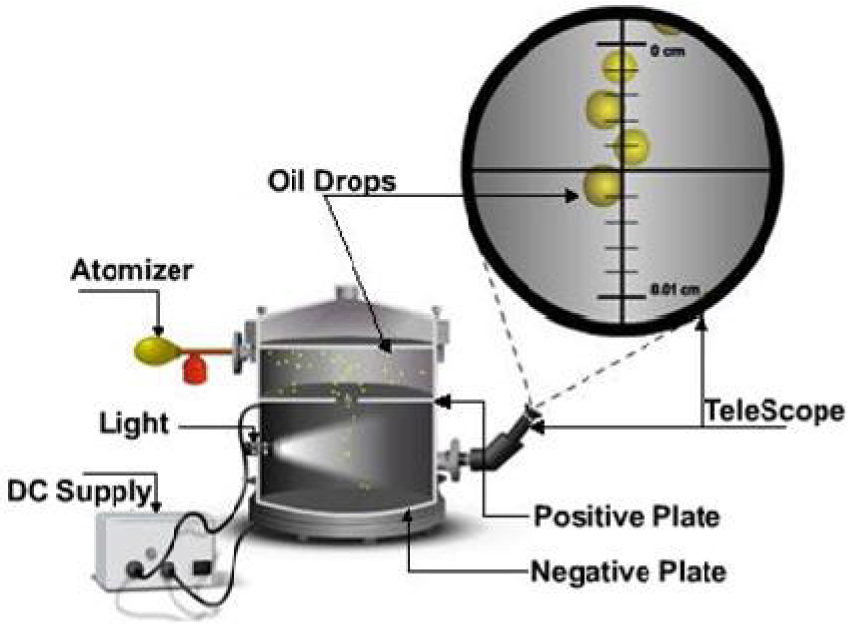
1. Click on 'START' button.
2. Click on Combo box to choose the oil.
3. Double click 'START' button of stop watch and notice the time taken t_1 by a drop, to travel distance l_1 between any two points .
4. Click 'Voltage On' to suspend the same oil drop in air, which is the balancing voltage V.
5. Click the 'X Ray ON' button and notice the time taken t_2 by same drop to travel distance l_2 between any two points.

$$q = \frac{6\pi\eta r(v_1 + v_2)d}{V}$$

6. Charge of drop is calculated using the equation,
7. Repeat the experiment for another oil.

Observations





Name of the oil=
Density of the oil=
Distance between the plates d=

T no	Distance l_1 (m)	Time t_1 (s)	Distance l_2 (m)	Time t_2 (s)	Terminal velocity in m/s		Radius r (m)	Balancing potential (V)	Charge on the drop in C
					$V_1=l_1/t_1$	$V_2=l_2/t_2$			
1									
2									
3									
4									
5									

$$q = \frac{6\pi\eta r(v_1 + v_2)d}{V}$$

SDM COLLEGE (AUTONOMOUS), UJIRE Department of Physics V SEM BSc:

Practical Questions

1. **Determine the energy gap of the given Thermister (perform the experiment at 6 different temperatures) by drawing relevant graph. Also determine its temperature coefficient of resistance at room temperature and at boiling point of water.**

2.Verify Stefan's law of radiation using electric bulb in one of the arms of Wheatstones bridge (6 different currents)

3. Determine Sp.charge of en electron using Thomson's apparatus.(two trials for each magnet in the first part and 6trials for second part)

4 Determine Self inductance of the given coil by using it in one arm of the Andersons bridge.(6 trials for DC brideg and 6 trials for AC bridge)

5. Draw frequency response curve of the given CE Amplifier.From the graph determine max mid band gain,lower cut of frequency.Also determine input impedance and out put impedance.Compare theoretical and experimental values.

6. For the given tube study the variations of count rate with applied voltage and thereby determine the plateau, the operating voltage and the slope of the plateau.

7.construct a regulated power supply using three pin regulator and given components and find out line and load regulation (Two cases each,minimum 8 readings in each case)Draw the relevant graphs

8. **Construct wien brideg oscillatror using the given components .Minimum 4trial compare theoretical and experimental values of frequencies**

UNITS OF MEASUREMENTS

FUNDAMENTAL UNITS		
Quantity	**Unit**	**Symbol**
1. Length	meter	m
2. Mass	kilogram	kg
3. Time	second	s
4. Electric Current	ampere	A
5. Temperature	kelvin	K
6. Luminious Intensity	candela	Cd
7. Amount of Substance	mole	mol
SUPPLEMENTARY UNITS		
Quantity	**Unit**	**Symbol**
1. Plane Angle	Radian	rad
2. Solid Angle	Steradian	Sr

DERIVED UNITS		
Quantity	**Unit**	**Symbol**
1. Area	square meter	m^2
2. Volume	cubic meter	m^3
3. Density	kilogram/ cubic meter	kg/m^3
4. Velocity	meter/second	m/s
5. Angular Velocity	radian/ second	r/s
6. Acceleration	meter/second square	m/s^2
7. Angular Accleration	radian/second square	rad/s^2
8. Frequency	hertz	Hz
9. Force	newton	N
10. Work energy	joule	J
11. Power	watt	W
12. Pressure	pascal	Pa
13. Electrical charge	coulomb	C
14. Potential difference	volt	V
15. Electrical resistance	ohm	Ω
16. Capacitance	farad	F
17. Inductance	henry	H
18. Magnetic field	telsa	T
19. Luminious flux	lumen	lm
20. Dynamic Viscocity	newton sec./ square meter	$N\text{-}s/m^2$

STANDARD PREFIXES IN MEASUREMENTS

Prefiks	Symbol	Multiplying factor
yotta	Y	$1\ 000\ 000\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{24}$
zetta	Z	$1\ 000\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{21}$
exa	E	$1\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{18}$
peta	P	$1\ 000\ 000\ 000\ 000\ 000 = 10^{15}$
tera	T	$1\ 000\ 000\ 000\ 000 = 10^{12}$
giga	G	$1\ 000\ 000\ 000 = 10^{9}$
mega	M	$1\ 000\ 000 = 10^{6}$
kilo	k	$1\ 000 = 10^{3}$
hecto	h	$100 = 10^{2}$
deka	da	$10 = 10^{1}$
deci	d	$0{,}1 = 10^{-1}$
centi	c	$0{,}01 = 10^{-2}$
milli	m	$0{,}001 = 10^{-3}$
mikro	µ	$0{,}000\ 001 = 10^{-6}$
nano	n	$0{,}000\ 000\ 001 = 10^{-9}$
piko	p	$0{,}000\ 000\ 000\ 001 = 10^{-12}$
femto	f	$0{,}000\ 000\ 000\ 000\ 001 = 10^{-15}$
atto	a	$0{,}000\ 000\ 000\ 000\ 000\ 001 = 10^{-18}$
zepto	z	$0{,}000\ 000\ 000\ 000\ 000\ 000\ 001 = 10^{-21}$
yocto	y	$0{,}000\ 000\ 000\ 000\ 000\ 000\ 000\ 001 = 10^{-24}$

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE
(Autonomous), UJIRE-574240

DEPARTMENT OF PHYSICS

KNOWLEDGE ENHANCEMENT THROUGH SKILL DEVELOPMENT

(LABORATORY WORK BOOK)

BSC -VIth SEMESTER

EXPERIMENTS

1. **Inverse square law for gamma rays**
2. **Hall Effect-Determination of Hall coefficient and carrier density**
3. **De-Morgan's Theorems**
4. **Half adder and full adder**
5. **Logic gates using diodes and transistor**
6. **TTL Gates**
7. **De-Sauty Bridge**
8. **IC-7400 as Universal Gate**
9. **Computer Simulation experiment**

Name: **Roll No:**

INSTRUCTIONS AND SAFETY MEASURES

1. Come well prepared and do the experiment neatly.

2. Follow directions of the Staff In-charge and handle the equipments carefully.

3. Observe strict silence and be Professional

4. Perform at least two trials and do the calculations independently

5. Report all injuries or breakages to the lab in-charge immediately. Also, report any equipment that you suspect is malfunctioning.

6. Be careful when working with apparatus that may be hot. When you pick it up, use tongs, a wet paper towel, or other appropriate holder.

7. Each time you use glassware, be sure to check it for chips and cracks. Inform Staff In-charge about any damaged glassware so that it can be properly disposed of.

8. Request the staff in-charge to ensure all electrical circuits are proper before you turn on the power.

9. When working with electrical circuits, be sure that the current is turned off before making adjustments in the circuit.

10. During electronic experiments, verify the values of resistors / capacitors to be used.

11. Switch off the circuit and multimeter when you finish the experiment

12. After finishing optical experiments switch off the sources.

13. While doing the LASER experiments avoid the beam targeting your eyes
14. Eating anything while working in the lab is prohibited

15. Always keep your work area neat and clean

16. Ensure that equipment remains in the same condition and place before you leave the laboratory

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (Autonomous), UJIRE-574240

DEPARTMENT OF PHYSICS

CERTIFICATE

This is to certify that ....with Roll Number...................has satisfactorily completed the course of Experiments in Practical Physics prescribed by the College for BSc VIth Semester during the year 20…...-- 20…….

Lecturer in charge of the Batch

Submitted on.....

CONTENTS

Expt No	Name of the Experiment	Date	Page Number

Experiment Number:Date:

1. Inverse square law for gamma Rays

AIM: To verify inverse square law for gamma rays.

APPARATUS: Gamma ray source, GM counters with tube, stop watch

PRINCIPLE: It is known that the intensity at a point due to a point source of light decreases inversely as the square of the distance between the point and the source. This is known as inverse square law in photometry. The law has been found to hold good in the case of gamma rays. This proves that gamma rays are electromagnetic radiation.

A radioactive sample emits gamma rays after a beta decay or K- capture. The sample is sandwiched in a plan Chet which absorbs the beta particles and allows only the gamma rays to pass through. For all practical purposes the source can be considered to be a point source.The number of gamma ray photons emitted is counted using a GM counter.

Let D be the rate of disintegration of source i.e. the no. of gamma photons emitted. The number of photons entering the GM tube is given by

$$N = \frac{D(areaofthewindow)}{4\pi x}$$

Where x is the distance between the tube window and the source. If a is the radius of circular window and E the fraction of gamma rays detected, we have,

$$N = \frac{D\pi a^2 E}{4\pi x^2} = \frac{DEa^2}{4x^2}$$

$$\log N = c - 2\log x,$$

Where c is a constant.

If a graph plotted connecting log N and log x, a straight line with a negative slope is obtained. The magnitude of the slope gives the exponent of x. This will be close to 2, thus verifying the inverse square law of gamma rays.

PROCEDURE: A GM tube held horizontally is connected to a counting unit "C" using a shielded cable. The unit is switched on and the voltage is set at the operating voltage of the tube. The counter is switched on without the gamma ray source near the tube. The number of counts registered is noted for five minutes.

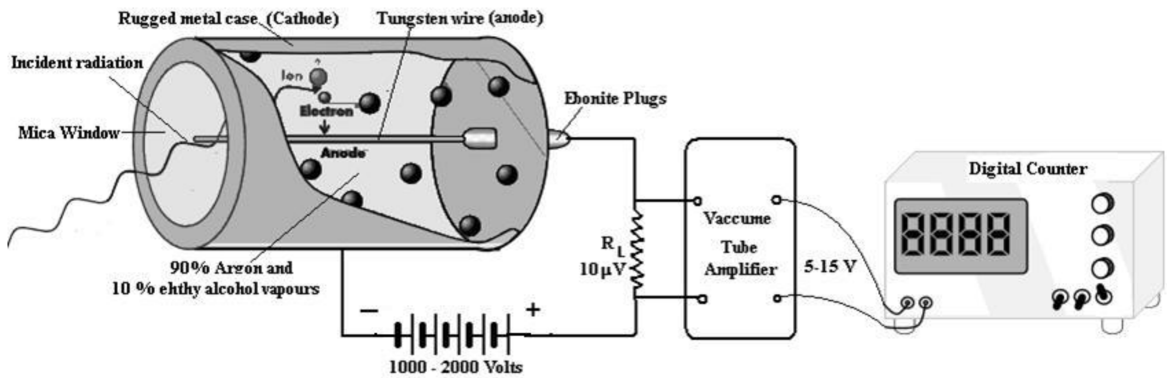
The experiment is repeated several times and the mean count per minute (N_b) is found out. This gives the background count due to traces of radioactive materials present in the neighborhood. The sources of gammarays is mounted on stand so as to be at the same height as the GM tube. The distance between the window and the source is measured. The number of counts registered is noted for an interval of two minutes. The observation is repeated 3 times and the mean count per minute (CPM) is found out as N_1. The experiment is repeated for different distances, N= (N_1-Nb) gives the CPM due to the source alone. If the error involved is taken into consideration the range of values of N is given by,

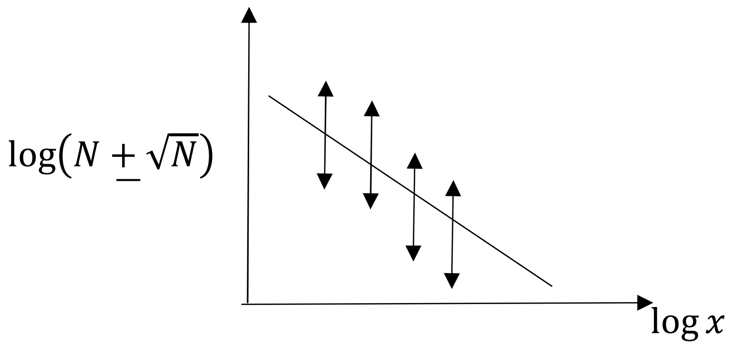
$$N + \sqrt{N} \quad \text{And} \quad N - \sqrt{N}$$

Hence each point on the graph connecting X and N is replaced by a short vertical line. The best straight line passing through the short lines is drawn and the slope is found out.

Result: The inverse square law is found to be correct within the limits of experimental error and the slope of the graph logX verses $\log(N + \sqrt{N})$=

Observations:





To find the back ground countsN_b

T no	Counts for 2 minutes	CPM
1		
2		
3		
4		

Mean N_b =

To find the rate of Disintegration:

Trail Number	Distance x (cm)	Counts for 2 minutes					CPM
		1	2	3	4	Mean	N_1
1	2						
2	3						
3	4						
4	5						
5	6						

T no	N =N1-Nb	logN	$N+\sqrt{N}$	$\log(N+\sqrt{N})$	$N-\sqrt{N}$	$\log(N-\sqrt{N})$
1						
2						
3						
4						
5						

Result: The inverse square law is found to be correct within the limits of experimental error and the slope of the graph log X verses $\log(N+\sqrt{N})$=

Experiment Number: Date:

2. Hall Effect-Determination of Hall Coefficient

Aim:

To determine the Hall voltage developed across the sample material and to determine Hall coefficient and Carrier density

Apparatus:

Electro Magnets, Constant current supply, Four probe, Digital gauss meter, Hall effect apparatus, Hall Probe, Gauss Probe etc

Theory:

If a current carrying conductor placed in a perpendicular magnetic field, a potential difference will generate in the conductor which is perpendicular to both magnetic field and current. This phenomenon is called Hall Effect. In solid state physics, Hall effect is an important tool to characterize the materials especially semiconductors. It directly determines both the sign and density of charge carriers in a given sample.

Consider a rectangular conductor of thickness ***t*** kept in XY plane. An electric field is applied in X-direction using Constant Current Generator (CCG), so that current ***I*** flow through the sample. If ***w*** is the width of the sample and ***t*** is the thickness. Hence current density is given by

$$J_x = I/wt \qquad (1)$$

If the magnetic field is applied along negative z-axis, the Lorentz force moves the charge carriers (say electrons) toward the y-direction. This results in accumulation of charge carriers at the top edge of the sample. This set up a transverse electric field $\mathbf{E_y}$ in the sample. This develop a potential difference along y-axis is known as Hall voltage V_H and this effect is called Hall Effect.

A current is made to flow through the sample material and the voltage difference between its top and bottom is measured using a volt-meter. When the applied magnetic field B=0,the voltage difference will be zero.

We know that a current flows in response to an applied electric field with its direction as conventional and it is either due to the flow of holes in the direction of current or the movement of electrons backward. In both cases, under the application of magnetic field the magnetic Lorentz force is

$$F_m = q(v \times B)$$

Which causes the carriers to curve upwards. Since the charges cannot escape from the material, a vertical charge imbalance builds up. This charge imbalance produces an electric field which counteracts with the magnetic force and a steady state is established. The vertical electric field can be measured as a transverse voltage difference using a voltmeter.

In steady state condition, the magnetic force is balanced by the electric force. Mathematically we can express it as

$$eE = evB \qquad (2)$$

Where 'e' the electric charge, 'E' the hall electric field developed, 'B' the applied magnetic field and 'v' is the drift velocity of charge carriers.
And the current 'I' can be expressed as,

$$I = neAv \qquad (3)$$

Where 'n' is the number density of electrons in the conductor of length l ,breadth 'w' and thickness 't'.
Using (1) and (2) the Hall voltage V_H can be written as,

$$V_H = Ew = vBw = \frac{IB}{net}$$

$$V_H = R_H \frac{IB}{t} \qquad (4)$$

by rearranging eq(4) we get

$$R_H = \frac{V_H * t}{I * B} \qquad (5)$$

Where R_H is called the Hall coefficient.

$$n = \frac{1}{R_H e} \qquad (6)$$

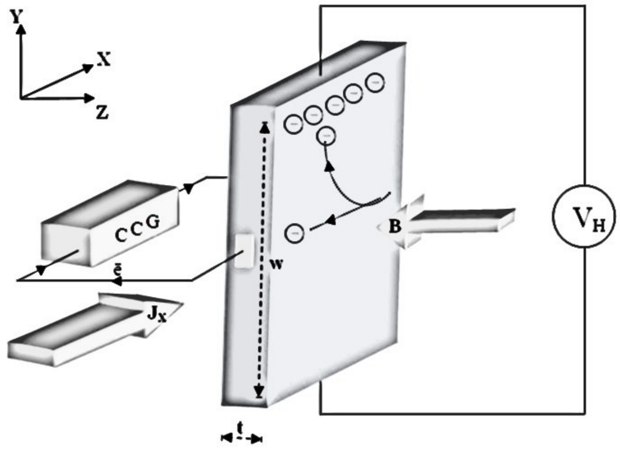
Procedure:

- Connect 'Constant current source' to the solenoids of the electromagnet.
- Set the gap between the magnets to 10 mm
- Four probe is connected to the Gauss meter and placed at the middle of the two solenoids.
- Switch ON the Gauss meter and Constant current source.
- Vary the current through the solenoid from 0.5 A to 1.5 A with the interval of 0.25A, and note the corresponding Gauss meter readings. Readings are tabulated
- Switch OFF the Gauss meter and constant current source and turn the knob of constant current source towards minimum current.
- Fix the Hall probe on a wooden stand. Connect wires marked as C to Constant Current Generator and connect wires marked as V to milli voltmeter in the Hall Effect apparatus
- Replace the Four probe with Hall probe and place the sample material at the middle of the two solenoids.
- Set the current I^* in the Hall probe to 8 mA for 0 magnetic field.
- Switch ON the constant current source and Hall effect apparatus.
- Carefully increase the current I in constant current source as in the previous step and measure the corresponding Hall voltage $\boldsymbol{V_H}$. Repeat this step for different magnetic field $\boldsymbol{B}$.
- Hence calculate the Hall coefficient $\boldsymbol{R_H}$ and carrier concentration.

Result

Particulars	N type material	P type material
Hall Coefficient **$cm^3.C^{-1}$**		
Carrier density **cm^{-3}**		

Observations



Thickness of the crystal, t = 0.005cm

Charge on the electron,e = 1.6X 10^{-19} C

Current through the Hall probe, I^*=8mA

Gap between the magnetic poles: 10 mm

Estimation of of Magnetic field

T no	**Current in mA** **I**	**Magnetic field in Gauss** **B**
1		
2		
3		
4		
5		
6		

Determination of Hall coefficient and carrier density

Sample -Germanium crystal N type

T no	**Magnetic Field Applied** **B** **Gauss**	**Hall voltage** V_H^* **Volts**	**Hall coefficient** R_H $R_H = \frac{V_H * t}{I * B}$ $cm^3.C^{-1}$	**Carrier Density** $n = \frac{1}{R_H e}$ **n=1/Rq** cm^{-3}
1				
2				
3				
4				
5				
6				

Average value of Hall coefficient=

Average value of Carrier concentration=

Sample -Germanium crystal P type

T no	**Magnetic Field Applied** **Gauss** **B**	**Hall voltage** V_H^*	**Hall coefficient** R_H $R_H = \frac{V_H * t}{I * B}$ $cm^3.C^{-1}$	**Carrier Density** $n = \frac{1}{R_H e}$ **n=1/Rq** cm^3
1				
2				
3				
4				
5				
6				

Average value of Hall coefficient=

Average value of Carrier concentration=

Result

Particulars	N type material	P type material
Hall Coefficient $cm^3.C^{-1}$		

Carrier density **cm^{-3}**		

Experiment Number:Date:

3. De Morgan's Theorems

Aim: To study Demorgan's theorems and verify the truth tables

Apparatus required: 5Vpowersupply, bread board,ICs7400,7402,7404,7408 ,and 7432. LEDs and Connecting wires etc

Theory: De-Morgan proposed two theorems under Boolean algebra which are used to simplify Boolean equations.The first theorem states that complement of the sum is equal to product of complements.
It is also understood as NOR is equivalent on bubbled AND.

$$\overline{A+B}=\overline{A}\,.\overline{B}$$

The second theorem states that complement of the product is equal to sum of complements or AND is equivalent to bubbled OR

$$\overline{AB}= \overline{A} +\overline{B}$$

Procedure:

1. **Verification of First Theorem**

.Initially IC 7402,IC 7404, IC 7400, IC 7408 and IC 7432 are carefully inserted into the bread board. Electrical connections are made as shown in circuit (1). For this NOR gate present in the 7402IC, truth table is verified.To check the out state a LED is connected to the output terminal.

Now connections are made as in the circuit (2) .using two NOT gates in IC 7404 and one AND gate in IC 7408, bubbled AND gate is designed and the truth table is verified.it is found that NOR output agrees verywell with the bubbled AND output for all cases.This verifies Demorgan's first theorem

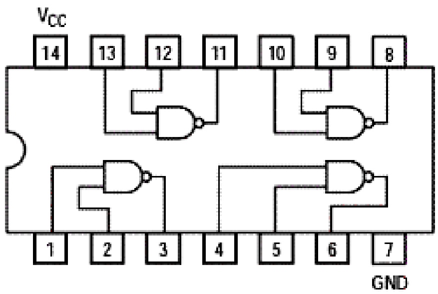
2. **Verification of second theorem**

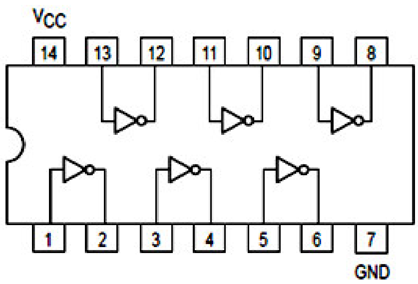
Electrical connections are made as shown in circuit (3) For this NAND gate present in the 7400IC, truth table is verified. Now connections are made as in the circuit (4) .using two NOT gates in IC 7404 and one OR gate in IC 7432, bubbled OR gate is designed and the truth table is verified. It is found that NAND output agrees verywell with the bubbled OR output for all cases. This verifies De-Morgan's second theorem.

Inference: The truth table summarizes the action of the circuits and thus De-Morgan's theorems are verified.

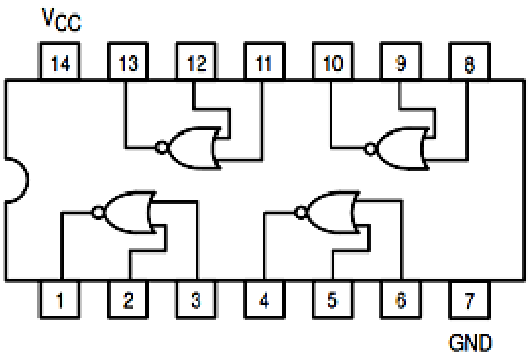
Observations

Pin diagrams

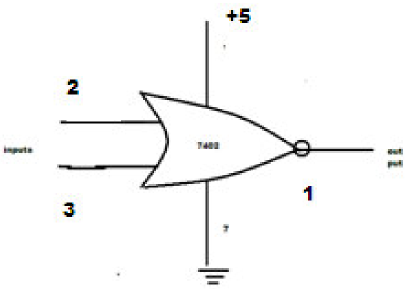


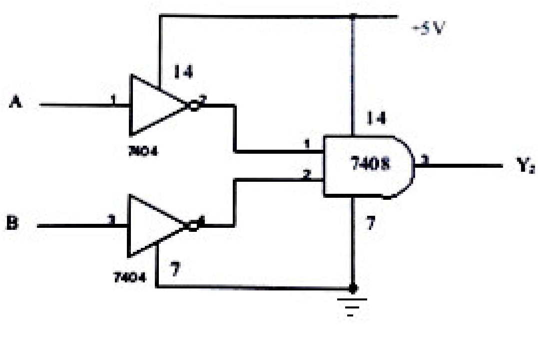


IC 7400, 7408 and 7432 **IC 7404**

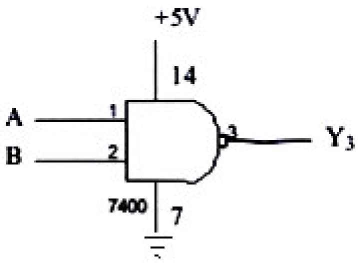


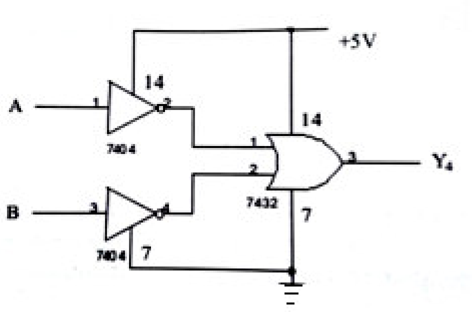
IC 7402





Circuit (1) NOR gate **Circuit (2) Bubbled AND gate**





Circuit (3) NAND gate

Circuit (4) Bubbled OR gate

Truth table

Inputs		First theorem		Second theorem	
		Outputs		Outputs	
B	A	NOR	Bubbled AND	NAND	Bubbled OR
0	0				
0	1				
1	0				
1	1				

Inference: The truth table summarizes the action of the circuits and thus De-Morgan's theorems are verified.

Experiment Number : Date :

4.HALF ADDER & FULL ADDER

AIM: To design and verify the action of Half Adder & Full Adder circuits.

APPARATUS REQUIRED:

S.No.	Name of the Apparatus	Range	Quantity
1.	Digital IC trainer kit		1
2.	AND gate	IC 7408	1
3.	OR gate	IC 7432	1
4.	X-OR gate	IC 7486	1
5.	Connecting wires	As required	

Description : The 7400 series of transistor-transistor logic (TTL) integrated circuits are historicallyimportant as the first widespread family of TTL integrated circuit logic.

The 7400 series contains hundreds of devices that provide everything from basic logic gates, flip-flops, and counters, to special purpose bus transceivers and Arithmetic Logic Units (ALU).IC 7408 is a quad two input AND gate,IC 7432 is quad two input OR Gate,IC 7486 is quad two input XOR Gate.Using these ICs a half adder and a full adder can be designed.

HALF ADDER :A combinational circuit which performs the addition of two bits at a time is calledhalf adder. Using one AND gate in IC 7408 and one XOR Gate in IC 7486 an half adder circuit can be constructed.

FULL ADDER :A combinational circuit which performs the arithmetic sum of three input bits at a timeis called full adder. The three input bits include two significant bits and a previous carry bit. A full adder circuit can be implemented with two half adders and one OR gate using two XOR Gates,two AND Gates and one OR Gates in the ICs provided

PROCEDURE:

1. All the three ICs are inserted in the respective slots carefully in the IC Trainer kit and the individual gates present in all IC s are checked by noting the out puts from each gates for different inputs

2. Connections are made as per the circuit diagrams.

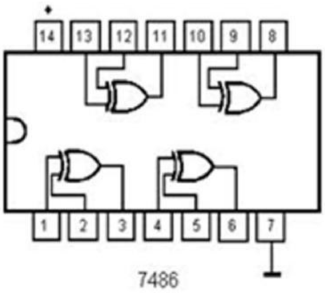
3. For all the ICs 7th pin is grounded and 14th pin is given +5 V supply.

4. Apply the inputs and verify the truth table for the half adder and full adder circuits.

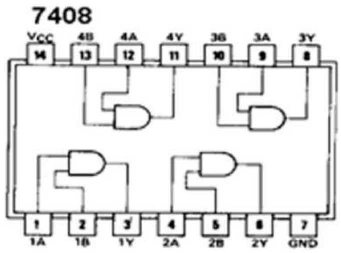
INFERENCE : Action of half adder and full adder circuits is summarized in the truth tables.

Observations

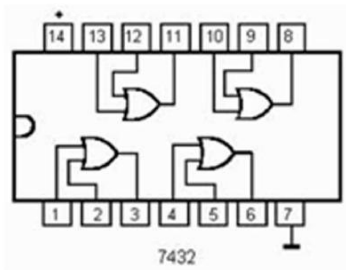
XOR gates in 7486 IC



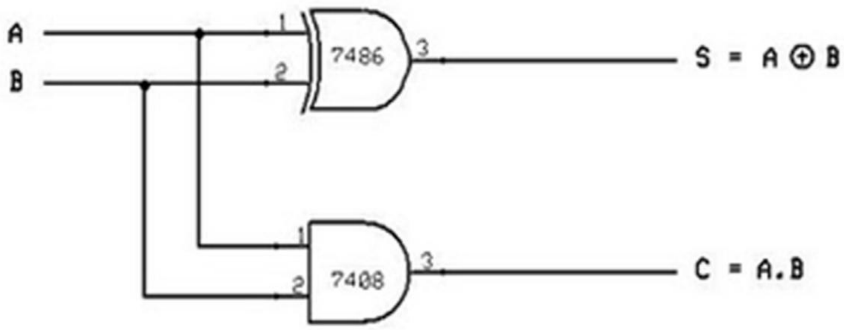
AND Gates in 7408 IC



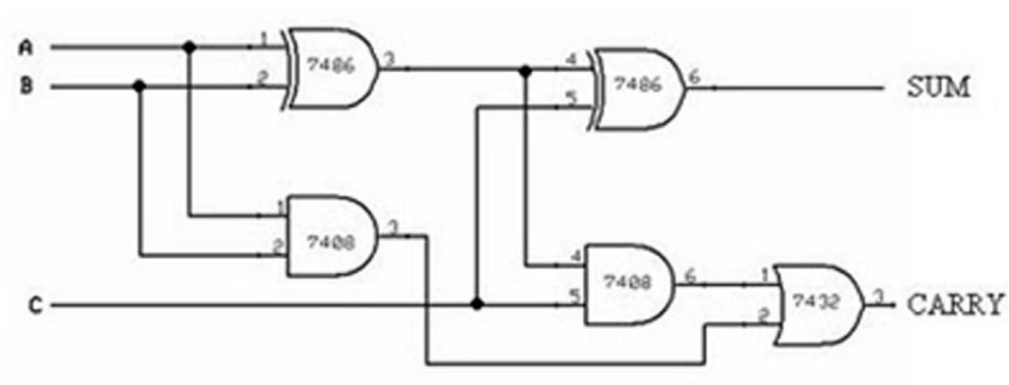
OR Gates in 7432 IC



HALF ADDER CIRCUIT



FULL ADDER CIRCUIT



Truth table to check four AND Gates in IC 7408

Input A	Input B	Expected output	Output Q Gate 1	Output Q Gate 2	Output Q Gate 3	Output Q Gate4
0	0	0				
0	1	0				
1	0	0				
1	1	1				

Truth table to check four OR Gates in IC 7432

Input A	Input B	Expected output	Output Q Gate 1	Output Q Gate 2	Output Q Gate 3	Output Q Gate4
0	0	0				
0	1	1				
1	0	1				
1	1	1				

Truth table to check four XOR Gates in IC 7486

Input A	Input B	Expected output	Output Q Gate 1	Output Q Gate 2	Output Q Gate 3	Output Q Gate4
0	0	0				
0	1	1				
1	0	1				
1	1	0				

TRUTH TABLE FOR HALF ADDER CIRCUIT

S. No	INPUT		OUTPUT			
	B	A	CARRY		SUM	
			voltage	state	voltage	state
1.	0	0				
2.	0	1				
3.	1	0				
4.	1	1				

TRUTH TABLE FOR FULL ADDER CIRCUIT

S.No	INPUT			OUTPUT			
	C	B	A	CARRY		SUM	
				voltage	state	voltage	state
1.	0	0	0				
2.	0	0	1				
3.	0	1	0				
4.	0	1	1				
5.	1	0	0				
6.	1	0	1				
7.	1	1	0				
8.	1	1	1				

Experiment Number : Date :

5.OR, AND and NOT gates using Diodes and Transistor

Aim : To construct OR and AND gates using diodes and NOT gate using transistor and to verify thetruth tables.

Apparatus required :5 V DC Power supply,breadboard,diodes,transistor and resistors

Theory : A logic gate is an electronic circuit which performs logic functions or takes a logic decision. Ithas one output and one or more inputs. Logic gates are the building blocks of the digital systems. They work on the logical algebra developed by George Boole. The Boolean operations namely 'OR' operation.'AND' operation and 'NOT' operation are implemented by three logic gates called 'OR' gate 'AND' gates and 'NOT" gate.

OR GATE:-

It implements Boolean 'OR' operation. An 'OR' gate is a logic circuit which has two or more inputs and one output whose output is high if one or all inputs are high

The fig (a) shows a two input 'OR' gate using two ideal diodes D1 and D2. Here A and B represent two inputs and Y the output. R represents the output load resistor. The fig(b) gives the symbolic representation of 'OR' gate.

Working

Case (i) : When A = O, B = O, both input voltages are zero. So both the diodes D1 and D2 do not conduct. Hence, current through R is Zero and so output voltage is zero i.e. Y =0.

Case (ii):- When A = 1, B =0 the diode D1 is forward biased and it conducts. D2 does not conduct. Since D1 is conducting, current flows through R. Hence, there is an output voltage is high and the state is Y = 1.

Case (iii) :- When A =0, B = 1 the diode D2 is forward biased and so it conducts. D1 does not conduct since D2 is conducting, current flows through R. Hence there is an output or Y = 1.

Case (iv) :- When A = 1, B =1 both the diodes D1 and D2 are forward biased. Hence both are conduct-ing. so current flows through R and there is an output voltage and Y =1.

The logic operation of the OR gate can be summarized in a tabular form known as truth table. A truth is defined as a table which gives the output state for all possible input combinations.

AND gate :-

An 'AND' gate implements Boolean 'AND' operation. It is a logic circuit with two or more inputs and one output whose output is high when all the inputs are high

Fig (a) shows a two - input AND gate using two ideal diodes and fig(b) gives its symbolic representa-tion. Here A and B represent the two input and Y the output. R represents the output load resistor. The two input voltages are assumed to be either 0 or 5 v.

When both A = OV and B = OV,

The inputs are short circuited to ground and. The 5V battery in the output side biases the diodes D1 and D2 in the forward direction. Hence both diodes conduct. The output is also shorted to ground through the diodes. Thus the output Y = O

ii) When A = 5V and B = OV diode D2 conducts and the output is shorted to ground through this diode. Therefore, output Y = O

iii) When A =OV and B = 5V, diode D1 conducts and the output is short circuited to ground through this diode. Therefore, the output Y = 0

iv) When both A = 5V and B = 5V neither D1 nor D2 conduct. Now current flows through R and the output Y = 1

NOT GATE :-

It is a logic circuit with only one input and one output.. If the input is 1, the output is 0 and when the input is 0 the output is 1. That is the NOT gate inverts the input, it is also called inverter A 'NOT' gate using transistor in fig(a) and its symbol in Fig(b).

i) When the input is low , i.e. A = OV, the transistor is cut OFF, making the collector current zero. Thus the potential drop across R is zero. The supply voltage of VCC appears at the output terminal. Hence the output Y = VCC. Thus when input is low, output is high.

ii) When input is high ie A =1, the transistor conducts (fully ON) drawing maximum collector current. Hence whole of VCC drops across R and output Y = O. Thus when input is high, the output is held at a low value.

PROCEDURE

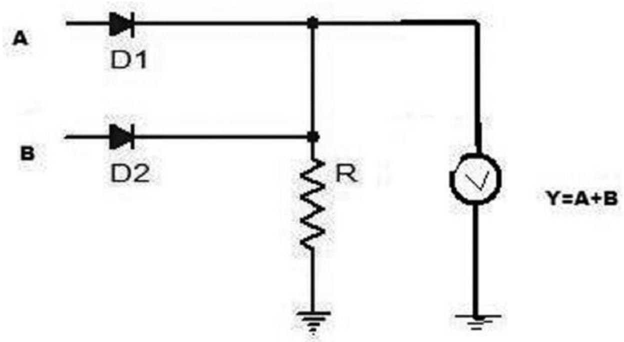
Construct the OR gate as in the fig 1.use the resistors according to the design calculations.for different input combinations note down the logic state of the out put using a voltmeter.write the truth table.

Construct AND and NOT circuit as shown and write the truth table.

RESULT

The truth tables of OR.AND and NOT are verified

OBSERVTIONS



OR gate Fig a

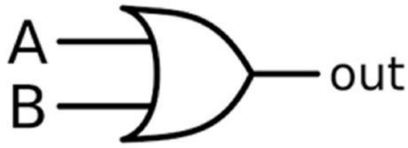
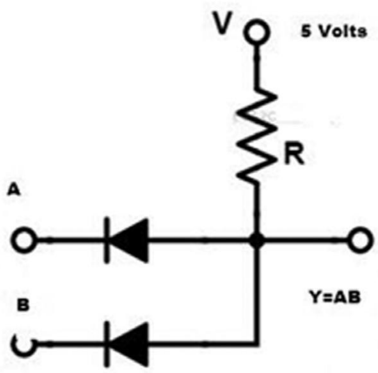


Fig B symbol



AND gate Fig a

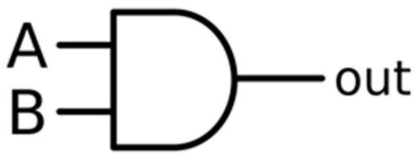
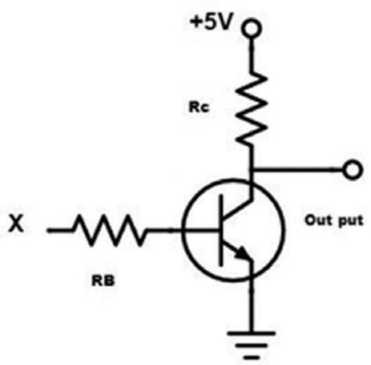


Fig b symbol



NOT gate Fig a

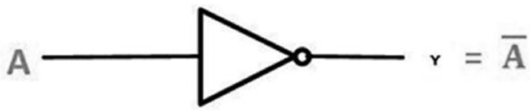


Fig b symbol

DESIGN CALCULATIONS

For OR and AND Gates

Supply voltage VS= 5 Volts

Diode used =IN 4001

Current through diode=5 mA

Voltage drop across the diode=0.7 volts

Therefore resistor R required is= (VS -0.7)/5mA=860 ohm=1kohm

For NOT Gate

Supply voltage VS= 5 Volts

Transistor used =BC 547

Let collector current IC=5 mA

Let Base current IB= 100 micro amp

Collector resistor RC=VCC/IC=5 volt/5mA=1 kohm

RB=(Input A-VBE)/IB=(5-0.7)/100 microamp= 43 kohm=47 kohm

TRUTH TABLE FOR OR and AND Gates

INPUT B		INPUT A		OR OUT PUT		AND OUT PUT	
Voltage	State B	Voltage	State A	Voltage	state Y=A+B	Voltage	state Y=AB
0	0	0	0				
0	0	5	1				
5	1	0	0				
5	1	5	1				

TRUTH TABLE FOR NOT GATE

IN PUT		OUT PUT	
voltage	state A	voltage	state $Y=\overline{A}$
0	0		
5	1		

Experiment Number : Date :

6.Transistor Transistor Logic Gates

Aim: To design TTL logic gates and to verify the truth tables

Apparatus required: NPN Transistors, 1k ohm resistors, 10 k ohm resistors,5V Power supply, breadboard, connecting wires, LEDs etc,

Principle: Depending on the voltage given to the base of a transistor, the transistor goes to saturationor cut off regions.This switching property of the transistor can be used to design TTL logic circuits.

When the base voltage is high the transistor conducts heavily and goes to saturation region giving low collector voltage. If the base voltage is low, transistor goes to cutoff region giving high collector voltage.

Procedure:

TTL NAND Gate

Using two NPN Transistors and resistors the circuit is designed as shown in fig 1.When both inputs are given low voltage transistors go to cut off giving high output, when both inputs are high, transistors go to saturation giving low output.Out put state is checked using a LED. For unequal inputs one of the transistors is saturated and the other cut off giving high output.

TTL AND Gate

The circuit is designed as shown in figure 2 .this is the NAND gate with inverter circuit. Truth table is verified for all types of inputs

TTL NOR Gate

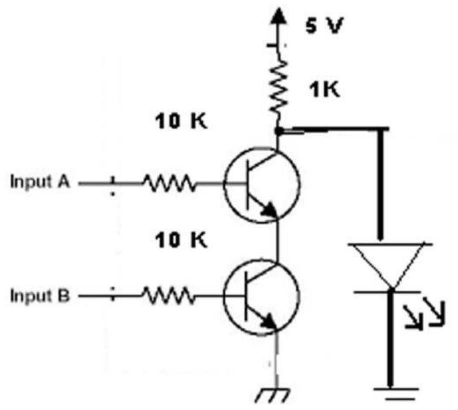
The circuit is designed as shown in figure 3.when both inputs are low, both transistors are cutoff giving high output. When both inputs are high, both the transistors are saturated giving low output. For unequal inputs one of the transistors is saturated and the other cut off giving low output. The truth table is verified.

TTL OR Gate

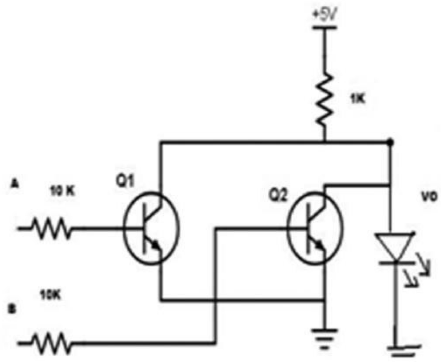
The circuit is designed as shown in figure 4 this is the NOR gate with inverter circuit. Truth table is verified for all types of inputs

Inference: Performance of different TTL Logic gates are analyzed and the truth tables are verified

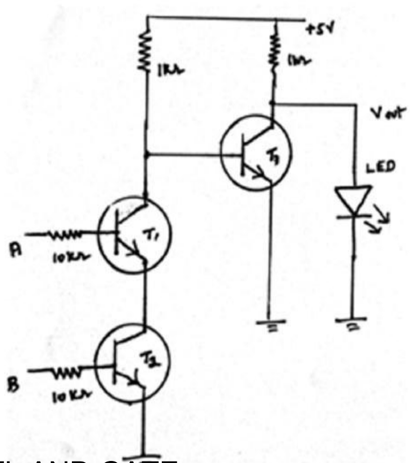
Circuit diagrams



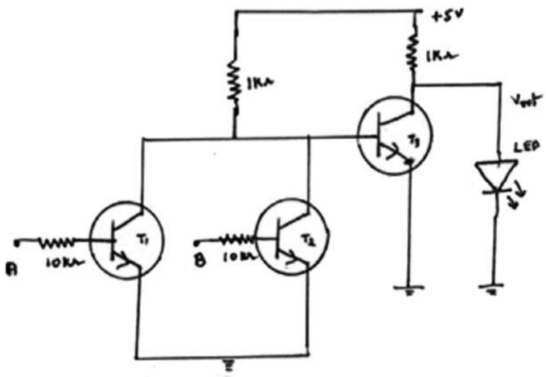
TTL NAND GATE



TTL NOR GATE



TTL AND GATE



TTL OR GATE

OBSERVATIONS

Input B		Input A		NAND Output		AND Output		NOR Output		OR Output	
Voltage	state	voltage	state	voltage	state	voltage	state	voltage	state	voltage	state
0	0	0	0								
0	0	5	1								
5	1	0	0								
5	1	5	1								

Experiment Number:Date:

7. DE SAUTY BRIDGE

AIM: To measure unknown capacitances using de-sautybridge andto verify the law of parallel combination of capacitances.

APPARATUS: R_1 decade resistance, R_2- decade resistance, C_2- Unknown capacitance, Fixed capacitance 0.1μF& 0.2μF. Inbuilt AC power supply of 1KHz.and earphone

PRINCIPLE:_ The De Sauty Bridge is a modified Wheatstone's network, consisting of two resistors and two capacitors arranged as shown in the diagram. The source is an AF oscillator. When the bridge is balanced, the sound in the headphone will be a minimum. If R_1 and R_2 are the resistances and C_1 and C_2 are the capacitances, from the network theory, we have $R_1/R_2=Z_1/Z_2$ where Z stands for the impedance in the respective branches. Hence we have at balance

$$R_1/R_2 = \frac{1/jwC1}{1/jwC2}$$

$$\frac{R_1}{R_2} = \frac{C_2}{C_1}$$

$$C_2 = \frac{R_1}{R_2} C_1$$

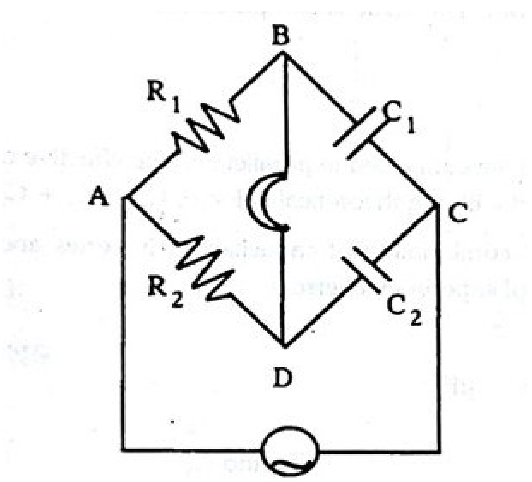
PROCEDURE:

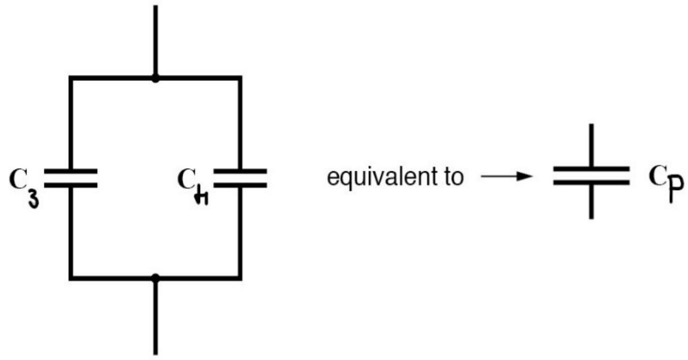
1. Connect the AC supply 1KHz with the terminals marked supply, unknown capacitor with the terminals marked C_2 and headphone with the terminals marked D(detector).
2. Set the resistance dial R_2 to some value say 1000 ohms and also set the standard capacitor C_1 at 0.1μF position.
3. Switch on the instrument.
4. Now adjust the decade resistance dial R_1 to minimize the sound in headphone.
5. Note the value of R_1, R_2 and C_1 and calculate the value of unknown capacitor using the formula. Repeat the experiment with different R_2
6. Similarly set the value of standard capacitor C_2 at 0.2μF position and repeat the experiment
7. Determine the Average value of unknown capacitance
8. Repeat the experiment for other unknown capacitances
9. Now the capacitors C_3 and C_4 are connected in parallel and the effective capacitance Cp is found out. It is compared with the theoretical value Cp= C_3+C_4.

Result

Capacitance InμF	**C_3**	**C_4**	**C_5**	**Parallel combination C_P**	
				Theoretical	**Experimental**

Circuit diagram





Parallel Combination

TABULATION:

To find the value of C_3

Unknown Capacitance	T no	R_2 (Ω)	R_1 (Ω)	C_1=0.1μF $C_3=\frac{R_1}{R_2}C_1$	R_1 (Ω)	C_2=0.2μF $C_3=\frac{R_1}{R_2}C_2$	Average Value of Capacitor C_3 In μF
C_3	1						
	2						
	3						
	4						

To find the value of C_4

Unknown Capacitance	T no	R_2 (Ω)	R_1 (Ω)	C_1=0.1μF $C_4=\frac{R_1}{R_2}C_1$	R_1 (Ω)	C_2=0.2μF $C_4=\frac{R_1}{R_2}C_2$	Average Value of Capacitor C_4 In μF
C_4	1						
	2						
	3						
	4						

To find the value of C_5

Unkown Capacitance	T no	R_2 (Ω)	R_1 (Ω)	C_1=0.1µF $C_5=\frac{R_1}{R_2}C_1$	R_1 (Ω)	C_2=0.2µF $C_5=\frac{R_1}{R_2}C_2$	Average Value of Capacitor C_5 InµF
C_5	1						
	2						
	3						
	4						

To verify Parallel combination of C_3& C_4:

T no	R_2 (Ω)	R_1 (Ω)	C_1=0.1µF	C_2=0.2µF
			$C_P=\frac{R_1}{R_2}C_1$	$C_P=\frac{R_1}{R_2}C_1$
1				
2				
3				
4				
5				

Theoretical value Cp = C_3+C_4

=

Result

Capacitance InµF	C_3	C_4	C_5	Parallel combination C_p	
				Theoretical	Experimental

Experiment Number : Date :

8.LOGIC GATES USING 7400 IC

AIM : To design basic logic gates using 7400 IC and to verify the NAND Gate as universal gate

Apparatus required :IC Trainer kit,7400 IC, IC Holder, connecting wires, voltmeter. Etc

Description : The 7400 series of transistor-transistor logic (TTL) integrated circuits are historicallyimportant as the first widespread family of TTL integrated circuit logic.

The 7400 series contains hundreds of devices that provide everything from basic logic gates, flip-flops, and counters, to special purpose bus transceivers and Arithmetic Logic Units (ALU). The first part number in the series, the 7400, designates a device containing four two-input NAND gates. Each gate uses two pins for input and one pin for its output, and the remaining two contacts supply power (+5 V) and connect the ground. This part was made in various packages including flat pack, plastic or ceramic dual in-line packages with 14 pins, and in surface mount packages as well. Additional numbers and letters in a full part number identify the package and other variations. Pin diagram and top view of IC is given below.

NAND Gate: The NAND gate represents the complement of the AND operation. Its name is anabbreviation of NOT AND. The graphic symbol for the NAND gate consists of an AND symbol with a bubble on the output, denoting that a complement operation is performed on the output of the The truth table and the graphic symbol of NAND gate is shown in the figure.

Universal Gate: A universal gate is a gate which can implement any Boolean function without need touse any other gate type. The NAND and NOR gates are universal gates. In practice, this is advantageous since NAND and NOR gates are economical and easier to fabricate and are the basic gates used in all IC digital logic families.

NAND Gate is a Universal Gate: NAND gate can used as an universal gate ie basic gates likeOR,AND,NOT XOR can be designed by a suitable combination of NAND Gates. As 7400 IC is a quad 2 in put NAND Gate, it can be used to design the fundamental gates.

NOT from NAND: A NOT gate is made by joining the inputs of a NAND gate. Since a NAND gateis equivalent to an AND gate followed by a NOT gate, joining the inputs of a NAND gate leaves only the NOT part.

AND from NAND : An AND gate is made by following a NAND gate with a NOT gate as shown. Thisgives a NOT NAND, i.e. AND.

OR from NAND : If the truth table for a NAND gate is examined or by applying De Morgan’s Laws, itcan be seen that if any of the inputs are 0, then the output will be 1. To be an OR gate, however, the output must be 1 if any input is 1. Therefore, if the inputs are inverted, any high input will trigger a high output.

NOR from NAND : A NOR gate is simply an inverted OR gate. Output is high when neither input Anor input B is high:

XOR from NAND : An XOR gate is constructed similarly to an OR gate, except with an additionalNAND gate inserted such that if both inputs are high, the inputs to the final NAND gate will also be high, and the output will be low.

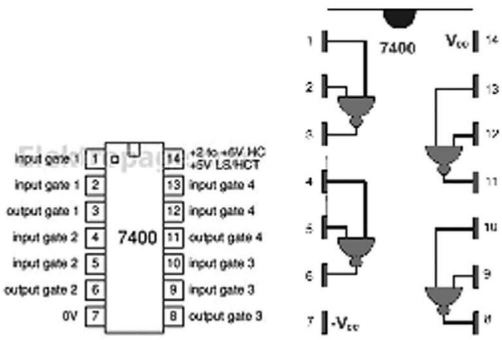
PROCEDURE

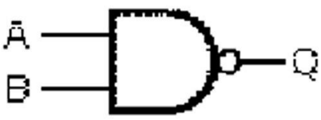
1. Initially 7400 IC is inserted in the slot carefully and external connections are made to the first gate as per the pin diagram. 7th pin is connected to ground and 14th pin is connected to 5V. NAND action is verified in this gate for different inputs and observations are recorded. similarly NAND action in all other gates is verified

2. Different gates are constructed as per the circuit diagram and truth tables are verified in each case by measuring the output voltage and writing the corresponding output state

INFERENCE: The truth tables shown here confirm the action of NAND gate as universal gate

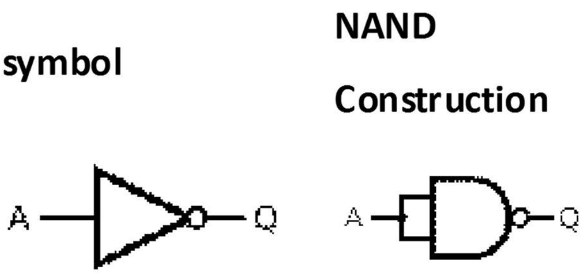
Observations





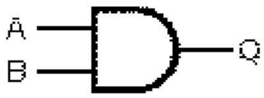
Pin diagram of 7400 IC   Symbol of NAND Gate

NOT Gate

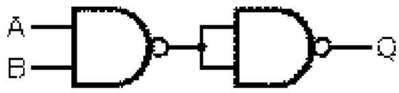


AND Gate

symbol



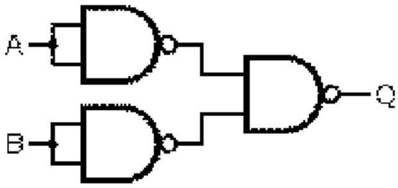
NAND Construction



OR Gate

symbol

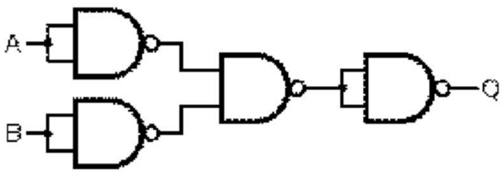
NAND Construction



NOR Gate

symbol

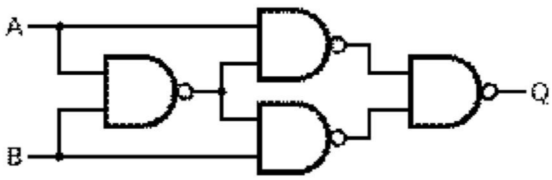
NAND Construction



XOR Gate

symbol

NAND Construction



Truth table to check 4 NAND Gates in IC 7400

Input A	Input B	Expected output	Output Q Gate 1	Output Q Gate 2	Output Q Gate 3	Output Q Gate4
0	0	1				
0	1	1				
1	0	1				
1	1	0				

Truth table for NOT Gate

Input A		Out put	
voltage	state	voltage	state
0	0		
5	1		

Truth table for AND,OR, NOR and XOR Gates

Input B		Input A		AND Out put		OR output		NOR output		XOR output	
voltage	state	voltage	state	voltage	state	voltage	state	voltage	state	voltage	state
0	0	0	0								
0	0	5	1								
5	1	0	0								
5	1	5	1								

9.SIMULATION EXPERIMENT

Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates.

Procedure

1)AND Gate

Step-1) Connect the supply(+5V) to the circuit.
Step-2) Press the switches for inputs "A" and "B".
Step-3) The bulb does not glow if any one or both the switches (2 and 3) are OFF and glows only if both the switches (2 and 3) are ON.
Step-4) Repeat step-2 and step-3 for all state of inputs.

2)OR Gate

Step-1) Connect the supply(+5V) to the circuit.
Step-2) Press the switches for inputs "A" and "B".
Step-3) The bulb glows if any one or both the switches are ON else it won't glow.
Step-4) Repeat step-2 and step-3 for all state of inputs.

3)NOT gate

Step-1) Connect the supply(+5V) to the circuit.
Step-2) Press the switch 1 to connect battery to the circuit.
Step-3) Press the switch 2 for input "A" .
Step-4) The bulb glows if switch 2 is OFF else it won't glow.

4)NAND gate

Step-1) Connect the supply(+5V) to the circuit.
Step-2) Press the switch 1 to connect battery to the circuit.
Step-3) Press the switches 2 and 3 for inputs "A" and "B".
Step-4) The bulb glows if any one or both the switches are OFF else it won't glow.

5)NOR gate

Step-1) Connect the supply(+5V) to the circuit.
Step-2) Press the switch 1 to connect battery to the circuit.
Step-3) Press the switches 2 and 3 for inputs "A" and "B".
Step-4) The bulb glows if both the switches are OFF else it won't glow.

6)Ex-OR gate

Step-1) Connect the supply(+5V) to the circuit .
Step-2) Press the switches for inputs "A" and "B".
Step-3) The bulb glows if one of the switches is ON and one of the switches is OFF else it won't glow.

7)Ex-NOR gate

Step-1) Connect the supply(+5V) to the circuit .
Step-2) Press the switches for inputs "A" and "B".
Step-3) The bulb glows if both the switches are ON or if both the switches are OFF else it won't glow.

TRUTH TABLE

INPUTS		OUT PUTS						
A	B	AND	OR	NOT	NAND	NOR	XOR	XNOR

B.Sc VI Semester Practical Examination Questions

1. **Determine the capacitance of the given capacitors using de- Sauty bridge . Connect them in parallel and measure the effective capacitance. Hence verify the parallel law of combination of capacitors.**

2. **Verify inverse square law for gamma rays using G.M.Tube and associated counter.**

3. **Using given ICs verify De-Morgan's theorems**

4. **Determine Hall coefficient and carrier density of the given materials using given Hall effect setup.6 trial in each case.**

5. **Construct OR, AND, and NOT gates using discrete components and verify their truth tables. Calculate the value of resistors required in each case**

6. **Using Digital ICs construct half adder and Full adders and demonstrate their action and draw their truth tables**

7. **Verify NAND Gate as a universal gate by using digital trainer kit and 7400 IC**

8. **Using the given components construct NAND.AND,NOR, and OR -TTL Gates and verify their truth tables**

UNITS OF MEASUREMENTS

FUNDAMENTAL UNITS		
Quantity	**Unit**	**Symbol**
1. Length	meter	m
2. Mass	kilogram	kg
3. Time	second	s
4. Electric Current	ampere	A
5. Temperature	kelvin	K
6. Luminious Intensity	candela	Cd
7. Amount of Substance	mole	mol
SUPPLEMENTARY UNITS		
Quantity	**Unit**	**Symbol**
1. Plane Angle	Radian	rad
2. Solid Angle	Steradian	Sr

DERIVED UNITS		
Quantity	**Unit**	**Symbol**
1. Area	square meter	m^2
2. Volume	cubic meter	m^3
3. Density	kilogram/ cubic meter	kg/m^3
4. Velocity	meter/second	m/s
5. Angular Velocity	radian/ second	r/s
6. Acceleration	meter/second square	m/s^2
7. Angular Accleration	radian/second square	rad/s^2
8. Frequency	hertz	Hz
9. Force	newton	N
10. Work energy	joule	J
11. Power	watt	W
12. Pressure	pascal	Pa
13. Electrical charge	coulomb	C
14. Potential difference	volt	V
15. Electrical resistance	ohm	Ω
16. Capacitance	farad	F
17. Inductance	henry	H
18. Magnetic field	telsa	T
19. Luminious flux	lumen	lm
20. Dynamic Viscocity	newton sec./ square meter	$N\text{-}s/m^2$

SCHEME FOR PRACTICAL EXAMINATIONS

BSC VIth SEMESTER

Particulars	Marks
Formula	5
Circuit diagram /Figure	5
Setup / tabulation	10
Observation and number of trials	20
Knowledge about the experiment	10
Calculation and graph	15
Result and accuracy with units	5
Class records- Regularity in completing the experiments/ Neatness / General impression	10
Internal assessment for Practicals	20
Total	100

Fundamental Physical Constants

Constant	Symbol	Value
Avogadro's number	N_A	$6.022\,141\,29 \times 10^{23}$/mol
Boltzmann's constant	k	$1.380\,6488 \times 10^{-23}$ J/K
Elementary charge	e	$1.602\,176\,565 \times 10^{-19}$ C
Electron mass	m_e	$9.109\,382\,91 \times 10^{-31}$ kg
Neutron mass	m_n	$1.674\,927\,351 \times 10^{-27}$ kg
Proton mass	m_p	$1.672\,621\,777 \times 10^{-27}$ kg
Speed of light in vacuum	c	2.99 792 458 m/s (exact)
Universal gravitation constant	G	$6.673\,84 \times 10^{-11}$ N · m^2/kg^2
Universal gas constant	R	8.314 4621 J/(mol · K)
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ N/A
Permittivity of free space	ε_0	$8.854\,187\,817 \times 10^{-12}$ C^2/(N · m^2)
Plank's constant	h	$6.626\,068\,57 \times 10^{-34}$ J · s

COLOUR CODE OF RESISTORS

Color	Color Name	1st digit 1st stripe	2nd digit 2nd stripe	Multiplier 3rd stripe	Tolerance 4th stripe
	Black	0	0	x1	-
	Brown	1	1	x10	1%
	Red	2	2	x100	2%
	Orange	3	3	x1,000	3%
	Yellow	4	4	x10,000	4%
	Green	5	5	x100,000	-
	Blue	6	6	x1,000,000	-
	Violet	7	7	-	-
	Grey	8	8	-	-
	White	9	9	-	-
	Gold	-	-	x0,1	5%
	Silver	-	-	x0,01	10%

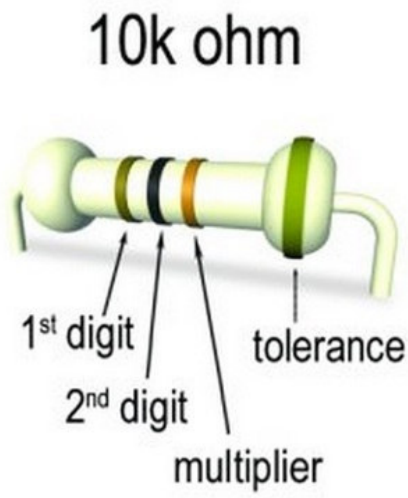


TABLE OF CAPACITOR CODES

Picofarad (pF)	Nanofarad (nF)	Microfarad (uF)	Code	Picofarad (pF)	Nanofarad (nF)	Microfarad (uF)	Code
10	0.01	0.00001	100	4700	4.7	0.0047	472
15	0.015	0.000015	150	5000	5.0	0.005	502
22	0.022	0.000022	220	5600	5.6	0.0056	562
33	0.033	0.000033	330	6800	6.8	0.0068	682
47	0.047	0.000047	470	10000	10	0.01	103
100	0.1	0.0001	101	15000	15	0.015	153
120	0.12	0.00012	121	22000	22	0.022	223
130	0.13	0.00013	131	33000	33	0.033	333
150	0.15	0.00015	151	47000	47	0.047	473
180	0.18	0.00018	181	68000	68	0.068	683
220	0.22	0.00022	221	100000	100	0.1	104
330	0.33	0.00033	331	150000	150	0.15	154
470	0.47	0.00047	471	200000	200	0.2	254
560	0.56	0.00056	561	220000	220	0.22	224
680	0.68	0.00068	681	330000	330	0.33	334
750	0.75	0.00075	751	470000	470	0.47	474
820	0.82	0.00082	821	680000	680	0.68	684
1000	1.0	0.001	102	1000000	1000	1.0	105
1500	1.5	0.0015	152	1500000	1500	1.5	155
2000	2.0	0.002	202	2000000	2000	2.0	205
2200	2.2	0.0022	222	2200000	2200	2.2	225
3300	3.3	0.0033	332	3300000	3300	3.3	335

STANDARD PREFIXES IN MEASUREMENTS

Prefiks	Symbol	Multiplying factor
yotta	Y	$1\ 000\ 000\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{24}$
zetta	Z	$1\ 000\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{21}$
exa	E	$1\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{18}$
peta	P	$1\ 000\ 000\ 000\ 000\ 000 = 10^{15}$
tera	T	$1\ 000\ 000\ 000\ 000 = 10^{12}$
giga	G	$1\ 000\ 000\ 000 = 10^{9}$
mega	M	$1\ 000\ 000 = 10^{6}$
kilo	k	$1\ 000 = 10^{3}$
hecto	h	$100 = 10^{2}$
deka	da	$10 = 10^{1}$
deci	d	$0{,}1 = 10^{-1}$
centi	c	$0{,}01 = 10^{-2}$
milli	m	$0{,}001 = 10^{-3}$
mikro	µ	$0{,}000\ 001 = 10^{-6}$
nano	n	$0{,}000\ 000\ 001 = 10^{-9}$
piko	p	$0{,}000\ 000\ 000\ 001 = 10^{-12}$
femto	f	$0{,}000\ 000\ 000\ 000\ 001 = 10^{-15}$
atto	a	$0{,}000\ 000\ 000\ 000\ 000\ 001 = 10^{-18}$
zepto	z	$0{,}000\ 000\ 000\ 000\ 000\ 000\ 001 = 10^{-21}$
yocto	y	$0{,}000\ 000\ 000\ 000\ 000\ 000\ 000\ 001 = 10^{-24}$