PHYSICS LABORATORY MANUAL

UNDER DBT - STAR COLLEGE SCHEME (2020-2021)

सत्यमेव जयते

Department of Biotechnology
Ministry of Science & Technology
Government of India

Prepared by

MARIAN STAR CENTRE
DEPARTMENT OF PHYSICS
ST. MARY'S COLLEGE (AUTONOMOUS)
Re-accredited with 'A+' Grade by NAAC
Thoothukudi

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Direct inquiries: E.R. Arumugam
A-1, Thenmozhi Nagar, Third Street
Keelkattalai, Chennai - 600 117.
Ph : 044-2247 0770, 94440 40272,
E-mail: cbapublisher@gmail.com

Preface

The physics lab manual is prepared this year, to help the students to have a better knowledge about how to go about with the practicals. It will be of much help to them in order to understand the basic principles in the field of light, heat, electricity, magnetism, properties of matter, electronics, non - electronics and computational methods of solving problems. The main objective is to give hands - on - training to our students so that they are able to put the theoretical concepts into practice.

The present manual gives them awareness on the systematic representation of the experiments and the approach with which they have to conduct in doing the experiments within the stipulated time. Thus in practical physics, the students obtain laboratory skills, design circuits and apply instrumentation knowledge to obtain the results. This manual is prepared as per the current syllabus and thus can help the students to follow the methods and learn to make the circuits and use various formulae for constructive design, calculation to get appropriate results.

And, lastly we would like to thank all those who have helped us in preparing this manual. A special thanks to our Management, DBT, Delhi through Star College Scheme, for giving us this wonderful opportunity to shape physics practicals in the manual format for the benefit of the UG students. There is always room for improvement. So kindly give your suggestions and corrections for better moulding the manual.

Acknowledgement

The Department of Physics would like to express our deep sense of gratitude to the Department of Biotechnology, Govt. of India, New Delhi for choosing our college and sanctioning the fund under the Star scheme. The Department of Physics has purchased various equipment's like ultrasonic interferometer, Forbe's apparatus, Muffle furnace and hot air oven etc. We have also purchased chemicals under this scheme. Our lab has been furnished and upgraded with new instruments through this scheme.

We are highly indebted to Dr. Sr. A S.J. Lucia Rose M.Sc.,M.Phil., Ph.D.,PGDCA., Principal and Chairman, Star College Scheme, St. Mary's College (Autonomous), Thoothukudi for her continuous academic guidance and encouragement.

We are thankful to Dr. Sr. A. Arockia Jenecius Alphonse, Overall Coordinator Member Secretary, Star College Scheme, St. Mary's College (Autonomous), Thoothukudi for her motivational support and encouragement in all our endeavours.

The Department of Physics would like to thank each and every faculty of our department for preparing this manual, spending much of their time and energy in an unconditional way. If not for their hard work, this would not have materialized. Once again we acknowledge a big thanks for their untiring work and support.

With the help of the Star scheme support, the department is strengthened in many ways. Thus our students have largely benefitted to develop their skills in a constructive way.

Department of Physics

Manual Contributors

- **Dr. Sr. Jessie Fernando,** M.Sc., M.Phil., Ph.D. HOD & Associate Professor
- **Dr. S. Euchrista Immaculate Sylvia,** M.Sc., M.Phil., Ph.D. Associate Professor
- **Mrs. A. Lucas Rexceline,** M.Sc., M.Ed., M.Phil., Associate Professor
- **Dr. M. Sheeba,** M.Sc., B.Ed., M.Phil., SET., Ph.D., Assistant Professor
- **Mrs. P. Dhanalakshmi,** M.Sc., B.Ed., SET. Assistant Professor
- **Mrs. R. Maria Navis Jeyaseeli,** M.Sc., B.Ed., M.Phil., Assistant Professor

B.Sc. Physics

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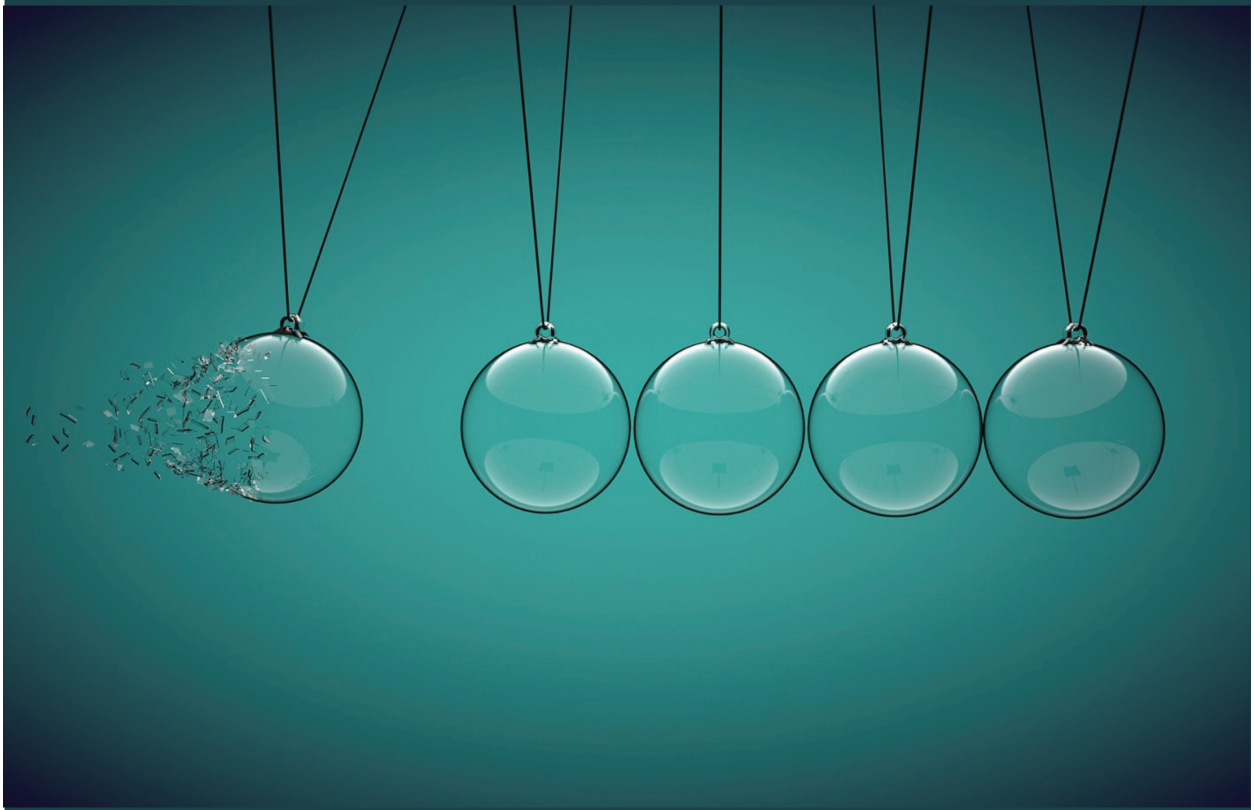
CORE PRACTICAL I



Core Practical I

Subject Code: 18UPHCR1

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To Find the Thickness of the Beam Using Screw Gauge

Distance moved by the screw for 5 rotations of head = 5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale =100

Least count = Pitch / Number of divisions on head scale = 1/ 100 = 0.01 mm

Zero coincidence = __________ divisions

Zero error = ZC × LC = ________ mm

Zero correction = __________ mm

Table 1.1.1 Thickness of the Beam

S. No	Pitch scale reading (mm)	Head scale coincidence (div)	Head scale reading (mm)	Observed reading PSR+HSR (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (d) = mm

Ex.No:1

Date:

YOUNG'S MODULUS – UNIFORM BENDING (PIN AND MICROSCOPE)

Aim:

To determine the Young's modulus of the material of the given beam by Uniform-Bending method using pin and microscope.

Apparatus Required:

Travelling Microscope, two knife edges for support, two weight hangers, slotted weights, pin, screw gauge and vernier caliper.

Formula:

Young's modulus of the given material of the beam

$$E = \frac{3Mgal^2}{2byd^3} \text{Nm}^{-2}$$

Where,

E = Young's modulus of the material of the beam in Pascal or N/m^2.

y = Elevation produced for 'M' Kilogram of load in m.

M = Mass suspended on either side of the beam in Kg.

g = Acceleration due to gravity (9.8 m/s^2).

l = Distance between the two knife edges in m.

b = Breadth of the beam in m.

d = Thickness of the beam in m.

a = Distance between the weight hanger and the adjacent knife edge in m

To Find the Elevation of the Beam Using Travelling Microscope

Least count of Traveling microscope (L.C) = 0.001cm (or) 0.001 $\times 10^{-2}$m

V.S.R = V.S.D × L.C

T.R = M.S.R + V.S.R

Distance between the two knife edges (l) = __________ $\times 10^{-2}$m

Distance between the weight hanger and the adjacent knife edge (a) = ____10^{-2}m

Table 1.1.2 Elevation of the Beam

S. No.	Load M 10^{-3} kg	Microscope readings $\times 10^{-2}$ m						Mean 10^{-2} m	Average elevation y (for M = 50g) 10^{-2}m	M/y 10^{-1} Kg/m
		Loading			Unloading					
		MSR	VSR	TR	MSR	VSR	TR			
1	50									
2	100									
3	150									
4	200									
5	250									

Mean M/y = $\times 10^{-1}$ Kg/m

Diagram:

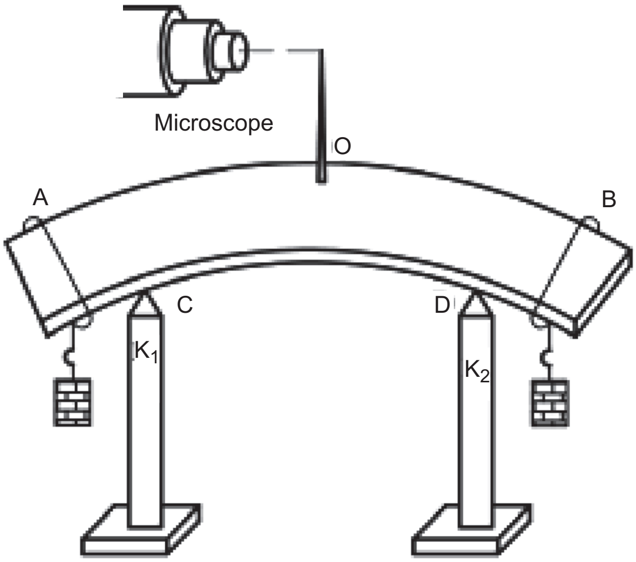


Figure 1.1.1 Uniform Bending

Procedure

The given beam is placed over the two knife edges (C & D) at a distance of 70 cm or 80 cm. Two weight hangers are suspended, one each on either side of the knife edge at equal distance from the knife edge. Since the load is applied at both points of the beam, the bending is uniform throughout the beam and the bending of the beam is called uniform bending. A pin is fixed vertically exactly at the centre of the beam. Now the bar has to be brought to elastic mood as follows; Additional weights are loaded and unloaded. This is repeated four or five times.

A traveling microscope is placed in front of this arrangement. Taking the weight hangers alone as the dead load, the tip of the pin is focused by the microscope and is adjusted in such a way that the tip of the pin just touches the horizontal cross wire. The reading on the vertical scale of the traveling microscope is noted. Now, equal weights are added on both the weight hangers, in steps of 50 gram. Each time the position of the pin is focused and the readings are noted from the microscope. The procedure is followed until the maximum load is reached.

The same procedure is repeated by unloading the weight from both the weight hanger in steps of same 50 gram and the readings are tabulated in the tabular column. From the readings, the mean of (M/y) is calculated. The thickness and the breadth of the

To find the breadth of the beam

Value of one main scale division = 0.1 cm

9 main scale divisions = 10 vernier scale divisions

n =10

Least count = $\frac{1}{n} \times$ 1m.s.d = $\frac{1}{10} \times 0.1 = 0.01$ cm

Table 1.1.3 Breadth of the Beam

S. No	Main scale reading (cm)	Vernier scale coincidence (div)	Vernier scale reading (cm)	Observed reading MSR+VSR (cm)	Correct reading = Observed reading +/ – Zero correction (cm)

Mean (b) = cm

beam are measured using screw gauge and vernier caliper respectively and are tabulated. By substituting all the values in the given formula, the Young's modulus of the given material of the beam can be calculated.

Calculations:

Mass suspended on either sides of the beam	$M = 50 \times 10^{-3}$Kg
Breadth of the beam	b = $\quad \times 10^{-2}$m
Thickness of the beam	d = $\quad \times 10^{-3}$ m
Acceleration due to gravity	g = 9.8m/sec^2
Mean value of	M/y = Kg/m
Distance between the two knife edges	l = $\quad \times 10^{-2}$m
Distance between the weight hanger and the adjacent knife edge	a = $\quad \times 10^{-2}$m

Young's modulus of the given material of the beam

$$E = \frac{3Mgal^2}{2byd^3} \qquad \text{Nm}^{-2}$$

Result:

The Young's modulus of the material of the given beam by uniform bending method

E = ____________ N/m^2.

Observations:

To Find the Breadth of the Bar (b) Using Vernier Caliper

Value of one main scale division = 0.1cm

9 main scale divisions = 10 vernier scale division

n =10

Least count = $\frac{1}{n} \times$ 1m.s.d = $\frac{1}{10} \times 0.1 = 0.01$ cm

Table 1.2.1 Breadth of the Bar

S. No	Main scale reading (cm)	Vernier scale coincidence (div)	Vernier scale reading (cm)	Observed reading MSR+VSR (cm)	Correct reading = Observed reading +/ – Zero correction (cm)

Mean (d) = _______ cm

To Find the Thickness of the Beam Using screw gauge

Distance moved by the screw for 5 rotations of head =5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale =100

Least count = Pitch / number of divisions on head scale = 1 / 100 = 0.01 mm

Zero coincidence = _____divisions

Zero error = ZC $\times$ LC = ______mm

Zero correction = _______mm

Ex.No: 2

Date:

YOUNG'S MODULUS – NON-UNIFORM BENDING (SCALE AND TELESCOPE)

Aim:

To determine the Young's modulus of a bar by non-uniform bending method using scale and telescope.

Apparatus Required:

Wooden bar of rectangular cross section (metre scale), two knife edges for support, slotted weights, optic lever, telescope, one support bar (metre scale), screw gauge and vernier caliper.

Formula:

Young's modulus of the material of the bar,

$$E = \frac{Mgl^3D}{2bd^3Lx}\,\mathrm{Nm}^{-2}$$

Where,

M = mass applied on the hanger to produce non-uniform bending of bar in kg.

g = acceleration due to gravity in $\mathrm{m/s^2}$.

l = length of the bar between the two knife edges in m.

x = shift in the telescope reading for mass in m.

L = effective length of optic lever in m.

D = distance between mirror and scale in m.

b = breadth of the bar in m.

d = depth of the bar in m.

Table 1.2.2 Thickness of the Bar

S. No	Pitch scale reading (mm)	Head scale coincidence (div)	Head scale reading (mm)	Observed reading (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (d) = _________ mm

To Find the Shift x

Length of the bar between the knife edges (l) = ______ m

Effective length of the optic lever (L) = ______ m

Distance between the scale and mirror (D) = ______ m

Table 1.2.3 Determination of Shift x

Load (10^{-3} kg)	Telescope Readings			Shift for 50gm (cm)
	Loading (cm)	Unloading (cm)	Mean (cm)	

Mean (x) = _______ cm

Diagram:

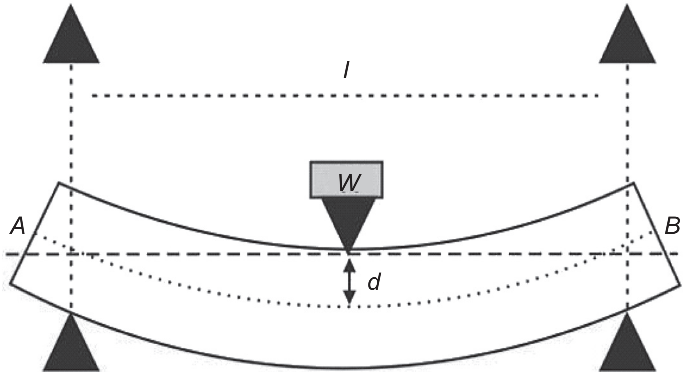


Figure 1.2.1 Non Uniform Bending

Procedure:

The experimental bar is placed symmetrically on the two knife edges, kept 0.7m apart. A weight hanger is suspended from the middle of the bar using a thread loop. An optic lever is placed with its front leg at the midpoint and the hind legs on the support of the bar placed over the knife edges. A scale and telescope is arranged in front of the optic lever at a distance. The telescope is focused to see the image of the scale through the optic lever mirror.

Now the bar has to be brought to elastic mood as follows; Additional weights are loaded and unloaded. This is repeated four or five times. Finally check whether readings are within the vertical scale of the telescope for loading of all weight.

With the dead weight alone, the telescope reading is noted. The load is increased in steps of 50gm on the hanger. The corresponding telescope readings are noted. Similarly, the readings are noted while unloading also. The mean readings are tabulated. Using these readings, the shift x of telescope readings for a particular load M is found out. The effective length of the optic lever mirror is measured as L. The distance between the telescope scale and optic lever mirror is measured as D. The young's modulus E can be calculated.

Calculations:

$M = 50$ gm

$g = 9.8$ m/s^2

$l =$ m

Young's modulus of the given bar by non - uniform bending,

$$E = \frac{Mgl^3 D}{2bd^3 Lx}\,\mathrm{Nm}^{-2}$$

Result:

Young's modulus of the material of the bar by non-uniform bending method

E = __________ N/m^2.

Ex.No: 3

Date:

YOUNG' S MODULUS – CANTILEVER DEPRESSION (PIN AND MICROSCOPE)

Aim:

To determine the Young's modulus of a given bar by measuring the depression of its loaded end when it is used as a cantilever.

Apparatus Required:

A rectangular wooden bar (metre scale), travelling microscope, screw gauge, vernier caliper, tall pin, weight hanger and slotted weights.

Formula:

$$\text{Young's modulus of the given bar, } E = \frac{4Mgl^3}{sbd^3} \quad \text{Nm}^{-2}$$

Where,

E = Young's modulus of the material of the bar in N/m^2.

s = depression of the loaded end for mass M in m.

g = acceleration due to gravity ($g = 9.8\ m/s^2$).

l = length of the cantilever in m.

b = breadth of the cantilever in m.

d = thickness of the cantilever in m.

Observations:

To Find the Breadth of the Bar (b) Using Vernier Caliper

Value of one main scale division = 0.1cm

9 main scale divisions = 10 vernier scale division,

n =10

Least count = $\frac{1}{n} \times$ 1m.s.d = $\frac{1}{10} \times 0.1 = 0.01$ cm

Table 1.3.2 Breadth of the Bar

S. No	Main scale reading (cm)	Vernier scale coincidence (div)	Vernier scale reading (cm)	Observed reading = MSR+VSR (cm)	Correct reading = Observed reading +/ – Zero correction (cm)

Mean (b) = _______ cm

To find the Thickness of the bar using Screw Gauge

Distance moved by the screw for 5 rotations of head =5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale =100

Least count = Pitch / number of divisions on head scale = 1/100 = 0.01 mm

Zero coincidence = _____ divisions

Zero error = ZC × LC = ______ mm

Zero correction = _______ mm

Diagram:

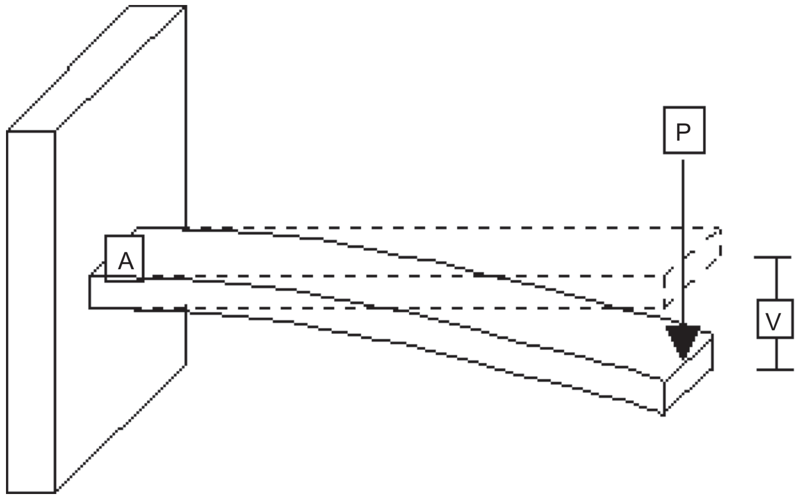


Figure 1.3.1 Cantilever Depression

Procedure:

The experimental bar is clamped at one end at the edge of the worktable using G – clamps. A weight hanger is suspended at the free end of the bar using a thread loop. A pin is fixed vertically using wax at the loaded end. A microscope is kept horizontally on a stand so that the tip of the pin is in the line with the axis of the microscope. The microscope is focused to see the image of the tip of the pin clearly. The length of the cantilever between the edge of the table and loaded point is kept at 50 cm. The bar is brought to elastic mood by repeatedly loading and unloading.

With the dead load alone (hanger only), the microscope is adjusted so that the cross wire coincides with the image of tip of the pin without parallax. The microscope reading is noted up to 3 decimals. The load is increased in steps of 50gm on the hanger up to 300gm. The corresponding microscope readings are taken. Similarly, the readings are taken while unloading in steps of 50 gm. The readings are tabulated. From these readings the depression for a particular load m is found out. The mean depression is found as s.

The breadth (b) of the bar is measured using vernier caliper. The thickness (d) of the bar is found using screw gauge. The young's modulus E is calculated using the formula given. The experiment may be repeated for different lengths of the cantilever.

Table 1.3.3 Thickness of the Bar

S. No	Pitch scale reading (mm)	Head scale coincidence (div)	Head scale reading (mm)	Observed reading (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (d) = _________ mm

To Find the Depression (s) at the Loaded End using Microscope

Value of one main scale division = 0.1cm

9 main scale divisions = 10 vernier scale division, n =10

Least count = $\frac{1}{n} \times$ 1m.s.d = $\frac{1}{50} \times 0.05 = 0.001$ cm

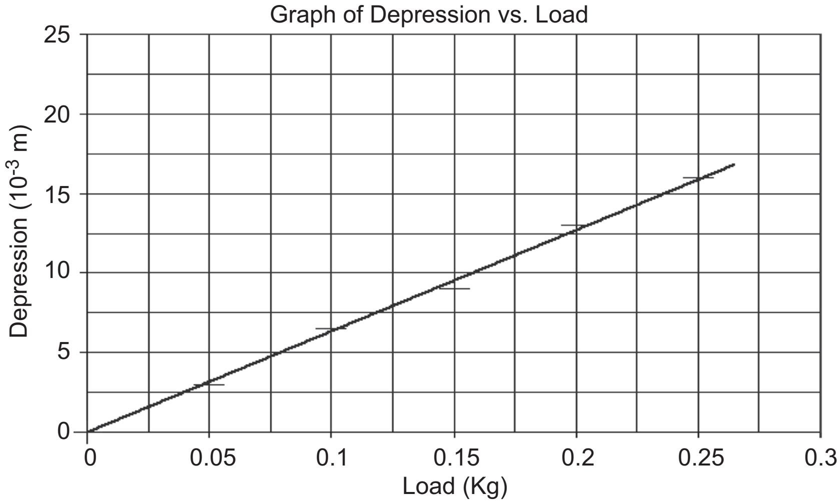
Length of the cantilever l = _______ cm

Table 1.3.4 Determination of Depression at the Loaded End

S. No.	Load M 10^{-3} kg	Microscope readings $\times 10^{-2}$ m						Mean 10^{-2} m	Average elevation y (for M = 50g) 10^{-2}m	M/y 10^{-1} Kg/m
		Loading			Unloading					
		MSR	VSR	TR	MSR	VSR	TR			
1	50									
2	100									
3	150									
4	200									
5	250									

Mean = _______ cm

Model Graph:



Calculation of E:

m = ______ $\times 10^{-3}$ Kg

$g = 9.8\ m/s^2$

l = _______ m

b = _______ m

d = _______ m

Young's modulus of the material of the bar using cantilever method

$$E = \frac{4Mgl^3}{sbd^3}$$

E = __________ Nm^{-2}

Result:

Young's modulus of the material of the bar using cantilever method by experiment, E = ________ Nm^{-2}.

Young's modulus of the material of the bar using cantilever method by graph, E = ________ Nm^{-2}.

Observations:

To Determine the Mass of One Drop of Liquid

Mass of empty beaker = Kg

Table 1.4.1 Determination of the Mass of One Drop of Liquid

S. No	Number of drops	Mass of beaker +n drops 10^{-3} Kg	Mass of n drops 10^{-3} Kg	Mass of one drop 10^{-3} Kg

Mass of one drop = _________ $\times 10^{-3}$ Kg

Ex.No: 4

Date:

SURFACE TENSION – DROP WEIGHT METHOD

Aim:

To determine the surface tension of the given liquid by drop weight method

Apparatus Required:

Burette, capillary tube, pinch cock, screw gauge, electronic balance and beaker.

Formula:

Surface tension of the given liquid, $\sigma = \frac{Mg}{3.8r}$ (N / m

Where,

M = mass of one drop of water in Kg.

g = acceleration due to gravity in m/s^2.

r = outer radius of the capillary tube in m.

s = surface tension of the liquid to be determined in N/m.

Procedure:

Fix a glass tube vertically below the burette using a rubber tube. Fix the pinch cock on the rubber tube. Fill the burette with water. Adjust the pinch cock such that 5 or 6 drops are formed per minute. Find the mass of the empty beaker.

Collect 30 drops of water in the beaker and find the mass of beaker + 30drops. Find the mass of 30 drops and then the mass of one drop is calculated. Collect 30 drops more and repeat the experiment. Find the average value of one drop of liquid, from that calculate the surface tension.

To Determine the Radius of the Drop Using Screw Gauge

Distance moved by the screw for 5 rotations of head = 5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Pitch = 5/5 mm = 1mm

Number of divisions on the head scale = 100

Least count = pitch/ No. of divisions on the head scale = 1/100 = 0.01mm

Zero coincidence = ____ divisions

Zero error = ZC × LC

Zero correction = ____ mm

Table 1.4.2 Determination of the Radius of the Drop

S. No	Pitch Scale Reading (mm)	Head Scale Coincidence (div)	Head Scale Reading (mm)	Observed Reading (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (d) = __________ mm

Radius (r) = __________ mm

Calculations:

Surface tension of the given liquid, $\sigma = \dfrac{Mg}{3.8r}$ (N / m)

Result:

The surface tension of the given liquid by drop weight method = ______ N/m.

Observations:

Distance moved by the screw for 5 rotations of head = 5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale = 100

Least count = pitch/ No. of divisions on the head scale = 1/100 = 0.01mm

Zero coincidence = ____ divisions

Zero error = ZC × LC

Zero correction = ____ mm

Table 1.5.1 To Find the Radius of Each Ball Using Screw Gauge

S. No	Pitch Scale Reading (mm)	Head Scale Coincidence (div)	Head Scale Reading (mm)	Observed Reading (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Ex.No: 5

Date:

COEFFICIENT OF VISCOSITY - STOKE'S METHOD

Aim:

To determine the coefficient of viscosity of a highly viscous liquid (such as caster oil) by stoke's method.

Apparatus Required:

A tall cylindrical jar, experimental liquid, thread, steel balls of different diameters, stop watch and Hare's apparatus.

Formula:

Coefficient of viscosity of oil $\eta = \dfrac{2g(d-\rho)r^2}{9v}$

$$\eta = \frac{2g(d-\rho)r^2 t}{9(AB)} \ (\mathrm{Ns/m^2})$$

where,

g - the acceleration due to gravity in m/s^2

d - the density of the ball (7.8×103 Kg/m^3 for steel).

ρ - the density of the liquid in the vertical column in Kg/m^3.

r - radius of the ball in m.

t - time taken to cross the region AB in the vertical oil column in second.

To Find (r^2t):

AB = _______ cm = _____ m

Table 1.5.2 Determination of (r^2t)

Ball no.	Radius (m)	Time taken to travel (AB) t (second)	r^2t (m^2s)

Mean (r^2t) = _________ m^2s

To Find the Relative Density of the Liquid Using Hare's Apparatus:

Table 1.5.3 Determination of the Relative Density of the Liquid

S. No.	h_1	h_2	$\rho_1/\rho_2 = h_1/h_2$

Procedure:

The experimentally highly viscous liquid such as castor oil is taken in a tall jar. Two thread marks A and B are made over the surface of the jar, separated by a distance of AB = 15 cm. The mark A should be sufficiently lower from the surface of liquid. A spherical steel ball is taken and its mean diameter is measured using a screw gauge. Its radius r is found. The ball is gently dropped from the surface of the liquid into the jar. The ball soon attains terminal velocity (uniform velocity) as it moves down. When it crosses the mark A, the stop clock is started. When the ball crosses the mark B, the stop clock is stopped. The time taken to travel the distance (AB) is found as t second. The distance (AB) is measured. The value of (r^2t) is calculated. The experiment is repeated by using steel balls of different radii. In each case, the value of r, t and hence (r^2t) is found out. The mean value of (r^2t) is calculated. The density of the liquid is found using Hare's apparatus as ρ. The coefficient of viscosity of oil can be calculated using the formula given.

Diagram:

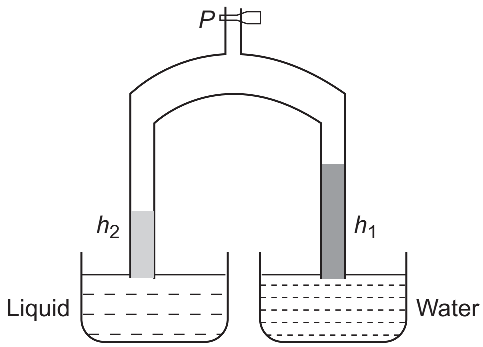


Figure 1.5.1 Hare's apparatus

Calculations:

Density of the ball d = 7.8×10^3 Kg/m^3

Density of the liquid ρ = (RD × 1000) = _____ Kgm^{-3}

$g = 9.8$m/s^2

Mean value of $(r^2 t)$ = m^{2}s

AB = meter

Coefficient of viscosity of oil $\eta = \dfrac{2g(d-\rho)r^2}{9v}$

$$\eta = \frac{2g(d-\rho)r^2 t}{9(AB)} \qquad (\mathrm{Ns/m^2})$$

$$\eta = \qquad (\mathrm{Ns/m^2})$$

Result:

The coefficient of viscosity of the highly viscous liquid = _________ (Ns/m^2).

Ex.No: 6

Date:

COEFFICIENT OF VISCOSITY-BURETTE METHOD

Aim:

To determine the co-efficient of viscosity of a given liquid (water) using Poiseuille's flow method.

Apparatus Required:

Graduated burette without stopper, retort stand with clamp, capillary tube, beaker, water, stop watch, meter scale, rubber tube, pinch cock and travelling microscope.

Formula:

Co-efficient of viscosity of the given liquid is, $\eta = \dfrac{\pi \rho g r^4 (ht)}{8lV} \mathrm{Ns/m^2}$

where,

g = Acceleration due to gravity in m/s^2.

ρ = Density of the liquid in kg/m^3.

r = Radius of the capillary tube in m.

l = Length of the capillary tube in m.

V = Volume of the liquid collected in m^3.

$h = \{(h_1 + h_2)/2\} - h_0$

h_1 = Height from table to initial level of water in the burette in m.

h_2 = Height from table to the final level of water in the burette in m.

h_0 = Height from table to mid portion of capillary tube in m.

t = Time taken for the liquid flow in second.

Observations:

To find *ht*:

$h_o =$ $\times 10^{-2}$ m

Table 1.6.1 Determination of *ht*

S. No	Burette reading	Time for the flow of 5cc liquid	Range	Time for the flow of 5cc liquid (t)	Height of initial reading h_1	Height of final reading h_2	$h = \left(\frac{(h_1 + h_2)}{2}\right) - h_0$	*ht*
	cc	s	cc	s	$\times 10^{-2}$m	$\times 10^{-2}$m	$\times 10^{-2}$m	$\times 10^{-2}$ms
1	0		0-5					
2	5		5-10					
3	10		10-15					
4	15		15-20					
5	20		20-25					
6	25		25-30					
7	30		30-35					
8	35		35-40					
9	40		40-45					
10	45		45-50					
11	50							

Mean (ht) = __________ $\times 10^{-2}$ ms

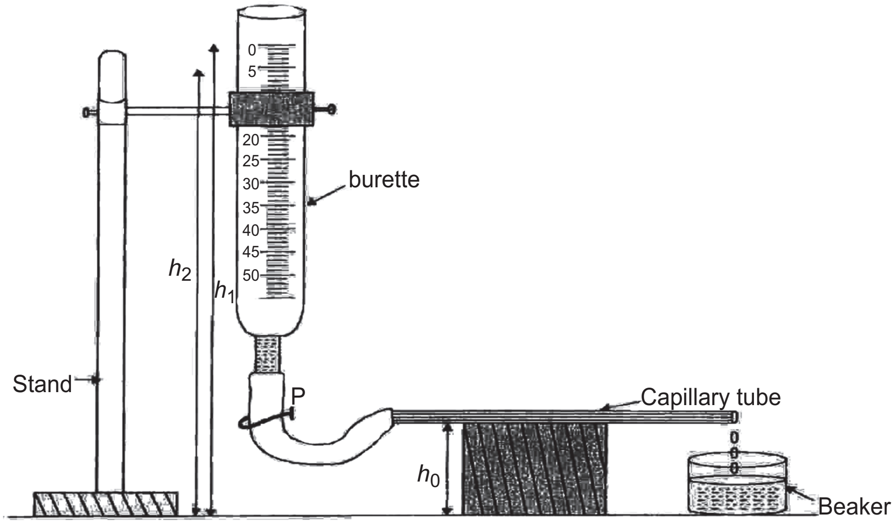


Figure 1.6.1 Viscosity of a liquid

Procedure:

Measurement of time for liquid flow:

The experimental set up is as shown in the figure. A graduated burette is washed with water and also with the given liquid whose viscosity is to be determined. The burette is then fixed vertically in a stand. A capillary tube is connected to the tip of the burette by means of a rubber tube and is held parallel to the table so that the flow of liquid is streamlined.

The given liquid is filled in the burette slightly above the zero-mark. Now the pinch clip is released. When the level of liquid reaches the zero-mark the stop-clock is started and the time is noted. Similarly, the time is noted when the liquid level crosses 5, 10, 15 50 cc. The time taken for the flow of every 5cc of the liquid '*t*' are determined.

The pressure head (*h*) is calculated by using a meter-scale. It is seen that as pressure Head '*h*' decreases, the time of flow '*t*' increases. The product ht is also calculated.

To find radius of the capillary tube (*r*) by using travelling microscope:

The capillary tube is held horizontally. The bore of the capillary tube is focused with the help of a travelling microscope. The horizontal crosswire of the travelling microscope is made to coincide with the top of the bore of the capillary tube. The reading in the vertical

To Measure the Diameter of the Capillary Tube:

LC = 0.001cm

Table 1.6.2 Determination of Diameter of the Capillary Tube

Horizontal cross wire				Vertical cross wire			
Position	**M.S.R (cm)**	**VSC (div)**	**MSR + (VSC × L.C) (cm)**	**Position**	**M.S.R (cm)**	**VSC (div)**	**MSR + (VSC × L.C) (cm)**
Top				Left			
Bottom				Right			

Mean = _________ cm

Difference d_1 = _______ cm

Difference d_2 = _______ cm

Average diameter of the capillary tube $d = d_1 - d_2$ = _______ $\times 10^{-2}$ m

Average radius of the capillary tube (r) = _______ $\times 10^{-2}$ m scale is noted. Now, the travelling microscope is moved so that the horizontal crosswire coincides with the bottom of the bore of the capillary tube and the vertical scale readings are noted. The difference between the two readings gives the diameter of the bore. Similarly using vertical crosswire, the readings in the horizontal scale corresponding to left and right edges of the bore of the capillary tube are taken. The difference between the two readings gives the diameter. The readings are tabulated. The average diameter and hence the radius of the capillary tube are determined. By using the given formula, the co-efficient of viscosity of the given liquid is calculated.

Calculations:

Radius of the capillary tube (r) = $\times 10^{-2}$m

Density of water (ρ) = 1000 kg/m^3

Length of the capillary tube (l) = $\times 10^{-2}$m

Volume of the water (V) = $\times 10^{-6}$ m^3

Acceleration due to gravity (g) = 9.8 m/s^2

Average value of 'ht' = ms

Co-efficient of viscosity of the given liquid is, $\eta = \dfrac{\pi \rho g r^4 (ht)}{8lV}$ Ns / m^2

Result:

The coefficient of viscosity of the given liquid (water) η = _________ Ns/m^2.

Ex.No: 7

Date:

COMPOUND PENDULUM

Aim:

To determine the acceleration due to gravity.
To determine the radius of gyration and the moment of inertia of the bar pendulum about an axis through center of gravity perpendicular to the plane of the bar.

Apparatus Required:

Bar pendulum, stop clock, pointer and metre scale.

Formula:

Acceleration due to gravity $g = 4\pi^2\left(\frac{l}{T^2}\right)$ $\quad$ m/s^2

where,

g = acceleration due to gravity in m/s^2.

l = length of the equivalent simple pendulum in sec.

T = period of simple pendulum in sec.

Procedure:

A uniform bar AB of about one metre length in which holes are drilled along the length at regular intervals is taken, It can be suspended on a horizontal knife edge about each of the holes. It can be made to oscillate about the axis of suspension in the vertical plane.

The bar pendulum is suspended from the first hole near the end A of the bar. It is allowed to oscillate with small amplitude. The time taken for twenty oscillations is noted using stop watch. From this, the time taken for one oscillation (T) is calculated. In a similar way, periods are found by suspending the pendulum from successive holes. The distance of each hole from the same end A of the bar is measured. The distance and period readings are tabulated.

Observations:

To Find Period of Oscillation

Table 1.7.1 Determination of Period of Oscillation

Distance of knife edge (hole) from the end A (cm)	Time taken for 20 oscillations			Period $T = \frac{t}{20}$ (s)
	Trial (1) (s)	Trial (2) (s)	Mean t (s)	

To Find $\left(\frac{1}{T^2}\right)$**:**

Table 1.7.2 Determination of (l/T²)

S. No.	Period (s)	PR (m)	QS (m)	$l = \frac{(PR + QS)}{2}$ (m)	$\frac{l}{T^2}$ (m/s^2)

Mean $\left(\frac{1}{T^2}\right)$ = _________ m/s^2

A graph is drawn taking the values of distance along the x- axis and the corresponding periods along the Y – axis. A graph as shown in the figure is obtained.

The graph consists of two curves symmetrical about the line CG. The line CG is a line drawn perpendicular to the X – axis at the distance equal to the distance of centre of gravity from the same end A. The point P and Q correspond to the minimum period of oscillation.

A line parallel to the x – axis is drawn corresponding to the known period T in the graph. The line intersects the curves at A, B, D and E. The points A and B (or B and D) are on either side of the centre of gravity not symmetrical with respect to it but having the same period T. Hence the distance AD (or BE) gives the length of the equivalent simple pendulum l corresponding to the period T. The distance AD and BE are measured. The value of $l = \frac{(\mathrm{AD}+\mathrm{BE})}{2}$ is calculated. Knowing the values of l and T the value of $\frac{l}{T^2}$ is calculated.

The value of acceleration due to gravity (g) at the place can be calculated using the formula, $g = 4\pi^2 \left(\frac{1}{T^2}\right) \mathrm{m/s^2}$

To find the radius of gyration and moment of inertia

From the graph, the point P and R corresponding to minimum period are calculated. The distance of the point P to the centre of gravity is equal to K, for the minimum period.

Similarly, the distance of point T to the centre of gravity is K, the radius of gyration of the bar about the axis through centre of gravity.

$$\text{Hence PQ} = K + K = 2K$$

Knowing the value of PQ from the graph, the radius of gyration of the pendulum can be found out using the relation.

$$K = \frac{PQ}{2}$$

The mass of the bar M is found using a paper balance. Hence the moment of inertia of the bar about an axis through the centre of gravity perpendicular to the plane of the bar can be calculated using the formula:

$$I = MK^2$$

Diagram:

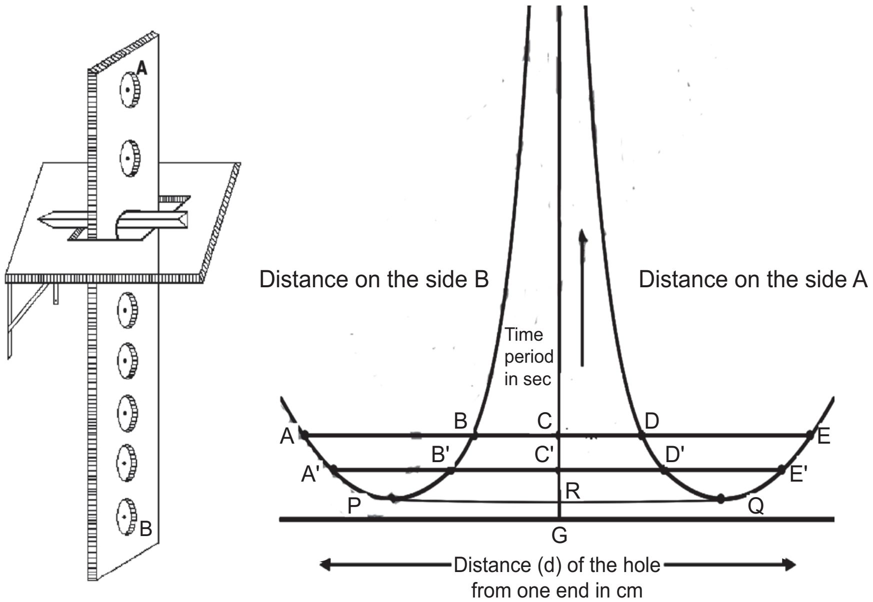


Figure 1.7.1 Compound Pendulum

Calculations:

Acceleration due to gravity $g = 4\pi^2 \left(\frac{1}{T^2} \right) \text{ m / s}^2$

Distance between points having minimum period

PQ = ______ metre

Radius of gyration K = $\frac{EF}{2}$ metre

Mass of the pendulum M = ______ Kg

Moment of inertia of the bar about the centre of gravity I = MK^2

= ________ Kg metre^2

Result:

Acceleration due to gravity at the place, g = ________m/s^2

Radius of gyration of the bar pendulum, K = ________ metre

Moment of inertia of the bar pendulum about an axis through its centre of gravity I = _________ Kgm^2

Observations:

To Determine the Period of Oscillation

Mass of the disc (M) = _____ $\times 10^{-3}$Kg

Table 1.8.1 Determination of Time Period of Oscillation

Length of the pendulum (L) 10^{-2}m	Time for 10 oscillations (second)				Time Period (T) second	$\frac{l}{T^2}$ 10^{-2} m/s^2
	Trial I	Trial II	Trial III	Mean		

Mean $\frac{l}{T^2}$ = ______ $\times 10^{-2}$ m/s^2.

Ex.No: 8

Date:

RIGIDITY MODULUS – TORSIONALPENDULUM

Aim:

To determine the rigidity modulus of the material of the wire and the moment of inertia of a circular disc about its axis of suspension by the method of torsional oscillations.

Apparatus Required:

Circular disc with chuck, given wire (suspension wire), stop clock, screw gauge and metre scale.

Formula:

Moment of inertia of the disc, $I = \frac{MR^2}{2} \text{Kg m}^2$

Rigidity modulus of the material of the wire, $n = \frac{8\pi IL}{T^2 r^4} \text{Nm}^{-2}$

where,

M = mass of the disc in Kg.

T = Period of oscillation of the Torsion pendulum in second.

R = Radius of the Torsion disc in m.

L = length of the suspension wire in m.

r = Radius of the pendulum wire in m.

Theory:

Torsion pendulum consists of a metal wire clamped to a rigid support at one end and carries a heavy circular disc at the other end. When the suspension wire of the disc is slightly twisted, the disc at the bottom of the wire executes torsional oscillations such that the angular acceleration of the disc is directly proportional to its angular displacement and the oscillations are simple harmonic.

To Determine the Diameter of the Suspension Wire Using Screw Gauge

Least count L.C = 0.01×10^{-3} m

Zero coincidence = ________ divisions

Zero error (Z.E) = (Z.C × L.C)

Zero correction = (Z.E × L.C) = ______ $\times 10^{-3}$m

Table 1.8.2 Determination of the Diameter of the Suspension Wire

S. No	Pitch Scale Reading (mm)	Head Scale Coincidence (div)	Head Scale Reading (mm)	Observed Reading PSR+HSR (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean diameter of the wire ($2r$) = ______ $\times 10^{-3}$m

Procedure:

One end of a long, uniform wire whose rigidity modulus is to be determined is clamped by a vertical chuck. To the lower end, a heavy uniform circular disc is attached by another chuck. The length of the suspension ‘l’(from top portion of chuck to the clamp is fixed to a particular value (say 60 cm or 70 cm). The suspended disc is slightly twisted so that it executes torsional oscillations. The first few oscillations are omitted. By using the pointer, (a mark made in the disc) the time taken for l0 complete oscillations are noted. Three trials are taken. Then the mean time period (time for one oscillation) is found. The above procedure is repeated for three different length of pendulum wire. From the above values of L and T, $\frac{L}{T^2}$ is calculated.

The diameter of the wire is accurately measured at various places along its length with screw gauge. From this, the radius of the wire is calculated. The circumference of the disc is measured and from that the radius of the disc is calculated. The moment of inertia of the disc and the rigidity modulus of the wire are calculated using the given formulae.

Calculations:

Circumference of the Disc	$2\pi R$	=	$\times 10^{-2}$m
Radius of the Disc	R	=	$\times 10^{-2}$m
Mass of the disc	M	=	$\times 10^{-3}$m
Radius of the wire	r	=	$\times 10^{-2}$m

Result:

Moment of inertia of the circular disc about the axis passing through its centre, (I) = _______ 10^{-3} kg m^2.

Rigidity modulus of the material of the wire, (n) = ________ N/m^2.

Ex.No: 9

Date:

SONOMETER – A.C. FREQUENCY

Aim:

To determine the frequency of the A.C. main supply using sonometer.

Apparatus Required:

Sonometer with brass wire, a low voltage a.c. source such as step-down transformer, two small magnets, screw gauge, etc.,

Formula:

Frequency of the source $n = \frac{1}{2l}\sqrt{\frac{T}{m}}$ (Hz)

Here T = Tension applied to the sonometer wire T+ Mg in Kg.

n = frequency of the wire in unison with a.c. in hertz.

l = length of the vibrating segment of the sonometer wire in m.

mass = volume × density

For unit length of the wire,

$$\text{Mass} = \pi r^2 \times 1 \times \text{density}$$

$$m = \pi r^2 d$$

where r is the radius of the wire.

Procedure:

A weight of 250 g is applied to the sonometer. The wire should be non-magnetic such as brass wire. The knife edges under the wire in the sonometer board are kept well separated.

Observation:

To Find the Radius of the Sonometer Wire using Screw Gauge

Distance moved by screw for 5 rotations of head = 5 mm

Distance moved by screw for 1 rotation of head = 1 mm

Number of divisions on the head scale = 100

Least count = Pitch / No. of divisions of H.S = 1/100 = 0.01mm

Zero coincidence = ______ Divisions

Zero error (Z.E) = (Z.E × L.C)

Zero correction = ______ mm

Table 1.9.1 Determination of Radius of the Sonometer Wire

S. No	Pitch Scale Reading (mm)	Head Scale Coincidence (div)	Head Scale Reading (mm)	Observed Reading (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean = ________ mm

The source of alternating current (a.c.) is a step-down transformer with 6V a.c. output. The secondary terminals of the transformer are connected to the ends of the sonometer wire.

Two small alnico magnets are placed at the middle of the board on either side of the wire, with opposite poles facing each other. Now the magnetic field between the magnets in the horizontal plane at right angles to the length of the wire. The primary of the transformer is connected to the main supply and is switched on.

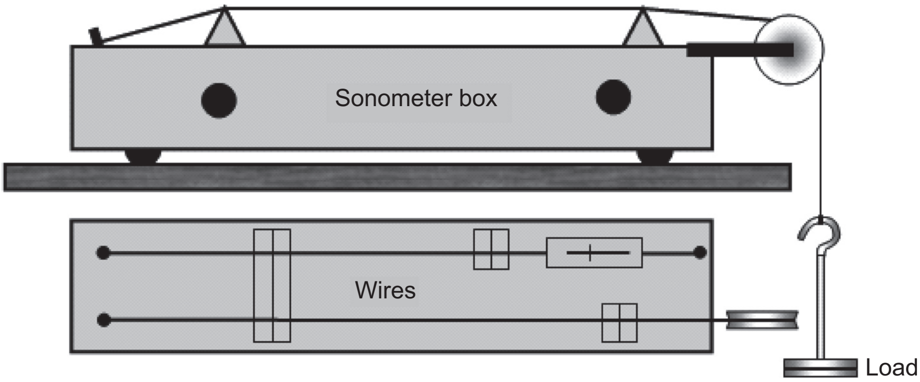


Figure 1.9.1 Sonometer

Keeping one knife edge fixed, the other knife edge is moved in order to change the length of the vibration wire. The wire vibrates due to the force produced by the magnetic field and the a.c. current in the wire. When the current is in the opposite direction of the same cycle of a.c. the sonometer wire makes one full vibration. This is a case of forced vibration.

The knife edge is adjusted so that the vibrating segment of the wire is in unison with the a.c. Now resonance takes place. The wire vibrates with maximum amplitude. If a paper rider is placed at the middle of the vibrating segment, it flutters and flies off. When the frequency of the sonometer wire and frequency of a.c. are equal to each other.

The length of the vibrating segment is measured as l. The value of (M/l^2) is calculated. The experiment is repeated by applying different weights such as 50 gms, 100 gms etc., In each case (M/l^2) is found out. The mean value of (M/l^2) calculated. The mean diameter of the sonometer wire is measured using screw gauge and its mean radius is found as r. The density of the material of the wire d is assumed. The linear density of the a.c. mains is calculated as

$$m = \pi r^2 d$$

To Find (M/l^2) of the Sonometer Wire:

Table 1.9.2 Determination of (M/l^2) of the Sonometer Wire

S. No.	Mass applied M (10^{-3} Kg)	Length of vibrating Segment (10^{-2} m)	(M/l^2) (10^1 Kg/m^2)

Knowing the tension T, the vibrating length l and the value of m, the frequency of the a.c. mains is calculated.

Calculations:

Mean (M/l^2) = __________

g = 9.8 m/s^2

linear density $= m = \pi r^2 d$

= ___________

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}} \quad \text{Hz}$$

$n^2 =$

$n =$ __________ Hz

Result:

The frequency of the A.C. mains supply is $n =$ _________ Hz.

Ex.No: 10

Date:

SPECIFIC HEAT CAPACITY OF A LIQUID – NEWTON'S LAW OF COOLING

Aim:

To determine the specific heat capacity of the liquid by cooling method.

Apparatus Required:

Spherical calorimeter, stand, sensitive thermometer, common balance, weight box, stop clock, liquid beaker and water beaker.

Formula:

For the same range of temperature,

Rate of cooling of calorimeter with water = Rate of cooling of calorimeter with liquid

$$\frac{[W_1C + (W_3 - W_1)\ S]}{t_2} = \frac{[W_1C + (W_2 - W_1)x]}{t_1}$$

$$[W_1C + (W_3 - W_1)S] = \frac{t_2}{t_1}[W_1C + (W_2 - W_1)x]$$

$$S = \frac{\left[(t_2 / t_1)\left(W_1C + \left(W_2 - W_1\right)x\right)\right]}{W_3 - W_1} - W_1C \quad \text{J / Kg / K}$$

where,

W_1 = mass of empty spherical copper calorimeter in Kg.

W_2 = mass of calorimeter with water in Kg.

W_3 = mass of calorimeter with liquid in Kg.

C = specific heat capacity of calorimeter in J/Kg/K.

S = specific heat capacity of liquid in J/Kg/K.

x = specific heat capacity of water in J/Kg/K.

Observations:

Mass of empty spherical copper calorimeter (W_1) = Kg

Mass of calorimeter with water (W_2) = Kg

Mass of calorimeter with liquid (W_3) = Kg

Table 1.10.2 Temperature – Time Readings

Temperature °C	Time (second)	
	Water	Liquid
70		
68		
66		
….		
…		
…		
50		

t_1 = time taken to cool through 4°C for water in second.

t_2 = time taken to cool through 4°C for liquid in the same range of temperature in second.

Procedure:

The mass of an empty calorimeter is found as W_1 correct to kilogram. It is filled with hot water at about 80°C. It is suspended in a stand and allowed to cool. A thermometer is kept in it. When the temperature reaches 70°C, a stop clock is started. This is zero time. The stop clock reading (time) is taken, when the temperature becomes 68°C, 66°C, 64°C ... 50°C. The thermometer is removed and the mass of the calorimeter with water is found as W_2.

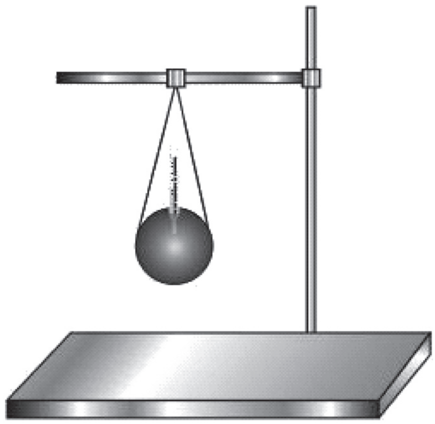


Figure 1.10.1 Newton's Law of Cooling

Water is replaced by liquid at about 80°C. As before temperature time readings are noted at 70°C, 68°C, 66°C, 64°C ... 50°C. The mass of calorimeter with water is found as W_3. Using these readings, the specific heat capacity of the liquid is found out.

Observations:

Mass of empty spherical copper calorimeter (W_1)	=	Kg
Mass of calorimeter with water (W_2)	=	Kg
Mass of calorimeter with liquid (W_3)	=	Kg

Table 1.10.3 Find $\frac{t_2}{t_1}$

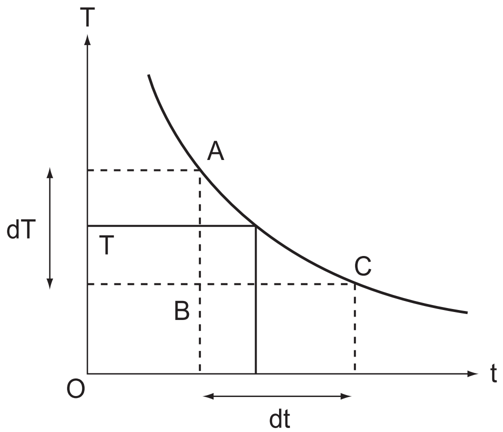
	Time taken for fall of 4^oC		$\frac{t_2}{t_1}$
Range of temperature ^oC	Water t_1 (s)	Liquid t_2 (s)	
70 - 66			
66 - 62			
64 - 60			
60 - 56			
56 - 52			

Mean $\frac{t_2}{t_1}$ = _________

To draw the cooing curves for water and liquid and to find $\frac{t_2}{t_1}$ from them:

Taking time along the x-axis and temperature along y-axis, a graph is drawn for water and liquid on the same graph sheet. Two horizontal lines are drawn corresponding to range of any two temperatures say 68°C and 64°C. The lines intersect liquid curves at two points. The corresponding time coordinates are noted from the graph. The time interval is found as t_2. Similarly, from water curve, t_1 is found. $\frac{t_2}{t_1}$ is calculated. By drawing different such sets of horizontal lines, the mean value of $\frac{t_2}{t_1}$ for the same range is found out. Substituting in the formula, the specific heat capacity of the liquid is calculated.

Model Graph:



Relation between Time and temperature

Calculations:

Mass of empty spherical copper calorimeter (W_1)	=
Mass of calorimeter with water (W_2)	=
Mass of calorimeter with liquid (W_3)	=
Specific heat capacity of calorimeter C	= 385 J/Kg/K
Specific heat capacity of water x	= 4200 J/Kg/K
Specific heat capacity of liquid S	= ?

Rate of cooling of liquid = Rate of cooling of water over the same range of temperature

$$\frac{[W_1C+(W_3-W_1)\ S]}{t_2}=\frac{[W_1C+(W_2-W_1)x]}{t_1}$$

$$[W_1C+(W_3-W_1)S]=\frac{t_2}{t_1}[W_1C+(W_2-W_1)x]$$

$$S=\frac{\left[(t_2/t_1)\left(W_1C+\left(W_2-W_1\right)x\right)\right]}{W_3-W_1}-W_1C \quad \mathrm{J/Kg/K}$$

Result:

Specific heat capacity of the liquid using Newton's law of cooling = _____ J/Kg/K.

Observations:

To Find $\frac{d\theta}{dt}$

Table 1.11.1 Determination of $\frac{d\theta}{dt}$

S. No.	Temperature	Time taken		
	^{0}C	min	sec	Total sec

Ex.No: 11

Date:

THERMAL CONDUCTIVITY OF A BAD CONDUCTOR – LEE'S DISC

Aim:

To determine the thermal conductivity of a bad conductor like card board using Lee's disc apparatus.

Apparatus Required:

Lee's disc apparatus, two thermometers, bad conductor, stop watch, steam boiler, vernier caliper, screw gauge and biscuit balance.

Formula:

Thermal conductivity of the given bad conductor,

$$K = \frac{\mathrm{MSx}\left(\frac{d\theta}{dt}\right)(r+2t)}{\pi r^2\left(\theta_1-\theta_2\right)2(r+t)}\ \mathrm{Wm}^{-1}\mathrm{k}^{-1}$$

where,

M = mass of the metal disc in Kg.

S = specific heat capacity of the metal disc in J/Kg/K.

$(d\theta/dt)$ = Rate of cooling at steady temperature in ^{o}C/s.

θ_1= Steady temperature of the steam chamber in ^{o}C.

θ_2 = Steady temperature of the metal disc in ^{o}C.

r = radius of the metallic disc in metre.

t = thickness of the metallic disc in metre.

x = thickness of the bad conductor in metre.

To Find the Thickness of the Metallic Disc using Vernier Caliper

Value of one main scale division = 0.1cm

9 main scale divisions = 10 vernier scale division, n =10

Least count = $\frac{1}{n} \times$ 1m.s.d = $\frac{1}{10} \times 0.1 = 0.01$ cm

Table 1.11.2 Determination of Thickness of the Metallic Disc

S. No	Main scale reading (cm)	Vernier scale coincidence (div)	Vernier scale reading (cm)	Observed reading MSR+VSR (cm)	Correct reading = Observed reading +/ – Zero correction (cm)

Mean (t) = _______ cm

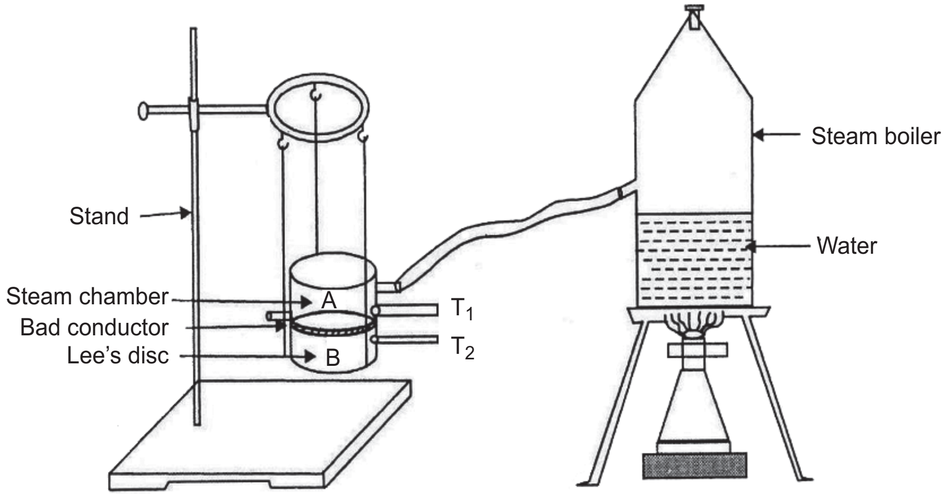


Figure 1.11.1 Lee's Disc

Description:

Lee's disc apparatus consists of a brass metal disc (B) suspended horizontally by three strings from a stand. A hollow steam chamber (A) with inlet and outlet for steam is placed above. The given bad conductor is placed between them. Two thermometers T_1 and T_2 are inserted to measure the temperatures of A and B respectively.

Procedure:

The experimental arrangement is as shown in Figure 1.11.1. Steam is allowed to pass through the steam chamber. The temperature indicated by two thermometers start rising. After 30 minutes a steady state is reached (i.e) the temperature of the lower disc will no longer rises. At this stage, steady temperatures θ_1 and θ_2 are recorded from the thermometers T_1 and T_2. Now the cardboard is removed and the lower disc is heated directly by keeping it in contact with the steam chamber. When the temperature of the lower disc attains a value of about 10°C more than its steady state temperature, the chamber is removed and the lower disc is allowed to cool down on its own accord.

When the temperature of the disc reaches 5°C above the steady temperature of the disc. i.e., $(\theta_2 + 5)$°C, a stop watch is started and the time is noted for every 1°C fall of temperature until the metallic disc attains temperature $(\theta_2 - 5)$°C.

To Find Thickness of the Card Board using Screw Gauge

Distance moved by the screw for 5 rotations of head = 5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale = 100

Least count = Pitch / number of divisions on head scale = 1/100 = 0.01 mm

Zero coincidence = _____ divisions

Zero error = ZC × LC = ______ mm

Zero correction = _______ mm

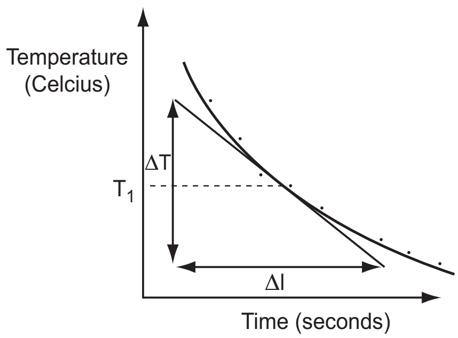
Table 1.11.3 Determination of thickness of the card board

S. No	Pitch scale reading (mm)	Head scale coincidence (div)	Head scale reading (mm)	Observed reading PSR+HSR (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (t) = _______ mm

The thickness and the radius of the metallic disc is found using screw gauge and vernier caliper respectively. The thickness of the bad conductor is found using screw gauge. The mass of the metallic disc is found by using biscuit balance. The readings are tabulated in the tabular column.

Model Graph:



A graph is drawn by taking time along the x-axis and the temperature along y-axis. Cooling curve is drawn. From the cooling curve $d\theta/dt$ is calculated by drawing a triangle by taking 0.5°C above and 0.5°C below the steady temperature θ_2. Substituting this $d\theta/dt$ in the given formula, thermal conductivity of the cardboard can be calculated.

Calculations:

Thermal conductivity of the given bad conductor $K = \dfrac{\mathrm{MSx}\left(\dfrac{d\theta}{dt}\right)(r+2t)}{\pi r^2\left(\theta_1-\theta_2\right)2(r+t)}\ \mathrm{Wm^{-1}k^{-1}}$

Result:

Thermal conductivity of the given bad conductor = _________ $\mathrm{Wm^{-1}\,K^{-1}}$

Ex.No: 12

Date:

AIR WEDGE - THICKNESS OF A THINWIRE

Aim:

To determine the thickness of a given thin fiber (or) wire (or) a sheet of paper by forming interference fringes due to an air-wedge.

Apparatus Required:

Travelling microscope, two optically plane glass plates, given fiber (or) wire (or) thin sheet of paper, sodium vapour lamp.

Formula:

Thickness of the given fiber (or) wire (or) thin sheet of paper is given by

$$t = \frac{L\lambda}{2\beta}\,(\mathrm{m})$$

where,

L = Distance between the tide end and the wire (or) paper in m.

λ = Wavelength of the monochromatic source of light (5893Å) in m.

β = Mean fringe width in m.

Theory:

Two plane glass plates are inclined at an angle by introducing a thin material (e.g. thin fiber (or) hair), forming a wedge shaped air film. Thin film is illuminated by sodium light, interference occurs between the two rays one reflected from the front surface and the other obtained by internal reflection at the back surface. Since in the case of a wedge-shaped film, thickness of the material remains constant only in direction parallel to the thin edge of the wedge, straight line fringes parallel to the edge of the wedge are obtained.

Observations:

To Find the Bandwidth (β)

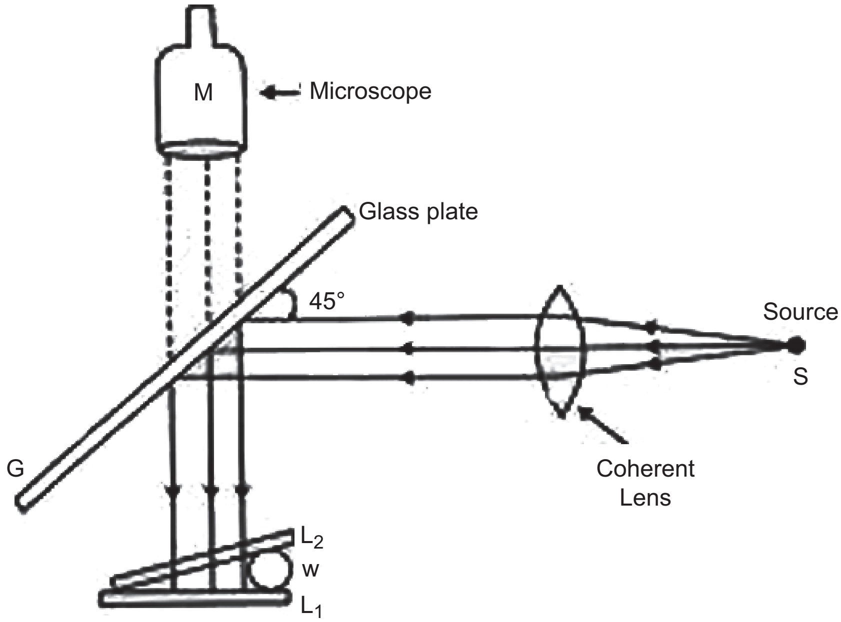
LC = 0.001 cm; TR = MSR + (VSC × LC)

Table 1.12.1 Determination of the Bandwidth (β)

Order of fringes	Horizontal cross wire			Width of 20 fringes (cm)	Fringe width (β) (cm)
	MSR (cm)	VSC (div)	TR (cm)		

Mean = _________ cm

Diagram:



L_1, L_2 - Transparent plane glass plates; w - specimen (wire)

Figure 1.12.1 Air Wedge

Procedure:

Two optically plane glass plates are placed one over the other and tied by means of a rubber band at one end. The given material of fiber (or) wire (or) paper is introduced on the other end, so that an air-wedge is formed between the plates. This set up is placed on the horizontal bed plate of the travelling microscope.

Light from the sodium vapour lamp (S) is rendered parallel by means of a condensing lens (L). The parallel beam of light is incident on a plane glass plate (G) inclined at an angle of 45° and gets reflected. The reflected light is incident normally on the glass plates in contact. Interference takes place between the light reflected from the top and bottom surfaces of the glass plates and is viewed through the travelling microscope (M). Hence large number of equally spaced dark and bright fringes are formed which are parallel to the edge of contact.

The microscope is adjusted so that the bright (or) dark fringe near the edge of contact is made to coincide with the vertical cross wire and this is taken as the n^{th} fringe.

The reading from the horizontal scale of the travelling microscope is noted. The microscope is moved across the fringes using the horizontal traverse screw and the readings are taken when the vertical crosswire coincides with every successive 5 fringes (5, 10, 15, 20...). The width of every 20 fringes is calculated and the width of one fringe is calculated. The mean of this gives the fringe width (β).

The distance between the tide end and the object is measured as 'L'. Substituting 'β' and 'L' in the given formula, the thickness of the given material can be determined.

Calculations:

Thickness of the given fiber (or) wire (or) thin sheet of paper is given by

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

Result:

The thickness of the given material of fiber (or) wire (or) paper = _______ m.

Ex.No: 13

Date:

SPECTROMETER - REFRACTIVE INDEX OF THE PRISM

Aim:

To determine the refractive index of the material of the prism.

Apparatus Required:

Spectrometer, Mercury vapour lamp, Glass prism, Reading lens and spirit level

Formula:

Refractive index of the prism $n = \dfrac{\sin\left(\dfrac{A+D}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

Where,

A = Angle of prism in degree.

D = Angle of minimum deviation in degree.

μ = Refractive index of the prism

Procedure:

The following initial adjustments of the spectrometer are made first.

i. The spectrometer and the prism table are arranged in horizontal position by using the leveling screws.

ii. The telescope is turned towards a distant object to receive a clear and sharp image.

iii. The slit is illuminated by a sodium vapour lamp and the slit and the collimator are suitably adjusted to receive a narrow, vertical image of the slit.

iv. The telescope is turned to receive the direct ray, so that the vertical slit coincides with the vertical crosswire.

Observations:

Table 1.13.1 Determination of the Angle of Prism 'A'

Least Count: 1′

Position of the color	Telescope Reading						Difference 2A		Mean 2A	A
	V_A			V_B						
	MSR	VSR	TR	MSR	VSR	TR	VA	VB		
Left										
Right										

Determination of Angle of prism (A)

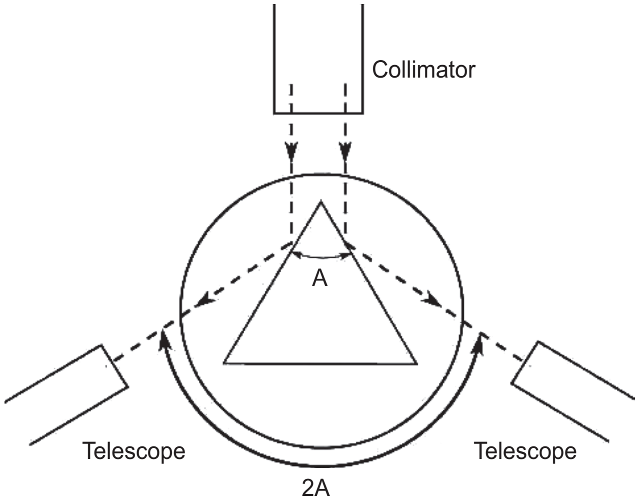


Figure 1.13.1 Angle of Prism

The given glass prism is mounted vertically at the centre of the prism table with its two reflecting faces facing the collimator and the base of the prism faces the telescope. Now the parallel rays of light coming out of the collimator falls almost equally on the two refracting faces of the prism and gets reflected. The telescope turned to receive the reflected image from one face (left) of the prism and fixed in that position. The tangential screw is adjusted until the vertical crosswire coincides with the fixed edge of the image of the slit. Now the readings on both the verniers (V_A and V_B) are noted.

Similarly, the readings corresponding to the reflected image of the slit on the other face (right) are also taken. The difference between the two readings of the same vernier gives twice the angle of the prism (2A). From the mean value of 2A the angle of the prism A is calculated.

Determination of angle of minimum deviation (D)

The prism is mounted on the prism table in such a way that the light from the collimator incident on one of the refracting faces of the prism. Here the light enters in to the prism and gets diffracted. The diffracted ray moves parallel to the base of the prism gets dispersed. Now the telescope is turned to receive the dispersed spectrum coming out of the other face of the prism. By viewing the spectrum, the prism table is slowly rotated either in clockwise or in anticlockwise direction in such a way that the spectrum moves towards

Table 1.13.2 Determination of the Angle of Minimum Deviation 'D'

Least Count: 1′

Position of the Image	Telescope Reading						Difference D		Mean D
	V_A			V_B					
	MSR	VSR	TR	MSR	VSR	TR	VA	VB	
Left									
Right									

the direct ray. At a particular position the spectrum retraces its path. When it retraces its path, stop the rotation of the prism table. This is the minimum deviation position.

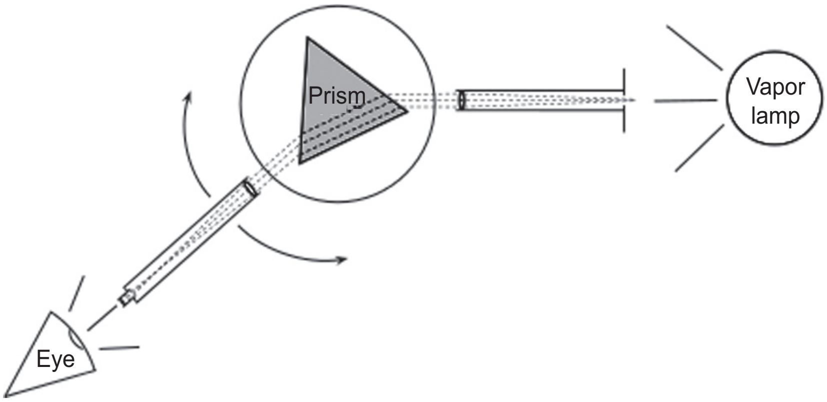


Figure 1.13.2 Angle of Minimum Deviation

The telescope is turned and the horizontal crosswire is made to coincide with the violet slit. Then both vernier scale readings (V_A and V_B) are noted. The prism is removed and the direct reading of the slit is taken. The difference between the direct reading and the refracted ray reading corresponding to the minimum deviation gives the angle of minimum deviation D. The refractive index of the prism is calculated by using the given formula.

Calculations:

Refractive index of the prism, $n = \dfrac{\sin\left(\dfrac{A+D}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

Result:

Angle of the prism (A) =

Angle of minimum deviation (D) =

The refractive index of the material of the prism (μ) =

Ex.No: 14

Date:

SPECTROMETER - DISPERSIVE POWER OF A PRISM

Aim:

To determine the Refractive index of the given glass prism for different colours of composite light. Dispersive power of the material of the prism using spectrometer.

Apparatus Required:

Spectrometer, Mercury vapour lamp, Glass prism, Reading lens and spirit level.

Formula:

Refractive index of the prism $\mu = \dfrac{\left(\sin\dfrac{(A+D)}{2}\right)}{\left(\sin\dfrac{A}{2}\right)}$

Dispersive power of the prism $\omega = \dfrac{n_2 - n_1}{n-1}$

where,

A = Angle of prism in degree.

D = Angle of minimum deviation in degree.

n_1 = Refractive index of one colour.

n_2 = Refractive index of another colour.

$n = \dfrac{(n_1 + n_2)}{2}$

Procedure:

The following initial adjustments of the spectrometer are made first. The spectrometer and the prism table are arranged in horizontal position by using the leveling screws. The telescope is turned towards a distant object to receive a clear and sharp image. The slit

Observations:

Table 1.14.1 Determination of the angle of prism 'A'

Least Count: 1′

<table>
<tr><th rowspan="3">Position of the color</th><th colspan="6">Telescope Reading</th><th colspan="2" rowspan="2">Difference 2A</th><th rowspan="2">Mean 2A</th><th rowspan="2">A</th></tr>
<tr><th colspan="3">V_A</th><th colspan="3">V_B</th></tr>
<tr><td>MSR</td><td>VSR</td><td>TR</td><td>MSR</td><td>VSR</td><td>TR</td><td>VA</td><td>VB</td><td></td><td></td></tr>
<tr><td>Left</td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Right</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

is illuminated by a mercury lamp and the slit and the collimator are suitably adjusted to receive a narrow, vertical image of the slit. The telescope is turned to receive the direct ray, so that the vertical slit coincides with the vertical crosswire.

Determination of Angle of prism (A)

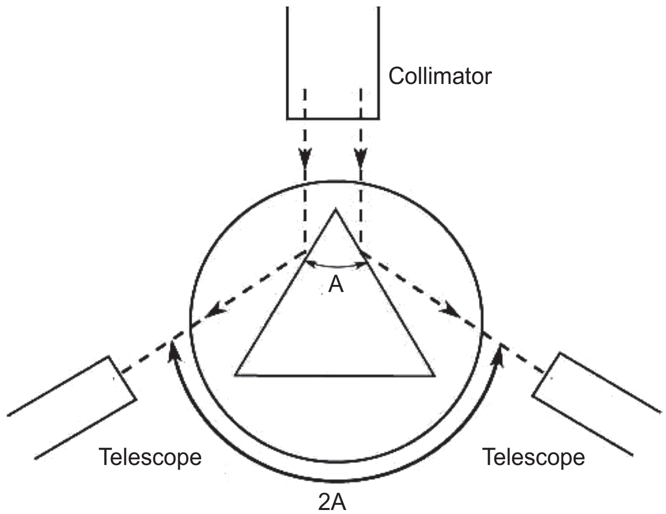


Figure 1.14.1 Angle of Prism

The given glass prism is mounted vertically at the centre of the prism table with its two refracting faces facing the collimator and the base of the prism faces the telescope. Now the parallel rays of light coming out of the collimator falls almost equally on the two refracting faces of the prism and gets reflected. The telescope turned to receive the reflected image from one face (left) of the prism and fixed in that position. The tangential screw is adjusted until the vertical cross wire coincides with the fixed edge of the image of the slit. Now the readings on both the verniers (V_A and V_B) are noted.

Similarly, the readings corresponding to the reflected image of the slit on the other face (right) are also taken. The difference between the two readings of the same vernier gives twice the angle of the prism (2A). From the mean value of 2A the angle of the prism A is calculated.

Determination of angle of minimum deviation (D)

The prism is mounted on the prism table in such a way that the light from the collimator incident on one of the refracting faces of the prism. Here the light enters in to the prism

Table 1.14.2 Determination of the angle of minimum deviation 'D'

Least Count: 1'

<table>
<tr><th rowspan="3">Position of the Image</th><th colspan="6">Telescope Reading</th><th colspan="2" rowspan="2">Difference D</th><th rowspan="2">Mean D</th></tr>
<tr><th colspan="3">V_A</th><th colspan="3">V_B</th></tr>
<tr><th>MSR</th><th>VSR</th><th>TR</th><th>MSR</th><th>VSR</th><th>TR</th><th>VA</th><th>VB</th><th></th></tr>
<tr><td>Violet
Blue
Green
Yellow
Red</td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Direct ray</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

and gets diffracted. The diffracted ray moves parallel to the base of the prism and gets dispersed. Now the telescope is turned to receive the dispersed spectrum coming out of the other refracting face of the prism.

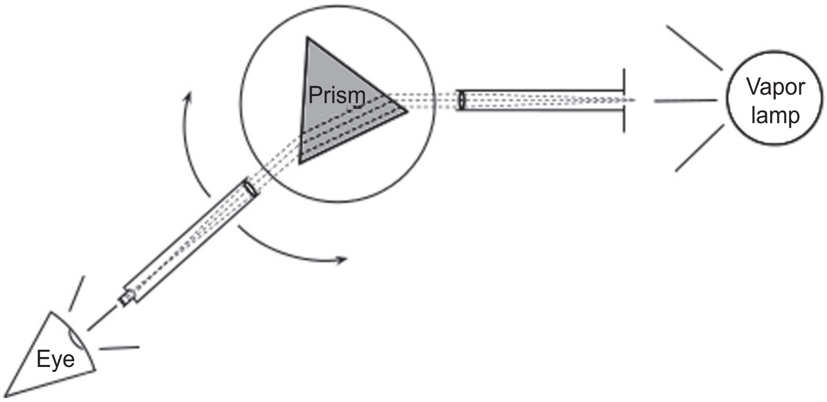


Figure 1.14.2 Angle of Minimum deviation

By viewing the spectrum, the prism table is slowly rotated either in clockwise or in anticlockwise direction in such a way that the spectrum moves towards the direct ray. At a particular position the spectrum retraces its path. When it retraces its path, stop the rotation of the prism table. This is the minimum deviation position.

The telescope is turned and the horizontal crosswire is made to coincide with the violet slit. Then both vernier scale readings (V_A and V_B) are noted. The experiment is repeated for blue, green, yellow and red slits. The prism is removed and the direct reading of the slit is taken. The difference between the direct reading and the refracted ray reading corresponding to the minimum deviation gives the angle of minimum deviation D. The dispersive power is calculated by using the given formula.

Calculation:

Refractive index of the prism, $\mu = \dfrac{\left(\sin\dfrac{(A+D)}{2}\right)}{\left(\sin\dfrac{A}{2}\right)}$

Dispersive power of the prism, $\omega = \dfrac{n_2 - n_1}{n-1}$

Result:

The refractive index of the material of the prism for the various colours of the composite light are determined and the values are tabulated.

Colour	Refractive Index
Violet	
Blue	
Green	
Yellow	
Red	

The dispersive power of the prism are determined and the values are tabulated.

Colour	Dispersive Power

CORE PRACTICAL II

Core Practical II

Subject Code: 18UPHCR2

CONTENT

Ex.No: 1

Date:

POTENTIOMETER – CALIBRATION OF LOW RANGE VOLTMETER

Aim:

1. To standardize the potentiometer for the fall of potential of 1/6 volt per metre.
2. To use the standardized potentiometer to calibrate a low range voltmeter.
3. To find the corrections for various voltmeter readings.

Apparatus Required:

Potentiometer, Rheostat, Galvanometer, High resistance, Battery, Jockey and Daniel cell.

Formula:

$$E_1 = l_1 \frac{E_0}{l_0} \text{ (V)}$$

Where,

E_0 = E.M.F of Daniel cell (V)

l_0 = Balancing length of Daniel cell (cm)

l_1 = Balancing length for various voltmeter reading (cm)

Table 2.1.1 Determination of l_1

$E_0 =$ V; $l_0 =$ 10^{-2} m

S. No	Voltmeter reading E_0 (V)	Balancing length for various voltmeter readings $l_1 \times 10^{-2}$ (m)	Calculated voltage $E_1 = E_1 \dfrac{E_0}{l_0}$ (V)	Corrected Voltage $(E_0 - E_1)$ (V)

Circuit Diagram:

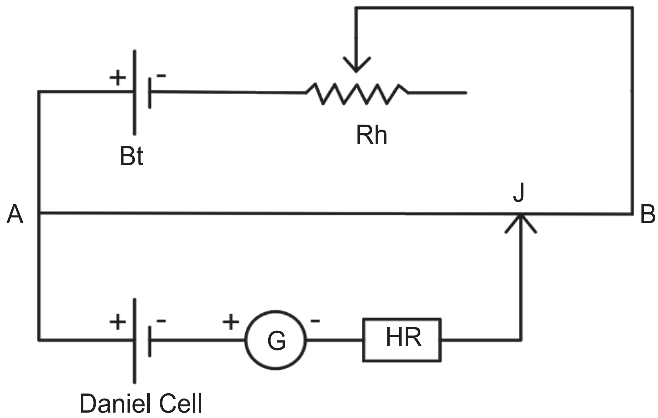


Figure 2.1.1

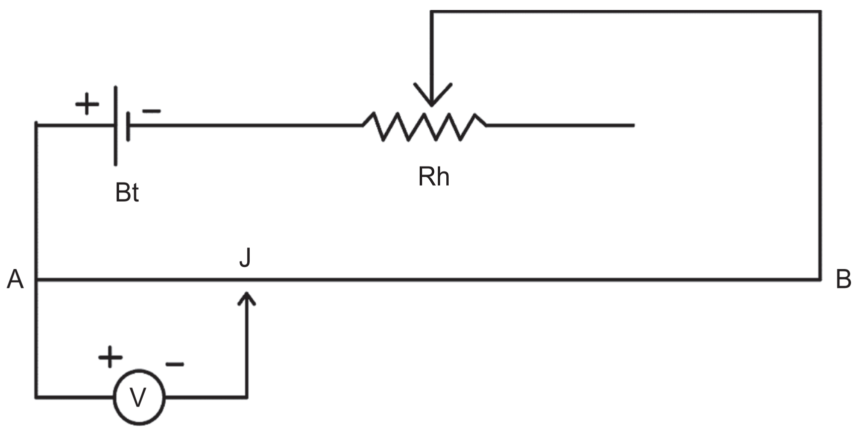


Figure 2.1.2

Procedure:

- To standardize the potentiometer:

  i. The circuit connections are made as shown in the Figure 2.1.1

  ii. Press the jockey at the ends A and B and note the deflections shown by the galvanometer. If the deflections are on both sides of neutral position of the galvanometer, the circuit is correct.

iii. Press the jockey at a distance of E.M.F of Daniel cell x 6 m from A and adjust the rheostat so that the galvanometer shows no deflection.

- To calibrate the voltmeter:

i. Don't alter the primary circuit. Disconnect the Daniel cell in the secondary circuit and connect the given voltmeter as shown in the Figure 2.1.2

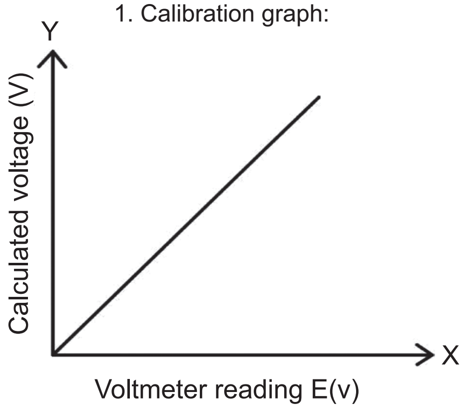
ii. Move the jockey over the wire from A, till the voltmeter shows 0.1V.

iii. Note the distance of the jockey from A.

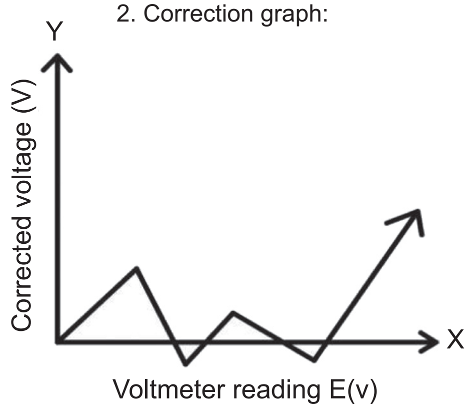
iv. Repeat the experiment for various values of the voltmeter readings.

Model Graphs:

1. Calibration graph:



2. Correction graph:



Result:

The corrections for various readings of the voltmeter are found out and the calibration and correction graphs are drawn.

Ex.No: 2

Date:

POTENTIOMETER – $\frac{R_1}{R_2}$ AND SPECIFIC RESISTANCE

Aim:

1. To compare the unknown resistance of the material of the coil with known resistance.
2. To find the specific resistance of the material of the coil.

Apparatus Required:

Potentiometer, Rheostat, Galvanometer, High resistance, Resistance coil, Battery, Jockey, Resistance box, DPDT switch.

Formula:

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}$$

$$R_2 = R_1 \frac{l_2}{l_1} \quad (\Omega)$$

where,

l_1 = Balancing length for known resistance R (m)

l_2 = Balancing length for the coil (m)

R_1 = Known resistance (Ω)

R_2 = Unknown resistance of the coil (Ω)

$$\rho = \frac{R_2 \pi r^2}{L} (\Omega\text{m})$$

where,

r = Radius of the coil (m)

L = Length of the coil (m)

$$LC = \frac{\text{pitch of screw gauge}}{\text{Total number of divisions on circular scale}} = \frac{1}{100} = 0.01\text{mm}$$

Zero Coincidence = ; Zero Error = ; Zero correction = ;

Table 2.2.1 Determination of radius of the coil

S. No	Pitch scale reading (mm)	Head scale coincidence (div)	Head scale reading (mm)	TR = PSR+HSR (mm)	Correct reading = TR + ZC (mm)

Mean = mm

Circuit Diagram:

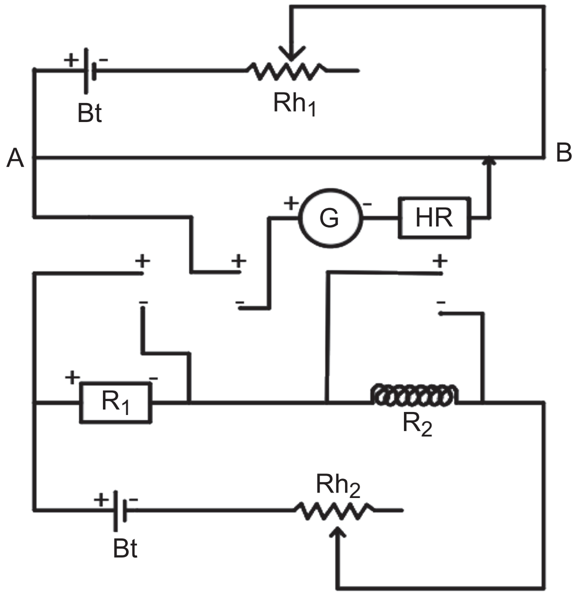


Figure 2.2.1

Procedure:

i. Electrical connections are made as shown in the Figure 2.2.1.

ii. A resistance box R_1 and the coil R_2 of unknown resistance are connected in the DPDT switch.

iii. With a suitable resistance (10 ohm) included in the resistance box, the circuit is switched on.

iv. To check the circuit connections, press the jockey at the ends A and B and note the deflections shown by the galvanometer.

v. If the deflections are on both sides of neutral position of the galvanometer, the circuit is correct.

vi. By moving the jockey over the wire, from A, the point on the wire at which the galvanometer shows null deflection i.e., balancing length AJ is found. The balancing length AJ = l_1 is noted.

vii. Now the DPDT switch is connected to the other side (R_2). The same procedure is repeated. The balancing length AJ = l_2 is noted.

Table 2.2.2 Determination of unknown resistance

S. No	Balancing Length		$R_2 = R_1 \frac{l_2}{l_1}$ (Ω)
	$l_1 \times 10^{-2}$ (m)	$l_2 \times 10^{-2}$ (m)	

Mean = (Ω)

viii. The same experiment is repeated for different positions of Rh_2.

ix. The unknown resistance R_2 is found using the formula. From the values of R_2, r and L, the specific resistance of the material of the wire is determined.

Result:

1. Resistance of the coil R_2 =

2. Specific resistance of the material of the coil ρ =

Ex.No: 3

Date:

POTENTIOMETER- CALIBRATION OF AMMETER

Aim:

To find the corrections of various readings of given ammeter using potentiometer.

Apparatus Required:

Potentiometer, Battery, Daniel cell, Rheostat, Galvanometer, High resistance, Ammeter, Jockey, Standard resistance etc.,

Formula:

From the theory of potentiometer,

$$\frac{E_2}{E_1} = \frac{l_2}{l_1} \quad (E_2 = IR)$$

$$I = \frac{E_1}{R} \times \frac{l_2}{l_1} \text{ (A)}$$

where,

E_1 = E.M.F of Daniel cell (V)

I = Calculated value of electric current in the secondary circuit (A)

l_1 = Balancing length of Daniel cell (m)

l_2 = Balancing length for potential difference across R (m)

Table 2.3.1 Determination of I_2

S. No	Ammeter Reading (A)	Balancing length $l_2 \times 10^{-2}$ (m)	Calculated current $I = \frac{E_1}{R} \times \frac{l_2}{l_1}$ (A)	Correction (I-A) (A)

R = (Ω); E_1 = (V); l_1 = 10^{-2} (m).

Circuit Diagram:

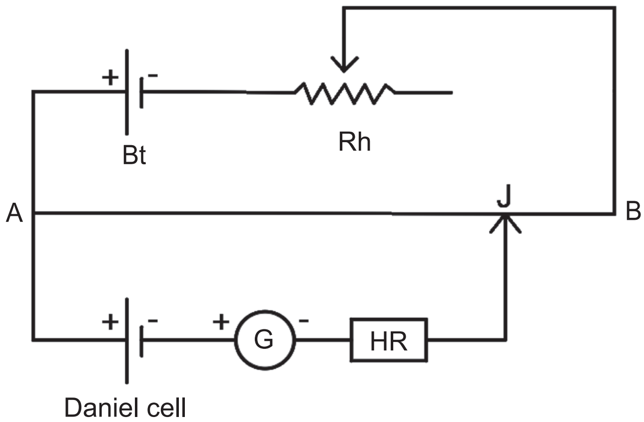


Figure 2.3.1

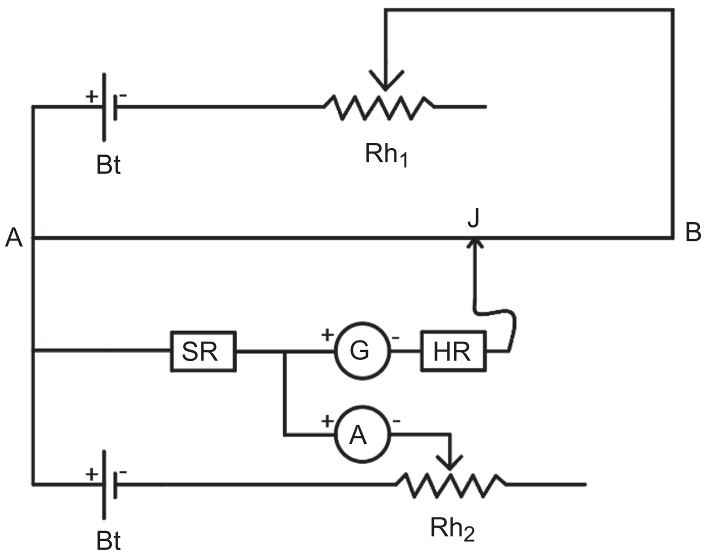


Figure 2.3.2

Procedure:

i. Electrical connections are made as shown in the Figure 2.3.1.

ii. Using Daniel cell of EMF of 1.08 V, galvanometer and high resistance in the primary circuit, the balancing length l_1 is found.

iii. The secondary circuit is made as in Figure 2.3.2.

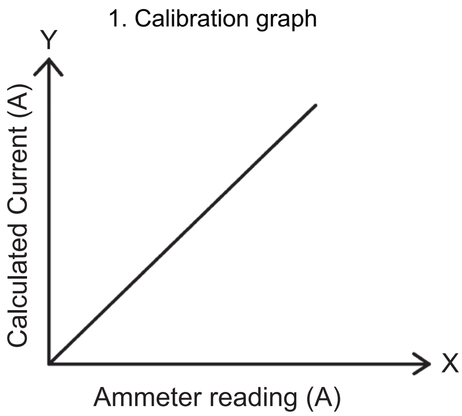
iv. Rh_2 is adjusted so that the ammeter reads 0.2 ampere. The balancing length l_2 for potential difference across the standard resistance SR is found.

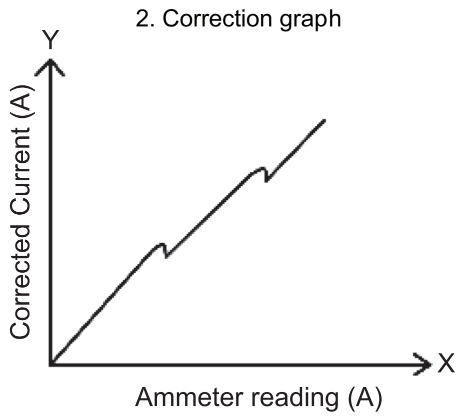
v. Knowing l_1 and l_2, the current in the secondary circuit is calculated from the formula given. The correction to the ammeter reading (I – A) is found out.

vi The experiment is repeated by adjusting the rheostat for reading 0.4, 0.6, 0.8, 1, 1.2 ampere in the ammeter. In each case, the balancing length is found and correction is calculated.

vii. The calibration graph is drawn by taking ammeter reading along the positive x axis and calculated current along the y axis. The correction graph is drawn by taking ammeter reading along the positive x axis and correction along the y axis.

Model Graphs:





Result:

The corrections to various readings of the ammeter are found out and their correction and calibration graphs are drawn.

Ex.No: 4

Date:

LCR SERIES RESONANCE CIRCUIT

Aim:

1. To set up a series resonance circuit and to study the frequency response of the circuit.
2. To determine its resonant frequency and Q factor of the circuit.
3. To determine the self-inductance of the coil.
4. To determine the bandwidth of the response curve.

Apparatus Required:

Audio Frequency Oscillator (AFO), Milliammeter, Voltmeter, Resistance box, Decade condenser box etc.,

Formula:

$$f_o = \frac{1}{2\pi\sqrt{LC}} \text{ (Hz)}$$

$$L = \frac{1}{4Cf_o^{\,2}\pi^2} \text{ (H)}$$

$$Q = \frac{f_o}{f_1 \sim f_2}$$

$$\text{Band width} = f_1 \sim f_2 \text{ (Hz)}$$

where,

f_o = Resonant frequency (Hz)

L = Self inductance of the coil (H)

C = Capacity of the capacitor (F)

Q = Q-factor of the circuit

f_1 = Lower cut off frequency (Hz)

Table 2.4.1 Determination of the current for different values of R

S. No	Frequency (Hz)	log (f)	Current in mA	
			$R_1 = 100\ \Omega$	$R_2 = 300\ \Omega$

f_2 = Upper cut off frequency (Hz)

R = Resistance of the circuit (Ω)

Circuit Diagram:

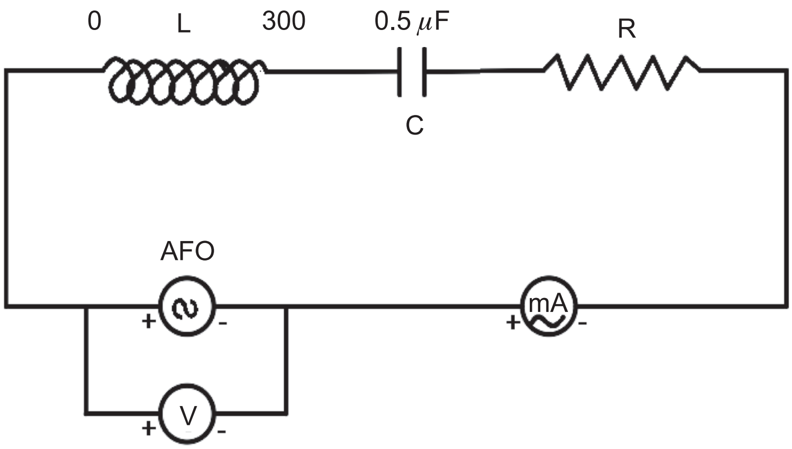


Figure 2.4.1

Procedure:

i. Connections are made as shown in the Figure 2.4.1

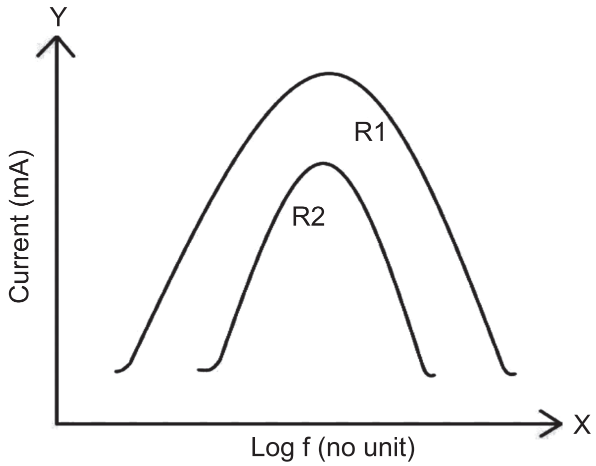
ii. Introduce 100 ohms in R and 0.05 μF in C.

iii. Measure the current in mA for various values of the frequency.

iv. Plot a graph between log f and current.

v. Repeat the experiment by varying the value of R.

Model Graph:



Result:

1. Resonant frequency f_o =
2. Self inductance of the coil L =
3. Q-factor of the circuit
   (i) for (R = 100 Ω) =
   (ii) for (R = 300 Ω) =
4. Band width
   (i) for (R = 100 Ω) =
   (ii) for (R = 300 Ω) =

Ex.No: 5

Date:

LCR PARALLEL RESONANCE CIRCUIT

Aim:

1. To study the frequency response of the circuit.
2. To determine its resonant frequency.
3. To determine the self inductance of the coil.
4. To determine the Q factor and impedance of the circuit.

Apparatus Required:

Audio Frequency Oscillator (AFO), Milliammeter, Resistance box, Decade condenser box, Inductance coil, etc.,

Formula:

$$L = \frac{1}{4Cf_o^2\pi^2} \text{ (H)}$$

$$Z = \frac{L}{CR} \ (\Omega)$$

$$\omega = 2\pi f_o$$

$$Q = \frac{Z}{L\omega}$$

where,

f_o = Resonant frequency (Hz)

L = Self inductance of the coil (H)

C = Capacity of the capacitor (F)

Q = Q-factor of the circuit

R = Resistance of the circuit (Ω)

Z = Impedance of the circuit (Ω)

ω = Angular resonance frequency

Table 2.5.1 Determination of current for different values of R

S. No	Frequency (Hz)	log (f)	Current in mA	
			$R_1 = 100\ \Omega$	$R_2 = 300\ \Omega$

Circuit diagram:

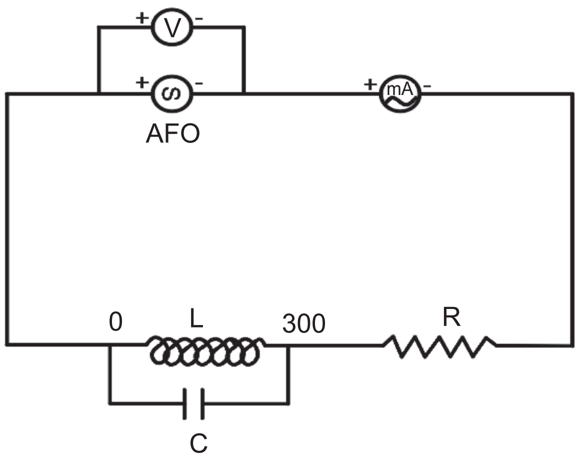


Figure 2.5.1

Procedure:

i. Connections are made as shown in the Figure 2.5.1

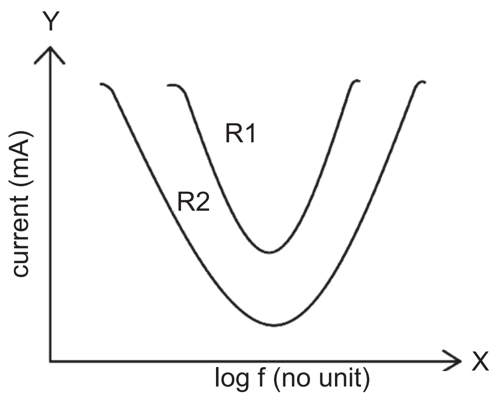
ii. Introduce 100 ohms in R and 0.05 μF in C.

iii. Measure the current in mA for various values of the frequency.

iv. Plot a graph between log f and current.

v. Repeat the experiment by varying the value of R.

Model Graph:



Result:

1. Resonant frequency f_o =
2. Self inductance of the coil L =
3. Q-factor of the circuit
   - (i) for (R = 100 Ω) =
   - (ii) for (R = 300 Ω) =
4. Band width
   - (i) for (R = 100 Ω) =
   - (ii) for (R = 300 Ω) =

Ex.No: 6

Date:

ABSOLUTE CAPACITY OF A CAPACITOR - B.G

Aim:

To determine the absolute capacity of a capacitor by using ballistic galvanometer.

Apparatus Required:

Ballistic Galvanometer, Commutator, Resistance box, Battery, Capacitor, Charge discharge key.

Formula:

$$C = \frac{T}{2\pi}\left(\frac{1}{G}\right)\left(\frac{P'}{d}\right)\left(\frac{\theta}{P}\right)\left(1+\frac{\lambda}{2}\right) \quad \textbf{farad}$$

where,

P = Known resistance (Ω)

T = Period of Galvanometer (s)

G = Resistance of Galvanometer (Ω)

d = Deflection with damping resistance (div)

C = Capacitance of capacitor (F)

θ = Kick produced in B.G due to discharge of capacitance, which is initially charged with voltage across P' (Ω) (div).

λ = Logarithmic decrement

Table 2.6.1 Determination of $\left(\frac{P'}{d}\right)$ and resistance of galvanometer

S. No	P' (Ω)	Deflection (div)			Resistance for half deflection G (Ω)			$\left(\frac{P'}{d}\right)\left(\frac{\Omega}{div}\right)$
		Left	Right	Mean	Left	Right	Mean	

Mean = __________

Table 2.6.2 Determination of $\left(\frac{\theta}{P}\right)$

S. No	P (Ω)	Q (Ω)	Kick produced in B.G (div) θ			$\left(\frac{\theta}{P}\right)\left(\frac{div}{\Omega}\right)$
			Left	Right	Mean	

Mean = __________

Circuit diagram:

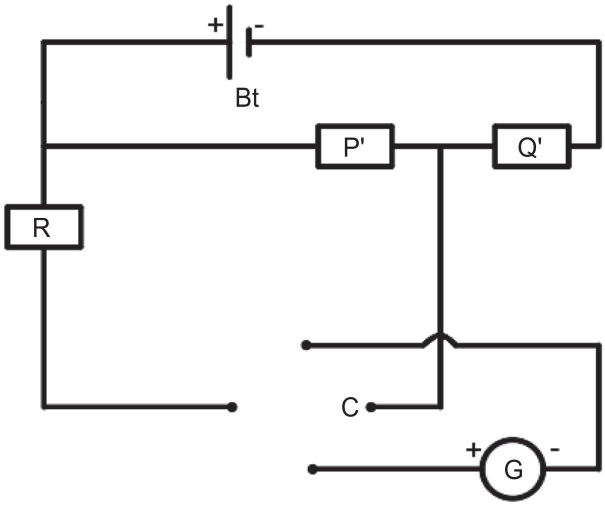


Figure 2.6.1

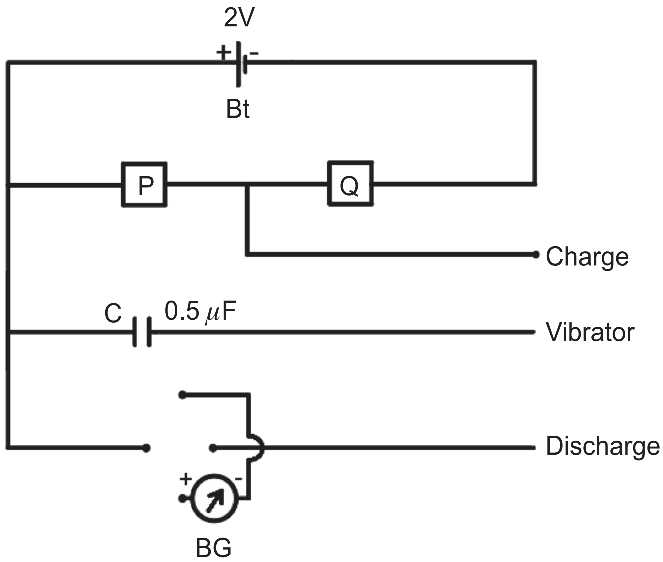


Figure 2.6.2

Table 2.6.3 Determination of λ

n	θ	λ

Mean = __________

$$\lambda = \frac{1}{(n-1)} 2.303 \log_{10}\left(\frac{\theta_1}{\theta_n}\right)$$

Procedure:

i. Connections are made as shown in Figure 2.6.1

ii. Introduce 0.1 ohm in P’and 10,000 ohm in Q’.

iii. Switch on the circuit and note the deflection in BG. Adjust the value of R so that the deflection becomes half the original value. This value of resistance gives the value of G, the resistance of the galvanometer. The above procedure is repeated by reversing the commutator plug to the other side. The average value of the deflection gives the value of d. Calculate $\left(\frac{P'}{d}\right)$.

iv. Repeat the experiment for various values of P' and determine the mean value of $\left(\frac{P'}{d}\right)$.

v. Make the circuit connections as shown in Figure 2.6.2.

vi. Introduce 5000 ohm in P and 5000 ohm in Q.

vii. Switch on the circuit and charge the capacitor. Discharge the capacitor through the B.G. Note the kick produced. Repeat this by reversing the commutator plug to the other side. Calculate the average value of the kicks produced as θ. Calculate $\frac{\theta}{P}$.

viii. Repeat the experiment for various values of P and determine the mean value of $\left(\frac{\theta}{P}\right)$

ix. Allow the B.G to oscillate freely. Note θ_1, θ_3 and θ_5, the first, third and fifth successive throws. Calculate λ.

x. Note the time taken for 10 oscillations and from that calculate the period of oscillation.

Result:

The absolute capacity of the capacitor =

Ex.No: 7

Date:

DESAUTY'S BRIDGE - DETERMINATION OF C IN SERIES AND PARALLEL

Aim:

1. To determine the capacitance of two capacitors connected individually.
2. To find the equivalent capacitance of two capacitors connected in series and parallel by forming Desauty's bridge.

Apparatus Required:

Condenser Box, Resistance box, Headphone and A.F.O.

Formula:

$$\frac{X_C}{X_{C_1}} = \frac{R_1}{R_2}$$

$$\frac{1/C\omega}{1/C_1\omega} = \frac{R_1}{R_2}$$

with C_1 alone:

$$C_1 = C\left(\frac{R_1}{R_2}\right) \quad (\mu\text{F})$$

with C_2 alone:

$$C_2 = C\left(\frac{R_1}{R_2}\right) \quad (\mu\text{F})$$

Table 2.7.1 Determination of C_1

S. No	R_1 (Ω)	R_2 (Ω)	$C_1 = C\left(\frac{R_1}{R_2}\right)$ (μF)

Table 2.7.2 Determination of C_2

S. No	R_1 (Ω)	R_2 (Ω)	$C_2 = C\left(\frac{R_1}{R_2}\right)$ (μF)

where,

$C_1, C_2 =$ Unknown values of capacitance (μF)

$R_1, R_2 =$ Known value of resistance (Ω)

In series

Experimental

$$C_s = C\left(\frac{R_1}{R_2}\right) \quad \mu\text{F}$$

Theoretical

$$C_s = \frac{C_1 C_2}{C_1 + C_2} \quad \mu\text{F}$$

In parallel

Experimental

$$C_p = C\left(\frac{R_1}{R_2}\right) \quad \mu\text{F}$$

Theoretical

$$C_p = C_1 + C_2 \quad (\mu\text{F})$$

where,

$C_s =$ Equivalent capacitance of capacitors connected in series (μF)

$C_p =$ Equivalent capacitance of capacitors connected in parallel (μF)

Table 2.7.3 Determination of C_s

S. No	R_1 (Ω)	R_2 (Ω)	$C_s = C\frac{R_1}{R_2}$ (μF)

Table 2.7.4 Determination of C_p

S. No	R_1 (Ω)	R_2 (Ω)	$C_p = C\frac{R_1}{R_2}$ (μF)

Circuit diagram:

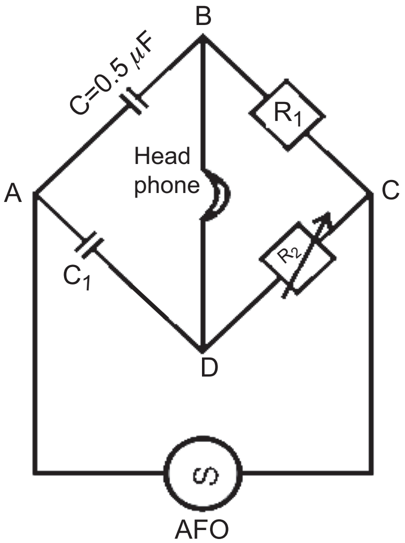


Figure 2.7.1

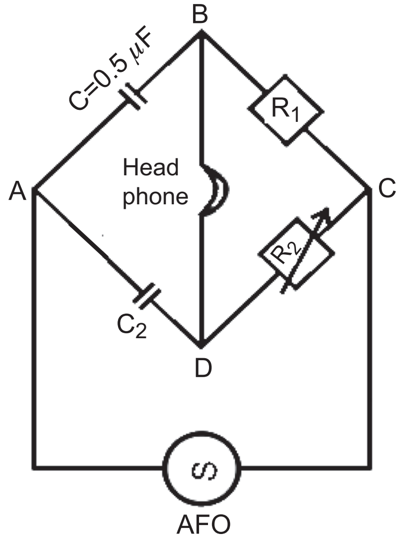


Figure 2.7.2

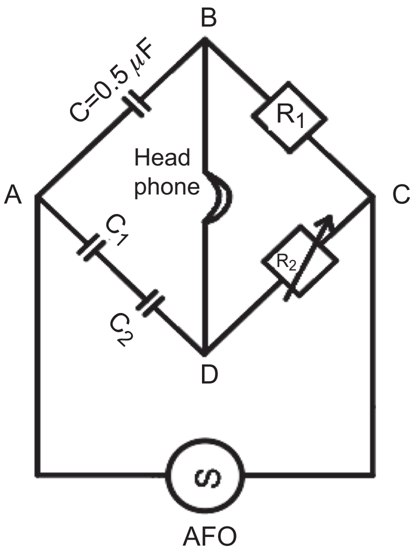


Figure 2.7.3

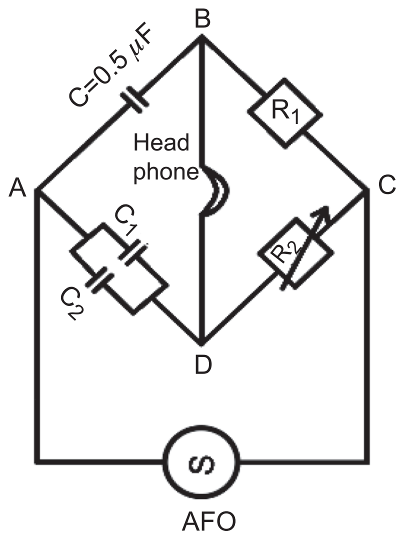


Figure 2.7.4

Procedure:

i. Connections are made as shown in the Figure 2.7.1

ii. Let R_1 = 100 Ω and adjust R_2 until null sound is heard in the headphone.

iii. Repeat step 2 for different values of R_1.

Result:

1. The value of the capacitance C_1 =
2. The value of the capacitance C_2 =
3. The equivalent capacitance of two capacitors =

Connected in series,

By theoretical method =

By experimental method =

Connected in parallel,

By theoretical method =

By experimental method =

Ex.No: 8

Date:

COMPARISON OF $\frac{C_1}{C_2}$ AND $\frac{E_1}{E_2}$ – B.G

Aim:

To compare the capacitances of two capacitors and to compare the EMFs of two cells using B.G.

Apparatus Required:

Ballistic Galvanometer, Resistance box, Commutator, Capacitors, Charge discharge key, Daniel cell, Lechlanche cell, DPDT key etc.,

Formula:

$$\frac{C_1}{C_2} = \frac{\theta_1}{\theta_2}$$

where,

C_1, C_2 = Capacitance of two capacitors (μF)

θ_1 = Kick for C_1 (div)

θ_2 = Kick for C_2 (div)

$$\frac{E_1}{E_2} = \frac{\theta_1}{\theta_2}$$

where,

E_1, E_2 = EMFs of Leclanche and Daniel cell (V)

θ_1 = Kick for cell of emf E_1 (div)

θ_2 = Kick for cell of emf E_2 (div)

Table 2.8.1 Determination of $\frac{C_1}{C_2}$

$C_1 =$ μF ; $C_2 =$ μF ; $\frac{C_1}{C_2} =$

S. No.	P (Ω)	Q (Ω)	Kick produced in the B.G (div) With capacitor C_1 (θ_1)			Kick produced in the B.G (div) With capacitor C_2 (θ_2)			$\frac{\theta_1}{\theta_2}$
			Left	Right	Mean	Left	Right	Mean	

Mean = _______

Table 2.8.2 Determination of $\frac{E_1}{E_2}$

$E_1 =$ V ; $E_2 =$ V ; $\frac{E_1}{E_2} =$

S. No.	P (Ω)	Q (Ω)	Kick produced in the B.G (div) With cell E_1 (θ_1)			Kick produced in the B.G (div) With cell E_2 (θ_2)			$\frac{\theta_1}{\theta_2}$
			Left	Right	Mean	Left	Right	Mean	

Mean = _______

Circuit diagram:

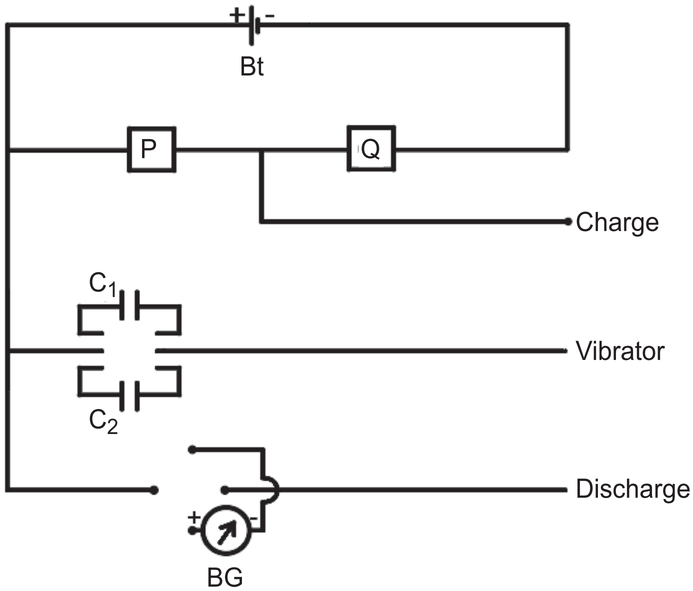


Figure 2.8.1

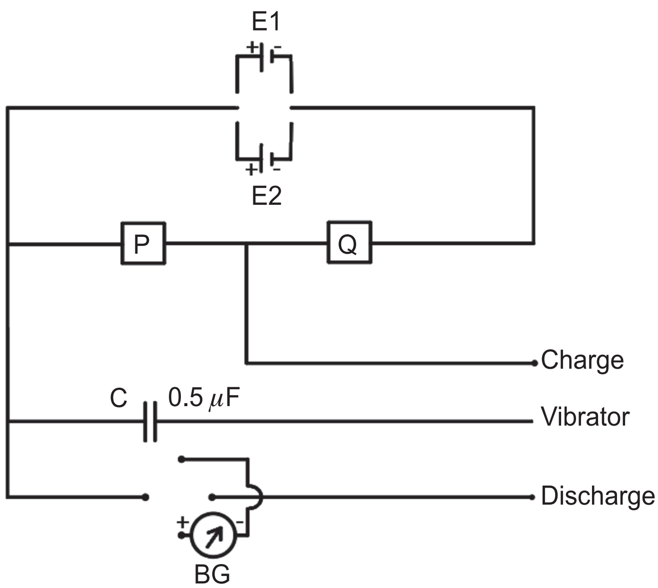


Figure 2.8.2

Procedure:

i. Connections are given as shown in the Figure 2.8.1

ii. Keep P = 5,000 ohm and Q = 5,000 ohm. The capacitor C_1 is included in the circuit using DPDT key.

iii. The capacitor C_1 is charged by pressing the charge-discharge key.

iv. The capacitor is then discharged through the B.G. The first throw in the B.G scale is noted.

v. The commutator is reversed. As before, the throw in the B.G on the other side of the scale is noted. The mean kick is found as θ_1.

vi. Then the capacitor C_2 is included in the circuit using DPDT key. As before, the capacitor C_2 is charged and then discharged through the B.G. The mean kick in this case is noted as θ_2.

vii. The ratio of capacitances of the given two capacitors is calculated using the given formula.

viii. The experiment is repeated by adjusting the values of P and Q. Then the mean value of $\frac{C_1}{C_2}$ is found out.

ix. The same procedure is repeated for $\frac{E_1}{E_2}$.

Result:

The ratio of capacitances of two given capacitors $\frac{C_1}{C_2}$:

By theoretical value =

By experimental value =

The ratio of the emfs of two given cells $\frac{E_1}{E_2}$:

By theoretical value =

By experimental value =

Ex.No: 9

Date:

BRIDGE RECTIFIER

Aim:

To construct the bridge rectifier using diodes and to measure the DC output voltage.

Apparatus Required:

Diodes, Step down transformer, Electrolytic capacitors 10μF and 470μF, Resistors, Voltmeter etc.,

Circuit diagram:

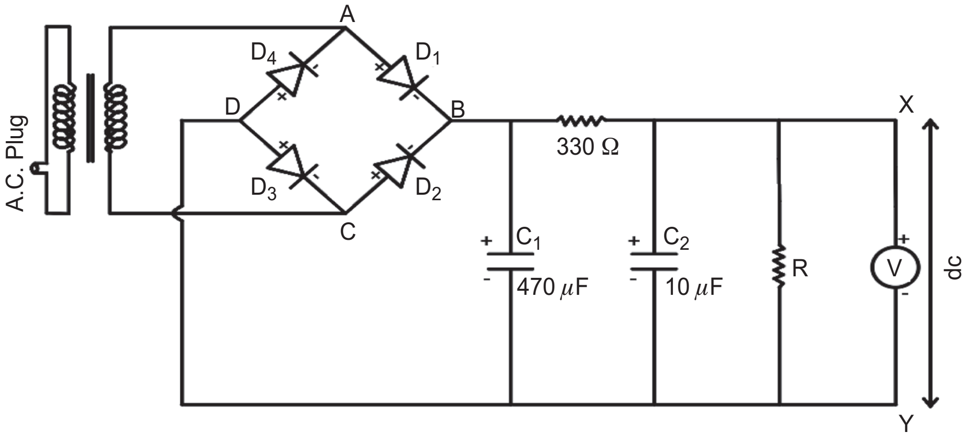


Figure 2.9.1

Procedure:

i. Electrical connections are made as shown in the Figure 2.9.1

ii. C_1 and C_2 are electrolytic capacitors, the longer leg in each being positive.

iii. After the connections are made, the multimeter which is set for resistance is used to test the continuity between the output terminals X and Y.

Table 2.9.1 Determination of the Output DC Voltage

Resistance (Ω)	Input AC voltage (V)	Output DC voltage (V)

iv. There will be continuity shown in the multimeter, when the positive probe of the multimeter is touched with end Y and the negative probe with the end X.

v. If the probes are interchanged, there should not be any continuity between X and Y.

vi. Now the primary power line is switched on. The AC voltage across the secondary is measured with the multimeter.

vii. This is rectified by the bridge circuit and the rectified DC voltage appears across X and Y.

viii. The DC voltage is measured using the multimeter.

ix. In this circuit, the combination of two capacitors C_1 and C_2 that are parallel to each other and the resistance R works as the smoothening circuit.

x. This removes the ripple present in the output of the bridge rectifier.

xi. Output DC voltage is measured for different values of R.

Result:

The bridge rectifier circuit is constructed and DC outputs are measured.

Ex.No: 10

Date:

ZENER CHARACTERISTICS

Aim:

To draw the volt ampere characteristics of Zener diode.

Apparatus Required:

Zener diode, Battery, Bread board, DC Voltmeter, Milliammeter, Microammeter, Connecting wires, 330 Ω resistor etc.,

Circuit diagram:

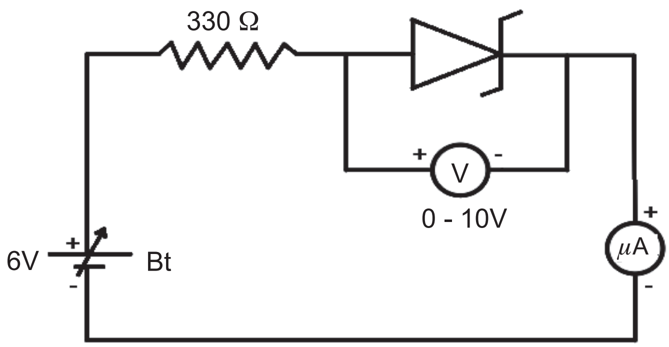


Figure 2.10.1

Procedure:

i. Make the connections as shown in Figure 2.10.1

ii. Take the readings in microammeter and milliammeter for different values of voltage applied across Zener diode.

iii. Make the connections as shown in Figure 2.10.2

iv. Take the readings in microammeter and milliammeter for different values of applied voltage across Zener diode.

v. Draw the graph between the applied voltage and current through the Zener diode.

Table 2.10.1 Forward bias

S. No.	Voltage across the Zener diode (V)	Current through the Zener diode	
		(μA)	(mA)

Table 2.10.2 Reverse bias

S. No.	Voltage across the Zener diode (V)	Current through the Zener diode	
		(μA)	(mA)

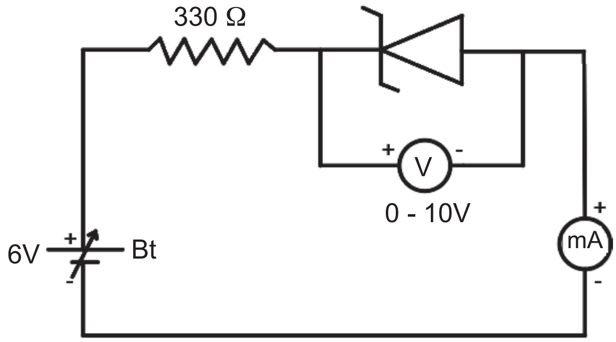
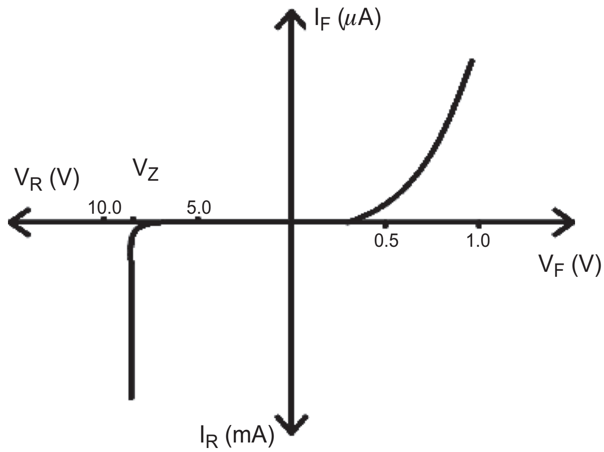


Figure 2.10.2

Model Graph:



Result:

1. The Zener breakdown voltage =
2. The graph is drawn for both forward and reverse bias conditions.

Ex.No: 11

Date:

AMPLIFIER CE MODE-WITHOUT FEEDBACK

Aim:

To construct the single stage RC coupled amplifier without feedback and to measure the frequency response

Apparatus Required:

Transistor, Oscillator, Power supply, Resistors, Capacitors, Multimeter etc.,

Formula:

$$\text{Voltage gain} = \frac{V_{output}}{V_{input}}$$

$$\text{Half power gain} = \frac{\text{Maximum power gain}}{\sqrt{2}}$$

$$\text{Bandwidth} = f_1 \sim f_2 \qquad \text{(Hz)}$$

where,

V_{output} = Output voltage (V)

V_{input} = Input voltage (V)

f_1 = Lower cut-off frequency (Hz)

f_2 = Upper cut-off frequency (Hz)

Table 2.11.1 Determination of gain:

S. No	Frequency (Hz)	log f	Output voltage without feedback (V)	Gain = $\frac{V_{output}}{V_{input}}$

Circuit Diagram:

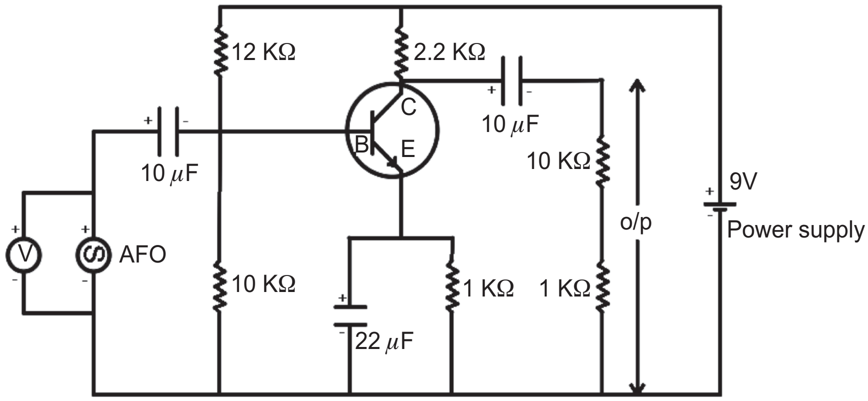


Figure 2.11.1

Procedure:

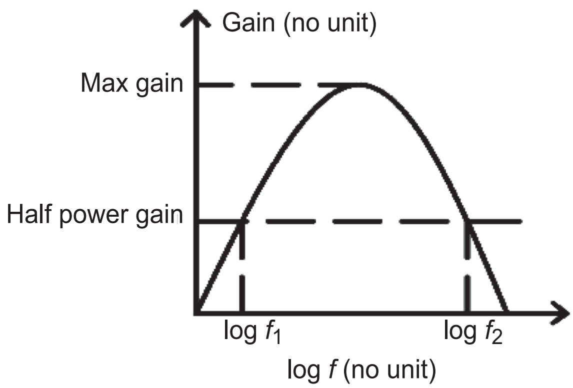
i. The input signal is applied with the function generator.

ii. The output voltage is measured for a given input for various frequencies.

iii. Gain is calculated using the formula.

iv. Finally, the graph is plotted between the gain values and the multiple frequencies applied to the circuit.

Model graph:



Result:

1. A single stage amplifier without feedback is constructed and a frequency response curve is drawn.
2. Half power gain =
3. Bandwidth =

Ex.No: 12

Date:

SPECTROMETER - NORMAL INCIDENCE

Aim:

1. To determine the number of lines per metre of the grating (to standardize the grating)
2. To find the wavelength of prominent lines of the mercury light spectrum.

Apparatus Required:

Spectrometer, Grating, Mercury vapour lamp, Reading lens etc.,

Formula:

(i) Number of lines per metre of grating

$$\sin\theta = \mathrm{Nm}\lambda$$

$$\mathrm{N} = \frac{\sin\theta}{\mathrm{m}\lambda} \quad \text{lines / metre}$$

(ii) Wavelength of prominent lines of the mercury light spectrum

$$\lambda = \frac{\sin\theta}{\mathrm{mN}} \quad \mathring{\mathrm{A}}$$

where,

θ = Angle of diffraction in degree

m = Order of the diffraction

(m = 1 for 1st order, m = 2 for 2nd order)

Table 2.12.1 Determination of the number of lines per unit length

Least Count:

Order of the colour	Telescope reading												Difference 2θ		Mean 2θ	θ	N (lines/ metre)
	Left						Right										
	V_A			V_B			V_A			V_B			V_A	V_B			
	MSR	VSR	TR	MSR	VSR	TR	MSR	VSR	TR	MSR	VSR	TR					

Diagram:

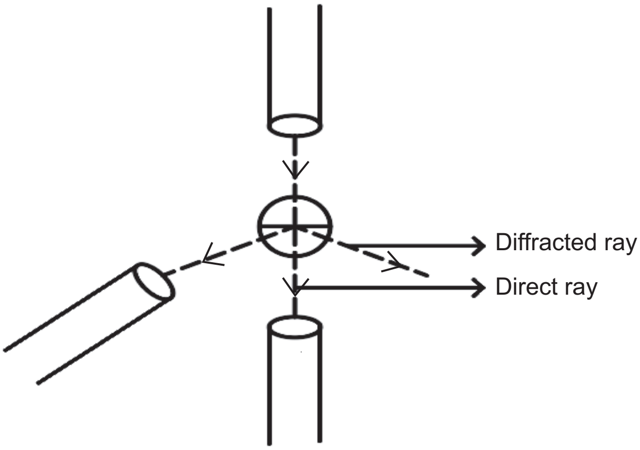


Figure 2.12.1

Procedure:

i. Do the initial adjustments. Illuminate the slit with mercury vapour lamp. Adjust the telescope to be in line with the collimator so as to observe the image of the slit. Make the image of the slit as narrow as possible.

ii. By adjusting the tangential screw of the telescope, make the crosswire to coincide with the image. Release the vernier and set the direct reading 0°- 180°and then fix the vernier.

iii. Move the telescope through an angle 90° and fix it.

iv. Mount the grating on the grating table and rotate the grating table so that the reflected image coincides with the cross-wire of the telescope and fix the grating table.

v. Now release the vernier table and rotate it through an angle 45° such that the grating plane becomes normal to the incident beam.

vi. Release the telescope to observe the direct image and spectrum on either side.

vii. Make the crosswire to coincide with the first order violet, blue, bluish green, green, yellow 1 and yellow 2 lines respectively. In each case, note the readings in vernier A and vernier B.

viii. Move the telescope to the right and repeat the previous step.

Table 2.12.2 Determination of the wavelength of various colours:

Least Count:

Order of the colour	Telescope reading												Difference 2θ		Mean 2θ	θ	λ (Å)
	Left						Right										
	V_A			V_B			V_A			V_B			V_A	V_B			
	MSR	VSR	TR	MSR	VSR	TR	MSR	VSR	TR	MSR	VSR	TR					

ix. With green colour wavelength as standard and with its diffracted value θ, N is calculated using the formula.

x. Using the value of N, wavelength of different spectral lines are calculated.

Result:

1. Number of lines per metre of the grating =
2. Wavelength of the prominent lines of the mercury spectrum are determined and the values are tabulated.

Colour	Wavelength (Å)

Ex.No: 13

Date:

SPECTROMETER - i-d CURVE USING PRISM

Aim:

1. To determine the angle of deviation (d) corresponding to known angles of incidence and to determine the angle of the prism from the i-d curve.
2. To determine the refractive index of the material of the prism.

Apparatus Required:

Spectrometer, Solid prism, Sodium vapour lamp etc.,

Formula:

$$A = i_1 + i_2 - d \text{(degree)}$$

$$\mu = \frac{\sin\frac{(A+D)}{2}}{\sin\left(\frac{A}{2}\right)}$$

where,

i_1, i_2 = angles of incidence for deviation (d) in degree.

A = Angle of the prism in degree.

D = Angle of minimum deviation in degree.

μ = Refractive index of the material of the prism.

Procedure:

i. All the preliminary adjustments of the spectrometer are made.

ii. The prism is mounted on the prism table.

Table 2.13.1 To find the angle of deviation

S. No.	$2i$ (degree)	i (degree)	Telescope Reading						Angle of deviation	
			Vernier A			Vernier B			Vernier A	Vernier B
			MSR	VSR	TR	MSR	VSR	TR		

Direct ray reading:

Vernier A: ___________ ; Vernier B: ___________

Adjustment to set the prism for a particular angle of incidence, '*i*':

i. Now the telescope is brought parallel to the collimator and the direct image of the slit is obtained at the vertical crosswire.

ii. The readings on both the verniers are set to be $0^{o} – 180^{o}$.

iii. Now the telescope is released and turned through an angle 90^{o} and clamped there.

iv. Place the prism on the prism table with one of its faces facing the collimator. Then the vernier table (or prism table) is rotated to and fro so that the image of the slit reflected from the face is made to coincide with the verticle crosswire of the telescope.

v. The vernier table is clamped there.

vi. Now the prism is set for the angle of incidence i.

vii. The telescope is then released, turned towards the refracted ray and the refracted image of the slit is obtained at the vertical crosswire.

viii. The readings (a) on both the verniers are noted.

ix. Again the telescope is brought in line with the collimator and the direct image of the slit is obtained at the cross wire.

x. The readings (b) on both the verniers are taken.

xi. The difference between '*a*' and '*b*' gives the angle of deviation.

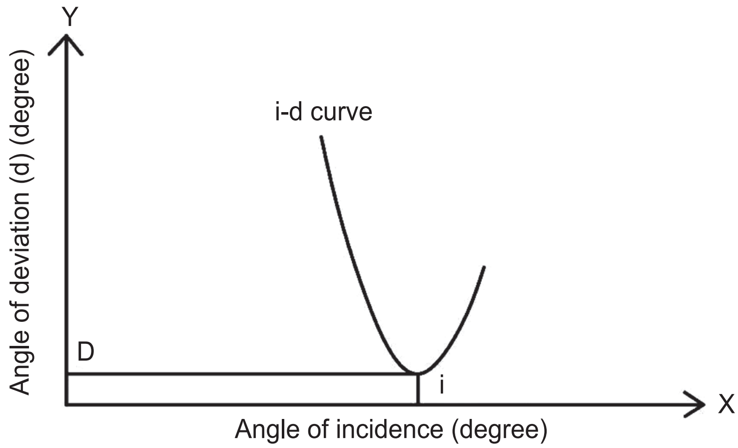
xii. The angles of deviation for different angles of incidence, say $i = 40^{o}$, 45^{o} , 50^{o} etc., are noted.

xiii. A graph is plotted with '*i*' along the X- axis and '*d*' along the Y-axis.

xiv. The angle of incidence corresponding to the angle of minimum deviation can be determined from the graph.

Then the angle of the prism and the refractive index can be calculated.

Model Graph:



Result:

1. Refractive index of the prism μ =
2. Angle of the prism A =

Ex.No: 14

Date:

MAGNETIC FIELD ALONG THE AXIS OF A CIRCULAR COIL - DETERMINATION OF B_H

Aim:

To determine the horizontal component of Earth's magnetic field using current carrying circular coil and deflection magnetometer.

Apparatus Required:

Circular coil apparatus, compass box, rheostat, battery or power supply, ammeter, commutator, key and connecting wires.

Formula:

The field along the axis of the circular coil,

$$H = \frac{nr^2 I}{2(r^2 + x^2)^{\frac{3}{2}}} \cdot \frac{1}{\tan\theta} \qquad \text{(A / m)}$$

$$B_H = \mu_0 H$$

$$B_H = \frac{\mu_0 \, n I r^2}{2(r^2 + x^2)^{\frac{3}{2}}} \left(\frac{1}{\tan\theta} \right) \quad \text{(Tesla)}$$

where,

B_H = Horizontal component of earth's magnetic field (T)

μ_0 = Permeability of the free space ($4\pi \times 10^{-7}$ Hm^{-1})

n = Number of turns included in the circuit (No unit)

I = Current flowing through the coil (A)

Number of turns in the coil n =

Circumference of the coil ($2\pi r$) =

Radius of the coil r =

To find horizontal component of the Earth's magnetic field

Table 2.14.1 Determination of H

S. No	**Distance x (cm)**	**Current I (A)**	**Deflection for eastern side**				**Deflection for western side**				Mean θ	$\frac{I}{\tan\theta}$
			θ_1	θ_2	θ_3	θ_4	θ_5	θ_6	θ_7	θ_8		

Mean = ________

r = Radius of the circular coil (m)

x = Distance between the centre of the compass box to the centre of the coil (m)

Circuit Diagram:

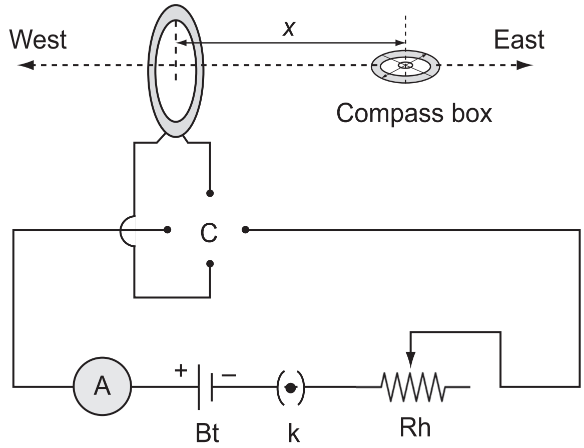


Figure 2.14.1

Procedure:

- The preliminary adjustments are carried out as follows.
  i. The leveling screws are adjusted so that the circular coil is vertical.
  ii. The wooden bench is adjusted to be along the magnetic east-west direction i.e., along aluminium pointer.
  iii. The circular coil is rotated so that its plane is in magnetic meridian i.e., along the north-south direction.
  iv. A compass box is placed with its centre coinciding with the axis of the coil.
  v. The compass box alone is rotated till the aluminium pointer reads $0° - 0°$
- Electrical connections are made as shown in the circuit diagram.
- The compass box is placed along its axis, with its centre at a distance x from the centre of the coil on one side.
- A suitable current (1A) is passed through the coil by adjusting rheostat so that the deflection of the aluminium pointer lies between 30º and 60º.

- The value of the current I is noted from ammeter.
- Two readings θ_1 and θ_2 corresponding to two ends of the pointer are noted.
- Now the direction of the current is reversed using commutator, two more readings θ_3 and θ_4 are noted.
- Now the compass box is taken to the other side and is kept at the same distance x.
- Four more readings θ_5, θ_6, θ_7 and θ_8 are taken as done before.
- These eight readings and their average value are tabulated.
- The experiment is repeated for another value of current, say 1.5 A by keeping the compass box at the same distance x.
- The radius of the circular coil is found by measuring the circumference of the coil using a thread around the coil.
- The number of turns n of the coil is noted.
- From the values of n, r, x and $I/\tan\theta$, the horizontal component of Earth's magnetic field is now found using the formula.

Result:

Horizontal component of the Earth's magnetic field at a place = ___________ T.

ALLIED PRACTICAL

Allied Practical

Subject Code: 18UPHAR1

CONTENTS

Ex.No:1

Date:

YOUNG'S MODULUS – UNIFORM BENDING (PIN AND MICROSCOPE)

Aim:

To determine the Young's modulus of the material of the given beam by Uniform-Bending method using pin and microscope.

Apparatus Required:

Travelling Microscope, two knife edges for support, two weight hangers, slotted weights, pin, screw gauge and vernier caliper.

Formula:

Young's modulus of the given material of the beam

$$E = \frac{3Mgal^2}{2byd^3} \qquad \text{Nm}^{-2}$$

Where,

E = Young's modulus of the material of the beam in Pascal or N/m^2.

y = Elevation produced for 'M' Kilogram of load in m.

M = Mass suspended on either side of the beam in Kg.

g = Acceleration due to gravity ($9.8\ m/s^2$).

l = Distance between the two knife edges in m.

b = Breadth of the beam in m.

d = Thickness of the beam in m.

a = Distance between the weight hanger and the adjacent knife edge in m

Observations:

To Find the Thickness of the Beam Using Screw Gauge

Distance moved by the screw for 5 rotations of head = 5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale =100

Least count = Pitch / Number of divisions on head scale = 1 /100 = 0.01mm

Zero coincidence = __________ divisions

Zero error = ZC × LC = ________ mm

Zero correction = __________ mm

Table 3.1.1 Thickness of the Beam

S. No.	Pitch scale reading (mm)	Head scale coincidence (div)	Head scale reading (mm)	Observed reading PSR+HSR (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (d) = mm

Diagram

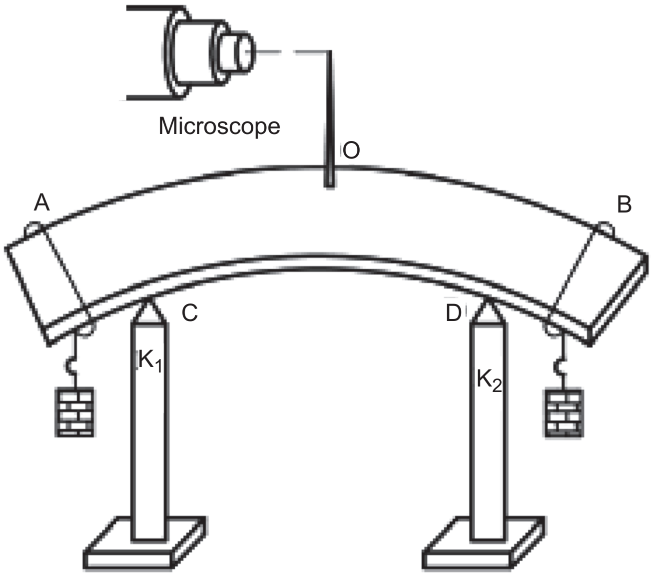


Figure 3.1.1 Uniform Bending

Procedure

The given beam is placed over the two knife edges (C & D) at a distance of 70 cm or 80 cm. Two weight hangers are suspended, one each on either side of the knife edge at equal distance from the knife edge. Since the load is applied at both points of the beam, the bending is uniform throughout the beam and the bending of the beam is called uniform bending. A pin is fixed vertically exactly at the centre of the beam. Now the bar has to be brought to elastic mood as follows; Additional weights are loaded and unloaded. This is repeated four or five times.

A travelling microscope is placed in front of this arrangement. Taking the weight hangers alone as the dead load, the tip of the pin is focused by the microscope and is adjusted in such a way that the tip of the pin just touches the horizontal cross wire. The reading on the vertical scale of the travelling microscope is noted. Now, equal weights are added on both the weight hangers, in steps of 50 gram. Each time the position of the pin is focused and the readings are noted from the microscope. The procedure is followed until the maximum load is reached.

To Find the Elevation of the Beam using Travelling Microscope

Least count of Travelling microscope (L.C) = 0.001cm (or) 0.001×10^{-2}m

V.S.R = V.S.D × L.C

T.R = M.S.R + V.S.R

Distance between the two knife edges (l) = __________ $\times 10^{-2}$m

Distance between the weight hanger and the adjacent knife edge (a) = ____10^{-2}m

Table 3.1.2 Elevation of the Beam

S. No.	Load M 10^{-3} kg	Microscope readings $\times 10^{-2}$ m						Mean 10^{-2} m	Average elevation y (for M = 50g) 10^{-2}m	M/y 10^{-1} Kg/m
		Loading			Unloading					
		MSR	VSR	TR	MSR	VSR	TR			
1	50									
2	100									
3	150									
4	200									
5	250									

Mean M/y = $\times 10^{-1}$ Kg/m

The same procedure is repeated by unloading the weight from both the weight hanger in steps of same 50 gram and the readings are tabulated in the tabular column. From the readings, the mean of (M/y) is calculated. The thickness and the breadth of the beam are measured using screw gauge and vernier caliper respectively and are tabulated. By substituting all the values in the given formula, the Young's modulus of the given material of the beam can be calculated.

Calculations:

Mass suspended on either sides of the beam	$M = 50 \times 10^{-3}$ Kg
Breadth of the beam	$b = \quad \times 10^{-2}$ m
Thickness of the beam	$d = \quad \times 10^{-3}$ m
Acceleration due to gravity	$g = 9.8$ m/sec^2
Mean value of	$M/y = \quad$ Kg/m
Distance between the two knife edges	$l = \quad \times 10^{-2}$ m
Distance between the weight hanger and the adjacent knife edge	$a = \quad \times 10^{-2}$ m

Young's modulus of the given material of the beam

$$E = \frac{3Mgal^2}{2byd^3} \qquad \text{Nm}^{-2}$$

To find the breadth of the beam

Value of one main scale division = 0.1 cm

9 main scale divisions = 10 vernier scale divisions

n =10

Least count = $\frac{1}{n} \times 1\text{m.s.d} = \frac{1}{10} \times 0.1 = 0.01$ cm

Table 3.1.3 Breadth of the Beam

S. No.	Main scale reading (cm)	Vernier scale coincidence (div)	Vernier scale reading (cm)	Observed reading MSR+VSR (cm)	Correct reading = Observed reading +/ – Zero correction (cm)

Mean (b) = ________ cm

Result:

The Young's modulus of the material of the given beam by uniform bending method E = ____________ N/m^2.

Observations:

To Find the Breadth of the Bar (b) Using Vernier Caliper

Value of one main scale division = 0.1cm

9 main scale divisions = 10 vernier scale division

n =10

Least count = $\frac{1}{n}$ × 1m.s.d = $\frac{1}{10}$ × 0.1 = 0.01 cm

Table 3.2.1 Breadth of the Bar

S. No.	Main scale reading (cm)	Vernier scale coincidence (div)	Vernier scale reading (cm)	Observed reading MSR+VSR (cm)	Correct reading = Observed reading +/ – Zero correction (cm)

Mean (b) = _______ cm

Ex.No: 2

Date:

YOUNG'S MODULUS – NON-UNIFORM BENDING (SCALE AND TELESCOPE)

Aim:

To determine the Young's modulus of a bar by non-uniform bending method using scale and telescope.

Apparatus Required:

Wooden bar of rectangular cross section (metre scale), two knife edges for support, slotted weights, optic lever, telescope, one support bar (metre scale), screw gauge and vernier caliper.

Formula:

Young's modulus of the material of the bar,

$$E = \frac{Mgl^3 D}{2bd^3 Lx} \text{Nm}^{-2}$$

Where,

M = mass applied on the hanger to produce non-uniform bending of bar in kg.

g = acceleration due to gravity in m/s^2.

l = length of the bar between the two knife edges in m.

x = shift in the telescope reading for mass in m.

L = effective length of optic lever in m.

D = distance between mirror and scale in m.

b = breadth of the bar in m.

d = depth of the bar in m.

To Find the Thickness of the Beam Using Screw Guage

Distance moved by the screw for 5 rotations of head =5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale =100

Least count = Pitch / number of divisions on head scale = 1 / 100 = 0.01 mm

Zero coincidence = _____divisions

Zero error = ZC × LC = ______mm

Zero correction = _______mm

Table 3.2.2 Thickness of the Bar

S. No.	Pitch scale reading (mm)	Head scale coincidence (div)	Head scale reading (mm)	Observed reading (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (d) = _________ mm

Diagram:

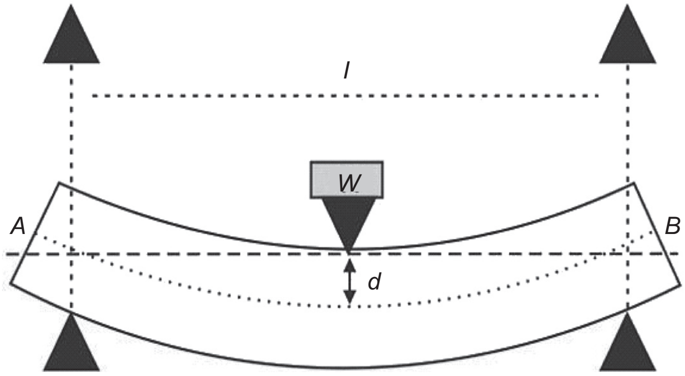


Figure 3.2.1 Non Uniform Bending

Procedure:

The experimental bar is placed symmetrically on the two knife edges, kept 0.7m apart. A weight hanger is suspended at the middle of the bar using a thread loop. An optic lever is placed with its front leg at the midpoint and the hind legs on the support of the bar placed over the knife edges. A vernier telescope is arranged in front of the optic lever at a distance. The telescope is focused to see the image of the scale through the optic lever mirror.

Now the bar has to be brought to elastic mood as follows; Additional weights are loaded and unloaded. This is repeated four or five times. Finally check whether readings are within the vertical scale of the telescope for all the weights loaded.

With the dead weight alone, the telescope reading is noted. The load is increased in steps of 50gm on the hanger. The corresponding telescope readings are noted. Similarly, the readings are noted while unloading also. The mean readings are tabulated. Using these readings, the shift x of telescope readings for a particular load M is found out. The effective length of the optic lever mirror is measured as L. The distance between the telescope scale and optic lever mirror is measured as D. The young's modulus E can be calculated.

To Find the Shift x

Length of the bar between the knife edges (l) = ______ m

Effective length of the optic lever (L) = ______ m

Distance between the scale and mirror (D) = ______ m

Table 3.2.3 Determination of Shift x

Load (10^{-3} kg)	Telescope Readings			Shift for 50gm (cm)
	Loading (cm)	Unloading (cm)	Mean (cm)	

Mean (x) = _______ cm

Calculations:

M = 50 gm

g = 9.8 m/s^2

l =   m

Young's modulus of the given bar by non - uniform bending,

$$E = \frac{Mgl^3 D}{2bd^3 Lx} \text{Nm}^{-2}$$

Result:

Young's modulus of the material of the bar by non-uniform bending method

E = __________ N/m^2.

Observations:

To Determine the Mass of One Drop of Liquid

Mass of empty beaker = Kg

Table 3.3.1 Determination of the Mass of One Drop of Liquid

S. No.	Number of drops	Mass of beaker +n drops 10^{-3} Kg	Mass of n drops 10^{-3} Kg	Mass of one drop 10^{-3} Kg

Mass of one drop = _________ $\times 10^{-3}$ Kg

Ex.No: 3

Date:

SURFACE TENSION – DROP WEIGHT METHOD

Aim:

To determine the surface tension of the given liquid by drop weight method

Apparatus Required:

Burette, capillary tube, pinch cock, screw gauge, electronic balance and beaker.

Formula:

Surface tension of the given liquid, $\sigma = \dfrac{Mg}{3.8r}$ (N / m)

Where,

M = mass of one drop of water in Kg.

g = acceleration due to gravity in m/s^2.

r = outer radius of the capillary tube in m.

s = surface tension of the liquid to be determined in N/m.

Procedure:

Fix a glass tube vertically below the burette using a rubber tube. Fix the pinch cock on the rubber tube. Fill the burette with water. Adjust the pinch cock such that 5 or 6 drops are formed per minute. Find the mass of the empty beaker.

Collect 30 drops of water in the beaker and find the mass of beaker + 30drops. Find the mass of 30 drops and then the mass of one drop is calculated. Collect 30 drops more and repeat the experiment. Find the average value of one drop of liquid, from that calculate the surface tension.

To Determine the Radius of the Drop Using Screw Gauge

Distance moved by the screw for 5 rotations of head = 5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Pitch = 5/5 mm = 1mm

Number of divisions on the head scale = 100

Least count = pitch/ No. of divisions on the head scale = 1/100 = 0.01mm

Zero coincidence = ____ divisions

Zero error = ZC × LC

Zero correction = ____ mm

Table 3.3.2 Determination of the Radius of the Drop

S. No.	Pitch Scale Reading (mm)	Head Scale Coincidence (div)	Head Scale Reading (mm)	Observed Reading (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (d) = __________ mm

Radius (r) = __________ mm

Calculations:

Surface tension of the given liquid, $\sigma = \dfrac{Mg}{3.8r}$ (N / m)

Result:

The surface tension of the given liquid by drop weight method = ______ N/m.

Observations:

Distance moved by the screw for 5 rotations of head = 5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale = 100

Least count = pitch/ No. of divisions on the head scale = 1/100 = 0.01mm

Zero coincidence = ____ divisions

Zero error = ZC × LC

Zero correction = ____ mm

Table 3.4.1 To Find the Radius of Each Ball Using Screw Gauge

S. No.	Pitch Scale Reading (mm)	Head Scale Coincidence (div)	Head Scale Reading (mm)	Observed Reading (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Ex.No: 4

Date:

COEFFICIENT OF VISCOSITY - STOKE'S METHOD

Aim:

To determine the coefficient of viscosity of a highly viscous liquid (such as caster oil) by stoke's method.

Apparatus Required:

A tall cylindrical jar, experimental liquid, thread, steel balls of different diameters, stop watch and Hare's apparatus.

Formula:

Coefficient of viscosity of oil $\eta = \dfrac{2g(d-\rho)r^2}{9v}$

$$\eta = \frac{2g(d-\rho)r^2 t}{9(AB)} \ (\mathrm{Ns/m^2})$$

where,

g - the acceleration due to gravity in m/s^2

d - the density of the ball (7.8 × 103 Kg/m^3 for steel).

ρ - the density of the liquid in the vertical column in Kg/m^3.

r - radius of the ball in m.

t - time taken to cross the region AB in the vertical oil column in second.

Procedure:

The experimentally highly viscous liquid such as castor oil is taken in a tall jar. Two thread marks A and B are made over the surface of the jar, separated by a distance of AB = 50 cm. The mark A should be sufficiently lower from the surface of liquid. A spherical

To Find (r^2t):

AB = _______ cm = _____ m

Table 3.4.2 Determination of (r^2t)

Ball no.	Radius r (m)	Time taken to travel (AB) t (second)	r^2t (m^2s)

Mean (r^2t) = _________ m^2s

To Find the Relative Density of the Liquid Using Hare's Apparatus:

Table 3.4.3 Determination of the Relative Density of the Liquid

S. No.	h_1	h_2	$\rho_1/\rho_2 = h_1/h_2$

steel ball is taken and its mean diameter is measured using a screw gauge. Its radius r is found. The ball is gently dropped from the surface of the liquid into the jar. The ball soon attains terminal velocity (uniform velocity) as it moves down. When it crosses the mark A, the stop clock is started. When the ball crosses the mark B, the stop clock is stopped. The time taken to travel the distance (AB) is found as t second. The distance (AB) is measured. The value of (r^2t) is calculated. The experiment is repeated by using steel balls of different radii. In each case, the value of r, t and hence (r^2t) is found out. The mean value of (r^2t) is calculated. The density of the liquid is found using Hare's apparatus as ρ. The coefficient of viscosity of oil can be calculated using the formula given.

Diagram:

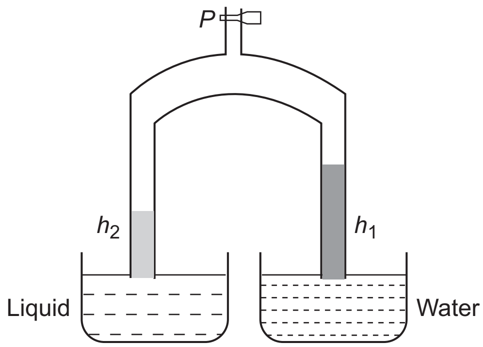


Figure 3.4.1 Hare's apparatus

Calculations:

Density of the ball d = 7.8×10^3 Kg/m^3

Density of the liquid ρ = (RD × 1000) = _____ Kgm^{-3}

g = 9.8m/s^2

Mean value of ($r^2 t$) = m^{2}s

AB = meter

Coefficient of viscosity of oil $\eta = \dfrac{2g(d-\rho)r^2}{9v}$

$$\eta = \frac{2g(d-\rho)r^2 t}{9(AB)} \qquad (\mathrm{Ns/m^2})$$

$$\eta = \qquad (\mathrm{Ns/m^2})$$

Result:

The coefficient of viscosity of the highly viscous liquid = __________ (Ns/m^2).

Ex.No: 5

Date:

COEFFICIENT OF VISCOSITY-BURETTE METHOD

Aim:

To determine the co-efficient of viscosity of a given liquid (water) using Poiseuille's flow method.

Apparatus Required:

Graduated burette without stopper, retort stand with clamp, capillary tube, beaker, water, stop watch, meter scale, rubber tube, pinch cock and travelling microscope.

Formula:

Co-efficient of viscosity of the given liquid is, $\eta = \dfrac{\pi \rho g r^4 (ht)}{8lV} \text{Ns/m}^2$

where,

g = Acceleration due to gravity in m/s^2.

ρ = Density of the liquid in kg/m^3.

r = Radius of the capillary tube in m.

l = Length of the capillary tube in m.

V = Volume of the liquid collected in m^3.

$$h = \left(\frac{(h_1 + h_2)}{2}\right) - h_0$$

h_1 = Height from table to initial level of water in the burette in m.

h_2 = Height from table to the final level of water in the burette in m.

h_0 = Height from table to mid portion of capillary tube in m.

t = Time taken for the liquid flow in second.

Observations:

To find *ht*:

$h_o =$ $\times 10^{-2}$ m

Table 3.5.1 Determination of ht

S. No.	Burette reading	Time for the flow of 5cc liquid	Range	Time for the flow of 5cc liquid (t)	Height of initial reading h_2	Height of final reading h_2	$h=\left(\frac{(h_1+h_2)}{2}\right)-h_0$	ht
	cc	s	cc	s	$\times 10^{-2}$m	$\times 10^{-2}$m	$\times 10^{-2}$m	$\times 10^{-2}$ms
1	0		0-5					
2	5		5-10					
3	10		10-15					
4	15		15-20					
5	20		20-25					
6	25		25-30					
7	30		30-35					
8	35		35-40					
9	40		40-45					
10	45		45-50					
11	50							

Mean (ht) = __________ $\times 10^{-2}$ms

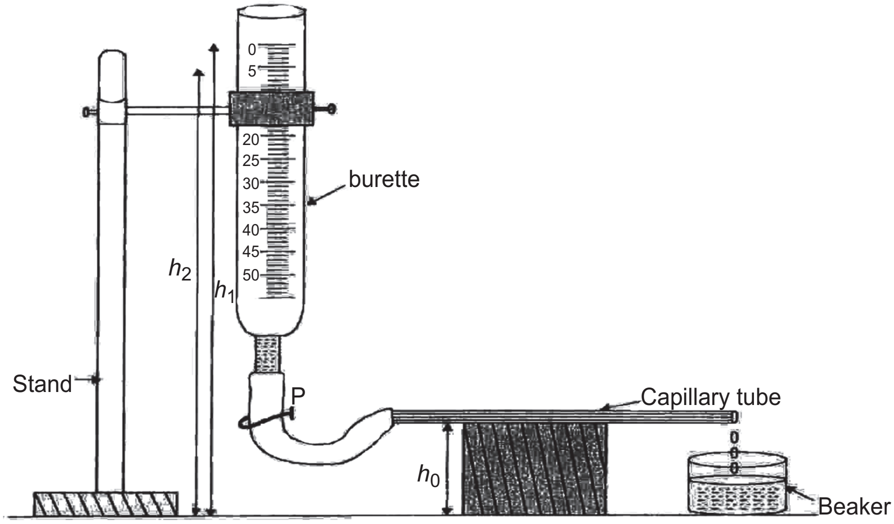


Figure 3.5.1 Viscosity of a liquid

Procedure:

Measurement of time for liquid flow:

The experimental set up is as shown in the figure. A graduated burette is washed with water and also with the given liquid whose viscosity is to be determined. The burette is then fixed vertically in a stand. A capillary tube is connected to the tip of the burette by means of a rubber tube and is held parallel to the table so that the flow of liquid is streamlined.

The given liquid is filled in the burette slightly above the zero-mark. Now the pinch clip is released. When the level of liquid reaches the zero-mark the stop-clock is started and the time is noted. Similarly, the time is noted when the liquid level crosses 5, 10, 15 50 cc. The time taken for the flow of every 5cc of the liquid '*t*' are determined.

The pressure head (*h*) is calculated by using a meter-scale. It is seen that as pressure Head '*h*' decreases, the time of flow '*t*' increases. The product ht is also calculated.

To find radius of the capillary tube (*r*) by using travelling microscope:

The capillary tube is held horizontally. The bore of the capillary tube is focused with the help of a travelling microscope. The horizontal crosswire of the travelling microscope is made to coincide with the top of the bore of the capillary tube. The reading in the vertical

To Measure the Diameter of the Capillary Tube:

LC = 0.001cm

Table 3.5.2 Determination of Diameter of the Capillary Tube

Horizontal cross wire				Vertical cross wire			
Position	**M.S.R (cm)**	**VSC (div)**	**MSR + (VSC × L.C) (cm) (d_1)**	**Position**	**M.S.R (cm)**	**VSC (div)**	**MSR + (VSC × L.C) (cm) (d_2)**
Top				Left			
Bottom				Right			

Difference d_1 = _______ cm

Difference d_2 = _______ cm

Average diameter of the capillary tube $d = \dfrac{d_1 + d_2}{2}$ = _______ $\times 10^{-2}$ m

Average radius of the capillary tube (r) = _______ $\times 10^{-2}$ m scale is noted. Now, the travelling microscope is moved so that the horizontal crosswire coincides with the bottom of the bore of the capillary tube and the vertical scale readings are noted. The difference between the two readings gives the diameter of the bore. Similarly using vertical crosswire, the readings in the horizontal scale corresponding to left and right edges of the bore of the capillary tube are taken. The difference between the two readings gives the diameter. The readings are tabulated. The average diameter and hence the radius of the capillary tube are determined. By using the given formula, the co-efficient of viscosity of the given liquid is calculated.

Calculations:

Radius of the capillary tube (r) = $\times 10^{-2}$m

Density of water (ρ) = 1000 kg/m^3

Length of the capillary tube (l) = $\times 10^{-2}$m

Volume of the water (V) = $\times 10^{-6}$ m^3

Acceleration due to gravity (g) = 9.8 m/s^2

Average value of 'ht' = ms

Co-efficient of viscosity of the given liquid is, $\eta = \dfrac{\pi \rho g r^4 (ht)}{8lV}$ Ns / m^2

Result:

The coefficient of viscosity of the given liquid (water) η = _________ Ns/m^2.

Observations:

To Determine the Time Period of Oscillation

Mass of the disc (M) = _____ $\times 10^{-3}$Kg

Table 3.6.1 Determination of Time Period of Oscillation

Length of the pendulum (L) 10^{-2}m	Time for 10 oscillations (second)				Time Period (T) second	L/T^2 10^{-2} m/s^2
	Trial I	Trial II	Trial III	Mean		

Mean L/T^2 = ______ $\times 10^{-2}$ m/s^2.

Ex.No: 6

Date:

RIGIDITY MODULUS – TORSIONAL PENDULUM

Aim:

To determine the rigidity modulus of the material of the wire and the moment of inertia of a circular disc about its axis of suspension by the method of torsional oscillations.

Apparatus Required:

Circular disc with chuck, given wire (suspension wire), stop clock, screw gauge and metre scale.

Formula:

Moment of inertia of the disc, $I = \frac{MR^2}{2} \text{ Kg m}^2$

Rigidity modulus of the material of the wire, $n = \frac{8\pi IL}{T^2 r^4} \text{ Nm}^{-2}$

where,

M = mass of the disc in Kg.

T = Period of oscillation of the Torsion pendulum in second.

R = Radius of the Torsion disc in m.

L = length of the suspension wire in m.

r = Radius of the pendulum wire in m.

Theory:

Torsion pendulum consists of a metal wire clamped to a rigid support at one end and carries a heavy circular disc at the other end. When the suspension wire of the disc is slightly twisted, the disc at the bottom of the wire executes torsional oscillations such that the angular acceleration of the disc is directly proportional to its angular displacement and the oscillations are simple harmonic.

To Determine the Diameter of the Suspension Wire using Screw Gauge

Least count L.C = 0.01×10^{-3} m

Zero coincidence = ________ divisions

Zero error (Z.E) = (Z.C × L.C)

Zero correction = (Z.E × L.C) = ______ $\times 10^{-3}$m

Table 3.6.2 Determination of the Diameter of the Suspension Wire

S. No.	Pitch Scale Reading (mm)	Head Scale Coincidence (div)	Head Scale Reading (mm)	Observed Reading PSR+HSR (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean diameter of the wire ($2r$) = ______ $\times 10^{-3}$m

Procedure:

One end of a long, uniform wire whose rigidity modulus is to be determined is clamped by a vertical chuck. To the lower end, a heavy uniform circular disc is attached by another chuck. The length of the suspension 'l'(from top portion of chuck to the clamp is fixed to a particular value (say 60 cm or 70 cm). The suspended disc is slightly twisted so that it executes torsional oscillations. The first few oscillations are omitted. By using the pointer, (a mark made in the disc) the time taken for l0 complete oscillations are noted. Three trials are taken. Then the mean time period (time for one oscillation) is found. The above procedure is repeated for three different length of pendulum wire. From the above values of L and T, L/T^2 is calculated.

The diameter of the wire is accurately measured at various places along its length with screw gauge. From this, the radius of the wire is calculated. The circumference of the disc is measured and from that the radius of the disc is calculated. The moment of inertia of the disc and the rigidity modulus of the wire are calculated using the given formulae.

Calculations:

Circumference of the Disc	$2\pi R$	=	$\times 10^{-2}$m
Radius of the Disc	R	=	$\times 10^{-2}$m
Mass of the disc	M	=	$\times 10^{-3}$kg
Radius of the wire	r	=	$\times 10^{-2}$m

Result:

Moment of inertia of the circular disc about the axis passing through its centre,

(I) = _______ 10^{-3} kg m^2.

Rigidity modulus of the material of the wire, (n) = ________ N/m^2.

Ex.No: 7

Date:

SPECIFIC HEAT CAPACITY OF A LIQUID – NEWTON'S LAW OF COOLING

Aim:

To determine the specific heat capacity of the liquid by cooling method.

Apparatus Required:

Spherical calorimeter, stand, sensitive thermometer, common balance, weight box, stop clock, liquid beaker and water beaker.

Formula:

For the same range of temperature,

Rate of cooling of calorimeter with water = Rate of cooling of calorimeter with liquid

$$\frac{[W_1C+(W_3-W_1)\ S]}{t_2}=\frac{[W_1C+(W_2-W_1)x]}{t_1}$$

$$[W_1C+(W_3-W_1)S]=\frac{t_2}{t_1}[W_1C+(W_2-W_1)x]$$

$$S=\frac{\left[(t_2/t_1)\left(W_1C+\left(W_2-W_1\right)x\right)\right]}{W_3-W_1}-W_1C \quad \text{J / Kg / K}$$

where,

W_1 = mass of empty spherical copper calorimeter in Kg.

W_2 = mass of calorimeter with water in Kg.

W_3 = mass of calorimeter with liquid in Kg.

C = specific heat capacity of calorimeter in J/Kg/K.

S = specific heat capacity of liquid in J/Kg/K.

x = specific heat capacity of water in J/Kg/K.

Observations:

Mass of empty spherical copper calorimeter (W_1) = Kg

Mass of calorimeter with water (W_2) = Kg

Mass of calorimeter with liquid (W_3) = Kg

Table 3.7.2 Temperature – Time Readings

Temperature °C	Time (second)	
	Water	Liquid
70		
68		
66		
….		
…		
…		
50		

t_1 = time taken to cool through 4°C for water in second.

t_2 = time taken to cool through 4°C for liquid in the same range of temperature in second.

Procedure:

The mass of an empty calorimeter is found as W_1 correct to kilogram. It is filled with hot water at about 80°C. It is suspended in a stand and allowed to cool. A thermometer is kept in it. When the temperature reaches 70°C, a stop clock is started. This is zero time. The stop reading (time) is taken, when the temperature becomes 68°C, 66°C, 64°C ... 50°C. The thermometer is removed and the mass of the calorimeter with water is found as W_2.

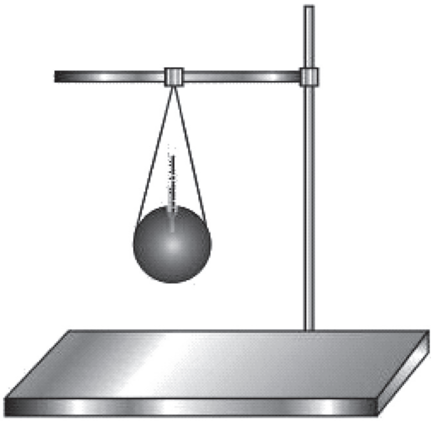


Figure 1.10.1 Newton's Law of Cooling

Water is replaced by liquid at about 80°C. As before temperature time readings are noted at 70°C, 68°C, 66°C, 64°C ... 50°C. The mass of calorimeter with water is found as W_3. Using these readings, the specific heat capacity of the liquid is found out.

Observations:

Mass of empty spherical copper calorimeter (W_1)	=	Kg
Mass of calorimeter with water (W_2)	=	Kg
Mass of calorimeter with liquid (W_3)	=	Kg

Table 3.7.3 Find $\frac{t_2}{t_1}$

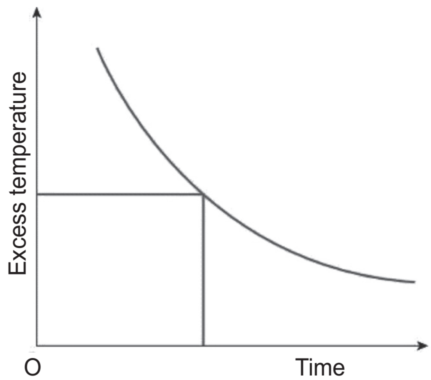
	Time taken for fall of 4^{o}C		$\frac{t_2}{t_1}$
Range of temperature ^{o}C	**Water t_1 (s)**	**Liquid t_2 (s)**	
70 - 66			
66 - 62			
64 - 60			
60 - 56			
56 - 52			

Mean $\frac{t_2}{t_1}$ = ________

To draw the cooing curves for water and liquid and to find $\frac{t_2}{t_1}$ from them:

Taking time along the x-axis and temperature along y-axis, a graph is drawn for water and liquid on the same graph sheet. Two horizontal lines are drawn corresponding to range of any two temperatures say 68°C and 64°C. The lines intersect liquid curves at two points. The corresponding time coordinates are noted from the graph. The time interval is found as t_2. Similarly, from water curve, t_1 is found. $\frac{t_2}{t_1}$ is calculated. By drawing different such sets of horizontal lines, the mean value of $\frac{t_2}{t_1}$ for the same range is found out. Substituting the formula, the specific heat capacity of the liquid is calculated.

Model Graph:



Relation between Time and temperature

Calculations:

Mass of empty spherical copper calorimeter (W_1)	=
Mass of calorimeter with water (W_2)	=
Mass of calorimeter with liquid (W_3)	=
Specific heat capacity of calorimeter C	= 385 J/Kg/K
Specific heat capacity of water x	= 4200 J/Kg/K
Specific heat capacity of liquid S	= ?

Rate of cooling of liquid = Rate of cooling of water over the same range of temperature

$$\frac{[W_1C + (W_3 - W_1)\ S]}{t_2} = \frac{[W_1C + (W_2 - W_1)x]}{t_1}$$

$$[W_1C + (W_3 - W_1)S] = \frac{t_2}{t_1}[W_1C + (W_2 - W_1)x]$$

$$S = \frac{\left[(t_2 / t_1)\left(W_1C + \left(W_2 - W_1\right)x\right)\right]}{W_3 - W_1} - W_1C \quad \mathrm{J / Kg / K}$$

Result:

Specific heat capacity of the liquid using Newton's law of cooling = _____ J/Kg/K.

Observations:

To Find $\frac{d\theta}{dt}$

Table 3.8.1 Determination of $\frac{d\theta}{dt}$

S. No.	Temperature	Time taken		
	^{0}C	min	sec	Total sec

Ex.No: 8

Date:

THERMAL CONDUCTIVITY OF A BAD CONDUCTOR – LEE'S DISC

Aim:

To determine the thermal conductivity of a bad conductor like card board using Lee's disc apparatus.

Apparatus Required:

Lee's disc apparatus, two thermometers, bad conductor, stop watch, steam boiler, vernier caliper, screw gauge and biscuit balance.

Formula:

Thermal conductivity of the given bad conductor,

$$K = \frac{\mathrm{MSx}\left(\frac{d\theta}{dt}\right)(r+2t)}{\pi r^2\left(\theta_1-\theta_2\right)2(r+t)}\ \mathrm{Wm^{-1}k^{-1}}$$

where,

M = mass of the metal disc in Kg.

S = specific heat capacity of the metal disc in J/Kg/K.

$(d\theta/dt)$ = Rate of cooling at steady temperature in ^{o}C/s.

θ_1= Steady temperature of the steam chamber in ^{o}C.

θ_2 = Steady temperature of the metal disc in ^{o}C.

r = radius of the metallic disc in metre.

t = thickness of the metallic disc in metre.

x = thickness of the bad conductor in metre.

To Find the Thickness of the Metallic Disc Using Vernier Caliper

Value of one main scale division = 0.1cm

9 main scale divisions = 10 vernier scale division,

n =10

Least count = $\frac{1}{n} \times$ 1m.s.d = $\frac{1}{10} \times 0.1 = 0.01$ cm

Table 3.8.2 Determination of Thickness of the Metallic Disc

S. No.	Main scale reading (cm)	Vernier scale coincidence (div)	Vernier scale reading (cm)	Observed reading MSR+VSR (cm)	Correct reading = Observed reading +/ – Zero correction (cm)

Mean (t) = _______ cm

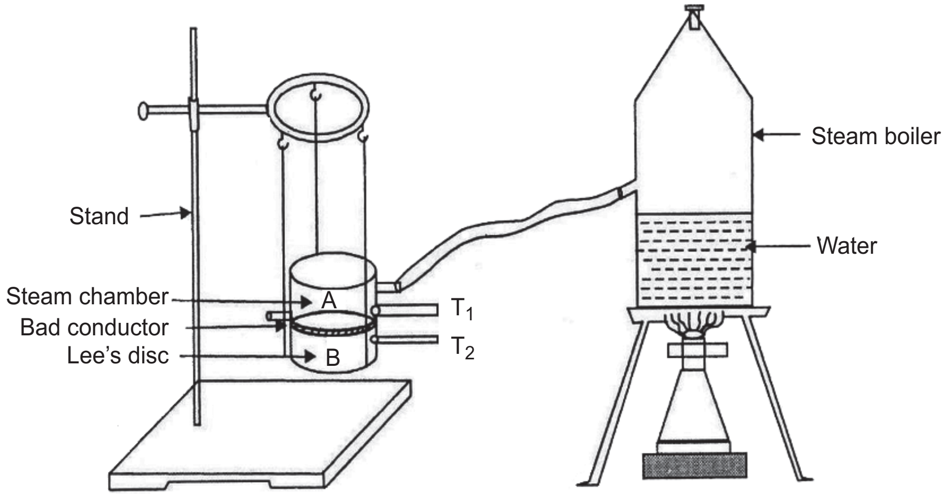


Figure 3.8.1 Lee's Disc

Description:

Lee's disc apparatus consists of a brass metal disc (B) suspended horizontally by three strings from a stand. A hollow steam chamber (A) with inlet and outlet for steam is placed above. The given bad conductor is placed between them. Two thermometers T_1 and T_2 are inserted to measure the temperatures of A and B respectively.

Procedure:

The experimental arrangement is as shown in Figure 3.8.1. Steam is allowed to pass through the steam chamber. The temperature indicated by two thermometers start rising. After 30 minutes a steady state is reached (i.e) the temperature of the lower disc will no longer rises. At this stage, steady temperatures θ_1 and θ_2 are recorded from the thermometers T_1 and T_2. Now the cardboard is removed and the lower disc is heated directly by keeping it in contact with the steam chamber. When the temperature of the lower disc attains a value of about 10^oC more than its steady state temperature, the chamber is removed and the lower disc is allowed to cool down on its own accord.

When the temperature of the disc reaches 5^oC above the steady temperature of the disc. i.e., $(\theta_2 + 5)^oC$, a stop watch is started and the time is noted for every 1^oC fall of temperature until the metallic disc attains temperature $(\theta_2 - 5)^oC$.

To Find Thickness of the Card Board using Screw Gauge

Distance moved by the screw for 5 rotations of head = 5 mm

Distance moved by the screw for 1 rotation of head = 1 mm

Number of divisions on the head scale = 100

Least count = Pitch / number of divisions on head scale = 1 / 100 = 0.01 mm

Zero coincidence = _____ divisions

Zero error = ZC × LC = ______ mm

Zero correction = _______ mm

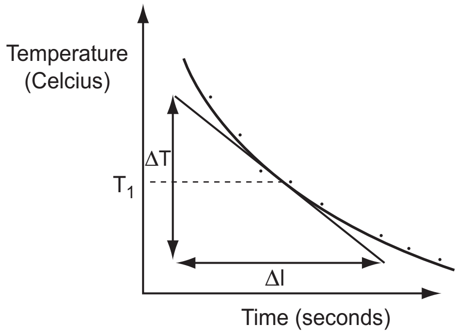
Table 3.8.3 Determination of thickness of the card board

S. No.	Pitch scale reading (mm)	Head scale coincidence (div)	Head scale reading (mm)	Observed reading PSR+HSR (mm)	Correct reading = Observed reading +/ – Zero correction (mm)

Mean (x) = _______ mm

The thickness and the radius of the metallic disc are found using vernier caliper. The thickness of the bad conductor is found using screw gauge. The mass of the metallic disc is found by using biscuit balance. The readings are tabulated in the tabular column.

Model Graph:



A graph is drawn by taking time along the x-axis and the temperature along y-axis. Cooling curve is drawn. From the cooling curve $d\theta/dt$ is calculated by drawing a triangle by taking 0.5°C above and 0.5°C below the steady temperature θ_2. Substituting this $d\theta/dt$ in the given formula, thermal conductivity of the cardboard can be calculated.

Calculations:

Thermal conductivity of the given bad conductor $K = \dfrac{\text{MSx}\left(\dfrac{d\theta}{dt}\right)(r+2t)}{\pi r^2(\theta_1-\theta_2)2(r+t)}\ \text{Wm}^{-1}\text{k}^{-1}$

Result:

Thermal conductivity of the given bad conductor = _________ $\text{Wm}^{-1}\ \text{K}^{-1}$

Ex.No: 9

Date:

AIR WEDGE - THICKNESS OF A THIN WIRE

Aim:

To determine the thickness of a given thin fiber (or) wire (or) a sheet of paper by forming interference fringes due to an air-wedge.

Apparatus Required:

Travelling microscope, two optically plane glass plates, given fiber (or) wire (or) thin sheet of paper, sodium vapour lamp.

Formula:

Thickness of the given fiber (or) wire (or) thin sheet of paper is given by

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

where,

L = Distance between edge of contact and the wire (or) paper in m.

λ = Wavelength of the monochromatic source of light (5893A^{o}) in m.

β = Mean fringe width in m.

Theory:

Two plane glass plates are inclined at an angle by introducing a thin material (e.g. thin fiber (or) hair), forming a wedge shaped air film. Thin film is illuminated by the light from sodium vapour lamp, interference occurs between the two rays, one reflected from the front surface and the other obtained by internal reflection at the back surface. Since in the case of a wedge-shaped film, thickness of the material remains constant only in direction parallel to the thin edge of the wedge, straight line fringes parallel to the edge of the wedge are obtained.

Observations:

To Find the Bandwidth (β)

LC = 0.001 cm; TR = MSR + (VSC × LC)

Table 3.9.1 Determination of the Bandwidth (β)

Order of fringes	Horizontal cross wire			Width of 20 fringes (cm)	Fringe width (β) (cm)
	MSR (cm)	VSC (div)	TR (cm)		

Mean = _________ cm

Diagram:

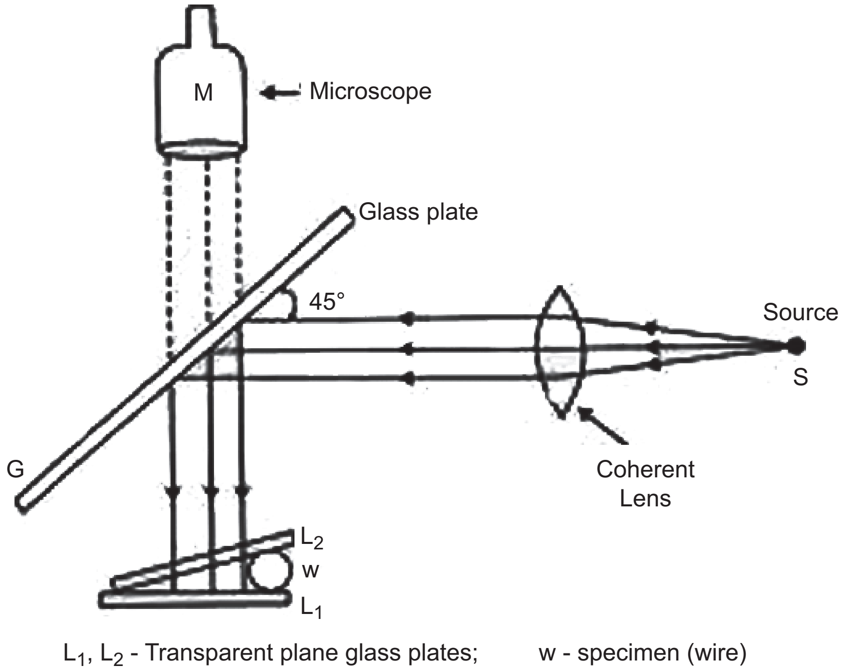


Figure 3.9.1 Air Wedge

Procedure:

Two optically plane glass plates are placed one over the other and tied by means of a rubber band at one end. The given material of fiber (or) wire (or) paper is introduced on the other end, so that an air-wedge is formed between the plates. This set up is placed on the horizontal bed plate of the travelling microscope.

Light from the sodium vapour lamp (S) is rendered parallel by means of a condensing lens (L). The parallel beam of light is incident on a plane glass plate (G) inclined at an angle of 45° and gets reflected. The reflected light is incident normally on the glass plates in contact. Interference takes place between the light reflected from the top and bottom surfaces of the glass plates and is viewed through the travelling microscope (M). Hence large number of equally spaced dark and bright fringes are formed which are parallel to the edge of contact.

The microscope is adjusted so that the bright (or) dark fringe near the edge of contact is made to coincide with the vertical cross wire and this is taken as the n^{th} fringe.

The reading from the horizontal scale of the travelling microscope is noted. The microscope is moved across the fringes using the horizontal traverse screw and the readings are taken when the vertical crosswire coincides with every successive 5 fringes (5, 10, 15, 20...). The width of every 20 fringes is calculated and the width of one fringe is calculated. The mean of this gives the fringe width (β).

The distance between the tide end and objects as 'L'. Substituting 'β' and 'L' in the given formula, the thickness of the given material can be determined.

Calculations:

Thickness of the given fiber (or) wire (or) thin sheet of paper is given by

$$t = \frac{L\lambda}{2\beta} (\mathrm{m})$$

Result:

The thickness of the given material of fiber (or) wire (or) paper = _______ m.

Ex.No: 10

Date:

SPECTROMETER - REFRACTIVE INDEX OF THE PRISM

Aim:

To determine the refractive index of the material of the prism.

Apparatus Required:

Spectrometer, Mercury vapour lamp, Glass prism, Reading lens and spirit level

Formula:

Refractive index of the prism $n = \dfrac{\sin\left(\dfrac{A+D}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

Where,

A = Angle of prism in degree.

D = Angle of minimum deviation in degree.

μ = Refractive index of the prism

Procedure:

The following initial adjustments of the spectrometer are made first.

i. The spectrometer and the prism table are arranged in horizontal position by using the leveling screws.

ii. The telescope is turned towards a distant object to receive a clear and sharp image.

iii. The slit is illuminated by a sodium vapour lamp and the slit and the collimator are suitably adjusted to receive a narrow, vertical image of the slit.

iv. The telescope is turned to receive the direct ray, so that the vertical slit coincides with the vertical crosswire.

Observations:

Table 3.10.1 Determination of the Angle of Prism 'A'

Least Count: 1′

Position of the color	Telescope Reading						Difference 2A		Mean 2A	A
	V_A			V_B						
	MSR	VSR	TR	MSR	VSR	TR	VA	VB		
Left										
Right										

Determination of Angle of prism (A)

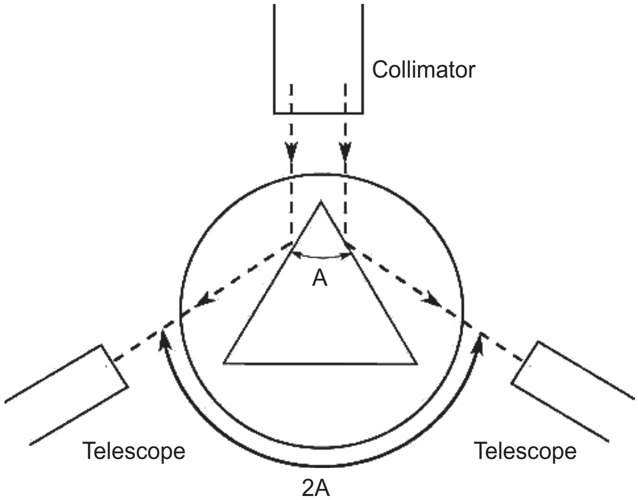


Figure 3.10.1 Angle of Prism

The given glass prism is mounted vertically at the centre of the prism table with its two reflecting faces facing the collimator and the base of the prism faces the telescope. Now the parallel rays of light coming out of the collimator falls almost equally on the two refracting faces of the prism and gets reflected. The telescope turned to receive the reflected image from one face (left) of the prism and fixed in that position. The tangential screw is adjusted until the vertical crosswire coincides with the fixed edge of the image of the slit. Now the readings on both the verniers (V_A and V_B) are noted.

Similarly, the readings corresponding to the reflected image of the slit on the other face (right) are also taken. The difference between the two readings of the same vernier gives twice the angle of the prism (2A). From the mean value of 2A the angle of the prism A is determined.

Determination of angle of minimum deviation (D)

The prism is mounted on the prism table in such a way that the light from the collimator incident on one of the refracting faces of the prism. Here the light enters in to the prism and gets diffracted. The diffracted ray moves parallel to the base of the prism gets dispersed. Now the telescope is turned to receive the dispersed spectrum coming out of the other face of the prism. By viewing the spectrum, the prism table is slowly rotated either in clockwise or in anticlockwise direction in such a way that the spectrum moves towards

Table 3.10.2 Determination of the Angle of Minimum Deviation 'D'

Least Count: 1′

<table>
<tr><th rowspan="3">Position of the Image</th><th colspan="6">Telescope Reading</th><th colspan="2" rowspan="2">Difference D</th><th rowspan="2">Mean D</th></tr>
<tr><th colspan="3">V_A</th><th colspan="3">V_B</th></tr>
<tr><th>MSR</th><th>VSR</th><th>TR</th><th>MSR</th><th>VSR</th><th>TR</th><th>VA</th><th>VB</th><th></th></tr>
<tr><td>Left</td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Right</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

the direct ray. At a particular position the spectrum retraces its path. When it retraces its path, stop the rotation of the prism table. This is the minimum deviation position.

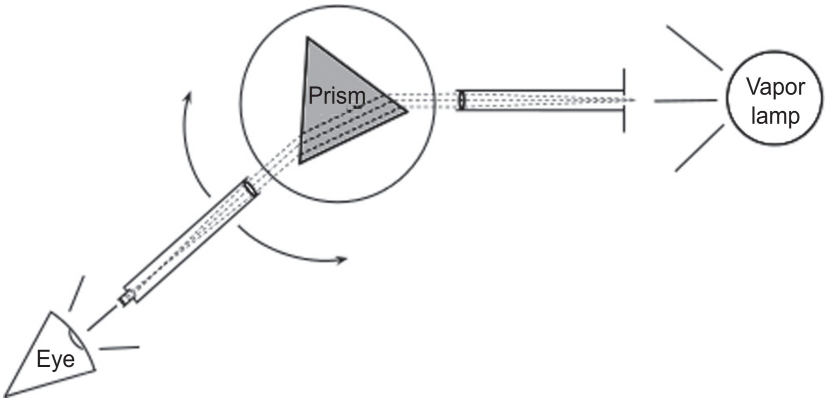


Figure 3.10.2 Angle of minimum deviation

The telescope is turned and the horizontal crosswire is made to coincide with the violet slit. Then both vernier scale readings (V_A and V_B) are noted. The prism is removed and the direct reading of the slit is taken. The difference between the direct reading and the refracted ray reading corresponding to the minimum deviation gives the angle of minimum deviation D. The refractive index of the prism is calculated by using the given formula.

Calculations:

Refractive index of the prism, $n = \dfrac{\sin\left(\dfrac{A+D}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

Result:

Angle of the prism (A) =

Angle of minimum deviation (D) =

The refractive index of the material of the prism (μ) =

Ex.No: 11

Date:

Basic Logic gates - AND, OR and NOT

Aim:

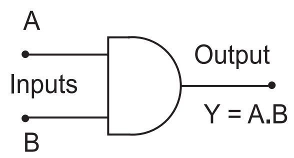
To construct the basic logic gates, namely AND, OR and NOT gates using diode and discrete components and to verify their truth tables.

Apparatus Required:

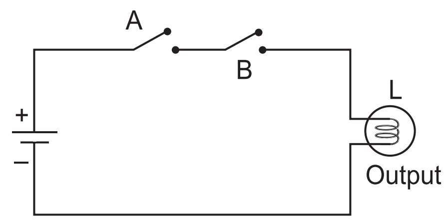
Two diodes, 10 Kohm resistor, 2.2 Kohm resistor, multimeter (voltmeter), two 6V batteries, breadboard, connecting leads and BC 107 transistor (npn).

Circuit diagram:

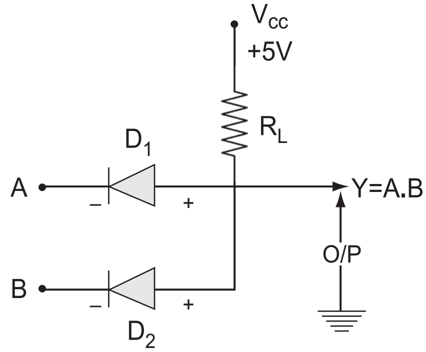
The AND logic gate



(a) Logic Symbol



(b) Electrical circuit



AND gate using diodes

Figure 3.11.1 AND gate

The AND logic gate

Table 3.11.1 Truth table

Input A (volt)	Input B (volt)	Output Y (volt)
0	0	0
1	0	0
0	1	0
1	1	1

Table 3.11.2 Verification table

Input A (volt)	Input B (volt)	Output Y (volt)

Procedure:

The circuit is connected as shown in the figure 3.11.1. A and B are the terminals to give inputs. All the ground points (G) are connected together at a single point (0 volt).

Now, 0V is taken as 0 state. i.e; V(0) = 0 Volt and 5V is taken as 1 state i.e; V(1) = 5Volt. That is positive logic system is followed.

Case 1: A = 0; B = 0; Y = ?

The input terminal A and B are connected to the ground terminal so as to have 0 input. The output voltage at Y is measured with respect to ground using a voltmeter. The observation is recorded.

Case 2: A = 1; B = 0; Y = ?

The input terminal A is connected to (+5) volt and B is connected to the ground. The output voltage Y is measured with respect to ground using a voltmeter. The observation is recorded.

Case 3: A = 0; B = 1; Y = ?

The input terminal B is connected to (+5) volt and A is connected to the ground. The output voltage Y is measured with respect to ground using a voltmeter. The observation is recorded.

Case 4: A = 1; B = 1; Y = ?

The input terminal A is connected to (+5) volt. The input terminal B is also connected to (+5) volt. The output voltage Y is measured with respect to ground using a voltmeter. The observation is recorded. The truth table is formed from the observations recorded.

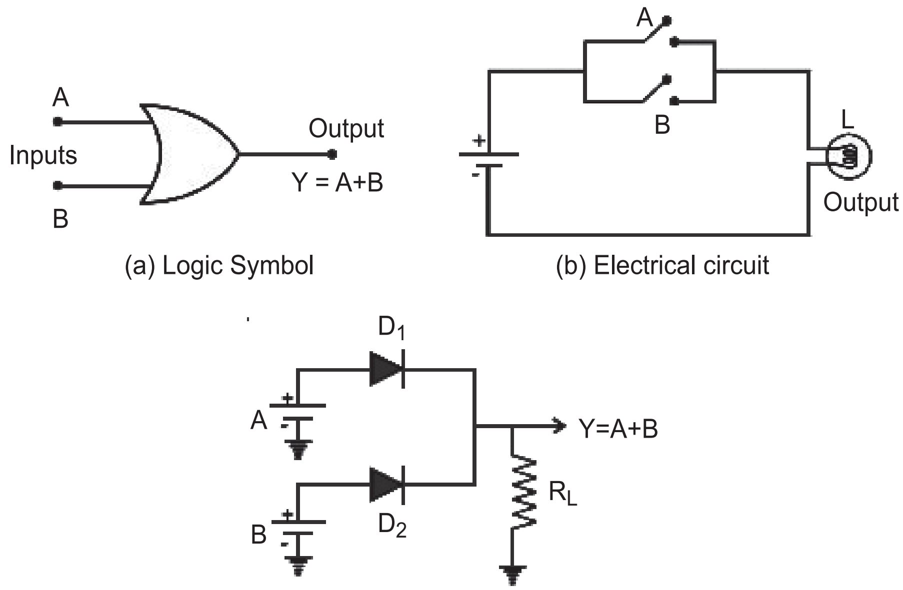
Observations:

The AND logic gate

$Y = A.B$

V(0) = 0V; V(1) = 5V

The OR logic gate



OR gate using diodes

Figure 3.11.2 OR gate

Procedure:

The circuit is connected as shown in the figure 3.11.2. The reference voltage V_R= 0; The logic level V(1) = 5V; The logic level V(0) = 0V. The diodes are IN 4001 or by 127.

Case 1: A = 0; B = 0; Y = ?

The input terminals A and B are connected to the ground(0V). The output voltage Y is measured with respect to ground using volt meter. The reading are recorded.

Case 2: A = 1; B = 0; Y = ?

The input A is connected to +5 V. The terminal B is grounded. The output voltage Y is measured with respect to ground using a voltmeter. The readings are recorded.

Case 3: A = 0; B = 1; Y = ?

The input terminal B is connected to (+5) volt and A is connected to the ground. The output voltage Y is measured with respect to ground using a voltmeter. The observation is recorded.

The OR logic gate

Table 3.11.3 Truth table

Input A (volt)	Input B (volt)	Output Y (volt)
0	0	0
1	0	1
0	1	1
1	1	1

Table 3.11.4 Verification table

Input A (volt)	Input B (volt)	Output Y (volt)

Case 4: A= 1; B= 1; Y = ?

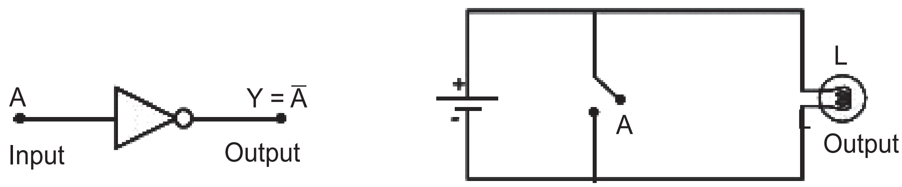
Now both the inputs are raised to V(1) state be connecting them together at +5V. The output voltage Y is measured with respect to ground using a voltmeter. The readings are recorded.

Observations:

The OR logic gate: $Y = A + B$

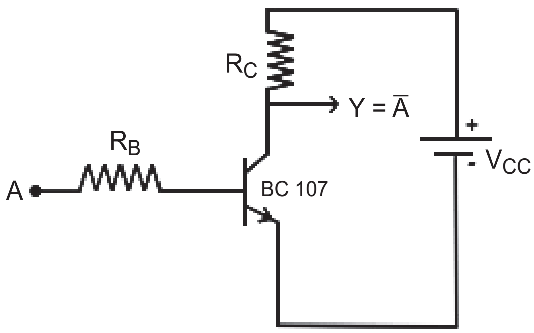
$V(0) = 0V; \quad V(1) = 5V$

The NOT logic gate using Transistor



(a) Logic Symbol (b) Electrical circuit

NOT Gate



NOT gate using Transistor

Figure 3.12.3 NOT gate

The NOT logic gate

Table 3.11.5 Truth table

Input A (volt)	Output Y (volt)
0	1
1	0

Table 3.11.6 Verification table

Input A (volt)	Output Y (volt)

Procedure:

The NOT logic gate circuit is connected as shown in the figure 3.12.3. BC 107 (npn) transistor is used. The logic gate V (1) corresponds to +5 volt and the state V(0) corresponds to 0 volt in the positive logic system. All the ground points are connected together G (0 volt) and voltage are measured with respect to this point G. The input terminal A is given +5 volt and it is in the V (1) state. The output voltage at Y is measured with respect to ground using a voltmeter and recorded.

Observations:

V (1) = +5V; V(0) = 0V;

NOT logic gate: $Y = \bar{A}$

Result:

The AND, OR and NOT gates are constructed using diode and discrete components and their truth tables are verified.

Ex.No: 12

Date:

HALF ADDER

Aim:

To construct a half adder circuit using IC 7408, IC 7486 and measure their respective outputs.

Apparatus Required:

IC 7408, IC 7486, bread board and connecting wires.

Formula:

Boolean expression for sum and carry of half adder

$$\text{Sum} = A\bar{B} + \bar{A}B = A \oplus B$$

$$\text{Carry} = A.B$$

Procedure:

- The IC chips are fixed in the bread board and the connections are made using wires.
- In all the IC's the pin 14 is connected to the positive of the battery supply. Pin 7 is connected to the negative of the battery supply.
- For various values of the input, the output is measured and tabulated.
- It is verified with the respective truth table and compared with the ideal value.

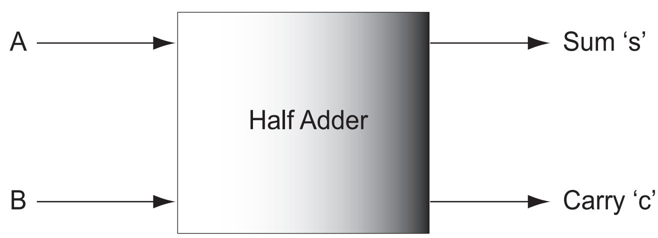


Figure 3.12.1 Half Adder

Observations:

Table 3.12.1 Truth table

Input		Output	
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Table 3.12.2 Verification Table

Input		Output	
A	B	Sum (D)	Carry (C)

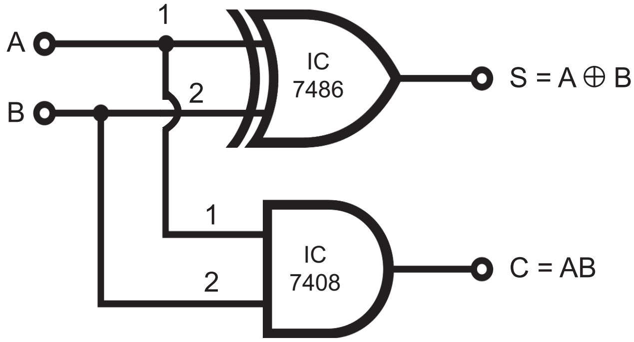


Figure 3.12.2 Circuit for half adder

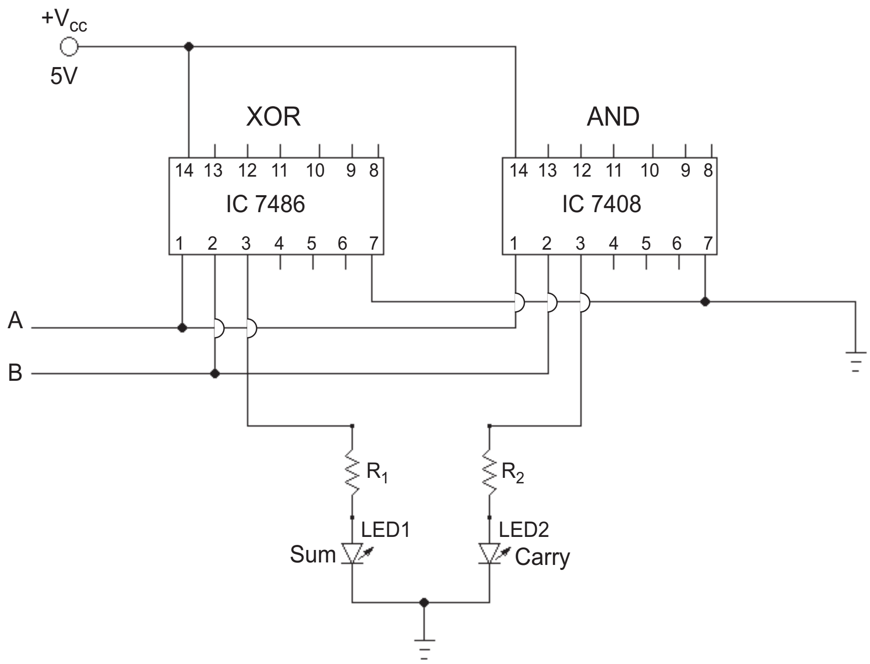


Figure 3.12.3: Pin Configuration

Result:

Thus, the Half Adder circuit is constructed and their respective outputs are measured.


NON ELECTRONICS

Non Electronics

Subject Code: 18UPHCR3

CONTENTS

Ex.No: 1

Date:

VERIFICATION OF CAUCHY'S DISPERSION FORMULA

Aim:

To find the refractive index and Cauchy's constants of a prism using spectrometer.

Apparatus Required:

Spectrometer, prism, mercury lamp and spirit level.

Formula:

(i) The refractive index of the material of the prism is given by the formula

$$\mu = \frac{\sin\left(\frac{A' + \delta_m}{2}\right)}{\sin\left(\frac{A'}{2}\right)} \qquad (1)$$

(ii) Variation of refractive index with wavelength may be represented by the Cauchy's relation

$$\mu = A + \frac{B}{\lambda^2} \qquad (2)$$

where A and B are the Cauchy's constant and can be determined as

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

$$A = \mu - \left(\frac{\mu_1 - \mu_2}{1 - \frac{\lambda_1^2}{\lambda_2^2}} \right) \qquad (2b)$$

Observation and Tabulation:

Value of one main scale division (1msd) = ______________

Number of divisions on the Vernier n = ______________

Least count (LC) = $\dfrac{\text{Value of 1msd}}{n}$ = ______________

[One degree = 60 minutes. ($1^{o} = 60'$)]

Table 4.1.1 Determination of angle of the prism

<table>
<tr><th rowspan="2"></th><th colspan="3">Ver I</th><th colspan="3">Ver II</th><th rowspan="2">Mean 2A'</th><th rowspan="2">A'</th></tr>
<tr><th>MSR</th><th>VSR</th><th>Total</th><th>MSR</th><th>VSR</th><th>Total</th></tr>
<tr><td>Reflected image from the first face ‘a’</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Reflected image from the second face ‘b’</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Difference between the above readings
2A' = a ~ b</td><td></td><td colspan="2">2A' = a ~ b</td><td></td><td></td><td></td></tr>
</table>

where,

A' is the angle of the prism in degree

δ_m is the angle of minimum deviation in degree

λ_1 and λ_2 are the wavelength of different colours of spectrum in m

Procedure:

Adjust the spectrometer for parallel rays.Determine the least count of the spectrometer. Place the prism on the prism table with its refracting edge at the centre and towards the collimator as shown in Figure 4.1.1. The light reflected from each of the two polished faces is observed through the telescope. The image of the slit so formed is focused on the cross-wire and the two positions of the telescope are noted. The difference of the two readings gives twice the angle of the prism i.e. $2A'$.Now place the prism such that its centre coincides with the centre of the prism table and the light falls on one of the polished face (Figure 4.1.2).The spectrum obtained out of the other face is observed through the telescope. Set the telescope at particular color. Rotate the prism table in one direction adjusting the telescope simultaneously to keep the spectral line in view. On continuing this rotation in the same direction, a position will come where the spectral lines recede in the opposite direction. This position where the spectrum turns away is the minimum deviation position for this color. Lock the prism table and note the readings of the verniers. Set the telescope crosswire on another color and again note the vernier readings. Take this observation for various colors.Remove the prism and see the slit

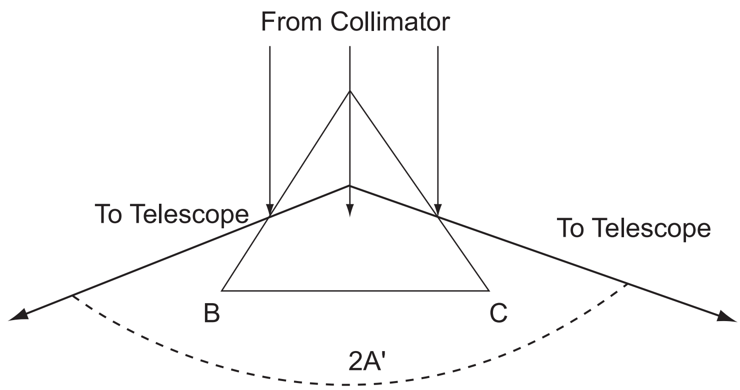


Figure 4.1.1 Angle of Prism

Table 4.1.2 Determination of refractive index of the colors of spectral lines

Colors of spectral lines Wavelength λ	Reading corresponding to the minimum deviation position of the refracted ray (b)						Angle of minimum deviation D = a~b			μ
	Ver I			Ver II						
	MSR	VSR	Total	MSR	VSR	Total	Ver I	Ver II	Mean	

Direct Ray Reading: V-1: V-II :

directly through the telescope. Set the slit on the crosswire and note the readings of the verniers. The difference in minimum deviation positions of various colors and direct positions of the slit give the angles of minimum deviation for corresponding colors.

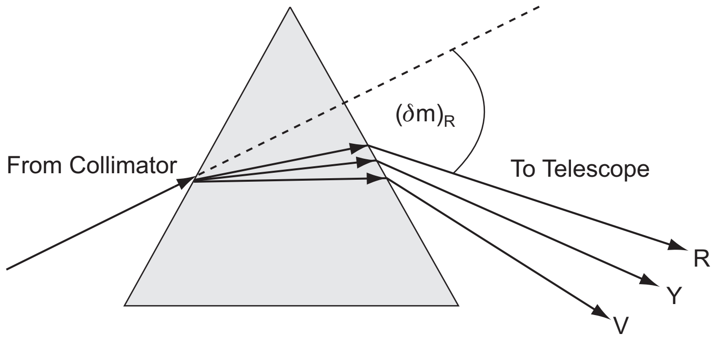


Figure 4.1.2 Angle of Minimum Deviation

Model Graph:

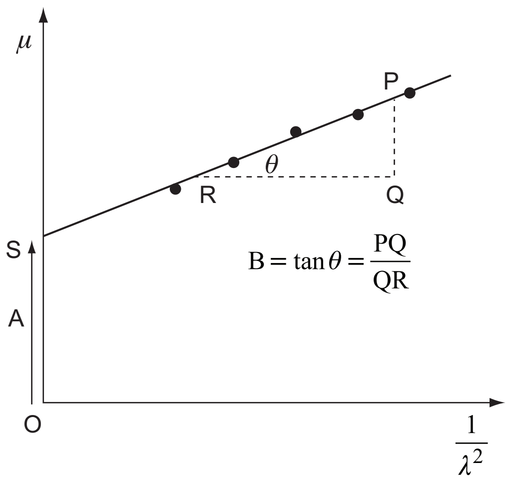


Table 4.1.3

S.No.	Color	Standard Wavelength λ in Å	Refractive index, μ
1	Blue	4693	
2	Green	5461	

Using any two value of wavelengths and μ for two colors, we get the values of B and A by using Equations (2a) and (2b) respectively.

Table 4.1.4 Cauchy's Constant

μ_1	μ_2	λ_1	λ_2	**B**	**A**
			Mean		

Cauchy's constants from graph A = __________ B = __________

Result:

Angle of the prism $A' =$ __________

Cauchy's constants $A =$ __________

$B =$ __________

Ex.No: 2

Date:

DETERMINATION OF WAVELENGTH USING SPECTROMETER – HARTMANN'S FORMULA

Aim:

To determine the wavelength of various lines in mercury spectrum.

Apparatus Required:

Spectrometer, mercury light source, prism, scale and telescope

Formula:

$$\lambda_1 = \lambda_0 + \frac{C}{S_1 - S_o}\,\mathrm{m}$$

$$\frac{\lambda_2 - \lambda_1}{\lambda_3 - \lambda_1} = \frac{(S_1 - S_2)(S_3 - S_o)}{(S_1 - S_3)(S_2 - S_o)}$$

$$C = \frac{(\lambda_2 - \lambda_1)(S_1 - S_o)(S_2 - S_o)}{(S_1 - S_2)}$$

$$\lambda_o = \lambda_1 - \frac{c}{s_1 - s_o}\,\mathrm{m}$$

where,

λ is the wavelength of spectral line in m.

S is the scale reading of the spectral line wavelength λ in m.

λ_0, C, S_o are the Hartman's constants.

$\lambda_1, \lambda_2, \lambda_3$ are the wavelength of three different spectral lines in m.

S_1, S_2, S_3 are the scale reading of the spectral lines of wavelength $\lambda_1, \lambda_2, \lambda_3$ in m.

Table 4.2.1 Determination of wave length

Colour	Scale reading	Calculated value of wavelength (Å)

Procedure:

The preliminary adjustment of the spectrometer are made. The slit of the collimator is illuminated by a mercury vapour lamp. The prism is mounted with one of the refracting faces in front of the collimator. The telescope is turned towards the base of the prism to observe the mercury spectrum due to refraction. The telescope is focused on bright green line of the spectrum. Clamping the verniers, the prism table is rotated so that green line moves towards side and is fixed exactly at minimum deviation position.

A mirror strip is attached to the telescope of the spectrometer. By placing scale and telescope arrangement in front of the mirror, the telescope and scale are adjusted so that the image of the scale readings reflected from the mirror can be seen clearly through the telescope of the scale and telescope arrangement. Now the vertical crosswire of spectrometer telescope is made to coincide with the least deviated red line of the mercury spectrum. The corresponding reading as seen through the telescope is noted. Experiment is repeated by making the vertical crosswire of the spectrometer telescope to coincide with each prominent line of mercury spectrum and corresponding scale readings are noted. Selecting three lines of known wavelength (yellow, green and blue) with their respective scale readings the Hartmann’s constants are calculated. Using the constants, wavelength for different lines of mercury spectrum is calculated using Hartmann’s formula.

Result:

Thus the wavelength of different lines of mercury spectrum is calculated using Hartmann’s formula.

Ex.No: 3

Date:

DETERMINATION OF REFRACTIVE INDEX OF THE MATERIAL OF THE PRISM USING SPECTROMETER -i – i′ CURVE

Aim:

To determine the refractive index of the material of the given prism.

Apparatus Required:

Spectrometer, prism and sodium vapor lamp.

Formula:

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\frac{A}{2}}$$

Angle of the prism $A = i + i' - d$

At minimum deviation position, $d = \mathrm{D}$, $i = i'$,

$$A + D = 2i$$

$$\frac{A+D}{2} = i$$

Hence $\mu = \dfrac{\sin i}{\sin\frac{A}{2}}$

where,

μ is the refractive index of the material of the given prism

A is the angle of the prism in degree

D is the angle of minimum deviation in degree

Table 4.3.1 Determination of angle of the prism

i^o	$\theta = 180\text{-}2i$	Reflected ray		Refracted ray		Angle of deviation		Mean deviation	θ'	$i' = 90 - \frac{\theta'}{2}$	$A = i + i' - d$
		V-I	V-II	V-I	V-II	V-I	V-II				

Direct Ray Reading: V-1: V-II :

Mean A = ___________

i is the angle of incidence in degree

d is the angle of deviation in degree

Procedure:

The initial adjustments of the spectrometer are to be done. Illuminate the slit with sodium vapor lamp and make the vertical crosswire of the telescope coincide with the image. Fix the telescope at the position. Release and rotate the Vernier table to read 0 - 180^{o} and fix it. Now release the telescope. If i is chosen as the angle of incidence, turn it through an angle $\theta = 180 - 2i$ and fix it there. For example, if $i = 40°$, $2i = 80°$ & $\theta = 180 - 80 = 100°$. So turn the telescope through 100° and fix it there.

Mount the prism on the prism table and rotate it so as to get the reflected image to coincide with the vertical crosswire. Release the telescope and get the refracted image and fix it note the reading for the refracted image. Turn the prism table such that the refracted ray moves to the minimum deviation position. Continue rotation until it comes back to its original position. Now the angle of incidence at the incident surface is i'. Release the telescope and make the vertical crosswire to coincide with the reflected ray from the incident surface. The difference between this reading and the direct reading is $\theta' = 180 - 2i'$. Therefore, $i' = 90 - \frac{\theta'}{2}$. Repeat this procedure for different angles of incidence.

Direct Ray Reading: V-I: V- II:

Model Graph:

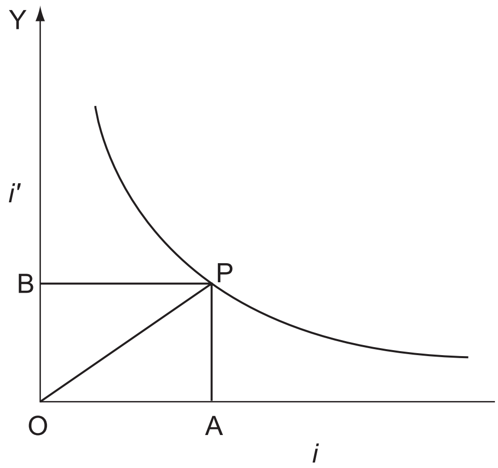
Plot a graph with $i \times i'$. The bisector intersects the graph at $i = i'$ where $d = D$

$$\text{So,} \quad A = 2i - D$$

$$A + D = 2i$$

$$\frac{A+D}{2} = i$$

$$\mu = \frac{\sin i}{\sin \frac{A}{2}}$$



Result:

The refractive index of the material of the prism is ________________.

Ex.No: 4

Date:

COMPARISON OF MUTUAL INDUCTANCE

Aim:

To compare the coefficient of mutual inductance between two pairs of coil.

Apparatus Required:

Spot galvanometer, resistance boxes, inductance coils, power supply, rheostat, plug keyand tap key.

Formula:

$$\frac{M_1}{M_2} = \frac{R_1 - R_2}{Q_1 - Q_2}$$

where,

M_1, M_2 are the coefficient of mutual inductance between two pairs of coil

R_1, R_2, Q_1, Q_2 are the resistance plugged in resistance boxes R, Q respectively in ohm

Procedure:

The circuit connections are made as shown in figure.Close Key K_1 and open key K_2. Introduce 100 ohms in R. Note the direction of kick produced in SG when key K is tapped (case 1). Close Key K_2 and open key K_1. Introduce 100 ohms in Q. Note the direction of kick produced in SG when key K is tapped (case 2). If the kicks produced in both the cases are in opposite directions, the connections are correct.If the kicks produced in both cases are in the same direction, the connections in any one of the four coils are interchanged. Now the kicks will be in the opposite directions.Close key K_1, K_2. Adjust the value of the resistance in Q still the kick produced in the SG is zero when the key K is tapped. Repeat the experiment for various values of R.

Table 4.4.1 Comparison of mutual inductance

No. of turns	R_1 Ω	R_2 Ω	Q_2 Ω	Q_2 Ω	$\frac{M_1}{M_2}=\frac{R_1-R_2}{Q_1-Q_2}$	Mean

Circuit Diagram

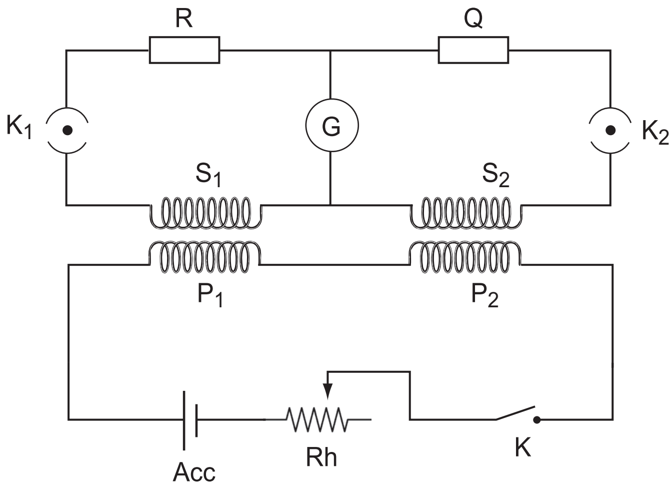


Figure 4.4.1 Comparison of mutual inductance

Result:

Using SG, the ratio of mutual inductance between two pairs of coils is found. The ratio of mutual inductances of two pairs of coils $\frac{M_1}{M_2}$ = ____________.

Ex.No: 5

Date:

ABSOLUTE DETERMINATION OF MUTUAL INDUCTANCE

Aim:

To determine the mutual inductance between a pair of coils using spot galvanometer.

Apparatus Required:

Resistance box, SG, Battery, commutator, DC power supply, plug key and inductance coil.

Formula:

$$M = r\left(\frac{\mathrm{T}}{2\pi}\right)\left(\frac{\theta}{d}\right)\left(1+\frac{\lambda}{2}\right)\mathrm{mH}$$

$$\lambda = \frac{2.303}{\mathrm{n}-1}\log\frac{\theta_1}{\theta_n}$$

where,

T is the period of oscillation in second

θ is the kick produced in division

λ is the logarithmic decrement

r is the low resistance in ohm

$\theta_1, \theta n$ is the deflection produced in division

M is the coefficient of mutual inductance between two pairs of coils in millihenry

d is the deflection produced in division

Table 4.5.1 Determination of $\frac{\theta}{d}$

S.No	Resistance (Ω)	Deflection produced d (div)			Kick produced θ (div)			$\frac{\theta}{d}$
		Left	Right	Mean	Left	Right	Mean	

Mean = ___________

Table 4.5.2 Determination of logarithmic decrement

n	θ	λ

Mean = ___________

Circuit Diagram

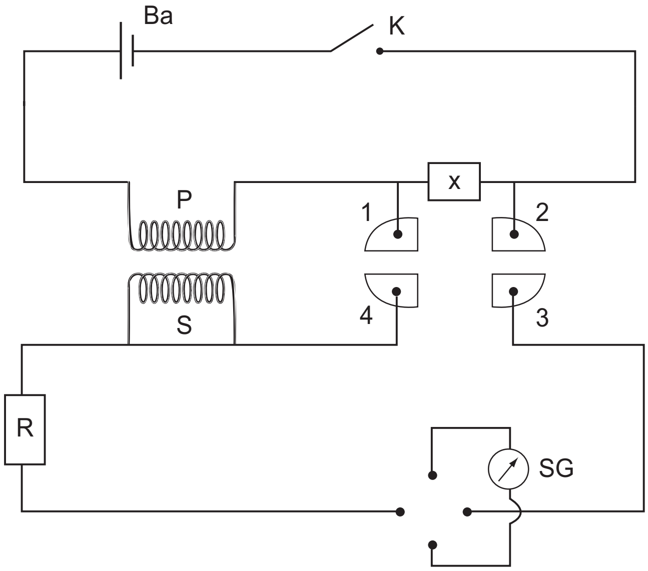


Figure 4.5.1 Determination of mutual inductance

Procedure:

Connections are made as given in the figure. In the four segment commutator two plugs are provided for connecting adjacent segments. If a plug is inserted in any socket the adjacent terminals get connected. The segments 1 and 2 as well as 3 and 4 are connected by inserting the plugs into the holes so that the secondary circuit is closed having no electrical connection with primary circuit. With suitable resistance in R the key K is pressed and there will be kick due to inductance. The commutator is reversed and again kick is observed. Let the average kick be θ, div. If λ is the logarithmic decrement, the corrected kick is, $\theta(1+\lambda/2)$.

Now the plugs are removed and inserted into other two holes connecting the segments 1 and 4 as well as 2 and 3. The PD between the terminals of 'r' is applied to the secondary circuit. The steady deflection is observed. The current is reversed by the commutator and again deflection is noted. Let the average deflection be '*d*'. The mutual inductance M of the pair coil is determined using the formula.

Result:

The mutual inductance between a pair of coil M = ________ mH.

Ex.No: 6

Date:

DETERMINATION OF HIGH RESISTANCE BY LEAKAGE USING SG

Aim:

To determine the resistance of the given high resistance using SG employing leakage method.

Apparatus Required:

High resistance, resistance boxes, power supply, plug keg, charge-discharge key, condenser box, commutator and spot galvanometer.

Formula:

$$R = \frac{t}{2.303 \times C \times log\frac{\theta_o}{\theta}} \quad \Omega$$

where,

R is the high resistance in ohm

θ_o is the maximum throw in division

θ is the throw in the SG after leakage for a given time t second in division

C is the capacitance of the capacitor in μF.

Procedure:

Wire up the circuit as shown in the figure. Keep the key K_1open and charge the capacitor for a known time say 10s and discharge it through the SG immediately. Note the throw. Discharge the capacity fully by shorting its terminals. Reverse the commutator and repeat the procedure. Take the average of the two throws and note it as θ_o. Charge the capacity again for the same time interval. Close the key K_1. Hold the charge discharge

Observation:

Capacitance of the capacitor C = ___________ F

Maximum throw to the left (without leakage) θ_o = __________ div

Maximum throw to the right (without leakage) θ_o = _________ div

Mean θ_o = _________ div

Table 4.6.1 Determination of high resistance

S. No	Leakage time t (s)	Throw in SG (div)			$R = \frac{t}{2.303 \times C \times \log \frac{\theta_o}{\theta}}$ Ω
		Left	Right	Mean θ	
1.					
2.					
3.					
4.					
5.					
6.					

Mean R = ___________ Ω

key in the in-between position and allow the capacitor to discharge through the given high resistance for a time interval *t*. After the time t, allow the capacitor to discharge through the SG by releasing the charge discharge keyfully. Note the throw. Discharge the capacitor fully. Reverse the commutator and repeat for the other side. Take the average throw as θ.Vary the discharge time t and repeat the experiment.

Circuit Diagram:

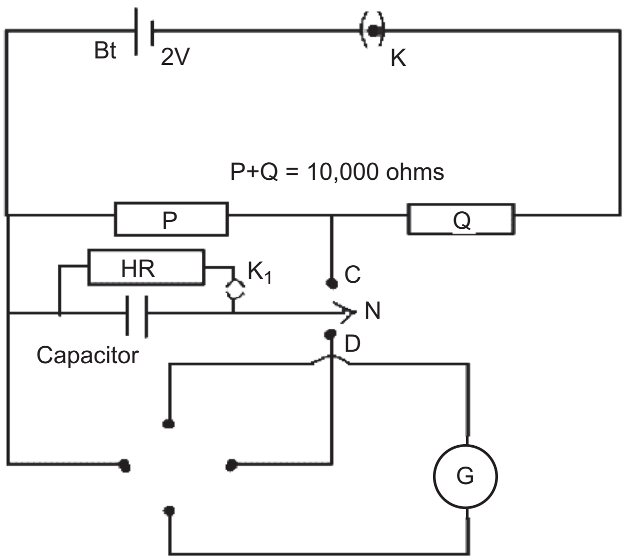


Figure 4.6.1 Determination of high resistance

Result:

The value of the given high resistance = ____________ Ω.

Ex.No: 7

Date:

DETERMINATION OF EMF OF A THERMOCOUPLE – SPOT GALVANOMETER

Aim:

To find out the EMF produced by a thermocouple using Spot Galvanometer.

Apparatus Required:

Spot galvanometer, resistance boxes, battery, galvanometer and key.

Formula:

$$e = S_v \left(\frac{R+G}{G}\right)\theta \qquad \text{Volts}$$

$$S_v = \frac{E}{(P+Q)}\left(\frac{P}{d}\right)\left(\frac{G}{R+G}\right) \qquad \left(\frac{\text{Volt}}{\text{division}}\right)$$

$$e = \frac{E}{(P+Q)}\left(\frac{P}{d}\right)\theta \qquad \text{Volts}$$

where,

e	is the thermo emf of the thermocouple in volt
S_v	is the voltage sensitivity in Volts / division
d, θ	is the deflection produced in the galvanometer
P,Q,R	are the resistances pluged in resistance boxes in Ω
G	is the resistance of spot galvanometer in Ω
E	is the voltage of battery in Volt

Table 4.7.1 Determination of P/d Ω/div

P+Q = Ω

P Ω	Deflection in SG (div)			$\frac{P}{d}$ Ω/div
	Right	Left	Mean	

Temperature of the cold junction = __________ °C.

Procedure:

Do the initial adjustments of the spot galvanometer and get the spot coincide with the zero of the scale. Wire up the circuit as shown in the figure. Introduce 10 Ω in the box P and adjust Q so as to bring the deflection of the galvanometer to a maximum within the scale. (If the deflection goes out of scale for a maximum value of resistance in Q, introduce some resistance in R around 100 – 500 Ω). Note down the deflection of the galvanometer. Reverse the commutator and obtain deflection on the other side and take the average deflection.

Now decrease P in steps, keeping P + Q constant noting down deflections on either side for each value of P.

Circuit Diagram:

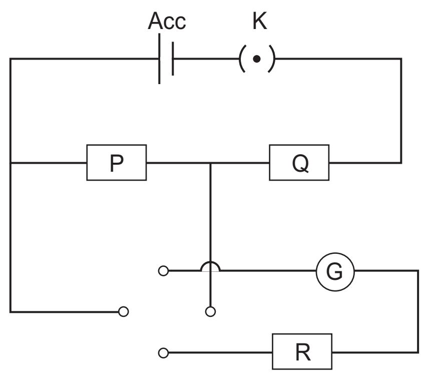


Figure 4.7.1 Determination of P/d Ω/div

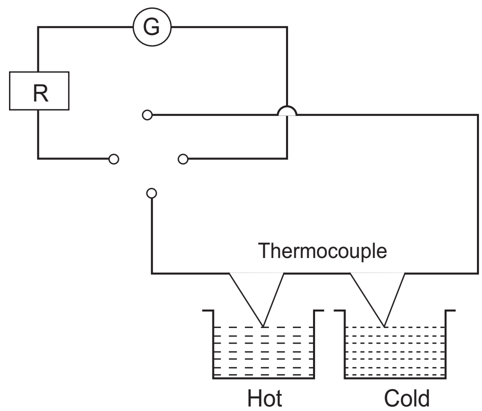


Figure 4.7.2 Determination of EMF of thermocouple

Table 4.7.2 Determination of thermo EMF/°C

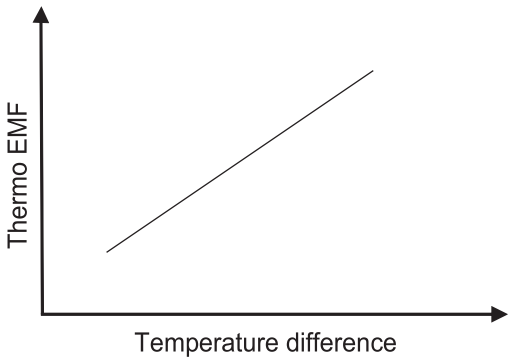
Temperature of hot junction in°C	Deflection (θ) in div			Thermo EMF (V)	Thermo EMF/°C (μV/°C)
	Temp rising	Temp falling	Mean θ		

Determination of EMF of thermocouple:

Remove the primary circuit containing the 2V battery and in its place connect the thermocouple as shown in the second figure. The resistance R is to be kept unchanged. Heat one junction of the thermocouple and maintain the other junction at room temperature or ice bath. As the temperature increases, the galvanometer will record a deflection proportional to the temperature difference between the two junctions. Note down the deflection for different temperatures of the hot junction until boiling point of water is reached. Repeat the observation for falling temperature of the hot junction at regular intervals.

Plot a graph with temperature difference between the two junction along x – axis and thermo-emf along Y – axis. The slop of the curve will give the thermo-emf generated for unit difference in temperature between the junctions.

Model Graph:



Result:

The thermo EMF/°C difference in temperature between the junctions of the thermocouple is found to be i) by calculation __________ μV/°C

ii) by graph ____________ μV/°C

Ex.No: 8

Date:

CALIBRATION OF HIGH RANGE VOLTMETER – POTENTIOMETER

Aim:

To calibrate the high range voltmeter using a potentiometer and a standard cell.

Apparatus Required:

Potentiometer, rheostat, voltmeter, galvanometer, high resistance, d.c. power source, connecting wires and standard cell (Daniel cell).

Formula:

Voltage measured using potentiometer,

$$V = 1.08\left(\frac{l}{l_o}\right)\frac{P+Q}{P} \text{ Volts}$$

where,

l_0 is the balancing length of the potentiometer wire (m)

P, Q are resistances included in the resistance boxes (Ω)

l is the balancing length against the different ratio of $[P + Q]$ (m).

Procedure:

(1) To standardize the potentiometer

For standardizing the potentiometer, firstly we apply a constant DC voltage across the two ends of the potentiometer. For this we can use a 2V accumulator or a 2V stabilized power supply. If a stabilized power supply of 6V is available, we have to use a potential divider arrangement with a rheostat and voltmeter to tap 2V. With this, we drop 2V across the 10m length of potentiometer wire.Further, for standardization, we use a

Circuit Diagram:

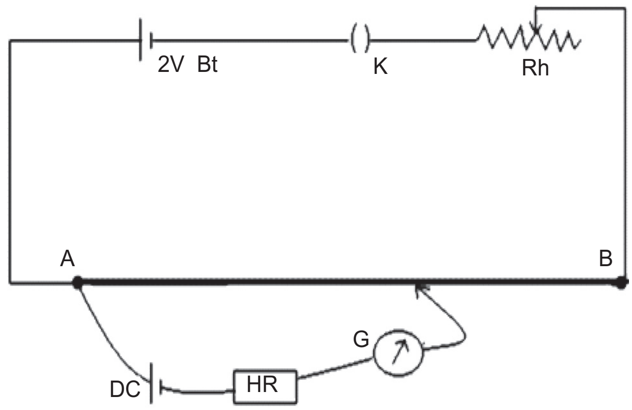


Figure 4.8.1 Determination of balancing length l_0

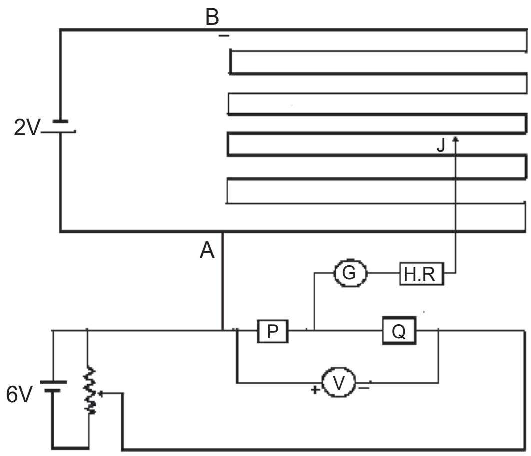
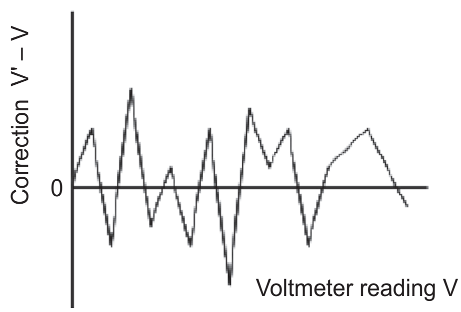


Figure 4.8.2 Determination of voltage

Model Graphs:



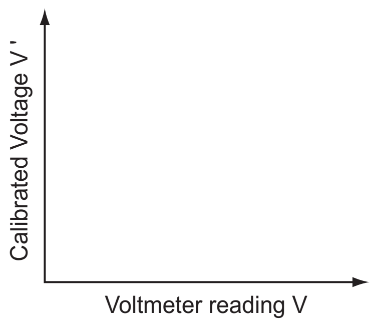


Table 4.8.1 Determination of voltage V′

S. No	Voltmeter reading (volt)	Balancing l cm	Calculated value of voltage V′ (Volt)	Correction $\Delta V = V' - V$

standard cell of constant emf (here, Daniel cell of 1.08V) Make the circuit as shown in Figure 4.8.1, wherein care must be taken to connect the positive end of potentiometer wire to the positive of the Daniel cell. Remove the plug in the high resistance (H.R) and press the jockey J on the potentiometer wire near the end A and note the direction of the deflection in the galvanometer G. Press the jockey near the other end B, and now the deflection in G must be opposite to the earlier deflection. If so the connections are correct, otherwise connections need to be checked.Now find the approximate balancing length (for which the deflection in G is zero) keeping the jockey near the approximate balancing length. H.R. can now be bypassed by putting its key. This results to more deflection in G, and now by adjusting the position of J, more accurate balancing length l_0 can be found. In other words, the potential across A and J is equal to the potential of Daniel cell (i.e., 1.08V). Then, the potential corresponding to 1m length of potentiometer wire is $\frac{1.08}{l_0} Vm^{-1}$..

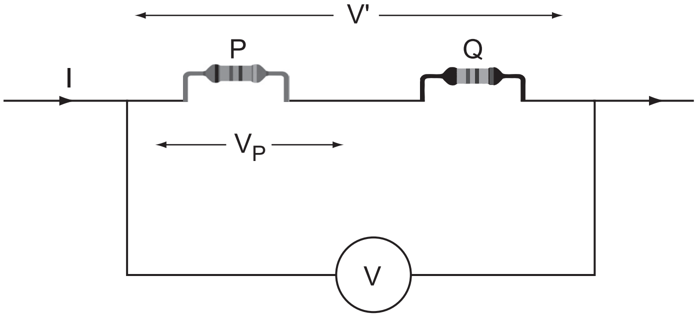


Figure 4.8.3

(2) To calibrate the voltmeter

Without disturbing the primary (earlier) circuit, disconnect the Daniel cell and make the new circuit as shown in Figure 4.8.2. Make sure that the polarities are maintained correctly at each point.Adjust the rheostat in the secondary circuit so that the voltmeter reads1 V. The resistances P and Q must be such that the potential difference across P is less than 2V, since the voltage between A and B are 2V. Now find the balancing length l, which corresponds to the potential across P. If V_P is the voltage across, then $V_P = l\left(\frac{1.08}{l_0}\right)$.

With this we shall now find the voltage across (P +Q), as shown below, and can be compared with the voltmeter reading. If V′ is the voltage across (P + Q), then from Fig.4.8.3 we have

$$I = \frac{V_P}{P} = \frac{V}{(P+Q)}$$

In other words,

$$V_P = \frac{VP}{(P+Q)} = 1.08\left(\frac{l}{l_0}\right) \text{(or)} \; V = 1.08\left(\frac{l}{l_0}\right)\left(\frac{P+Q}{P}\right)$$

Repeat the experiment for different voltmeter readings (e.g. 1V-5V in steps of 0.5V), by either keeping the resistances P and Q the same or varying them each time suitably, if necessary. Tabulate the observations as follows and draw the calibration graph and correction graph.

Result:

The given high range potentiometer is calibrated and calibration and correction graphs are drawn.

Ex.No: 9

Date:

DETERMINATION OF THE SELF INDUCTANCE OF A COIL BY ANDERSON BRIDGE

Aim:

To determine the self inductance of a coil by Anderson bridge.

Apparatus Required:

Capacitor, Galvanometer, DC Source, AC Source, inductance coil.

Formula:

The following formula is used for the determination of self inductance of coil.

$$L = C\left[RQ + rR\left\{1 + \frac{Q}{P}\right\}\right] \qquad \text{(mH)}$$

$$\text{Since, } S = \frac{Q}{P}R\text{; thus } L = C\left[RQ + rR\left\{1 + \frac{S}{R}\right\}\right]$$

$$L = C[RQ + r\{R + S\}]$$

$$\text{If } P = Q \text{ then } S = R\text{; Hence, } L = C\,[RQ + 2rR]$$

$$L = RC[Q + 2r] \qquad \text{(mH)}$$

where,

L is the self inductance of the coil in mH

C is the capacitance in μF

R, P, Q and S are the resistance included in the resistance boxes in ohm

Observation:

$P =$ ___________ Ω $\quad Q =$ ___________ Ω

Value of R and r when $C =$ ___________ μf

Table 4.9.1 Determination of self inductance of the coil

S. No	Inductor	R(Ω) (for zero deflection in Galvanometer (G) under DC balancing)	r(Ω) (for no sound in Headphone (H) under AC balancing)	L (mH) (Inductance) $L = RC[Q + 2r]$
1.	First			$L_1 =$
2.	Second			$L_2 =$
3.	Third			$L_3 =$

Circuit Diagram:

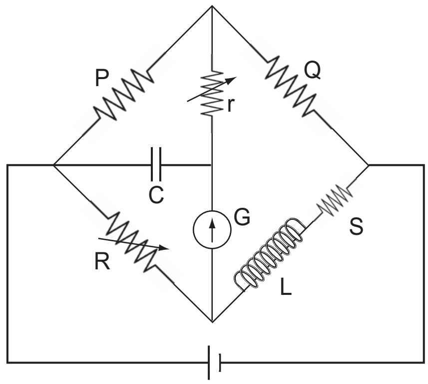


Figure 4.9.1 DC balancing

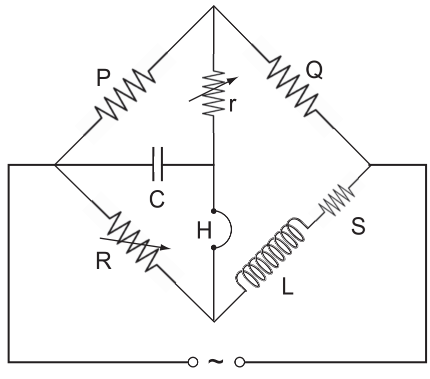


Figure 4.9.2 AC balancing

Procedure:

Make connections as shown in figure 4.9.1. Now vary R, keeping r equal to zero, so that deflection in galvanometer becomes zero. This is a DC balancing. Note this value of R. Now, make connections as shown in figure 4.9.2. i.e. replace DC source with AC source, replace galvanometer with Head phone. Now vary *r* keeping the same value of R, so that no sound is heard in Headphone. This is known as AC balancing. Note the value of *r*. Calculate the value of L using above formula and given value of C & Q for your circuit. Repeat the procedure for the different inductors and different values of C.

Result:

The self inductance of the coil = _____________.

Ex.No: 10

Date:

DETERMINATION OF VELOCITY OF ULTRASONIC WAVES IN A LIQUID USING ULTRASONIC INTERFEROMETER

Aim:

To determine the velocity of ultrasonic waves in a given liquid and also to determine the compressibility of the liquid.

Apparatus Required:

Ultrasonic interferometer, measuring cell, frequency generator, given liquid, etc.

Formula:

Velocity of ultrasonic waves in the given liquid, $v = \lambda f$ m/s

Compressibility of the given liquid, $K = \dfrac{1}{v^2 \rho} \quad m^2 / N$

where,

$\lambda = 2d/n$ is the wavelength of the ultrasonic wave in m

f is the frequency of ultrasonic waves in Hz

d is the distance moved by the micrometer screw in m

n is the number of oscillations

ρ is the density of the given liquid in kgm^{-3}.

(i) To find the velocity of ultrasonic waves in the liquid

Type of liquid = Frequency of the Generator (f) = _____ Hz

LC = 0.01mm

Table 4.10.1 Determination of velocity of ultrasonic waves in the liquid

S.No	No. of oscillations (n)	Reading for '*n*' oscillations								$d = R_1 - R_2 \times 10^{-3}$m	$\lambda = 2d/n \times 10^{-3}$m	Velocity $v = f\lambda$ in ms^{-1}
		Initial reading (R_1)				Final reading (R_2)						
		PSR $\times 10^{-3}$m	HSC div	HSR $\times 10^{-3}$m	TR $\times 10^{-3}$m	PSR $\times 10^{-3}$m	HSC div	HSR $\times 10^{-3}$m	TR $\times 10^{-3}$m			

Mean = ___________

Calculation:

(i) Wavelength of the ultrasonic waves =

Frequency of ultrasonic waves =

The velocity of ultrasonic waves in the given liquid, v =

(ii) The compressibility of the given liquid, K =

Density of the given liquid (ρ) =

Velocity of Ultrasonic waves in the given liquid, $v = \lambda f$

Compressibility of the given liquid, $K = 1/v^2 \rho$

Initial adjustments:

In high frequency generator two knobs are provided for initial adjustments. One is marked with `*Adj*' (set) and other with 'Gain' (Sensitivity). With knob marked `*Adj'* the position of the needle on the ammeter is adjusted and with the knob marked 'Gain', the sensitivity of the instrument can be increased for greater deflection, if desired.

Procedure:

The measuring cell is connected to the output terminal of high frequency generator through a shielded cable. The cell is filled with the experimental liquid before switching ON the generator. Now, when the frequency generator is switched ON, the Ultrasonic waves move normal from the Quartz crystal till they are reflected back by the movable reflector plate. Hence, standing waves are formed in the liquid in between the reflector and the quartz crystal. The distance between the reflector and crystal is varied using the micrometer screw such that the anode current of the generator increases to a maximum and then decreases to a minimum and again increases to a maximum. The distance of separation between successive maximum or successive minimum in the anode current is equal to half the wavelength of the Ultrasonic waves in the liquid. (Figure 4.10.1) Therefore, by noting the initial and final position of the micrometer screw for one complete oscillation (maxima-minima-maxima) the distance moved by the reflector can be determined.

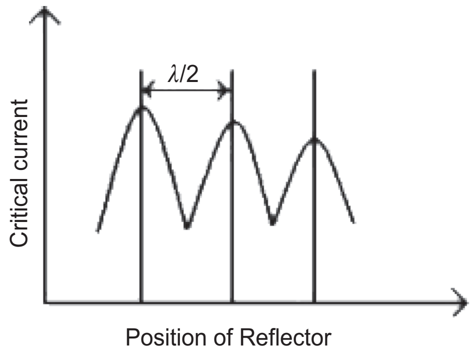


Figure 4.10.1

To minimize the error, the distance (d) moved by the micrometer screw is noted for 'n' number of oscillations (successive maxima), by noting the initial and final reading in the micrometer screw and is tabulated. From the total distance (d) moved by the

micrometer screw and the number oscillations (n), the wavelength of ultrasonic waves can be determined using the formula $\lambda = 2d/n$. The velocity of the ultrasonic waves and compressibility of the given liquid can be calculated using the given formula.

$$v = \lambda f \quad \text{m/s}$$

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

Result:

Velocity of ultrasonic waves in the given liquid, v =

Compressibility of the given liquid, K =

Ex.No: 11

Date:

CHARACTERISTICS OF THERMISTOR

Aim:

To study the characteristics of a thermistor.

Apparatus Required:

Thermistor, Hot plate, Thermometer, Ohmmeter, beaker with water.

Formula:

$$R_{T_1} = R_{T_2} \exp\left[\beta\left(\frac{1}{T_1} - \frac{1}{T_2}\right)\right]$$

where,

R_{T1} is the resistance of the thermistor at absolute temperature T_1°K in Ω

R_{T2} is the resistance of the thermistor at absolute temperature T_2°K in Ω

β is a constant depending upon the material of thermistor, typically 3500 to 4500°K

Diagram:

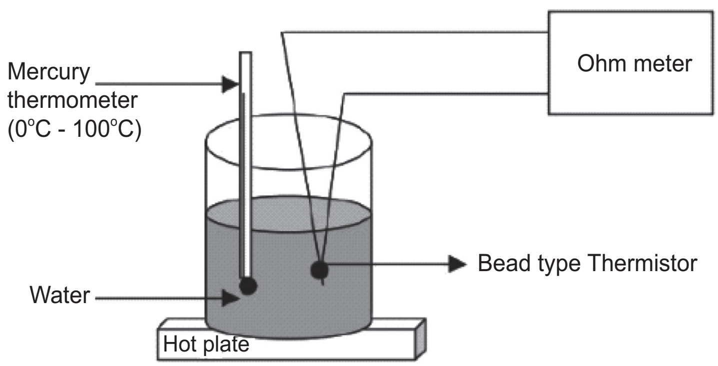


Figure 4.11.1 Determination of resistance

Table 4.11.1 Determination of resistance

S. No.	Temperature (°C)	Resistance (Ω)	
		Heating	Cooling
1	Room temperature		
2	35		
3	40		
4	45		
5	50		
6	55		
7	60		
8	65		
9	70		
10	75		
11	80		
12	85		
13	90		
14	95		
15	BP water (100° C)		

Procedure:

Make the connections as shown in Figure 4.11.1. Increase the temperature of the water in a beaker in steps of 5°C. Note down the temperature and corresponding resistance of the thermistor with the help of ohm meter / DMM. Plot the graph of temperature Vs resistance for both sets of reading keeping and cooling taken. Calculate the value of β by using given formula.

Result:

Value of β

1. While heating
2. While cooling

Ex.No: 12

Date:

DETERMINATION OF REFRACTIVE INDICES OF CALCITE PRISM

Aim:

To use a prism shaped double refracting crystal to determine the refractive indices of the material corresponding to ordinary and extra-ordinary rays.

Apparatus Required:

A quartz or calcite prism, a spectrometer, a sodium vapour lamp.

Formula:

$$n_0 = \frac{\sin[\frac{A+(D_m)_0}{2}]}{sin\frac{A}{2}}$$

$$n_e = \frac{\sin[\frac{A+(D_m)_e}{2}]}{sin\frac{A}{2}}$$

where,

n_o is the refractive index for ordinary ray

n_e is the refractive index for extra-ordinary ray

A is the angle of prism in degree

$(D_m)_0$ is the angle of minimum deviation for ordinary ray

$(D_m)_\mathrm{e}$ is the angle of minimum deviation for extra-ordinary ray

Table 4.12.1 Determination of angle of the prism

Telescope reading for angle of the prism												2A		Mean 2A	A
Left						Right									
Ver $_A$			Ver $_B$			Ver $_A$			Ver $_B$			V_A	V_B		
MSR	VSR	TR	MSR	VSR	TR	MSR	VSR	TR	MSR	VSR	TR				

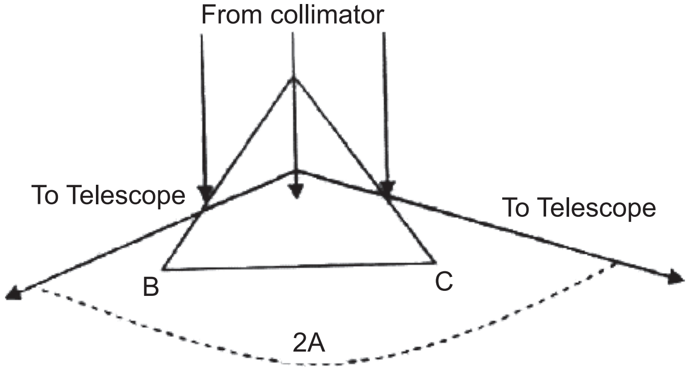


Figure 4.12.1 Angle of prism

Procedure:

Measurement of refracting angle "A" of the prism:

The quartz (or calcite) prism is kept on the prism table with its refracting edge at the center and pointing towards the collimator. The light from the collimator is incident upon both the refracting surfaces simultaneously and they give rise to reflected images. The telescope is turned first to one side to receive the reflected image. When the image is in the field of view, the telescope is clamped. With the help of the tangential screw, the vertical cross wire of the telescope is slowly moved and it is coincided with the image of the slit. In this position, the reading of the main scale and vernier scale of both windows are read and recorded. The telescope is unclamped and rotated to the other side till the reflected image from the second refracting surface of the prism comes into the field of view. When the image of the slit is sighted, the telescope is clamped and with the help of

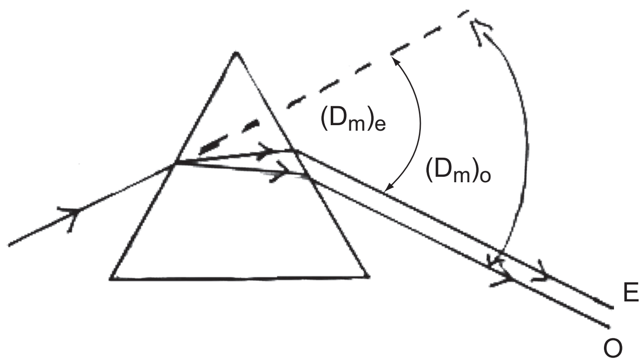


Figure 4.12.2 Angle of Minimum Deviation

Table 4.12.2 Determination of angle of minimum deviation

Ray	**Reading for minimum deviation position**						**D**		**Mean D**
	Telescope reading								
	Ver A			**Ver B**					
	MSR	VSR	Total	MSR	VSR	Total	Ver A	Ver B	
Ordinary ray									
Extra-ordinary ray									

Direct ray reading: Ver A: Ver B:

tangential screw, the vertical crosswire is made to coincide with image of the slit. Again the readings of scales from both the windows are recorded. From readings, the angle of the prism is determined. The angle of the prism is equal to half of the difference between the readings in the two positions of the telescope.

Measurement of the angle of deviation:

The prism table is rotated slowly till the prism base becomes nearly parallel to the collimator beam. The telescope is turned to get the refracted image on the vertical cross wire. Two yellow images of the slit are observed. One yellow image of the slit is coincided with vertical cross wire. Now the prism table is rotated so that the image moves to one side. The telescope is moved with the help of the tangential screw so that it follows the image. Finally a position is reached when the image becomes nearly stationary. A further rotation of the prism table in the same direction makes the spectral line recede. By moving the prism table slowly twice or thrice, the stationary position of the yellow line is ascertained. The cross wire of the telescope are made to coincide with the yellow line. This is the position of minimum deviation. The position of the telescope is read on both windows. The readings are recorded. Now the second yellow image of the slit is coincided with the vertical cross wire and readings are recorded. The prism is removed from the prism table and the telescope is brought to view the image of the slit directly and its position is read and recorded. This position corresponds to that of the undeviated image (Direct reading). The angle through which the telescope has been rotated from undeviated position to deviated position gives the angle of minimum deviation.

Result:

1. The refractive index for ordinary ray (n_o) = _________.
2. The refractive index for extra-ordinary ray (n_e) = ________.
3. The difference [(n_e) – (n_o)] = ________ .

Ex.No: 13

Date:

DETERMINATION OF PARTICLE SIZE OF LYCOPODIM POWDER USING LASER

Aim:

To determine the particle size of micro particles (lycopodium powder) using laser diffracting grating.

Apparatus Required:

LASER source, fine micro particles having nearly same size (say lycopodium powder), glass plate, screen, and metre scale.

Formula:

Size of the micro particle using laser diffraction grating,

$$2d = \frac{n\lambda D}{x_n} \quad m$$

where,

n is the order of diffraction

λ is the wave length of laser light used in m (690 nm)

D is the distance between the glass plate and the screen in m.

x_n is the distance between the central bright spot and the n^{th} fringe in m.

Procedure:

When LASER is passed through a glass plate spread with fine micro particles, the beam gets diffracted by the particles and circular rings are obtained on the screen as shown in Figure 4.13.1. By measuring the radii of the rings and the distance between the glass plate and the screen, the size of the particle can be determined.

Table 4.13.1 Determination of particle size

S. No	Order of diffraction n	Distance between the screen and the glass plate (D) $\times 10^{-2}$ m	Distance between the central bright and n^{th} fringe (x_n) $\times 10^{-2}$ m	Particle size 2d m
1.	1 2 3			
2.	1 2 3			
3.	1 2 3			

Mean 2d = __________

Calculation:

Order of diffraction (n) =

Wave length of laser light (λ) = m

Distance between the glass plate and the screen (D) = m

Distance between the central bright spot and the nth fringe (x_n) = m

The size of the micro particle using laser diffraction grating, 2d = $\frac{n\lambda D}{x_n}$ m

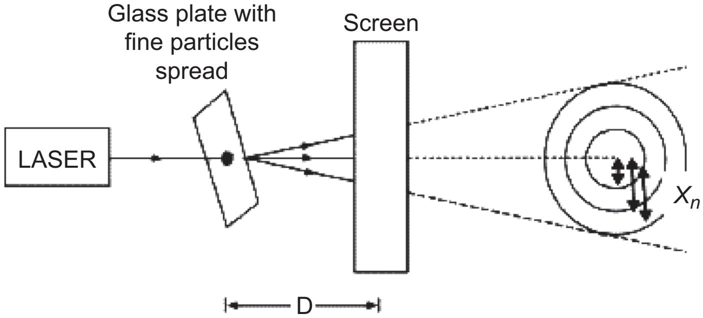


Figure 4.13.1

Sprinkle the fine micro particles (lycopodium) on the glass plate. Mount the LASER source on a stand. Place a screen in front of the LASER source at some distance. Mount the glass plate on a separate stand and place it between the LASER source and the screen.Switch ON the laser source and allow the beam to pass through the glass plate. Adjust the distance (D) between the glass plate and screen to get a clear circular fringe pattern (diffraction pattern) on the screen. The intensity is found to be decrease from zeroth order (central spot) to higher orders.Measure the distance (D) between the glass pate and the screen using metrescale.Measure the distance (x_n) of the first order, second order and so on from the central bright spot (radii of the rings).Repeat the experiment by varying the distance (D) between the glass plate and the screen and the readings are tabulated.

Result:

The size of the micro particle using laser diffraction grating, $2d$ = ______________m.

Ex.No: 14

Date:

DETERMINATION OF WAVELENGTH OF LASER LIGHT USING DIFFRACTION GRATING

Aim:

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

Apparatus Required:

Diffraction grating, LASER source, screen and metre scale.

Formula:

$$\text{Wavelength of laser light, } \lambda = \frac{\sin\theta}{nN} \quad m$$

where,

θ is the angle of diffraction in degree

N is the number of lines per metre in the grating (N =15,000 lines/inch)
(1 inch =2.54 cm)

λ is the wavelength of laser (m)

n is the order of diffraction

Procedure:

The laser beam is allowed to fall normally on a diffraction grating. A white screen is kept at a distance L from the grating as shown in Figure 4.14.1. The directed ray of the laser beam will appear as a small dot in the middle of the screen. In addition, diffracted spots will appear at equal distance on either side of the centre spot (corresponding to direct ray). If D is the distance of the diffracted spot from the centre spot, then the angle of diffraction satisfies the relation, $\theta = \tan^{-1}\left(\frac{D}{L}\right)$. From this we can calculate $\sin\theta$. This

Table 4.14.1 Determination of sin θ

Distance between grating and screen L (cm)	Distance between centre spot and spot on left side D_1 (cm)	Distance between centre spot and spot on right side D_2 (cm)	Mean D (cm)	$\theta = \tan^{-1}\left(\frac{D}{L}\right)$ (deg)	sinθ (deg)

Mean value of $\sin\theta$ = _______ mm

experiment is repeated for different L. Then using the above formula, the wavelength (λ) of the laser is calculated.

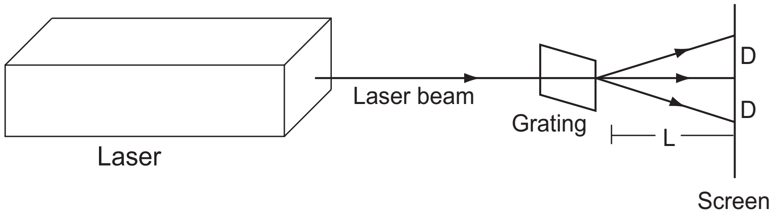
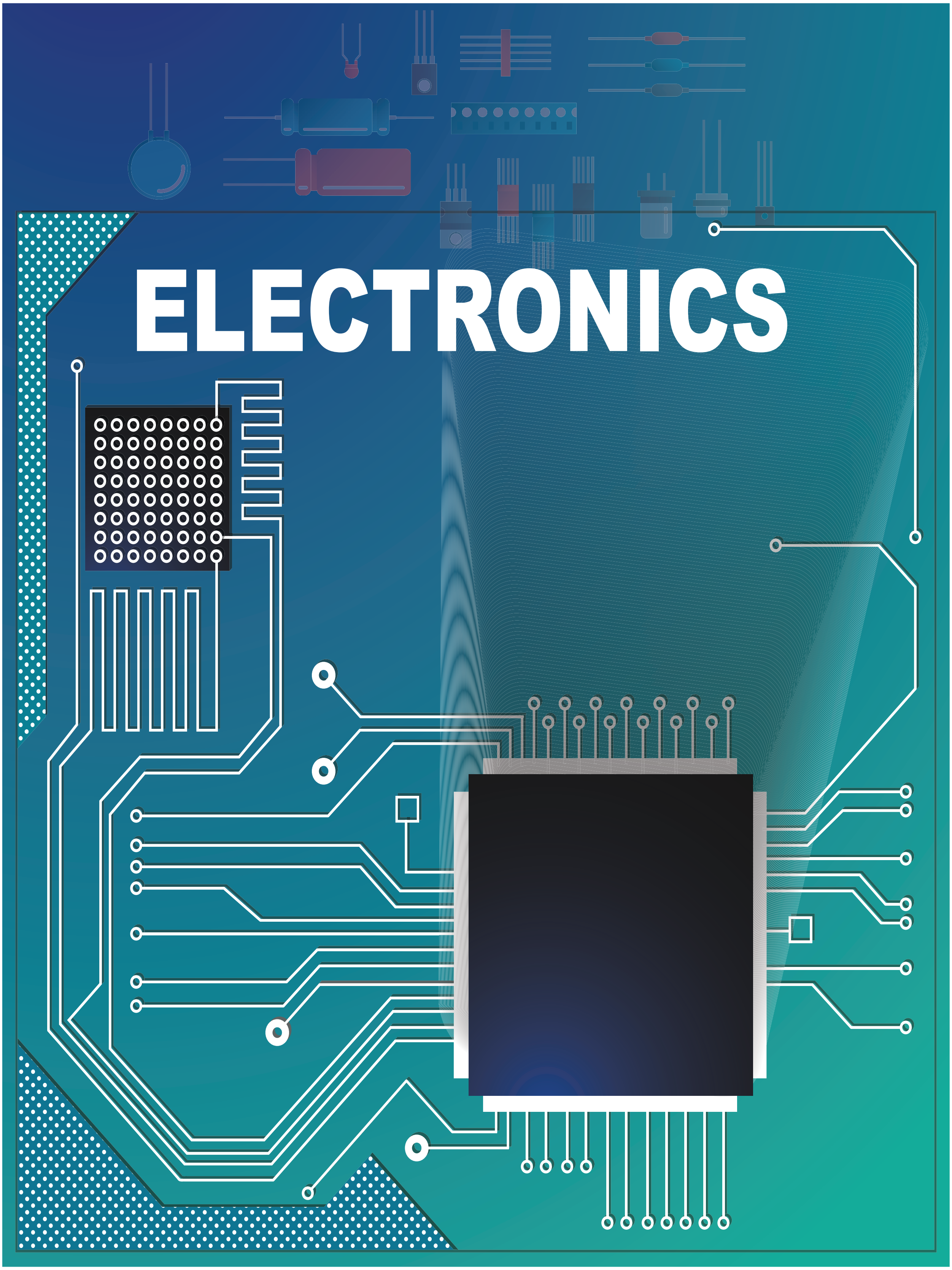


Figure 4.14.1 Determination of sin θ

Result:

Wavelength of laser light, λ = ____________ .


ELECTRONICS

Electronics

Subject Code: 18UPHCR4

CONTENTS

Ex.No: 1

Date:

DUAL POWER SUPPLY

Aim:

To construct a dual power supply with IC voltage regulators and to measure the output voltage before and after regulation.

Apparatus Required:

Diodes IN 4007, 12V-0-12V, audio frequency oscillator (AFO), transformer, voltage regulators, IC7812, IC 7912, 1000μF and connecting wires.

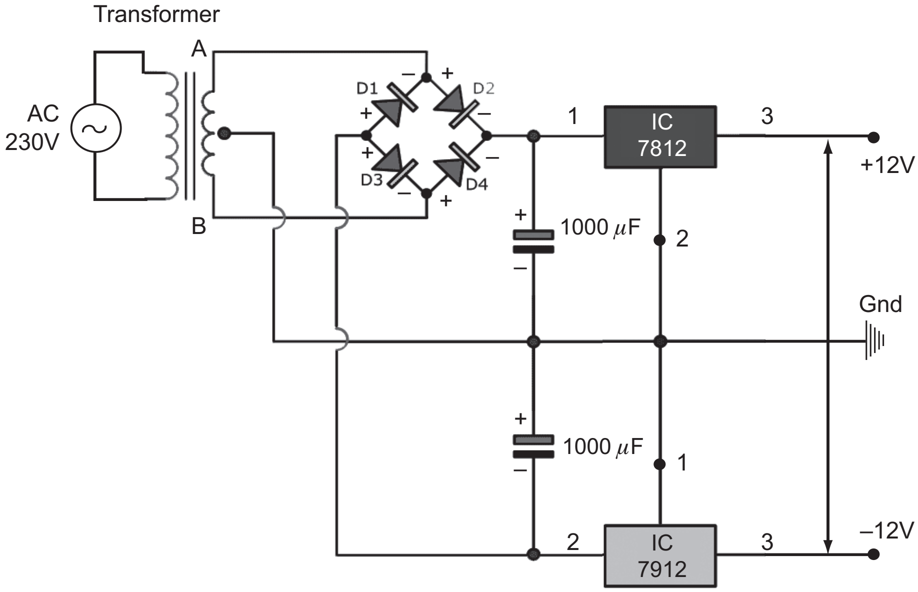
Procedure:

7812 → +ve regulative voltage IC

7912 → –ve regulative voltage IC

1. Connections are made as given in the circuit diagram below.
2. The transformer is a step down transformer. The input voltage should be chosen between 12V & 15V.
3. The pin configuration of IC 7812 and IC 7912 are as given in Figure 1.2 and 1.3 respectively.
4. Output is measured across pin 3 and ground potential. The expected output voltage should be +12V and -12V at the outputs of 7812 and 7912 respectively.

Circuit Diagram:



Dual Power Supply

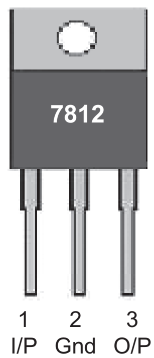


Figure 1.1.1 Pin Diagram of 7812

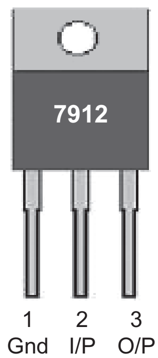


Figure 1.1.2 Pin Diagram of 7912

Result:

The dual power supply is constructed and its outputs are measured.

i. 7812 - Voltage before regulation = -----------V

ii. 7812 - Voltage after regulation = -----------V

iii. 7912 - Voltage before regulation = -----------V

iv. 7912 - Voltage after regulation = -----------V

Ex.No: 2

Date:

VERIFICATION OF DE-MORGAN'S THEOREM

Aim:

To verify De-Morgan's law using IC's.

Apparatus Required:

AND gate – IC 7408,OR gate – IC 7432, NOT gate – IC 7404, IC trainer kit, voltmeter and connecting wires.

Formula:

De-Morgan's law:

I Law:

The complement of the sum is equal to the product of the individual complements.

$$\overline{A+B} = \overline{A}.\overline{B}$$

II Law:

The complement of the product is equal to the sum of the individual complements.

$$\overline{A.B} = \overline{A}+\overline{B}$$

Procedure:

1. Circuit is made as per the circuit diagrams given below by fixing the IC's on the bread board of the IC kit. For all the circuits pin 14 is connected to positive terminal of the battery. Pin 7 is connected to negative terminal of the battery.
2. Output is measured from the output pin as shown in the diagrams.
3. Various values are chosen for the input and their outputs are measured using voltmeter and the truth table is verified.

Table 5.2.1 Truth table

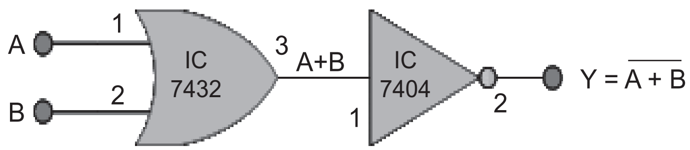
A	B	A+B	$\overline{A+B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Table 5.2.2 Verification table

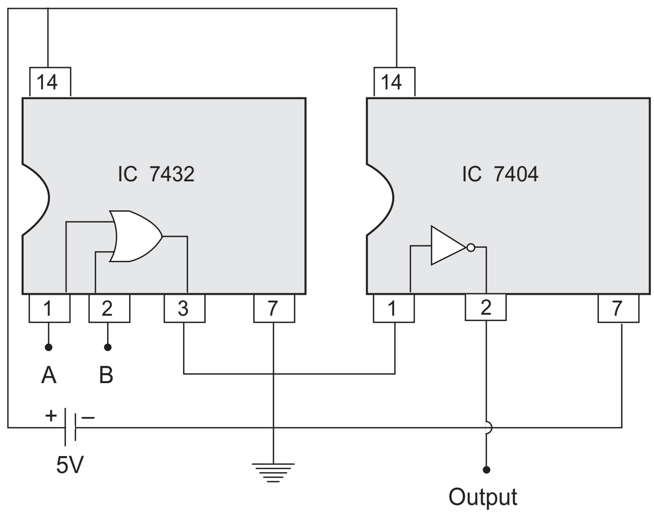
A_V	B_V	$\overline{A_V + B_V}$

Circuit Diagram:

I Law (L.H.S):



2 input 'OR' gate plus a 'NOT' gate



NOR gate

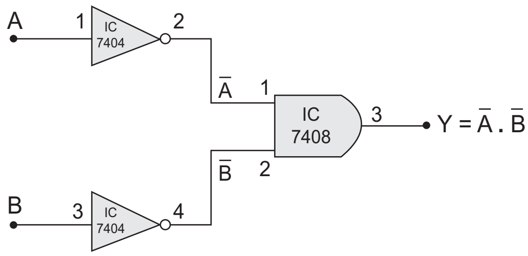
Table 5.2.3 Truth table

A	B	$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$
0	0	1	1	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	0

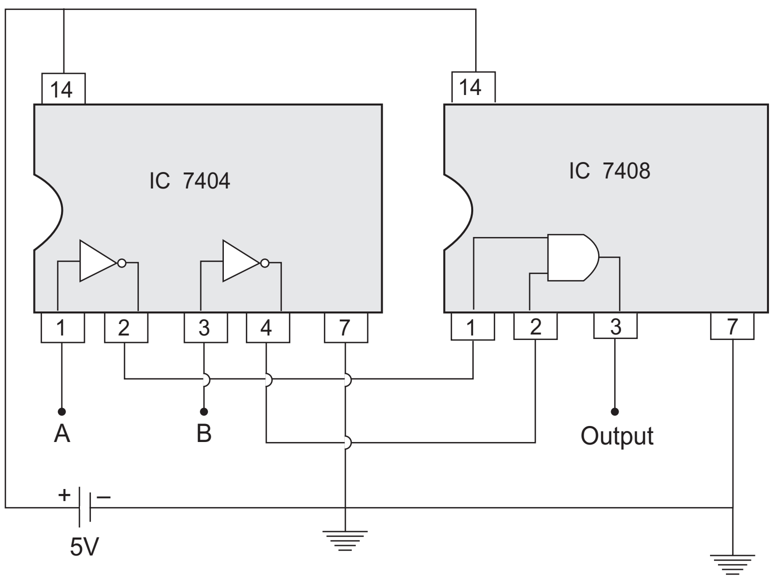
Table 5.2.4 Verification table

A_V	B_V	$\overline{A_V} . \overline{B_V}$

I Law (L.H.S):



A
1
IC
7404
2
$\bar{A}$
1
IC
7408
3
Y = $\bar{A}$. $\bar{B}$
$\bar{B}$
2
B
3
IC
7404
4



14
IC 7404
1
2
3
4
7
14
IC 7408
1
2
3
7
A
B
Output
+
–
5V

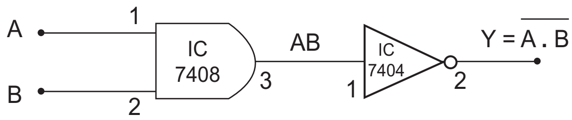
Table 5.2.5 Truth table

A	B	A.B	$\overline{A \cdot B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

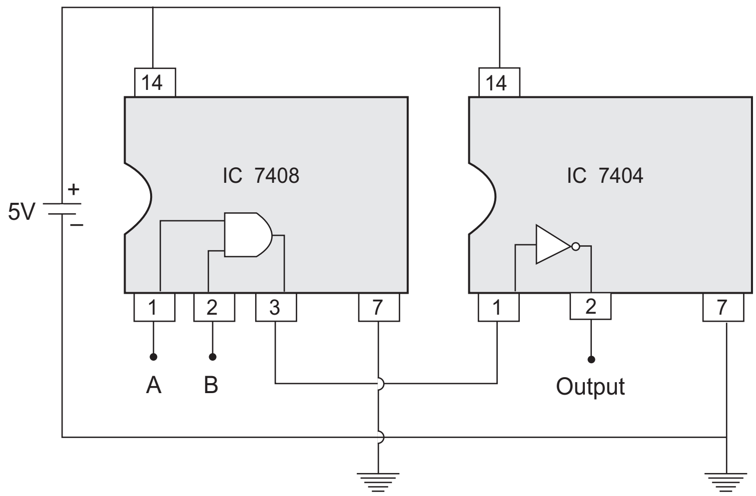
Table 5.2.6 Verification table

A_V	B_V	$\overline{A_V . B_V}$

II Law (L.H.S):



NAND GATE



NAND GATE

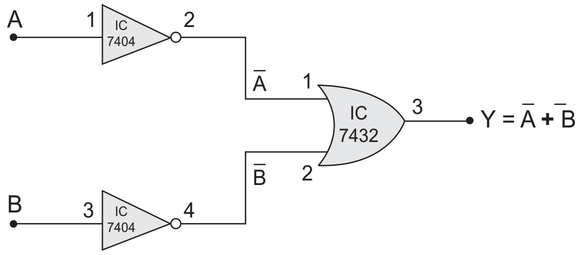
Table 5.2.5 Truth table

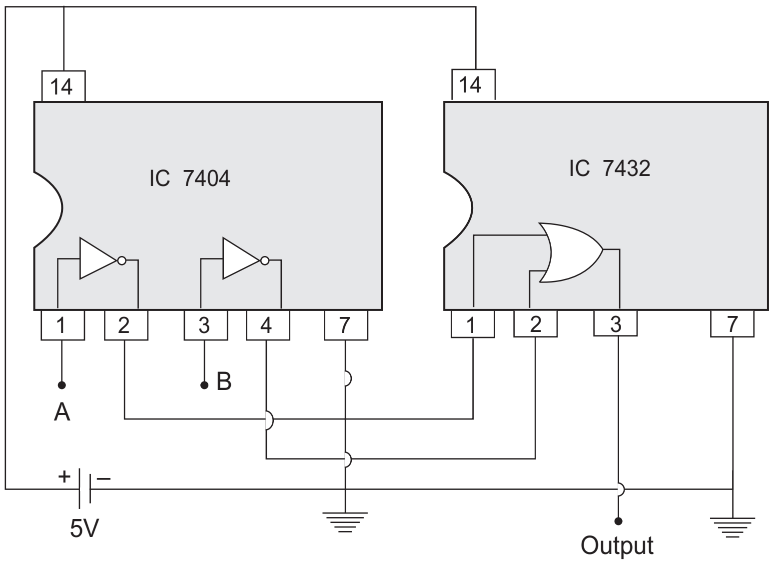
A	B	$\overline{A}$	$\overline{B}$	$\overline{A}+\overline{B}$
0	0	1	1	1
0	1	1	0	1
1	0	0	1	1
1	1	0	0	0

Table 5.2.6 Verification table

A_V	B_V	$\overline{A_V}.+\overline{B_V}$

II Law (R.H.S):





Result:

Using IC's, the De-Morgan's laws are verified.

Ex.No: 3

Date:

CONSTRUCTION OF OR, AND, NOT, NOR, NAND USING DISCRETE COMPONENTS

Aim:

To construct logic gates OR, AND, NOT, NOR, NAND using discrete components and verify the truth table.

Apparatus Required:

NPN transistor, battery, resistors, diodes, voltmeter, IC trainer kit and connecting wires.

Procedure:

1. The circuit for each gate is constructed as given in the diagrams on the bread board of the IC kit using discrete components such as diodes, resistors and transistor.
2. Inputs are varied for the four combination of inputs such as 0V & 0V, 0V & 5V, 5V& 0V and 5V & 5V.
3. For each input combinations the output is measured across y and ground potential and hence the truth table is verified. For NOT gate, there is only one input. i.e, 0V & 5V accordingly the output is measured.

OR GATE

Table 5.3.1 Truth Table

A	B	y = A+B
0	0	0
0	1	1
1	0	1
1	1	1

Table 5.3.2 Verification Table

A_V	B_V	$y = A_V + B_V$

AND GATE

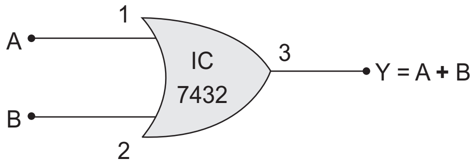
Table 5.3.3 Truth Table

A	B	y = A . B
0	0	0
0	1	0
1	0	0
1	1	1

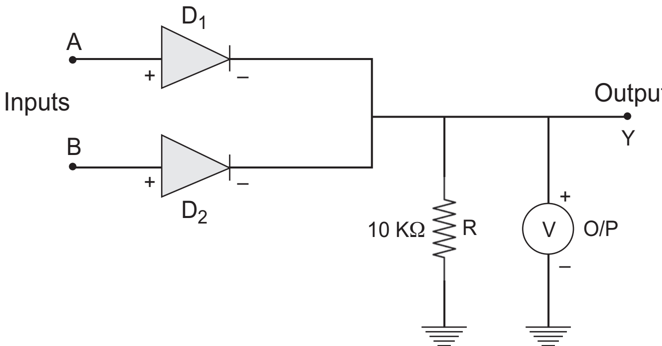
Table 5.3.4 Verification Table

A_V	B_V	$y = A_V . B_V$

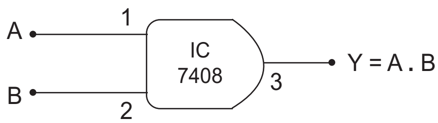
Circuit Diagram:



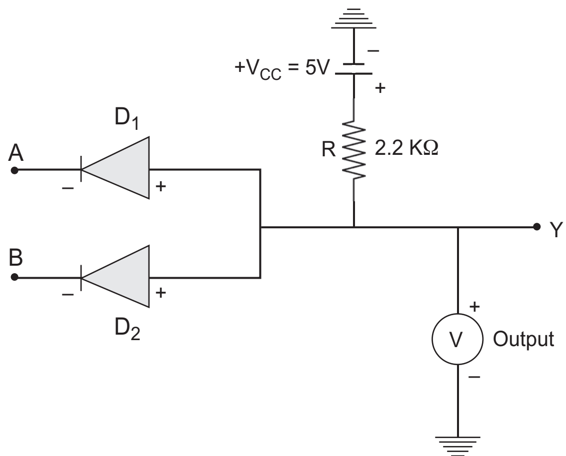
OR GATE



OR Gate Using Diodes and Resistors



AND GATE



AND Gate using Diodes and Resistors

NOT GATE

Table 5.3.5 Truth Table

A	$y = \overline{A}$
0	1
1	0

Table 5.3.6 Verification Table

A_V	$y = \overline{A_V}$

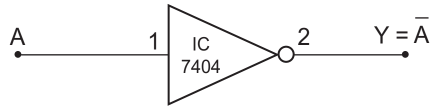
NOR GATE

Table 5.3.7 Truth Table

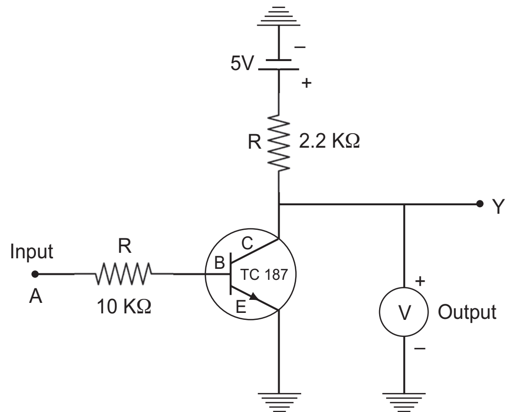
A	B	$y = \overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

Table 5.3.8 Verification Table

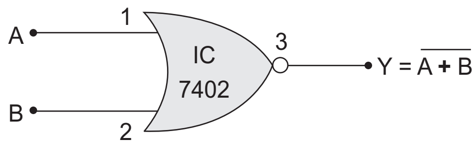
A_V	B_V	$y = \overline{A_V + B_V}$



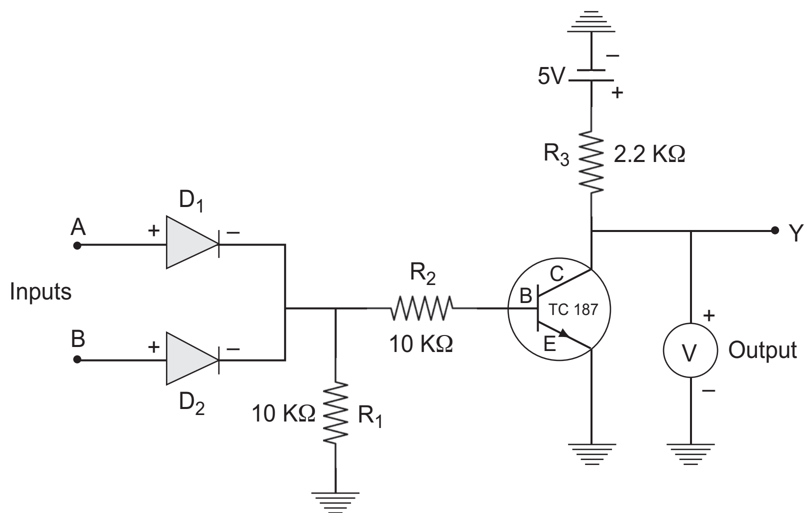
NOT GATE



NOT Gate Using Diodes, Resistors and Transistors



NOR GATE



NOR Gate Using Diodes, Resistors and Transistors

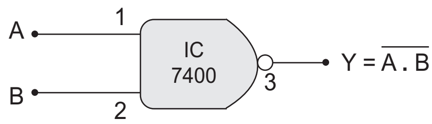
NAND GATE

Table 5.3.8 Truth Table

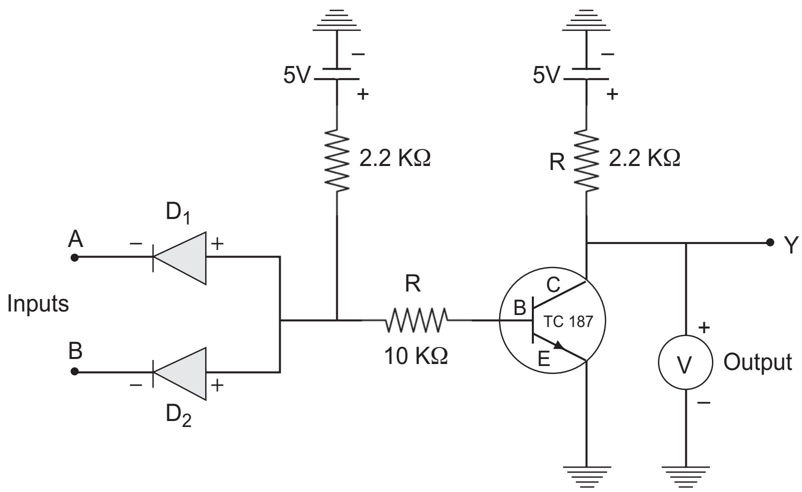
A	B	$y = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

Table 5.3.9 Verification Table

A_V	B_V	$y = \overline{A_V . B_V}$



NAND GATE



NAND Gate Using Diodes, Resistors and Transistors

Result:

Thus the truth table for OR, AND, NOT, NOR, NAND are verified using discrete components.

Ex.No: 4

Date:

OP-AMP - ADDER AND SUBTRACTOR

Aim:

To construct the adder and subtractor circuit using op-amp and to measure the output.

Apparatus Required:

IC 741, dual regulated power supply, resistors, battery, IC trainer kit, voltmeter and connecting wires.

Formula:

i) Adder $$V_0 = -\frac{R_f}{R}\left(V_1 + V_2\right)\text{volt}$$

If $R_f = R$, then

$$V_0 = -\left(V_1 + V_2\right)\text{volt}$$

ii) Subtractor $$V_0 = \left(V_2 - V_1\right)\text{volt}$$

where,

V_1 and V_2 are the input voltages in V

V_0 is the output voltage in V

R_f is the feedback resistance in ohm

Procedure:

1 The circuit is made on the bread board as per the circuit diagram. Dual power supply of 12 V-0V- 12V is switched on to start the experiment.

2. For various input voltages (V_1) and (V_2), the output (V_0) is measured and the table is filled.

3. The expected value and experimental value are noted and verified as per the formula for adder and subtractor.

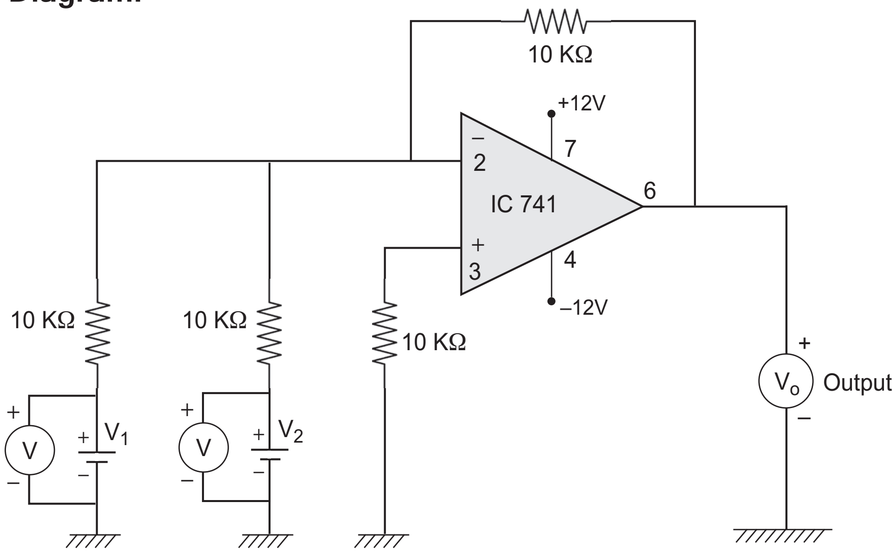
Table 5.4.1 Determination of Output Voltage

S. No	V_1 (V)	V_2 (V)	V_0 by theory $V_1 + V_2$ (V)	V_0 by Experiment (V)	Correction

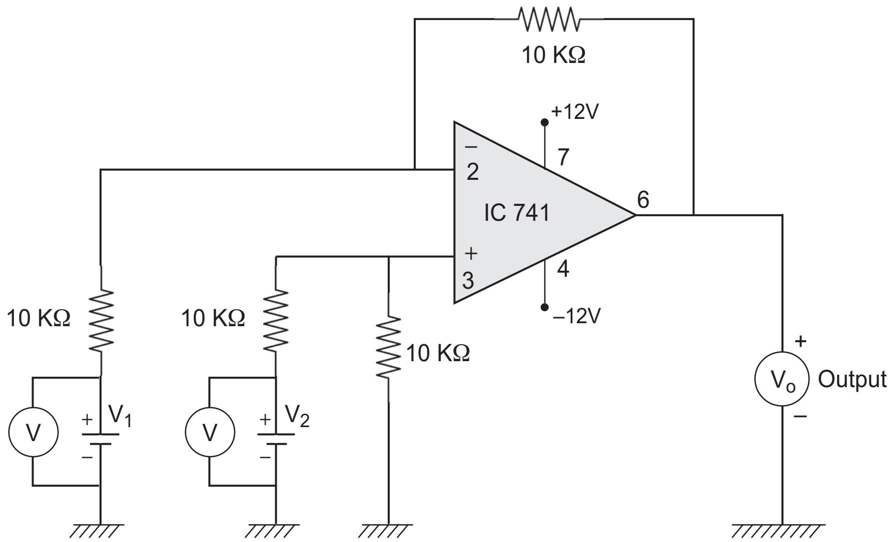
Table 5.4.2 Determination of Output Voltage

S. No	V_1 (V)	V_2 (V)	V_0 by theory $V_1 - V_2$ (V)	V_0 by Experiment (V)	Correction

Circuit Diagram:



Adder using OP-AMP



Subtractor using OP-AMP

Result:

The adder and subtractor circuits are constructed using op-amp and the outputs are measured.

Pin configuration

IC No.	IC Gates	Inputs- pin No.	Outputs –pin No.
7400	NAND	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7408	AND	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7432	OR	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7486	X-OR	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7404	NOT	1,3,5,9,11,13	2,4,6,8,10,12
7402	NOR	(2.3),(5,6),(8,9),(11,12)	1,4,10,13

Ex.No: 5

Date:

HALF ADDER AND FULL ADDER

Aim:

To construct the half adder and full adder circuit using IC 7408, IC 7486 and IC 7432 and to measure their respective output.

Apparatus Required:

IC 7408, IC 7486, IC 7432, IC 7404, IC 7400, IC 7402, IC trainer kit, voltmeter and connecting wires.

General Information:

1. The IC chips are fixed in the bread board and the connections are made as per the diagram using wires.
2. Voltage and logic levels for TTL gates are as follows:

   V_{cc} = Power supply voltage 5.0 ± 1.01

   V_{ih} = High level input voltage, voltage required for a logic ONE at the input (2.4 V to 4.5 V)

   V_{il} = Low level input voltage, voltage required for a logic ZERO at the input (0.1 V to 0.7 V)

   V_{oh} = High level input voltage required for a logic ONE at the output and it is guaranteed minimum of 2.4 volts.

   V_{ol} = Low level input voltage required for a logic ZERO at the output and it is guaranteed mam of 0.4 volts.

Procedure:

1. The IC chips are fixed in the bread board of the IC kit and the connections are made using wires as per the circuit diagram.

HALF ADDER

Table 5.5.1 Truth Table

Input		Output	
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

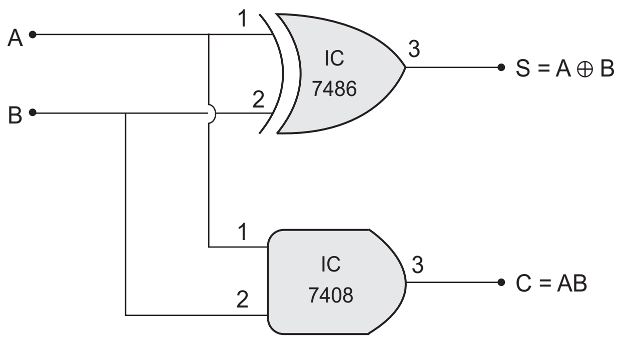
Table 5.5.2 Verification Table

Input		Output	
A	B	Sum	Carry

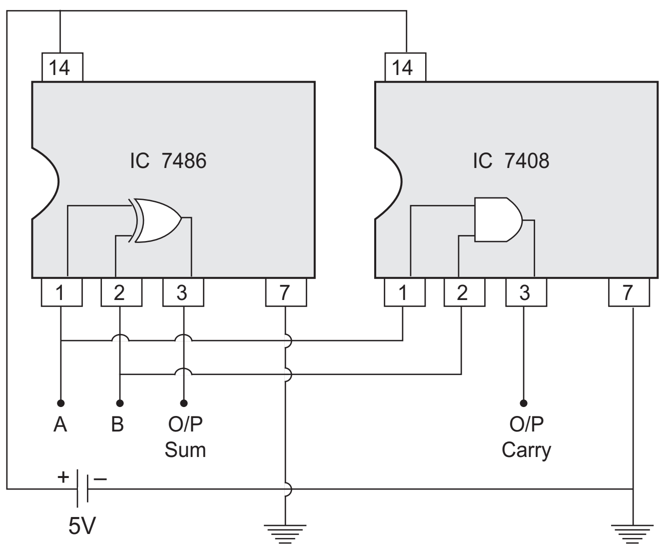
2. In all the IC's the pin 14 is connected to the positive of the battery supply. Pin 7 is connected to the negative of the battery supply.
3. For various values of the input, the output is measured and tabulated.
4. It is verified with the respective truth table and compared with the ideal value.

Formula:

Boolean expression for sum and carry of half adder



HALF ADDER



CIRCUIT FOR HALF ADDER

FULL ADDER

Table 5.5.3 Truth Table

Input			Output	
A	B	C	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

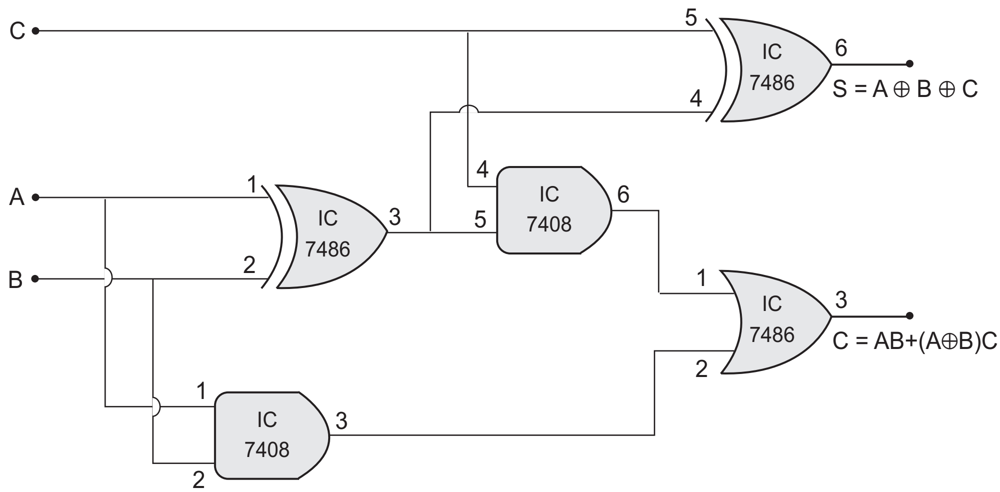
Table 5.5.4 Verification Table

Input			Output	
A	B	C	Sum	Carry

Boolean expression for sum and carry of full adder

$$\text{Sum} = A \oplus B \oplus C$$

$$\text{Carry} = A.B + (A \oplus B)C$$



FULL ADDER

Result:

The half adder and full adder circuits are constructed and their outputs are measured.

Ex.No: 6

Date:

OP-AMP - DIFFERENTIATOR AND INTEGRATOR

Aim:

To construct the differentiator and integrator circuits using op-amp and measure its output.

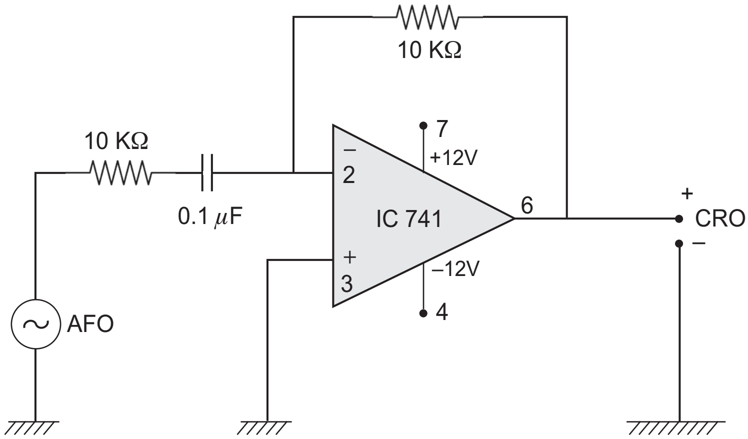
Apparatus Required:

IC 741, audio frequency oscillator (AFO), CRO, capacitor, resistor, bread board and connecting wires.

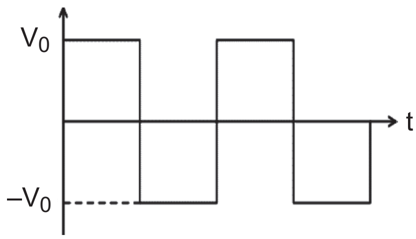
Procedure:

1. The circuit is made as shown in the circuit diagram and dual power supply is switched on.
2. The audio frequency oscillator is adjusted using the frequency knob and the voltage knob to get a square wave in the input CRO.
3. In the output side, the waveform is noted in the output CRO and traced out in a tracing sheet.
4. For differentiator, the output wave is sharp edge spikes.
5. For integrator, the output wave is triangle shaped.

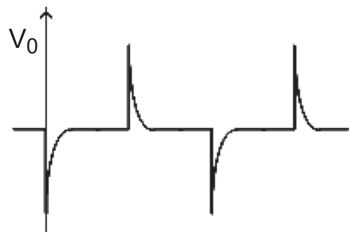
Circuit Diagram:



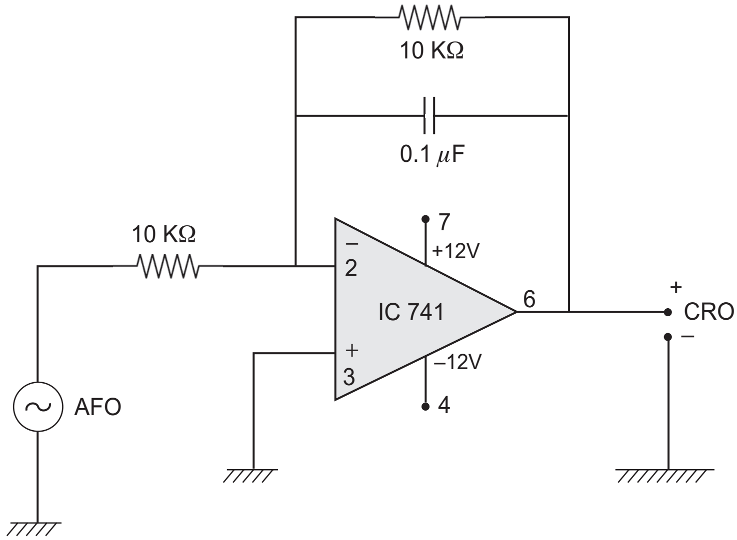
DIFFERENTIATOR



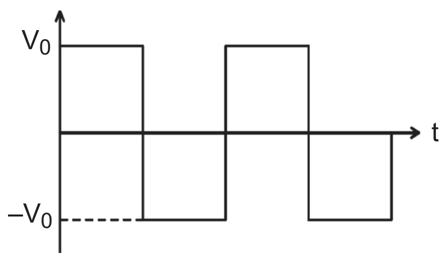
Input wave form



Expected output wave form



INTEGRATOR



Input wave form

Expected output wave form

Result:

Thus the differentiator and integrator circuits are constructed using op-amp and their output waves are traced.

Ex.No: 7

Date:

HARTLEY OSCILLATOR

Aim:

To construct Hartley oscillator and find its frequency to determine the self-inductance of the coil.

Apparatus Required:

Transistor, power supply, CRO, capacitor,resistors, inductor and head phone.

Formula:

$$f = \frac{1}{2\pi\sqrt{LC}} \text{Hz}$$

$$f^2 = \frac{1}{4\pi^2 LC} \text{Hz}$$

$$\text{Since } f = \frac{1}{T} \text{ Hz}$$

$$L = \frac{T^2}{4\pi^2 C} \text{Henry}$$

where,

C = is the capacitance of the capacitor in μf

f = is the frequency in Hz

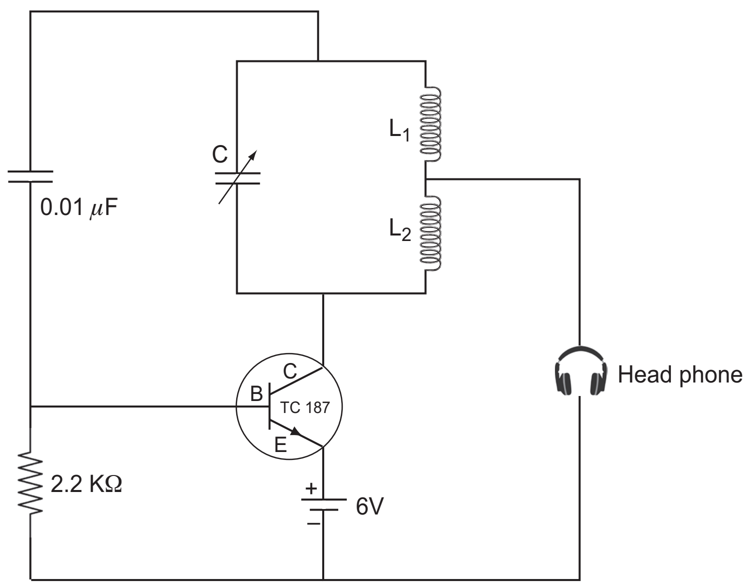
L = is the self - inductance in Henry

T = is the time in second

Procedure:

1. Circuit connections are made as shown in the circuit diagram.
2. Introduce various capacitance (0.1 μF to 0.9μF) in the capacitance connected in the tank circuit.
3. For each capacitance introduced, measure the frequency of time period of oscillations of the sine wave generated in the CRO.
4. Fill the tabular column below, using the values of C and T.
5. Substitute the values of T^2/C and calculate L for each set of readings.
6. Find the mean of L.
7. Draw the graph with C in Y-axis and T^2 in X-axis. Take the slope as shown in model graph.
8. Calculate the value of L graphically and compare with experimental value.

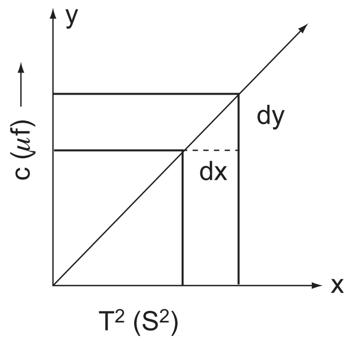
Circuit diagram:



HARTLEY OSCILLATOR

Table 5.7.1 Determination of Self Inductance of Coil

S. No.	$(C \times 10^{-6})$ F	$(T \times 10^{-3})$ S	$(T^2 \times 10^{-6})$ S^2	$\frac{T^2}{C}$ $(s^2/\mu F)$	L (mH)



Slope, $m = \frac{dy}{dx}$

$\frac{T^2}{C} = \frac{1}{m}$

Model Graph

Result:

Hartley oscillator is constructed and the self-inductance of the coil is determined.

i. By Experimental method,

The self-inductance of the coil = ________________mH

ii. By graphical method,

The self-inductance of the coil = ________________mH

Ex.No: 8

Date:

COLPITT'S OSCILLATOR

Aim:

To construct Colpitt's oscillator and to find its frequency to determine the self-inductance of the coil.

Apparatus Required:

Transistor, CRO, power supply, resistors, inductor and capacitor.

Formula:

$$f = \frac{1}{2\pi\sqrt{LC}}\,\text{Hz}$$

$$f^2 = \frac{1}{4\pi^2 LC}\,\text{Hz}$$

$$L = \frac{T^2}{4\pi^2 C}\,\text{Henry}$$

$$C = \frac{C_1 C_2}{C_1 + C_2}\,\mu\text{F}$$

Where,

C = is the capacitance of the capacitor in μF

f = is the frequency in hertz

L = is the inductance in henry

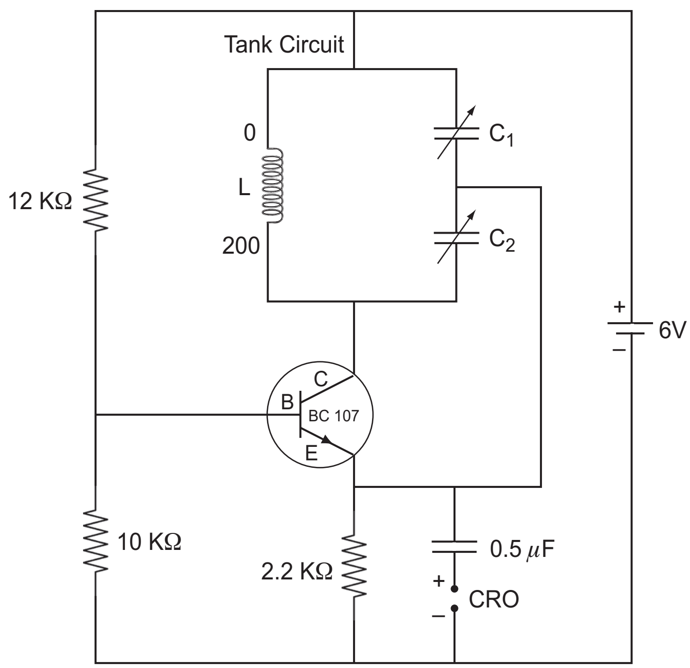
Table 5.8.1 Determination of Self Inductance of Coil

S. No	$C_1\ \mu F$	$C_2\ \mu F$	$C\ \mu F$	T ms	$T^2\ ms^2$	L mH

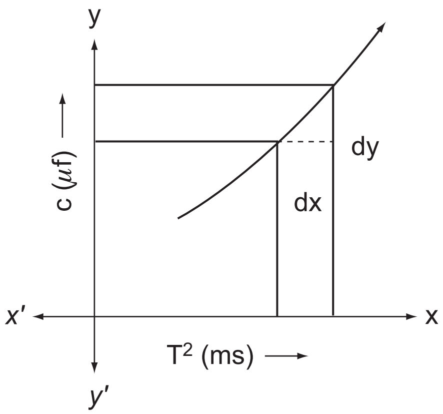
Procedure:

1. Circuit connections are made as shown in the diagram below.
2. Vary the values of C_1 & C_2 and for each set of C_1 & C_2, the time period of oscillation of the sine wave is measured in the CRO.
3. Fill the tabular column for various sets of C_1 & C_2 values.
4. Calculate the self-inductance of the coil (L) using the formula.
5. Find the mean of L.
6. Draw the graph for C in Y- axis & T^2 in X-axis. Take the slope as shown in model graph.
7. Calculate the values of L graphically and compare with experimental value.

Circuit Diagram:



COLPITT'S OSCILLATOR



$$\text{Slope, } m = \frac{dy}{dx}$$

$$\frac{T^2}{C} = \frac{1}{slope}$$

Model Graph

Result:

Colpitt's oscillator is constructed and theself-inductance of the coil is determined.

iii. By Experimental method,

The self-inductance of the coil = ________________

iv. By graphical method,

The self-inductance of the coil = ________________

Ex.No: 9

Date:

ASTABLE MULTIVIBRATOR

Aim:

To construct an astable multivibrator using IC 555 timer and to study its characteristics.

Apparatus Required:

Resistors, power supply, variable capacitor, IC 555, bread board and CRO.

Formula:

$$T = 0.69\ (R_A + 2R_B)C\ \ \text{ms}$$

where,

T = is the time period of oscillation of the output wave in ms

R_A, R_B = are the resistance in ohm

C = is the capacitance of variable capacitor in μF

Duty cycle is the ratio of the duration (t_1) of the high state to the total period (T) of the multivibrator.

$$\text{Duty cycle} = \frac{t_1}{T}$$

where

T = is the charging and discharging time in second

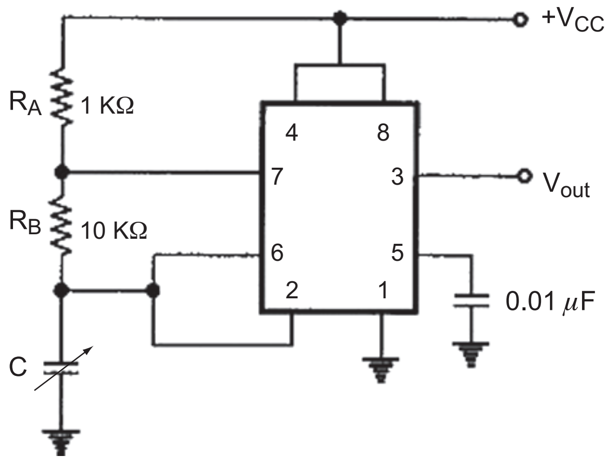
t_1 = is the charging time in second

$$\text{Duty cycle} = \frac{R_A + R_B}{R_A + 2R_B} \times 100\%$$

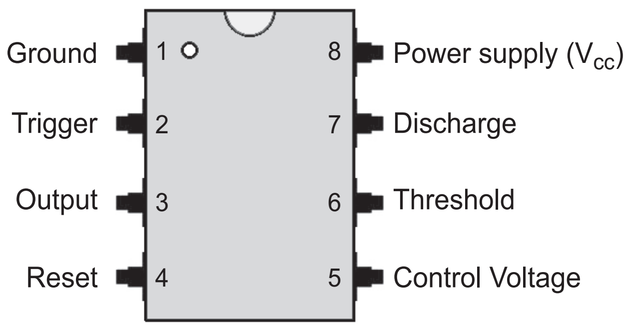
Procedure:

1. Circuit is made as per the diagram below.
2. Power supply of 5V is switched on for a particular value of variable capacitance.
3. The output square wave is noted in the CRO connected between pin 3 and 1.
4. Time period of the square wave is noted for various capacitance values of the variable capacitor.
5. The experimental value of T is compared with theoretical value.
6. Duty cycle is calculated using the formula. The expected duty cycle is 50%

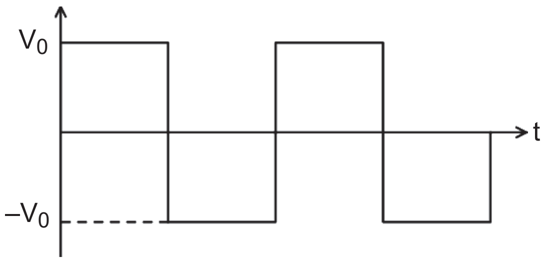
Circuit Diagram:



Astable Multivibrator



Pin Configuration of 555 timer



Expected output waveform

Result:

Astable multivibrator is constructed using IC 555 timer and its characteristics are studied.

Ex.No: 10

Date:

SINGLE STAGE AMPLIFIER WITH FEEDBACK

Aim:

1. To construct a single stage RC coupled amplifier.
2. To determine the voltage gain at different frequencies.
3. To draw the frequency response curve.
4. To determine its band width.

Apparatus Required:

Transistor, audio frequency oscillator, power supply, resistors, bread board, multimeter and connecting wires.

Formula:

$$\text{Voltage gain} = \frac{V_{out}}{V_{in}}$$

$$\text{Half power gain} = \frac{\text{Maximum gain}}{\sqrt{2}}$$

$$\text{Bandwidth} = f_1 \sim f_2 \text{Hz}$$

where,

V_{out} = the output voltage in volt

V_{in} = the input voltage in volt

f_1 = the lower cut off frequency/ Half power frequency (Hz)

f_2 = the upper cut off frequency/ Half power frequency (Hz)

Table 5.10.1 Determination of Gain of Amplifier

$V_{in} = 0.4V$

Frequency (Hz)	Log f	Output voltage with feedback (V)	Gain = $\frac{V_{out}}{V_{in}}$

Calculation:

Log f_1 = __________

f_1 = antilog of (log f_1) Hz

f_1 = _________ Hz

Log f_2 = __________

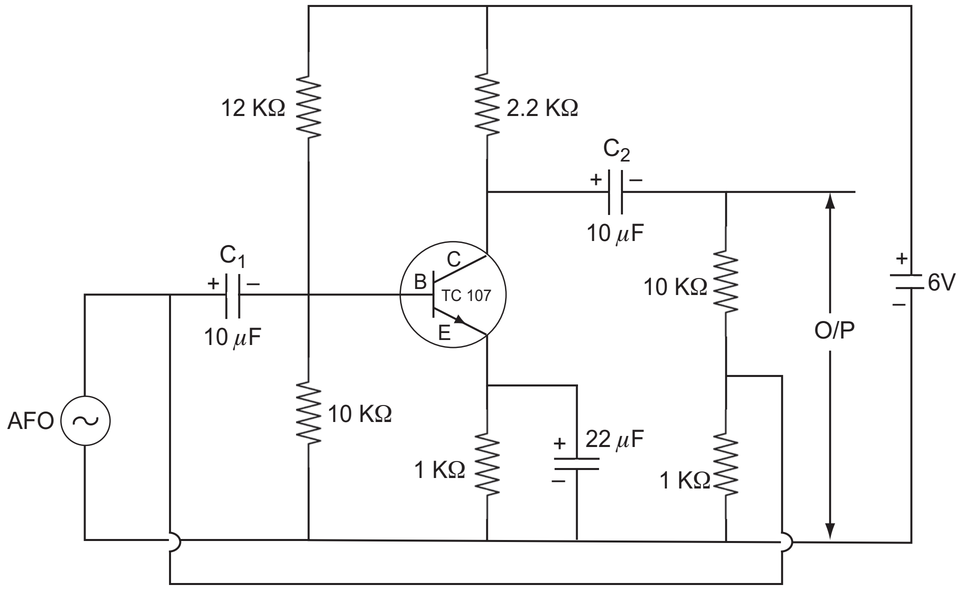
f_2 = antilog of (log f_2) Hz

f_2 = _________ Hz

Bandwidth = $f_1 \sim f_2$ Hz

= _________ Hz

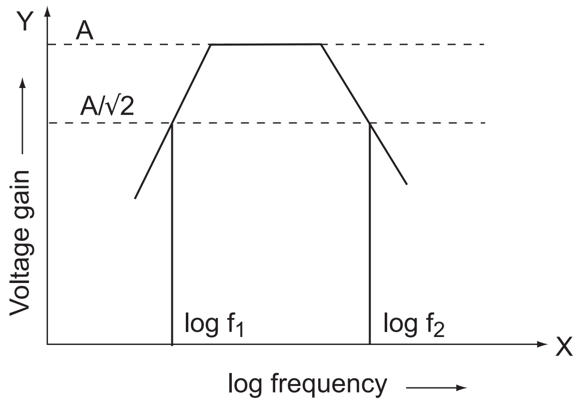
Circuit Diagram:



Single Stage Amplifier with Feedback

Procedure:

1. Make the circuit connection as shown in the diagram below.
2. In order to activate the transistor, bias voltage is given by switching ON the power supply to 6V.
3. Adjust the amplitude knob of AFO so that the input voltage to the base of the transistor is 0.4V.
4. Due to potential divider arrangement, a small current flows through the base of the transistor.
5. After applying small input AC signal, find out the output voltage for different frequencies, keeping the input voltage constant.
6. Calculate the voltage gain for each frequency (ranging from 20 Hz to 1.5 Mz) and fill in the tabulation columns.
7. Draw the frequency response curve as given in the model graph and determine the mid frequency gain, lower and upper cut-off frequencies and the bandwidth.



Model Graph

Result:

Single stage RC coupled amplifier is constructed with feedback and its frequency response curve is drawn.

Upper cut off frequency = ________________ Hz

Lower cut off frequency = ________________ Hz

Bandwidth = ________________ Hz.

Pin configuration

IC No.	IC Gates	Inputs- pin No.	Outputs –pin No.
7408	AND	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7432	OR	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7404	NOT	1,3,5,9,11,13	2,4,6,8,10,12

Ex.No: 11

Date:

SOLVING BOOLEAN EXPRESSION

Aim:

To solve Boolean expressions by using AND,NOT and OR gates using IC Chips.

Apparatus Required:

AND gate – IC 7408, OR gate – IC 7432, NOT gate – IC 7404, voltmeter, IC trainer kit and connecting wires.

Formula:

Distributive Laws:

$$A.(B+C)=(A.B)+(A.C)$$
$$A+(B.C)=(A+B).(A+C)$$

Associative Laws:

$$(A+B)+C=A+(B+C)$$
$$(A.B).C=A.(B.C)$$

General Information:

1. No connections are required for an unused gate in the package.
2. Voltage and logic levels for TTL gates are as follows:

   V_{cc} - Power supply voltage 5.0 ± 1.01

   V_{ih} - High level input voltage, voltage required for a logic ONE at the input (2.4 V to 4.5 V)

   V_{il} - Low level input voltage, voltage required for a logic ZERO at the input (0.1 V to 0.7 V)

   V_{oh} - High level input voltage required for a logic ONE at the output and it is guaranteed minimum of 2.4 volts.

L.H.S: A . (B + C)

Table 5.11.1 Truth Table

A	B	C	Y=A. (B+C)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Table 5.11.2 Verification Table

A (V)	B (V)	C (V)	Y=A.(B+C) (V)

R.H.S: (A . B) + (A . C)

Table 5.11.3 Truth Table

A	B	C	Y=(A.B) + (A.C)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Table 5.11.4 Verification Table

A (V)	B (V)	C (V)	Y=(A.B) +(A.C) (V)

V_{ol} - Low level input voltage required for a logic ZERO at the output and it is guaranteed maximum of 0.4 volts.

Procedure:

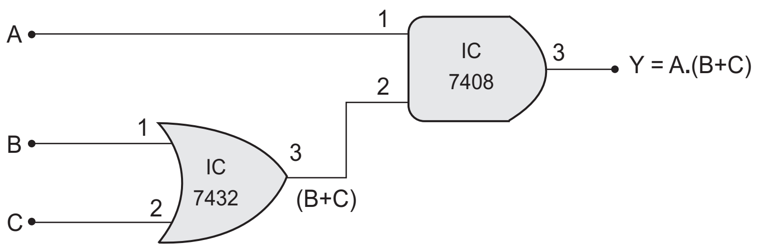
1. Make the connection as given in the circuit separately for each law.
2. For various input combinations, measure the output value by connecting the voltmeter between the output pin and ground terminal.
3. Compare it with the truth table to check the voltage levels match with the high and low level in the truth table.

Distributive Law:

(i) A . (B + C) = (A . B) + (A . C)

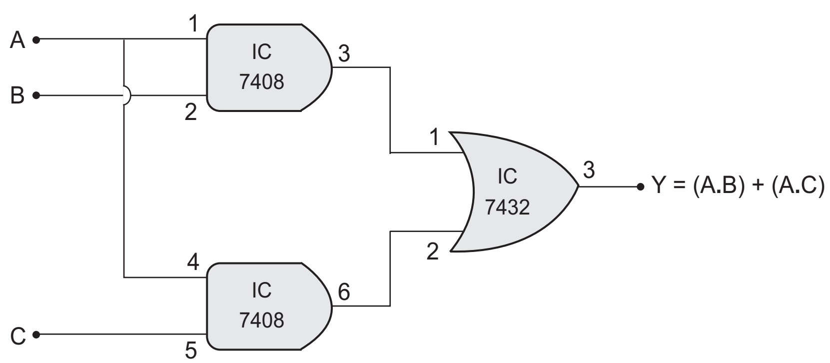
L.H.S: A . (B + C)

Circuit Diagram:



R.H.S: (A . B) + (A . C)

Circuit Diagram:



L. H. S: A + (B.C)

Table 5.11.5 Truth Table

A	B	C	Y =A + (B.C)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Table 5.11.6 Verification Table

A (V)	B (V)	C (V)	Y =A+(B.C) (V)

R.H.S: (A+B) **.** (A+C)

Table 5.11.7 Truth Table

A	B	C	Y = (A+B) . (A+C)
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

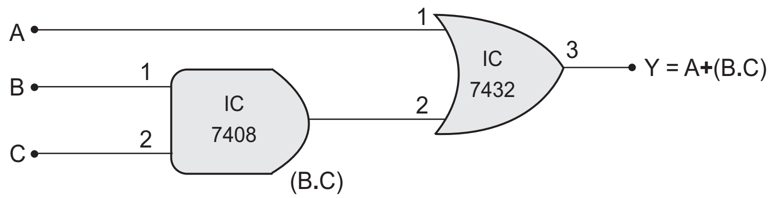
Table 5.11.8 Verification Table

A (V)	B (V)	C (V)	Y = (A+B) . (A+C) (V)

(ii) A+(B.C)=(A+B).(A+C)

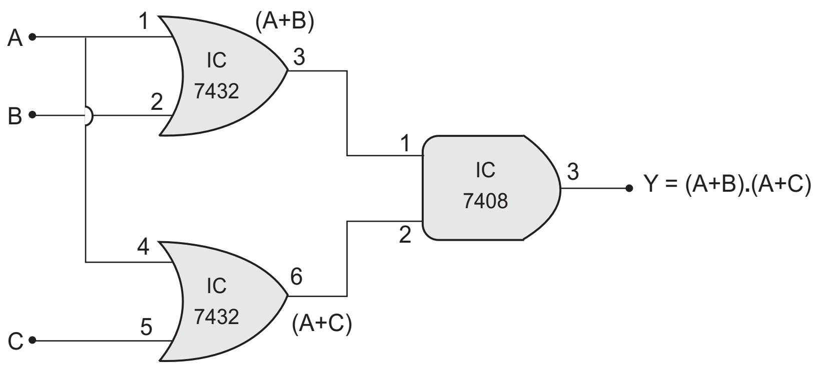
L. H. S: A + (B.C)

Circuit Diagram:



R.H.S: (A+B) **.** (A+C)

Circuit Diagram:



L. H. S: (A+B) + C

Table 5.11.9 Truth Table

A	B	C	Y =A + (B+C)
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Table 5.11.10 Verification Table

A (V)	B (V)	C (V)	Y =A + (B+C) (V)

R.H.S: A +(B+C)

Table 5.11.11 Truth Table

A	B	C	Y = (A+B)+C
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Table 5.11.12 Verification Table

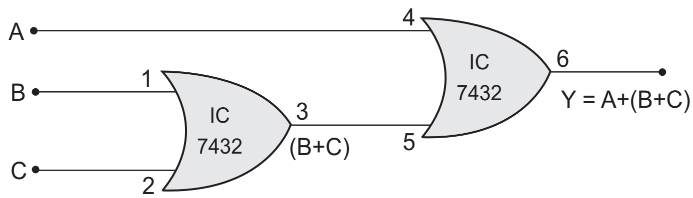
A (V)	B (V)	C (V)	Y = (A+B)+C (V)

(i) Associative Laws:

$$(A+B) + C = A + (B+C)$$

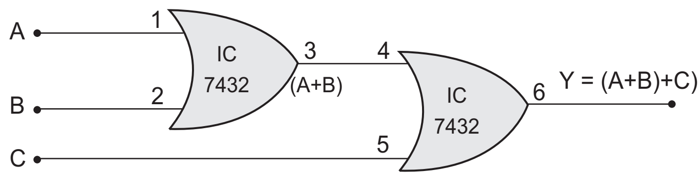
L. H. S: $(A+B) + C$

Circuit Diagram:



R.H.S: $A + (B+C)$

Circuit Diagram:



L. H. S: (A.B).C

Table 5.11.13 Truth Table

A	B	C	Y = (A.B).C
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Table 5.11.14 Verification Table

A (V)	B (V)	C (V)	Y = (A.B).C (V)

R.H.S: A +(B+C)

Table 5.11.15 Truth Table

A	B	C	Y = A.(B.C)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

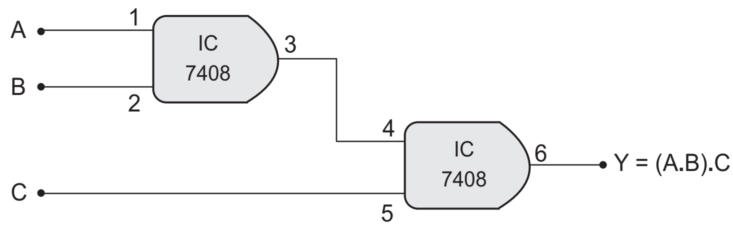
Table 5.11.16 Verification Table

A (V)	B (V)	C (V)	Y = A.(B.C) (V)

(ii) (A.B).C = A.(B.C)

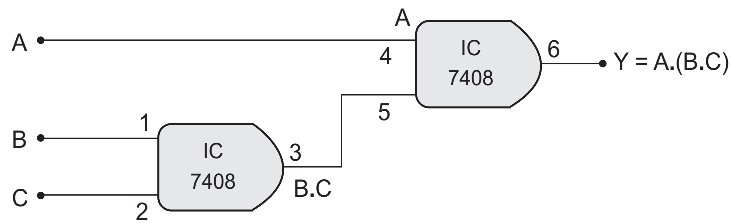
L. H. S: (A.B).C

Circuit Diagram:



R. H. S: A.(B.C)

Circuit Diagram:



Result:

Boolean expressions are solved using AND, NOT and OR gates using IC Chips.

Pin configuration

IC No.	IC Gates	Inputs- pin No.	Outputs –pin No.
7400	NAND	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7402	NOR	(2.3),(5,6),(8,9),(11,12)	1,4,10,13

Ex.No: 12

Date:

NAND AND NOR AS UNIVERSAL BUILDING BLOCKS

Aim:

To verify the truth table for NAND and NOR gates and to verify them as universal building blocks.

Apparatus Required:

NAND gate – IC 7400, NOR gate- IC 7402, IC trainer kit, voltmeter and connecting wires.

General Information:

1. No connections are required for an unused gate in the package.
2. Voltage and logic levels for TTL gates are as follows:

   V_{cc} = Power supply voltage 5.0 ± 1.01

   V_{ih} = High level input voltage, voltage required for a logic ONE at the input (2.4 V to 4.5 V)

   V_{il} = Low level input voltage, voltage required for a logic ZERO at the input (0.1 V to 0.7 V)

   V_{oh} = High level input voltage required for a logic ONE at the output and it is guaranteed minimum of 2.4 volts.

   V_{ol} = Low level input voltage required for a logic ZERO at the output and it is guaranteed maximum of 0.4 volts.

Procedure:

1. Make the connections as given in the circuit separately for each gate.
2. For various input combinations, measure the output value by connecting the voltmeter between the output pin and ground terminal.

AND gate using NOR gates

Table 5.12.1 Truth Table

A	B	y = A . B
0	0	0
0	1	0
1	0	0
1	1	1

Table 5.12.2 Verification Table

A_V	B_V	$y = A_V . B_V$

OR gate using NOR gates

Table 5.12.3 Truth Table

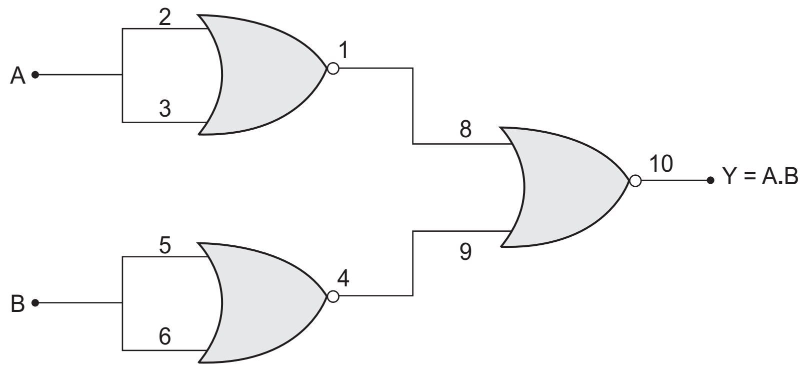
A	B	y = A + B
0	0	0
0	1	1
1	0	1
1	1	1

Table 5.12.4 Verification Table

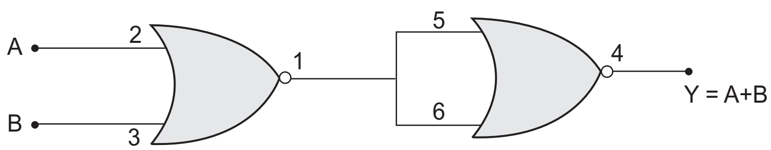
A_V	B_V	$y = A_V + B_V$

3. Compare it with the truth table to check the voltage levels match with the high and low level in the truth table.

Circuit Diagram:



AND gate using NOR gates



OR gate using NOR gates

NOT gate using NOR gates

Table 5.12.5 Truth Table

A	$y = \overline{A}$
0	1
1	0

Table 5.12.6 Verification Table

A_V	$y = \overline{A_V}$

NAND gate using NOR gates

Table 5.12.7 Truth Table

A	B	$y = A . B$	$y = \overline{A . B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Table 5.11.8 Verification Table

A_V	B_V	$y = \overline{A_V . B_V}$

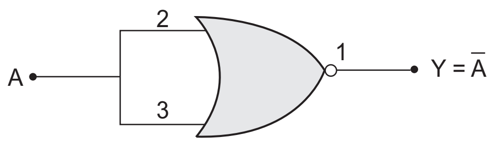
EX-OR gate using NOR gates

Table 5.12.9 Truth Table

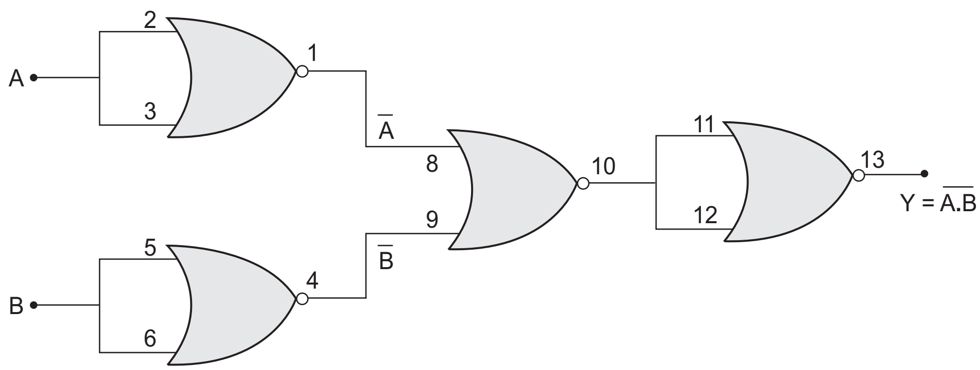
A	B	$y = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Table 5.11.10 Verification Table

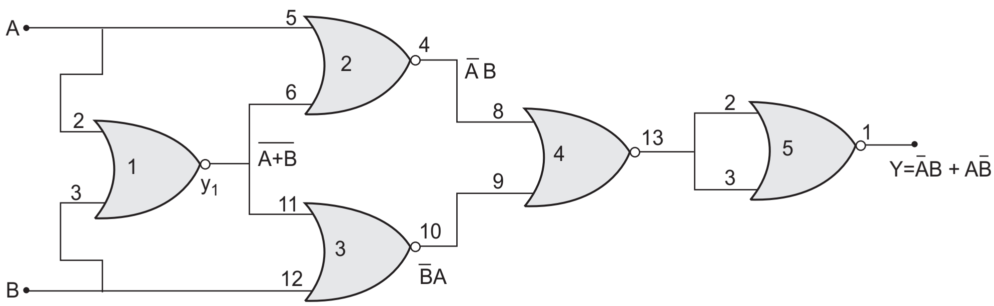
A_V	B_V	$y = A_V \oplus B_V$



NOT gate using NOR gates



NAND gate using NOR gates



EX-OR gate using NOR gates

AND gate using NAND gates

Table 5.12.11 Truth Table

A	B	$y = A \cdot B$
0	0	0
0	1	0
1	0	0
1	1	1

Table 5.11.12 Verification Table

A_V	B_V	$y = A_V \cdot B_V$

OR gate using NAND gates

Table 5.12.13 Truth Table

A	B	$y = A + B$
0	0	0
0	1	1
1	0	1
1	1	1

Table 5.11.14 Verification Table

A_V	B_V	$y = A_V + B_V$

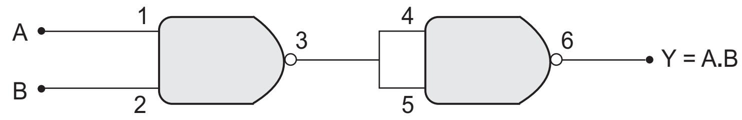
NOT gate using NAND gate

Table 5.12.15 Truth Table

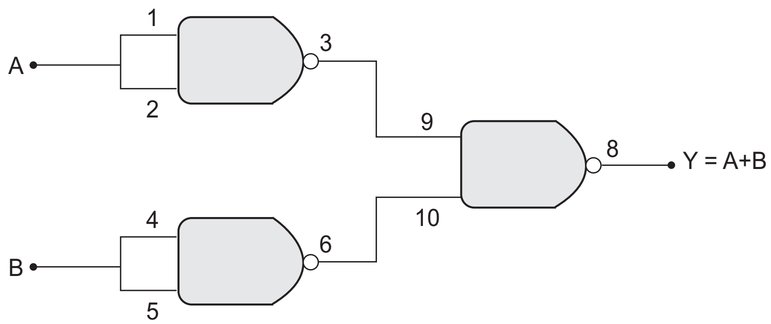
A	$y = \overline{A}$
0	1
1	0

Table 5.11.16 Verification Table

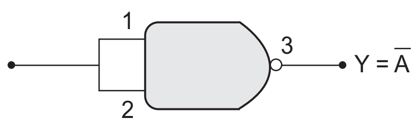
A_V	$y = \overline{A_V}$



AND gate using NAND gates



OR gate using NAND gates



NOT gate using NAND gate

NOR gate using NAND gates

Table 5.12.17 Truth Table

A	B	$y = \overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

Table 5.11.18 Verification Table

A_V	B_V	$y = \overline{A_V + B_V}$

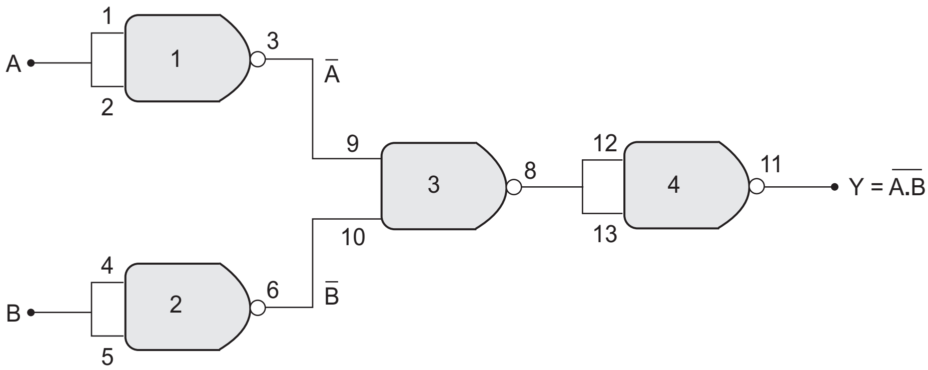
EX-OR gate using NAND gates

Table 5.12.19 Truth Table

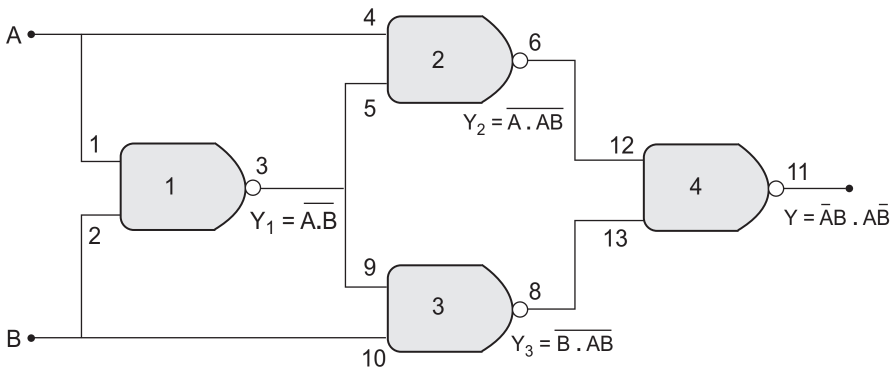
A	B	$y = A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Table 5.11.20 Verification Table

A_V	B_V	$y = A_V \oplus B_V$



NOR gate using NAND gates



EX-OR gate using NAND gates

Result:

Thus the NAND and NOR gates are justified as universal building blocks and their truth tables are verified using corresponding IC's.

Pin configuration

IC No.	IC Gates	Inputs- pin No.	Outputs –pin No.
7400	NAND	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7408	AND	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7432	OR	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7486	X-OR	(1,2),(4,5),(9,10),(12,13)	3,6,8,11
7404	NOT	1,3,5,9,11,13	2,4,6,8,10,12
7402	NOR	(2.3),(5,6),(8,9),(11,12)	1,4,10,13

Ex.No: 13

Date:

HALF SUBTRACTOR AND FULL SUBTRACTOR

Aim:

To construct and study the following arithmetic circuits of half subtractor and full subtractor.

Apparatus Required:

IC 7408, IC 7486, IC 7432, IC 7404, IC 7400, IC 7402, IC trainer kit, voltmeter and connecting wires.

General Information:

1. No connections are required for an unused gate in the package.
2. Voltage and logic levels for TTL gates are as follows:

   V_{cc} = Power supply voltage 5.0 ± 1.01

   V_{ih} = High level input voltage, voltage required for a logic ONE at the input (2.4 V to 4.5 V)

   V_{il} = Low level input voltage, voltage required for a logic ZERO at the input (0.1 V to 0.7 V)

   V_{oh} = High level input voltage required for a logic ONE at the output and it is guaranteed minimum of 2.4 volts.

   V_{ol} = Low level input voltage required for a logic ZERO at the output and it is guaranteed maimum of 0.4 volts.

Procedure:

1. The IC chips are fixed in the bread board of the IC kit and the connections are made using wires.
2. In all the IC's the pin 14 is connected to the positive of the battery supply. Pin 7 is connected to the negative of the battery supply.

Half Subtractor

Table 5.13.1 Truth Table

Input		Output	
A	B	D	Br
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Table 5.11.2 Verification Table

Input		Output	
A	B	D	Br

Full Subtractor

Table 5.13.3 Truth Table

Input			Output	
A_n	B_n	Br_{n-1}	D_n	Br_n
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Table 5.13.4 Verification Table

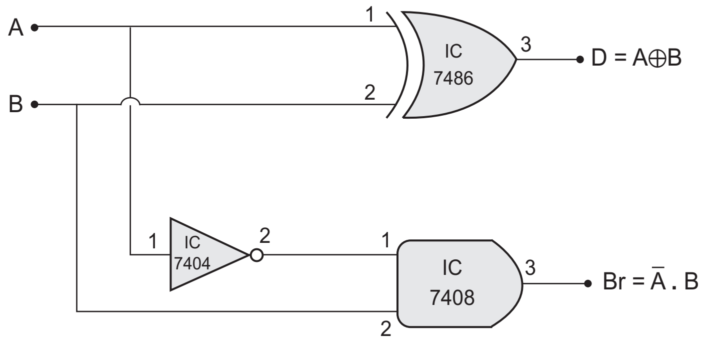
Input			Output	
A_n (V)	B_n (V)	Br_{n-1} (V)	D_n (V)	Br_n (V)

3. For various values of the input, the output is measured and tabulated.
4. It is verified with the respective truth table and compared with the ideal value.

Circuit Diagram:

$$D = A \oplus B$$

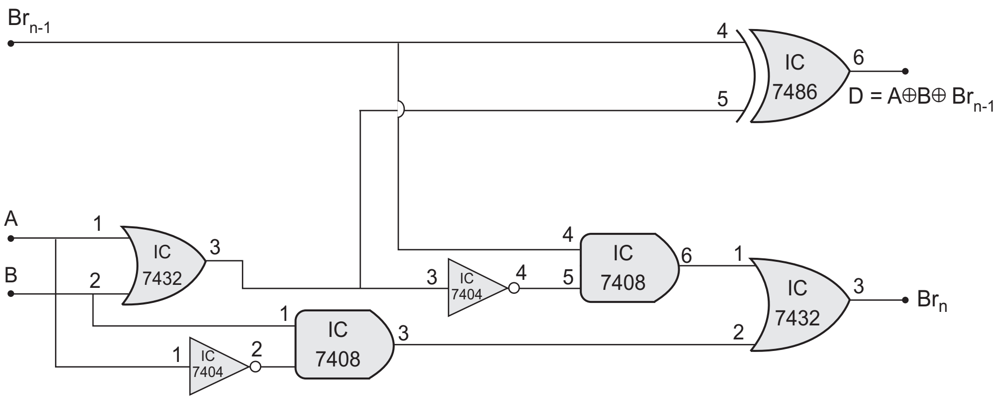
$$Br = \bar{A}.B$$



Half Subtractor

$$D_n = A_n \oplus B_n \oplus B_{rn-1}$$

$$\text{(i.e)} \quad Br_n = \bar{A}_n . B_n + B_{rn-1}(\overline{A_n \oplus B_n})$$



Full Subtractor

Result:

Thus arithmetic circuits of half subtractor and full subtractor are constructed and studied.

Ex.No: 14

Date:

HIGH PASS AND LOW PASS FILTER

Aim:

To find the cut-off frequency of low pass and high pass filter using op-amp.

Apparatus Required:

Resistor, capacitor, voltmeter, oscillator

Formula:

$$f_c = \frac{1}{2\pi RC}\,\text{Hz}$$

where,

f_c = the cut – off frequency in Hz

R = the resistance in ohm.

C = is the capacitance of the capacitor in μF

$$\text{Gain} = \frac{V_{out}}{V_{in}}$$

V_{out} = is the output voltage

V_{in} = the input voltage

Procedure:

1. Connections are made as per the circuit for high pass and low pass filter.
2. The voltage in the audio frequency oscillator is adjusted for 2V.
3. The frequency is varied from 100 Hz to 10,000 Hz and the respective output voltage is taken for each frequency maintaining the input voltage constant.

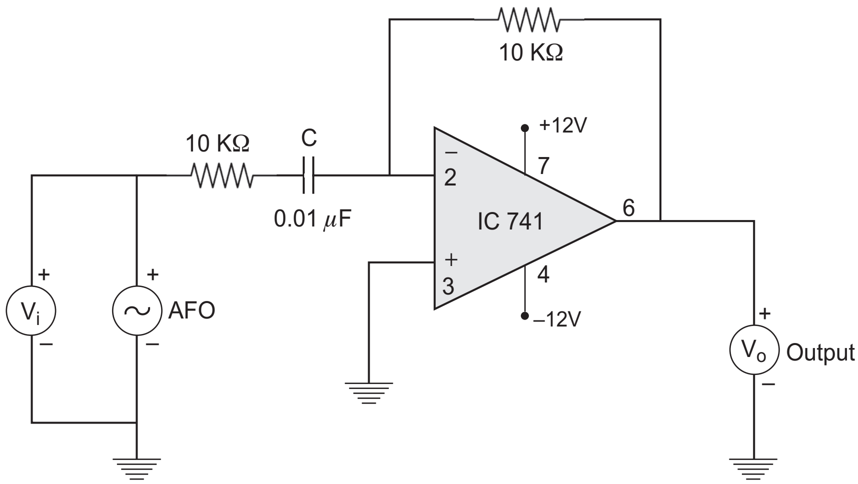
Table 5.14.1 Determination of Gain of Amplifier

High Pass Filter

Frequency (Hz)	Log f	Output voltage with feedback (V)	Gain $= \frac{V_{out}}{V_{in}}$

4. Gain in the amplifier is calculated using the formula.
5. Graph is drawn with the gain on the Y-axis and log f on the X-axis.
6. It is to be noted from the graph that high pass filter allows higher frequency voltages through it, which is seen from the constant gain band width for higher frequency.
7. For low pass filter the constant gain band width is observed for low frequency voltages.
8. The experimental value of the cut off frequency is compared with the theoretical value and noted in the result.

Circuit Diagram:

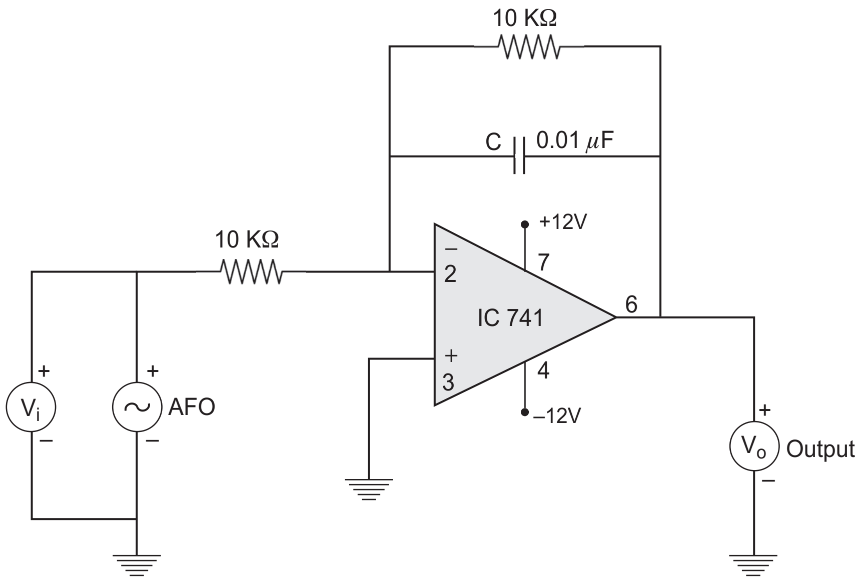


High pass filter

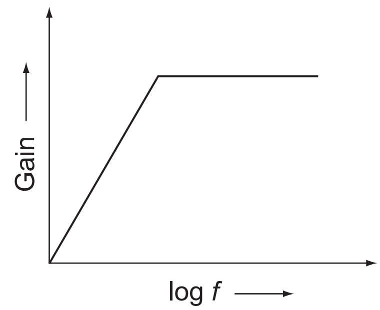
Table 5.14.2 Determination of Gain of Amplifier

Low Pass Filter $V_{in} = 2V$

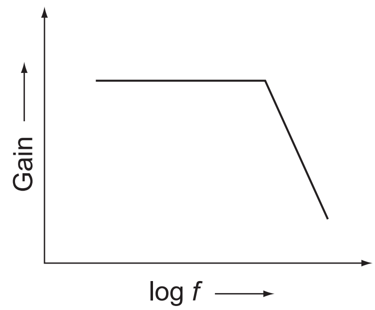
Frequency (Hz)	**Log f**	**Output voltage with feedback (V)**	**Gain = $\frac{V_{out}}{V_{in}}$**



Low Pass filter



Model graph for high pass filter



Model graph for low pass filter

Result:

i. For High pass filter,

Theoretical value of f_c = ____________________ Hz

Experimental value of f_c = ____________________ Hz

ii. For low pass filter,

Theoretical value of f_c = ____________________ Hz

Experimental value of f_c = ____________________ Hz.


Programming in
C++
C++
ATTENTION

Programming in C++

Subject Code: 18UPHCR5

CONTENTS

Program:

```
//pgm to perform arithmetic operations using do while loop
#include<iostream.h>
#include<conio.h>
void main()
{
float a,b,sum,diff,mul,div;
char ch;
clrscr();
do
{
cout<< "\n Arithmetic Operations" ;
cout<< "\n *****************" ;
cout<< "Enter the value of a:";
cin>>a;
cout<< "Enter the value of b:";
cin>>b;
sum = a+b;
diff = a – b;
mul = a*b;
div = a/b;
cout<< "Addition:" << sum;
cout<< "Subtraction:" << diff;
cout<< "Multiplication:" <<mul;
cout<< "Division:" <<div;
cout<< "Do you want to continue?";
cin>>ch;
while(ch=='y');
getch();
}
```

Ex.No: 1

Date:

SIMPLE ARITHMETIC OPERATIONS USING DO-WHILE LOOP

Aim:

To read any two numbers from the keyboard and perform simple arithmetic operations such as addition, subtraction, multiplication and division and display the result using do while loop.

Sample Data:

Manual Calculations:

Output Expected:

Result:

Thus the arithmetic operations are performed using do while loop.

Program:

```
// pgm to display the name of the day in a week using switch case statement
#include<iostream.h>
#include<conio.h>
void main()
{
int day;
clrscr();
cout<< "\n Displaying the name of the day" ;
cout<< "\n ***********************";
cout<< "Enter the number between 1 to 7:";
cin>>day;
switch(day)
{
case 1:
{
cout<< "\n The first day is Sunday.";
break;
}
case 2:
{
cout<< "\n The second day is Monday.";
break;
}
case 3:
{
cout<< "\n The third day is Tuesday.";
break;
}
```

Ex.No: 2

Date:

NAME OF THE DAY IN A WEEK USING SWITCH-CASE STATEMENT

Aim:

To display the name of the day in a week using switch case statement.

Sample Data:

Manual Calculations:

Output Expected:

```
case 4:
{
cout<< "\n The fourth day is Wednesday.";
break;
}
case 5:
{
cout<< "\n The fifth day is Thursday.";
break;
}
case 6:
{
cout<< "\n The sixth day is Friday.";
break;
}
case 7:
{
cout<< "\n The seventh day is Saturday.";
break;
}
default:
{
cout<< "\n Sorry. Invalid number.";
break;
}
}
getch();
}
```

Result:

Thus the name of the day in a week is displayed using switch case statement.

Program:

```
//pgm to check the validity of the entered character using nested if-else structure
#include<iostream.h>
#include<conio.h>
void main()
{
char i;
clrscr();
cout<<"\n CHECKING THE VALIDITY OF A CHARACTER";
cout<<"\n…………………………………………………………;
cout<<"\n ENTER ANY CHARACTER :";
cin>>i;
if(i>= 'A' &&i<= 'Z')
{
cout<<"\n The entered character is an uppercase alphabet.";
}
else
{
if(i>='a' &&i< ='z')
{
cout<<"\n The entered character is a lowercase alphabet.";
}
else
{
if (i>= '0' &&i<= '9')
{
cout<<"\n The entered character is a number.";
}
```

Ex.No: 3

Date:

VALIDITY OF THE ENTERED CHARACTER USING IF ELSE

Aim:

To check the validity of any entered character (whether it belongs to the alphabet set or a number or a special character) using if else structure.

Sample Data:

Output Expected:

```
else
{
cout<<"\n The entered character is a special character";
}
}
}
cout<<"\n………………………………………………..";
getch();
}
```

Result:

Thus the arithmetic operations are performed using do while loop.

Program:

```
//pgm to solve quadratic equation using nested if-else structure
#include<iostream.h>
#include<conio.h>
#include<math.h>
void main()
{
float a,b,c,x1,x2,rp,ip;
clrscr();
cout<< "\n SOLVING QUADRATIC EQUATION:"
cout<< "\n********************************:"
cout<< "Enter the values of a, b and c:";
cin>>a>>b>>c;
d = (b*b) – (4*a*c);
if(d>=0)
{
if(d>0)
{
x1=(-b+sqrt(d))/(2*a);
x2=(-b-sqrt(d))/(2*a);
cout<< "\n The Roots are Real and Distinct.";
cout<< "x1 = " << x1 << "\n";
cout<< "x2 = " << x2 <<  "\n";
}
else
{
x1=-b/(2*a);
x2=x1;
cout<< "\n The Roots are Equal.";
cout<< "x1 ="<< x1 << "\n";
cout<< "x2 ="<< x2 <<  "\n";
}
```

Ex.No: 4

Date:

QUADRATIC EQUATION

Aim:

To solve a quadratic equation using nested if else structure

Sample Data:

Manual Calculations:

```
}
else
{
rp=-b/(2*a);
ip= sqrt(abs(d))/(2*a);
cout<< "\n The Roots are Imaginary.";
cout<< "x1 =" <<rp<< "+" <<ip<< "i"<< "\n";
cout<< "x2 =" <<rp<< "-" <<ip<< "i"<<"\n";
}
getch();
}
```

Output Expected:

Result:

Thus the given quadratic equation is solved using nested if else structure.

Program:

a) **//pgm to find the sum of series 1+3+5+ ……. +n using for loop**

```
#include<iostream.h>
#include<conio.h>
void main()
{
clrscr();
int sum = 0, i, j = 1, p;
cout<< "/n………………………………….";
cout<< "/n SUM OF SERIES 1+3+5+…+n";
cout<< "/n………………………………….";
cout<< "/n Enter the number of terms:";
cin>>p;
for (i = 1; i<=p; i++)
 {
 sum = sum+j;
   j = j+2;
 }
cout<< "/n Sum of series 1+3+5+………… +n is:";
cout<<sum;
cout<< "/n……………………….";
getch();
}
```

Ex.No: 5

Date:

SUM OF SERIES USING FOR LOOP

Aim:

a) To find the sum of the series 1+3+5+……+n using for loop

Sample Data:

Manual Calculations:

Output Expected:

Program:

b) //pgm to find the sum of sine series

```
#include<iostream.h>
#include<conio.h>
void main()
{
clrscr();
int i, j, n, x1;
float sum,term,x,pie=3.14;
cout<< “/n...........................”;
cout<< “/n SUM OF SINE SERIES”;
cout<< “/n.................................”;
cout<< “/n Enter the number of terms:”;
cin>>n;
cout<< “/n Enter the value of angle:”;
cin>>x1;
x=(x1*pie)/180;
sum=x;
term=x;
j=3;
for (i=1; i<n; i++)
  {
  term = (- term*x*x)/(j*(j-1));
  sum = sum + term;
   j = j+2;
  }
cout<< “/n Sum of the sine series is :”<<sum;
cout<< “/n.......................................”;
getch();
}
```

Aim:

b) To find the sum of the Sine series $x - x^3/3! + x^5/5! \ldots\ldots.\ x^n/n!$ using for loop

Sample Data:

Manual Calculations:

Output Expected:

Program:

c) //pgm to find the sum of series 1^2+2^2+4^2 + … n^2 using for loop

```
#include<iostream.h>
#include<conio.h>
void maim()
{
int sum = 1, i, p, j = 0;
clrscr();
cout<< "/n………………………………………………….";
cout<< "/n SUM OF SERIES 1^2+2^2+4^2+………..+n^2";
cout<< "/n…………………………………………………..";
cout<< "/nEnter the number of terms:";
cin>>p;
for (i=1; i<=p; i++)
 {
  sum = sum + (j*j);
   j = j+2;
 }
cout<< "/n Sum of series 1^2+2^2+4^2+………..+n^2 is:";
cout<< sum;
getch();
}
```

Aim:

c) To find the sum of the series $1^2 + 2^2 + 4^2 + \ldots n^2$ using for loop

Sample Data:

Manual Calculations:

Output Expected:

Result:

Thus the sum of the series

a) $1 + 3 + 5 + \ldots\ldots n$

b) $x - x^3/3! + x^5/5! \ldots\ldots. x^n/n!$

c) $1^2 + 2^2 + 4^2 + \ldots\ n^2$ are found using for loop.

Program:

```
//pgm to perform addition of two matrices and display its transpose
#include<iostream.h>
#include<conio.h>
#include<math.h>
void main()
{
int i,j,m,n,A[20][20], B[20][20], C[20][20];
clrscr();
cout<< “MATRIX ADDITION AND ITS TRANSPOSE \n”;
cout<< “*************************************\n”;
cout<< “\n Type the order of the matrices:” ;
cin>>m>>n;
cout<< “\n Type the elements of matrix A in matrix form:” ;
for(i=0;i<m;i++)
{
for(j=0;j<n;j++)
{
cin>>A[i][j];
}
}
cout<< “\n Type the elements of matrix B in matrix form:” ;
for(i=0;i<m;i++)
{
for(j=0;j<n;j++)
{
cin>>B[i][j];
}
}
```

Ex.No: 6

Date:

MATRIX ADDITION AND ITS TRANSPOSE

Aim:

To perform Matrix addition and display its transpose

Sample Data:

Manual Calculations:

```
for(i=0;i<m;i++)
{
for(j=0;j<n;j++)
{
C[i][j] = A[i][j]+B[i][j];
}
}
cout<< “MATRIX ADDITION \n”;
cout<< “\n **************** \n:”
for(i=0;i<m;i++)
{
for(j=0;j<n;j++)
{
cout<<C[i][j]<< “\t”;
}
cout<< “\n”;
}
cout<< “MATRIX TRANSPOSE \n”;
cout<< “ **************** \n:”;
for(j=0;j<n;j++)
{
for(i=0;i<m;i++)
{
cout<<C[i][j]<< “\t”;
}
cout<< “\n”;
}
getch();
}
```

Output Expected:

Result:

Thus the matrix addition for given matrices is found out and its transpose is displayed.

Program:

```
//pgm to perform matrix multiplication
#include<iostream.h>
#include<conio.h>
#include<math.h>
void main()
{
int i, j, k, m, n, p, q, A[20][20], B[20][20], C[20][20];
clrscr();
cout<< "MATRIX MULTIPLICATION \n";
cout<< "************************\n";
XXX: cout<< "\n Type the order of the matrix A:";
cin>>m>>p;
cout<< "\n Type the order of the matrix B: " ;
cin>>q>>n;
if(p==q)
{
goto YYY;
}
else
{
goto XXX;
}
YYY: cout<< "\n Type the elements of matrix A in matrix form:";
for(i=0;i<m;i++)
{
for(j=0;j<p;j++)
{
cin>>A[i][j];
}
}
```

Ex.No: 7

Date:

MULTIPLICATION OF TWO MATRICES

Aim:

To read the elements of given two matrices of order mxn and to perform matrix multiplication.

Sample Data:

Manual Calculations:

```
cout<< "\n Type the elements of matrix B in matrix form:" ;
for(i=0;i<q;i++)
{
for(j=0;j<n;j++)
{
cin>>B[i][j];
}
}
for(i=0;i<m;i++)
{
for(j=0;j<n;j++)
{
C[i][j] = 0;
for(k=0;k<p;k++)
{
C[i][j] = C[i][j] +A[i][k]*B[k][j];
}
}
}
cout<< "RESULTANT MATRIX \n";
cout<< "\n ****************** \n:"
for(i=0;i<m;i++)
{
for(j=0;j<n;j++)
{
cout<<C[i][j]<< "\t";
}
cout<< "\n";
}
getch();
}
```

Output Expected:

Result:

Thus the matrix multiplication is performed.

Program:

a) //pgm to display the content of an array using pointer arithmetic

```
#include<iostream.h>
#include<conio.h>
void main()
{
inta[6] = {100, 200, 300, 400, 500, 600}, i, *p;
clrscr();
p= &a[0];
cout<< "DISPLAY OF AN ARRAY ELEMENTS \n";
cout<< "\n ******************************* \n:"
for(i=0;i<6;i++)
{
cout<<*p<< "\t";
p++;
}
getch();
}
```

Ex.No: 8

Date:

DISPLAY THE CONTENT OF AN ARRAY AND CURRENT DATE

Aim:

a) To display the content of an array using pointer arithmetic

Sample Data:

Manual Calculations:

Program:

b) //pgm to display the current date using class

```
#include<iostream.h>
#include<conio.h>
class date
{
private:
int day, month, year;
public:
void getdata()
{
cout<< “Enter the day, month and year: \n”;
cin>>day>>month>>year;
}
void display()
{
cout<< “The current date is  :”;
cout<<day<<”/”<<month<<”/”<<year<< “.”;
}
};
void main()
{
date d;
clrscr();
d.getdata();
clrscr();
cout<< “DISPLAYING THE CURRENT DATE\n”;
cout<< “\n ******************************** \n:”
d.display();
getch();
}
```

Aim:

a) To display the content of an array using pointer arithmetic

Sample Data:

Output Expected:

Result:

Thus (a) the content of an array using pointer Arithmetic is displayed and (b) the current date is displayed in the format dd/mm/yyyy.

Program:

```
// pgm to generate Fibonacci series using constructor
#include<iostream.h>
#include<conio.h>
class fibo
{
private:
int a, b, c;
public:
fibo( )
{
a=0;
b=1;
c=a+b;
}
void read();
void swap();
void display();
};
void fibo :: read( )
{
cout<< "\t"<<a<< "\t"<<b;
}
void fibo :: swap( )
{
a =b;
b =c;
c =a+b;
}
void fibo :: display( )
{
```

Ex.No: 9

Date:

FIBONACCI NUMBERS USING CONSTRUCTOR

Aim:

To generate the Fibonacci series using constructor

Sample Data:

Output Expected:

```
cout<< "\t"<<c;
}
void main( )
{
fibo f;
clrscr( );
int n;
cout<< "\n *****************";
cout<< "\n FIBONACCI SERIES";
cout<< "\n *****************";
cout<< "\n Enter the number of terms:" ;
cin>>n;
f.read( );
for (int i=2; i<n; i++)
{
f.display( );
f.swap( );
}
getch();
}
```

Manual Calculations:

Result:

Thus the Fibonacci series is generated using constructor.

Program:

```
//pgm to display the student details using inheritance
#include<iostream.h>
#include<conio.h>
class student
{
private:
char name[20], sex[20];
int rollno;
public:
void read ( )
{
cout<< "\n Enter the name:";
cin>>name;
cout<< "\n Enter the rollno:";
cin>>rollno;
cout<< "\n Enter the sex:";
cin>>sex;
}
void display ( );
};
class details:public student
{
private:
int ht, wt;
public:
void read1( )
{
read( );
cout<< "\n Enter the height:";
cin>>ht;
```

Ex.No: 10

Date:

STUDENT DETAILS USING INHERITANCE CONCEPT

Aim:

To read the following information from the keyboard to which the basic class consists of name, roll number and sex. The derived class contains the data members such as height and weight and display the contents of class using inheritance.

Sample Data:

Output Expected:

```
cout<< "\n Enter the weight :";
cin>>wt;
}
void display1( );
};
void student::display( )
{
cout<< "\t\n *****************";
cout<< "\t\n STUDENT DETAILS";
cout<< "\t\n *****************";
cout<< "\n Name :" <<name;
cout<< "\n Roll Number :" <<rollno;
cout<< "\n Sex :" <<sex;
}
void details::display1( )
{
display( );
cout<< "\n Height :" <<ht<< "cm";
cout<< "\n Sex :" <<wt<< "kg";
}
void main ( )
{
details d;
clrscr( );
d.read1( );
clrscr();
d.display1( );
getch();
}
```

Manual Calculations:

Result:

Thus the student details are displayed using inheritance.

Program:

```
//pgm to find the period of simple pendulum
#include<iostream.h>
#include<conio.h>
#include<math.h>
#define g 9.8
const float pie=3.14;
class period
{
private:
float l,T;
public:
void process (float l)
{
T=2*pie*sqrt(l/g);
}
void display( )
{
cout<< “\n The period of Simple Pendulum:”<<T<< “seconds”;
}
};
void main( )
{
period p;
clrscr( );
float l;
cout<< “\t\n SIMPLE PENDULUM”;
cout<< “\t\n ****************\n”;
cout<< “Enter the value of l:”;
cin>>l;
p.process(l);
p.display( );
getch( );
}
```

Ex.No: 11

Date:

PERIOD OF A SIMPLE PENDULUM

Aim:

To find the period of simple pendulum.

Sample Data:

Manual Calculations:

Output Expected:

Result:

Thus the period of simple pendulum is calculated.

Program:

```
//pgm to find the Young's modulus using uniform bending method
#include<iostream.h>
#include<conio.h>
#include<math.h>
#define g 9.8
class modulus
{
private:
float E;
public:
void process (float m, float a, float l, float b, float d, float y)
{
E = (3*m*g*a*pow(l,2))/(2*b*pow(d,3)*y);
}
void display( )
{
cout<< "\n Young's modulus of the Material ="<< E<< "N/sq.m";
}
};
void main( )
{
modulus y1;
clrscr( );
float m, a, l, b, d, y;
cout<< "\t\n YOUNG'S MODULUS – UNIFORM BENDING";
cout<< "\t\n *****************************************\n";
cout<< "\n Enter the values of m, a and l:";
cin>>m>>a>>l;
cout<< "\n Enter the values of b, d and y:";
cin>>b>>d>>y;
y1.process(m, a, l, b, d, y);
y1.display( );
getch( );
}
```

Ex.No: 12

Date:

YOUNG'S MODULUS - UNIFORM BENDING METHOD

Aim:

To calculate the young's modulus from the data obtained using uniform bending method.

Sample Data:

Manual Calculations:

Output Expected:

Result:

Thus the Young's modulus of the material using uniform bending method is calculated.

Program: (a) Immediate Addressing Mode for Addition

Memory Address	Mnemonics	Opcode	Remarks
2000	XRA A	AF	Clear the accumulator
2001	MVI B,	06	Move the data to Reg.B
2002			
2003	MVI C,	0E	Move the data to Reg.C
2004			
2005	ADD B	80	Add A and B
2006	ADD C	81	Add A and C
2007	STA 2030	32	Store the result in 2030 H
2008		30	
2009		20	
200A	HLT	76	End of the program

Address	Register	Input	Output
2002	B		
2004	C		

Ex.No: 13

Date:

ADDITION AND SUBTRACTION OF TWO HEXADECIMAL NUMBERS USING 8085 MICROPROCESSOR

Aim:

a) To write a program to add two hexadecimal numbers using 8085 microprocessor.

Apparatus Required:

8085 Microprocessor programming kit.

Sample Data:

Manual Calculations:

Program: (b) Indirect Addressing Mode for Addition

Memory Address	Mnemonics	Opcode	Remarks
2000	XRA A	AF	Clear the Accumulator
2001	LXI H, 2501H	21	Set HL as memory pointer
2002		01	
2003		25	
2004	MOV B, M	46	Move the content M to B
2005	INX H	23	Increment the register pair L
2006	MOV C,M	4E	Move the content M to C
2007	ADD B	80	Add B to A
2008	ADD C	81	Add C to A
2009	STA 2509 H	32	Store the result in 2509 H
200A		09	
200B		25	
200C	HLT	76	End of the program

Address	Register	Input	Output
2501	B		
2502	C		

Program: (a) Immediate Addressing Mode for Subtraction

Memory Address	Mnemonics	Opcode	Remarks
2000	XRA A	AF	Clear the accumulator
2001	MVI B,	06	Move the data to Reg.B
2002			
2003	MVI A,	3E	Move the data to Reg.A
2004			
2005	SUB B	90	Subtract B from A
2006	STA 2030	32	Store the result in 2030 H
2007		30	
2008		20	
2009	HLT	76	End of the program

Address	Register	Input	Output
2002	B		
2004	C		

Aim:

b) To write a program to subtract two hexadecimal numbers using 8085 microprocessor.

Sample Data:

Manual Calculations:

Program: (b) Indirect Addressing Mode for Addition

Memory Address	Mnemonics	Opcode	Remarks
2000	XRA A	AF	Clear the Accumulator
2001	LXI H, 2501H	21	Set HL as memory pointer
2002		01	
2003		25	
2004	MOV A, M	46	Move the content M to A
2005	INX H	23	Increment the register pair L
2006	MOV B,M	46	Move the content M to B
2007	SUB B	90	Subtract B from A
2008	STA 2509 H	32	Store the result in 2509 H
2009		09	
200A		25	
200B	HLT	76	End of the program

Address	Register	Input	Output
2501	B		
2502	C		

Result:

Thus the program to add and subtract of two hexa decimal numbers using 8085 microprocessor are executed.

Program: (a) Performing ORA function

Memory Address	Mnemonics	Opcode	Remarks
2000	MVI B,	06	Move the data to Reg.B
2001			
2002	MVI C,	0E	Move the data to Reg.C
2003			
2004	MOV A,B	78	Move the content B to A
2005	ORA C	B1	Logically ORing the datas in Regs. A and C
2006	STA 2100H	32	Store the result in 2100 H
2007		00	
2008		21	
2009	HLT	76	End of the program

Address	Input
2001	
2003	

Address	Output
2100	

Ex.No: 14

Date:

PERFORM ORA B, XRA B AND CMA FUNCTIONS USING 8085 MICROPROCESSOR

Aim:

a) To write a program to perform the instruction ORA using 8085 microprocessor.

Apparatus Required:

8085 Microprocessor programming kit

Sample Data:

Manual Calculations:

Program: (b) Indirect Addressing Mode for Addition

Memory Address	Mnemonics	Opcode	Remarks
2000	MVI B,	06	Move the data to Reg.B
2001			
2002	MVI C,	0E	Move the data to Reg.C
2003			
2004	MOV A,B	78	Move the content B to A
2005	XRA C	A9	Logically Exclusive ORing the datas in Regs. A and C
2006	STA 2100H	32	Store the result in 2100 H
2007		00	
2008		21	
2009	HLT	76	End of the program

Address	Input
2001	
2003	

Address	Output
2100	

Aim:

b) To write a program to perform the instruction XRA using 8085 microprocessor.

Sample Data:

Manual Calculations:

Program: (c) Finding one's complement of a number using CMA

Memory Address	Mnemonics	Opcode	Remarks
2000	LDA 2100 H	3A	Load the input in the address 2100 H
2001		00	
2002		21	
2003	CMA	2F	Complement of the input
2004	STA 2200H	32	Store the result in 2200 H
2005		00	
2006		22	
200B	HLT	76	End of the program

Address	Input
2100	

Address	Output
2200	

Aim:

c) To find the 1's complement of the number stored at memory location 2100H and store the complement number at memory location 2200 H using the instruction CMA.

Sample Data:

Manual Calculations:

Result:

Thus the program to perform the logical operations such as ORA, XRA and CMA are executed.

St. Mary's College founded in the year 1948, with just 21 students has grown multifold nurturing around 3000 students at present. The institution is committed to the noble cause of liberating young women, especially the ones belonging to coastal areas and preparing them to assume leading roles in making societal changes. Most of the students who have passed out from the institution and scaled greater heights are first generation learners. St. Mary's owns the proud privilege of educating such young women.

St. Mary's College (Autonomous) sent the proposal for Star College Scheme on 10th May 2018. The funds under Star College scheme was sanctioned on 16th March 2019. Four departments of the college namely Physics, Chemistry, Botany and Zoology have been recommended by the Department of Biotechnology (DBT), Ministry of Science & Technology, Government of India, New Delhi, to receive financial assistance under the Star College Scheme. For implementation of the Star College Scheme, the DBT, New Delhi has sanctioned 82 Lakhs.

The objective of the Star College Scheme is to strengthen Life Science and Biotechnology education and training at the undergraduate level to encourage and attract students to pursue a career in Life Sciences.

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Phone: 044 2247 0770, 94440 40272
Email: cbapublisher@gmail.com

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