Manonmaniam Sundaranar University,

Directorate of Distance & Continuing Education,

Tirunelveli - 627 012 Tamilnadu, India

OPEN AND DISTANCE LEARNING (ODL) PROGRAMMES

(FOR THOSE WHO JOINED THE PROGRAMMES FROM THE ACADEMIC YEAR 2023–2024)

B.Sc. Mathematics

Course Material

Allied Physics Practical - II

JEPHP2

Prepared

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Tirunelveli - 12

ALLIED PHYSICS PRACTICAL – II

JEPHP2

1. Radius of curvature of lens by forming Newton's rings

Aim

To determine the radius of curvature of lens by forming Newton's rings

Apparatus required

Sodium lamp, convex lens, Plano convex lens, Travelling microscope, Plane glass plate.

Formula

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

Where;

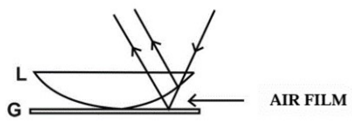
R = Radius of curvature of the curved face of the plano-convex lens

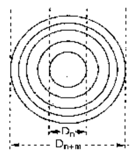
m = An integer number (of the rings)

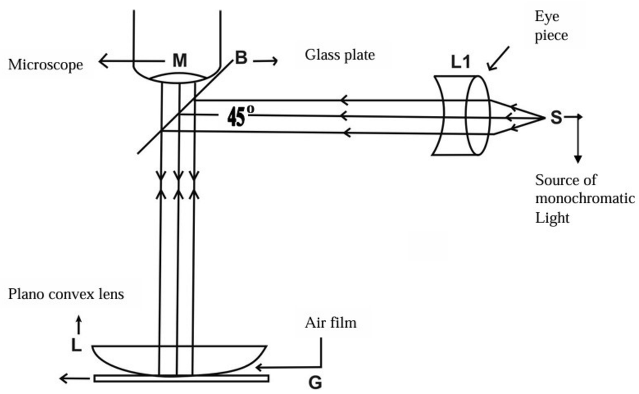
D_n = diameter of n^{th} ring

D_m = diameter of m^{th} ring

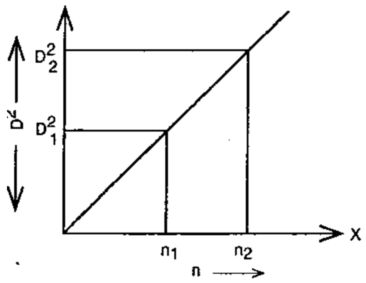
Experimental setup







Model graph



Graph between n and D²

Observation

Mean wavelength of sodium light (λ) = 5893 Å

Table 1 - Measurement of the diameter of the rings

Ring No (n)	Reading of the microscope						Diameter D_n (R_l - R_r) (cm)	D_n^2 (cm^2)
	Left			Right				
	Main scale (cm)	Vernier scale (cm)	Total (R_l) (cm)	Main scale (cm)	Vernier scale (cm)	Total (R_r) (cm)		
10								
8								
6								
4								
2								

Table 2 - To draw the graph of diameter² vs Ring No

Ring No(n)	D_n (cm)	D_n^2 (cm^2)
10		
8		
6		
4		
2		

Procedure

1. Level the traveling microscope.
2. Adjust the positions of the Collimating Convex Lens and Plano Convex Lens (Newton's
3. Apparatus) on the wooden platform to form the Newton's Ring.
4. Place the crosswire of the eyepiece of the traveling microscope on the tangent position of
5. the 10th dark ring at the left position from the center ring.
6. Take the scale reading on the horizontal scale of the traveling microscope.
7. By only using the tangent screw of the traveling microscope place the crosswire on the 8th
8. dark ring and record the scale reading on the horizontal scale of the traveling
9. microscope.
10. Repeat the step (5) for 6th, 4th and 2nd dark rings.
11. Now place the crosswire of the eyepiece on the tangent position of the 2nd dark ring at the
12. right side from the center ring.
13. Take the scale reading on the horizontal scale of the traveling microscope.
14. Repeat the step (7) and step (8) for 4th ,6th ,8th and 10th dark rings at the right-hand side.
15. Calculate diameter of the rings from Table 1.

Calculation

n-m = 2

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

Result

The radius of curvature of lens by forming Newton's rings**(R) =** **cm**

2. Thickness of a wire using air wedge

Aim

To determine the thickness of a wire using air wedge.

Apparatus required

Travelling microscope, optically plane glass plates, A thin wire, Sodium vapour lamp, Reading lens, Scale.

Formula

Thickness of the given wire,

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

Where;

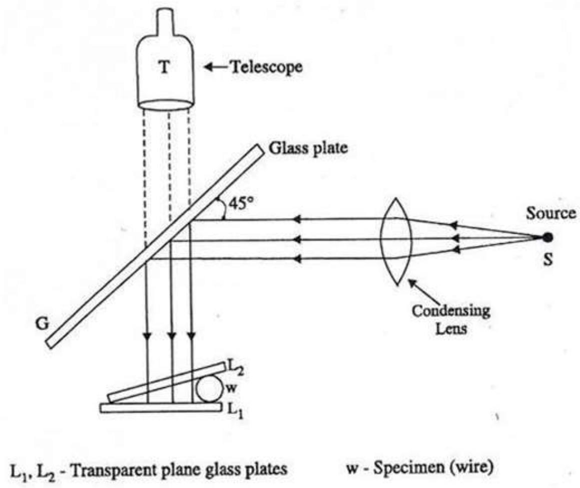
t - thickness of the given wire in m

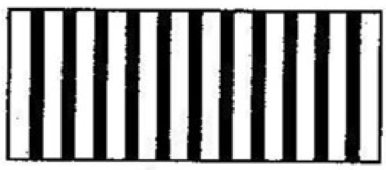
L - distance between the tied end and the thin wire in m

λ - wavelength of sodium vapor light in m

β - fringe width in m

Experimental setup





Observation

Length of the air wedge	L =		$\times 10^{-2}$ m
Wavelength of the sodium light	λ =	5893	$\times 10^{-10}$ m
Band width	β =		$\times 10^{-2}$ m

Table

To determine the fringe width (β)

LC = 0.001cm TR = MSR + (VSC × LC)

Order of fringes	Microscope reading			Width for 5 fringes (10^{-2} m)	Fringe width β (10^{-2} m)
	MSR (10^{-2} m)	VC (div)	TR (10^{-2} m)		

Procedure

1. Two optically plane glass plates are placed one over the other and tied at one end.
2. The given wire is introduced near the other end, so that an air wedge is formed.
3. The distance between the wire and the tied end (L) is measured using a scale.
4. Light from a sodium vapour lamp is incident on a plane glass plate inclined at 45^0C to
5. the horizontal.
6. The reflected light from the plane glass plate is incident normally on the optically
7. plane glass plates forming the air wedge and reflected back.
8. The reflected light from the air-wedge is viewed through the eye-piece of a
9. microscope. The microscope is moved up and down and adjusted for clear
10. interference fringes of alternate dark and bright.
11. The microscope is fixed so that the vertical cross-wire coincides with the dark band
12. (say nth band) and the reading is noted.
13. The microscope is moved across the fringes and readings are noted when the vertical
14. cross-wire coincides with the (n+5)th, (n+10)th….. dark bands.
15. The observed readings are tabulated and the band width ((β) is calculated.
16. The thickness of the given wire/thin-sheet is calculated using the formula.

Calculation

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

Result

The thickness of a thin wire using air wedge method **(t) =** **m**

3. Wave length of mercury lines using spectrometer and grating

Aim

To determine the wave length of mercury lines using spectrometer and grating

Apparatus required

Spectrometer, plane transmission grating, sodium vapour lamp, mercury vapour lamp, reading lens

Formula

Wavelength of lines in mercury spectrum,

$$\boldsymbol{\lambda = \frac{\sin\theta}{Nn}\ (m)}$$

Where;

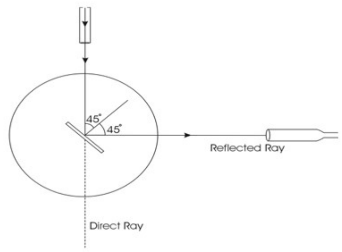
θ =angle of diffraction in degrees

N = order of diffraction (spectrum)

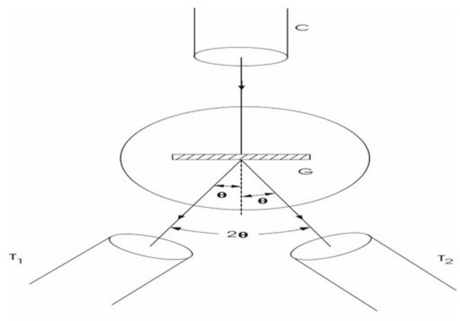
n = number of lines per meter in the grating

Experimental setup

Normal incidence



Spectral lines



Observation

Order of diffraction (n) =

Number of lines per meter in the grating (N) = lines/m

Angle of diffraction in degrees for violet line (θ) =

Table

Colour of Light	Diffracted Ray Reading (Degree)												Difference 2θ (Degree)			θ (Degree)
	Left						Right									
	Vernier A			Vernier B			Vernier A			Vernier B						
	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR	MSR	VSC	TR	VER A	VER B	Mean	
Blue																
Green																
Yellow																
Red																

Procedure

1. The telescope is turned towards a distant object and its focusing screw is adjusted till the image of the object is clearly seen. In this position, the telescope is capable of receiving parallel rays.
2. The slit is illuminated with sodium vapour lamp or Hg vapour lamp. The telescope is turned so that the telescope and the collimator are in a line. In this position one can see the image of the slit through the telescope. The clear image of the slit is obtained by adjusting the collimator screw. The slit must be adjusted to be narrow and vertical.
3. This is done with a spirit level. The spirit level is kept on the prism table and the three levelling screws of the prism table are adjusted till the air bubble comes to the centre.
4. After making the initial adjustments, the plane transmission grating is mounted on the grating table.
5. The telescope is released and placed in front of the collimator. The direct reading is taken after making the vertical cross-wire to coincide with the fixed edge of the image of the slit which is illuminated by a source of light.
6. The telescope is then rotated by an angle 90^0 (either left or right) and fixed.
7. The grating table is rotated until on seeing through the telescope the reflected image of the slit coincides with the vertical cross-wire. This is possible only when a light emerging out from the collimator is incident at an angle 45^0 to the normal to the grating.
8. The vernier table is now released and rotated by an angle 45^0 towards the collimator. Now light coming out from the collimator will be incident normally on the grating
9. The slit is now illuminated by white light from mercury vapour lamp.
10. The central direct image will be an undispersed image. The telescope is moved to either side of the direct image, the diffraction pattern of the spectrum of the first order and second order are seen.

11. The readings are taken by coinciding the prominent lines namely violet, green, yellow and red with the vertical cross wire. The readings are tabulated and from this, the angles of diffraction for different colours are determined. The wavelengths for different lines are calculated by using the given formula. The number of lines per metre in grating is assumed.

Calculation

Wavelength of violet $\lambda_v = \frac{\sin}{Nn}\ (m)$

Result

Wavelength of mercurylines using spectrometer and grating were tabulated

Spectral line colour	Wavelength $(10^{-10}m)$
Violet	
Blue	
Green	
Yellow 1	
Yellow 2	
Red	

4. Refractive index of material of the lens by minimum deviation

Aim

To determine the refractive index of material of the lens by minimum deviation

Apparatus required

Spectrometer, prism lens, sodium vapour lamp, mercury vapour lamp, reading lens.

Formula

Refractive index of the material of the prism,

$$\mu = \frac{\sin i}{\sin r}$$

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

Where;

i, r = incident and refracted angle

A = Angle of prism

D = Angle of minimum deviation

Experimental setup

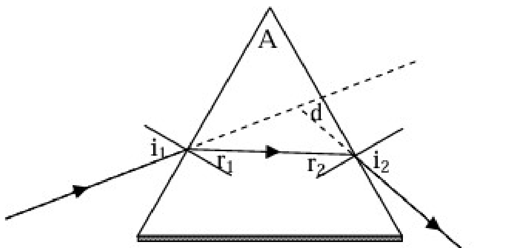


Fig:a

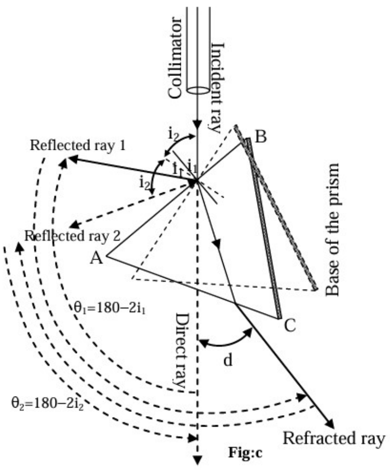


Fig:c

Observation

Value of one main scale division (1 m s d) =

Number of divisions on the vernier n =

Least count (L C) $= \frac{\text{Value of 1 m s d}}{\text{n}} =$

[One degree = 60 minute, (1° = 60′)]

Table

Angle of incidence ‘i’	Direct reading	$\theta=180^0-2i$	Reading corresponding to refracted ray ‘a’						Reading corresponding to refracted ray ‘b’						Angle of minimum deviation d=a-b		
			VER 1			VER 2			VER 1			VER 2					
			MSR	VSR	TR	MSR	VSR	TR	MSR	VSR	TR	MSR	VSR	TR	VER 1	VER 2	MEAN
35																	
40																	
45																	
50																	
55																	

Procedure

1. Align the telescope parallel to the collimator and note the reading on one of the verniers.
2. Rotate the telescope by an angle θ = 180° - 2i and clamp it.
3. Place the prism on the prism table with face AB towards the collimator.
4. Adjust the prism table until the image of the slit reflected from face AB aligns with the vertical cross wire and clamp it.
5. Set the prism for the angle of incidence i.
6. Release the telescope, aim it towards the refracted ray, and note the readings on both verniers as 'a'.
7. Realign the telescope with the collimator to obtain the direct image of the slit and note the readings on both verniers as 'b'.
8. Calculate the difference between 'a' and 'b' to find the angle of deviation.
9. Repeat the process for different angles of incidence, such as i = 40°, 45°, 50°, etc.

Note:

- For prisms with refractive indices around 1.5 to 1.6, the range of angles of incidence (i) is typically 35° to 65°.
- For prisms with refractive indices around 1.6 to 1.7, the range of angles of incidence (i) is typically 40° to 70°.

Calculation

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

Result

Angle of prism **A =**

Refractive index of material of the prism lens $\boldsymbol{\mu}$ =

5. Refractive index of liquid using liquid prism

Aim

To determine the refractive index of liquid using liquid prism

Apparatus required

Spectrometer, sodium vapour lamp, reading lamp, reading lens, spirit level, hollow glass prism, and the given liquid.

Formula

Refractive index of the liquid,

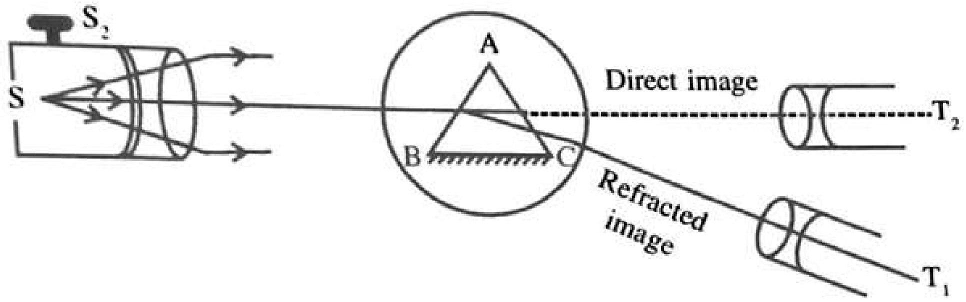
$$\mu = \frac{\sin\frac{A+D}{2}}{\sin\frac{A}{2}}$$

Where;

A = Angle of the prism

D = Angle of minimum deviation

Experimental setup



Observation

Value of one main scale division = degree= minute

Number of divisions on the vernier, n =

Least count (LC) = = minute

Table - To find angle of the prism (A)

	Vernier 1			Vernier 2			2A (X_1- X_2)		A	
	MSR	VSR	TR	MSR	VSR	TR	VER 1	VER 2	VER 1	VER 2
Reading of the image reflected from face AB (X_1)										
Reading of the image reflected from face AC (X_2)										

$$A = \frac{VER\ 1 + VER\ 2}{2}$$

	Vernier 1			Vernier 2			2D (X_1- X_2)		D	
	MSR	VSR	TR	MSR	VSR	TR	VER 1	VER 2	VER 1	VER 2
Reading of the image reflected from face AB (X_1)										
Reading of the image reflected from face AC (X_2)										

$$D = \frac{VER\ 1 + VER\ 2}{2}$$

Procedure

1. Mount the prism on the prism table with its base towards the clamp.
2. Rotate the prism table to ensure symmetric illumination on faces AB and AC from the collimator.
3. Clamp the vernier table in place.
4. Adjust the telescope to view the image of the slit reflected from face AB, then clamp the telescope.
5. Without disturbing the setup, adjust to view the image of the slit reflected from face AC. If the arrangement is disturbed, return to face AB and readjust.
6. Bring the telescope back to face AB to view the brightest image of the slit and clamp it.

7. Align the cross wire of the telescope with the image using the tangential screw. Ensure alignment at the center of the image if the slit is narrow, or at the fixed edge if the slit is wider.
8. Note the readings of the circular scale and coinciding vernier divisions on both verniers. Calculate the total reading.
9. Unclamp the telescope and bring it to face AC to view the image of the slit.
10. Clamp the telescope and adjust the cross wire to coincide with the image using the tangential screw. Note the corresponding readings on both verniers and calculate the total readings for each.
11. The difference in readings between verniers on faces AB and AC yields twice the angle of the prism.
12. Find the mean value of the angle of the prism A from the obtained readings.
13. Set the prism in the minimum deviation position by placing prism ABC on the prism table and ensuring light from the collimator falls on face AC at an acute angle.
14. Observe the spectrum through face AB while gradually rotating the prism table; the spectral line shifts due to changing angles of incidence and deviation.
15. Identify the position where the spectral line becomes stationary upon rotation, indicating the minimum deviation position.
16. Fix the prism table once the spectral line appears stationary to establish the minimum deviation position.
17. Turn the telescope to position T so its cross wire aligns with the image of the slit, achieved by fixing the telescope and using the tangential screw for fine adjustments.
18. Record main scale readings and vernier scale coincidence divisions for both verniers, calculating the total reading for each vernier as usual.

Calculation

$$\mu = \frac{sin\frac{A+D}{2}}{\sin\frac{A}{2}}$$

Result

The refractive index of the given liquid $\boldsymbol{\mu}$ =

6. Determination of AC frequency using sonometer

Aim

To determine the frequency of AC with the help of Sonometer.

Apparatus required

Sonometer with non-magnetic wire (Nichrome), Ammeter, step down transformer (2-10 Volts), Key, Horse shoe magnet, Wooden stand for mounting the magnet, set of 50 gm masses, screw gauge and meter scale (fitted with the sonometer).

Formula

Frequency of AC,

$$n = {}^{1}/_{2l}\sqrt{\frac{T}{M}}$$

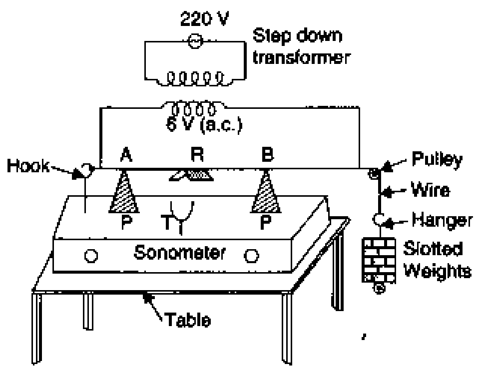
Tension T = Mg

Mass per unit length m = $\pi r^2 d$

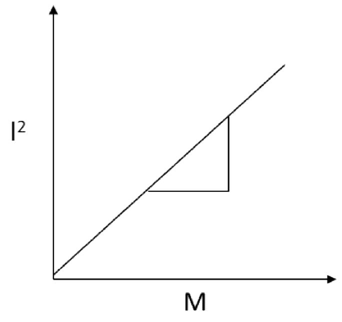
Where;

l	-	Length of the sonometer wire between two bridges.
M	-	Total mass loaded on the wire.
d	-	density of the wire (Nichrome).
r	-	Radius of the sonometer wire.
π	-	3.14
g	-	Acceleration due to gravity.

Experimental setup



Model graph



Observation

Mass of the hanger = 50 gm

Acceleration due to gravity (g) = 980 cm/sec2.

Density of sonometer wire (nichrome) = 8.18848 gm/cc

Table 1

Measurement of radius of sonometer wire (r)

Least count of screw gauge = cm

Zero error of the screw gauze = cm

S.No	(PSR) in mm	(HSC) in div	HSR= (HSC×LC)	Observed reading OR=PSR+HSR	Correct Reading =OR±ZC
1					
2					
3					
4					
5					

Table 2

Measurement of T, l and frequency of the AC Mains

SI.No.	Total Mass Loaded = Mass of hanger + Mass on its M (gm)	Tension in wire T = Mg (gm cm/s2)	Position of first bridge a (cm)	Position of second bridge b (cm)	Length of wire between two bridges l=a-b (cm)	Frequency (Hz)
1.						
2.						
3.						
4.						
5.						

Mean frequency = Hz

Procedure

1. Measure the diameter of the wire with screw gauze at several points along its length. At each point two mutually perpendicular diameters 90 should be measured. Evaluate the radius of the sonometer wire.
2. Connect the step-down transformer to AC mains and connect the transformer output (6 Volts connection) to the two ends of the sonometer wire through a rheostat, ammeter and a key, as shown in the figure.
3. Place the two movable sharp-edged bridges A and B at the two extremities of the wooden box.
4. Mount the horse shoe magnet vertically at the middle of the sonometer wire such that the wire passes freely in between the poles of the magnet and the face of the magnet is normal to the length of the wire. The direction of current flowing through the wire will now be normal to the magnetic field.
5. Apply a suitable tension to the wire, say by putting 100 gm masses on the hanger [tension in the wire = (mass of the hanger + mass kept on the hanger) .g]. Switch on the mains supply and close the key K and then adjust the two bridges A and B till the wire vibrates with the maximum.
6. Amplitude (in the fundamental mode of resonance) between the two bridges. Measure the distance between the two bridges.
7. Increasing the load M by steps of 50 gm, note down the corresponding values of l for maximum amplitude (in the fundamental mode of resonance). Take six or seven such observations.
8. Knowing all the parameters, using the relations given in equations 1 and 2 calculate the frequency of AC mains for each set of observation separately and then take mean.
9. Also plot a graph between the mass loaded, M along the X-axis and the square of the length (l_2) along Y-axis. This graph should be a straight line. Find the slope of this line and then using the equations 1 and 2, calculate the frequency of AC mains from this graph also.

Frequency(n) = $\sqrt{\frac{g}{4 \times slope \times m}}$

Calculation

Experimental

$$n = {}^{1}/_{2l} \sqrt{\frac{T}{M}}$$

Graphical

Frequency (n) = $\sqrt{\frac{g}{4 \times slope \times m}}$

Result

The frequency of AC as calculated,

Experimental calculations	=		**Hz.**
Graphical calculations	=		**Hz.**
Standard Value	=	**50**	**Hz.**

7. Specific resistance of a wire using PO box

Aim

To determine the specific resistance of a wire using PO box

Apparatus required

APostOfficebox, Wheatstonebridge, variableresistances, galvanometer, voltage source, connecting wires etc.

Formula

Wheatstone bridge balancing resistance,

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

Specific resistance of the wire,

$$R_x = \frac{R_2}{R_1} R_3$$

Where;

R1 = Known resistance in ohm

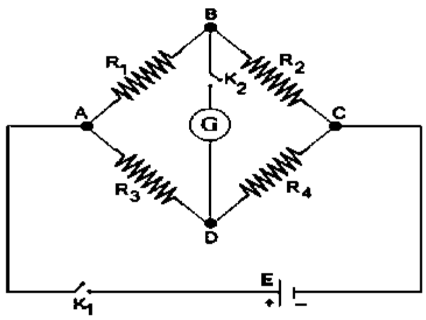
R2 =Known resistance in ohm

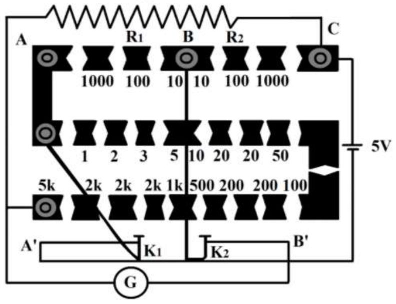
R3 = Known resistance in ohm

R4 = Known resistance in ohm

Rx = Unknown resistance in ohm

Experimental setup





Observation

Table -Determination of R_x for different values of the ratio R_1/R_2

S.No	R_1 Ω	R_2 Ω	R_3 Ω							$R_x = \frac{R_2}{R_1} R_3$ Ω
			$\times 0.1$	$\times 1.0$	$\times 10$	$\times 100$	$\times 1000$	$\times 10\,k$	Total (R_3)	
1.	10	10								
2.	10	100								
3.	10	1000								
4.	100	10								
5.	1000	10								

Procedure

1. Connect the-ve terminal of the DC voltage to 'I' terminal and the +ve terminal to 'J' terminal of the bridge
2. Connect Galvanometer's +ve and-ve terminals to M and N terminals respectively
3. Connect K &Lterminals of variable resistance to E & G (R_3) terminals of bridge.
4. Connect O &Pterminals of unknown resistance to H & F (R_x) terminals of bridge.
5. Set all rotaries at 0Ω.
6. Keep the key K_1 in 'Off' position.
7. Switch 'On' power.
8. Set the resistance Rx at an some value (preferably below 1 k) by rotating its dial Knob.
9. Then set resistances R_1 and R_2 at 10Ω.
10. Switch on the key K_1 and observe the deflection on galvanometer.
11. Adjust the value of R_3 in steps of 0.1Ω , 1 Ω,10Ω ,100Ω ,1000Ω ,10k aspertherequire ment beginning from zero, till the null point is obtained in the galvanometer.
12. Note down the value of R_3 in the given observation table.
13. Change the ratio R_1/R_2 to 1/10 by setting R_1 =10Ω and R_2 =100Ω. Repeat steps 11-12.
14. Change the ratio R_1/R_2 to 1/100 by setting R_1 = 10Ω and R_2 = 1000Ω. Repeat steps 11-12.
15. Change the ratio R_1/R_2 to 10 by setting R_1 =100Ω and R_2 =10Ω. Repeat steps 11-12.
16. Change the ratio R_1/R2 to 100 by setting R_1 =1000Ω and R_2 =10Ω. Repeat steps 11-12.
17. For each of ratios R_1/R_2, calculate R_x
18. Find the mean R_x from the above values.
19. Determine the theoretical value of Rx with the help of dial knob as follows. Here the dial knob can rotate 10 times corresponding to 0 to 10 numbers, it is said to be main

scale reading. A unit main scale reading corresponds to 1000Ω. Its each rotation has 50 divisions and is said to be circular scale reading (least count = 10Ω). For example, if there are 5 rotations by main scale it means the resistance on main scale is 5×5000Ω . If the circular scale is at 30, it means the additional resistance on the circular scale is 30×10Ω . Andthe value of Rx is 5000 Ω +300Ω =5300 Ω.

20. Compare the the theoretical value of Rx with the experimentally obtained value.

Calculation

Main scale reading of the dial knob, m	=	
Circular scale reading of the dial knob, c	=	
Theoretical R_x = (m 1000+c 10)	=	Ω
Experimental from table 1 R_x	=	Ω

Result

Specific resistance of a wire $\mathbf{R_X}$ = Ω

8. Thermal conductivity of poor conductor using Lee's disc

Aim

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

Apparatus required

1. Lee's disc apparatus
2. Bad conductor in the form of thin disc
3. Steam generator
4. Two thermometers of 110^0 C range
5. Stop watch
6. Screw gauge
7. Rough balance.

Formula

The thermal conductivity of bad conductivity,

$$k = \frac{MS\left(\frac{d\theta}{dt}\right) d(r + 2h)}{\pi r^2(\theta_1 - \theta_2)(2r + 2h)} (wm^{-1}k^{-1})$$

Where;

M - Mass of the metallic disc in kg.

S - Specific heat capacity of the material of the disc in Jkg -1K-1.

$(\frac{d\theta}{dt})$ - Rate of cooling at steady temperature in K/s.

θ1 - Steady temperature of a steam chamber K.

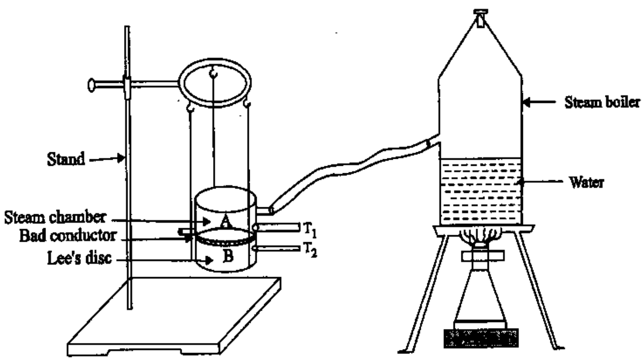
θ2 - Steady temperature of the metallic disc K.

r - Radius of the metallic disc m.

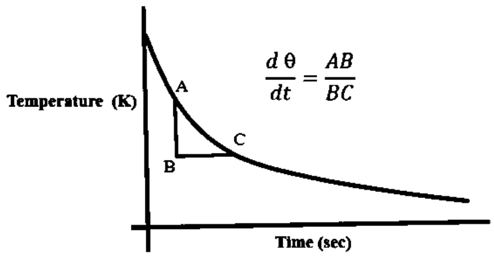
h - Thickness of the metallic disc m.

d - Thickness of the bad conductor m.

Experimental setup



Model graph



From graph, $\left(\frac{d\theta}{dt}\right)$ = 0.036 K/s

Observation

Steady temperature of steam chamber	θ1 =	________________K
Steady temperature of the metallic disc	θ2 =	________________K
Mass of the metallic disc	M =	________________x 10^{-3}kg
Specific heat capacity of the metallic disc	S =	________________$Jkg^{-1}K^{-1}$
Thickness of the bad conductor	d =	________________x 10^{-3} m
Thickness of the metallic disc	h =	________________x 10^{-3} m
Radius of the metallic disc	r =	________________x 10^{-2} m
Mean rate of fall of temperature at a mean	$\left(\frac{d\theta}{dt}\right)$ =	________________(K/s)

Table 1:

To measure the thickness of the given bad conductor (d) using screw gauge

Least Count = 0.01 mm   Zero Error (ZE):   division

Zero Correction (ZC):   mm

S.No	(PSR) in mm	(HSC) in div	HSR= (HSC×LC)	Observed reading OR=PSR+HSR	Correct Reading =OR±ZC
1					
2					
3					
4					
5					

Mean d = ___ x 10^{-3} m

Table 2:

To determine the thickness of the metallic disc (h) using screw gauge

Least Count = 0.01 mm Zero Error (ZE): division

Zero Correction (ZC): mm

S.No	(PSR) in mm	(HSC) in div	HSR= (HSC×LC)	Observed reading OR=PSR+HSR	Correct Reading =OR±ZC
1					
2					
3					
4					
5					

Mean d = ___ x 10^{-3} m

Table 3:

To determine the rate of cooling of disc at θ

S. No.	Temperature in K	Time in Sec
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Procedure

1. Allow the steam to pass through the inlet of the vessel B and it escapes out through the outlet. The temperature indicated by the two thermometers will start rising.
2. After the steady state is reached (there will be no change in the temperature with time), the temperatures in both the thermometers are noted as θ1and θ2respectively. This is the static part of the experiment.
3. The bad conductor is removed by gently lifting the upper steam chamber. Now the lower metallic disc is allowed to be directly in contact with the steam chamber.
4. When the temperature of the lower disc attains a value of about 10^0 C more than its steady state temperature ($\theta 2$), the steam chamber is then removed and the lower metallic disc is allowed to cool down on its own.
5. A stop watch is started when the temperature is 5ºC above the steady temperature θ2 and time is noted for every 1ºC fall in temperature until the metallic disc attains 5ºC below θ2.
6. A graph between temperature and time is drawn. Rate of cooling dθ/dt at θ2 is calculated from the graph.
7. The mass of the disc (M) is found using rough balance and the thickness (d) of the bad conductor and thickness of the metallic disc (h) are measured using screw gauge.

Calculation

$$k = \frac{MS\left(\frac{d\theta}{dt}\right)d(r+2h)}{\pi r^2(\theta_1-\theta_2)(2r+2h)} wm^{-1}k^{-1}$$

Result

Thermal conductivity of the given bad conductor, by lee's disk method **K = Wm^{-1}K^{-1}.**

9. Determination of figure of meritablegalvanometer

Aim

To determine the internal resistance of a galvanometer by half deflection method, and to find its figure of merit.

Apparatus required

A battery, a galvanometer (pointer type), 5000ohm resistance box, 100ohm resistance box, two one-way keys, D.C.C. copper wire for making connections and sand paper.

Formula

Galvanometer resistance G,

$$G = \frac{RS}{R - S}\ (\Omega)$$

Figure of merit K,

$$K = \frac{E}{(R + G)\theta}(amp/div)$$

Where;

θ = defelection in galvanometer

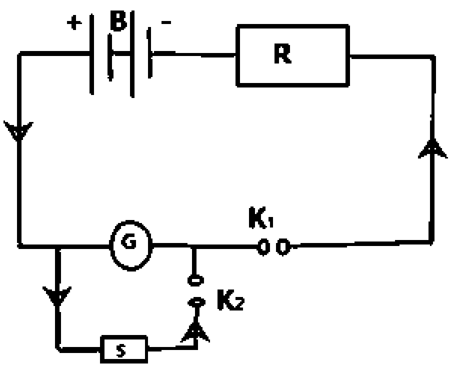
R = resistance from resistance box

S = shunt resistance

E = emf of the cell

Experimental setup

Circuit diagram



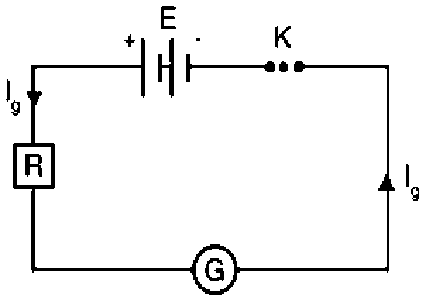


Fig. of merit of galvanometer

Observation

Table 1- Resistance of the Galvanometer by Half Deflection Method

No.of. Obs	Resistance R (ohm)	Deflection in galvanometer θ	Shunt resistance S (ohm)	Half deflection $\theta/2$	Galvanometer resistance $G = \frac{RS}{R-S}$ (Ω)
1.					
2.					
3.					
4.					

Table 2 - Figure of Merit

No.of. Obs	Number of cells	e.m.f. of the cells E(V) or reading of battery	Resistance from R.B. R (ohm)	Deflection θ (div)	Figure of merit $K = \frac{E}{(R+G)\theta}$ (amp/div)
1.					
2.					
3.					
4.					

Procedure

1. Draw the circuit diagram as shown in Fig. and make the connection accordingly.
2. See that plugs of the resistance boxes are tight.
3. Take out the high resistance (say 2000 Ω) from the resistance box R and insert the key K1 only.
4. Adjust the value of R so that deflection is maximum, even in number and within the scale.
5. Note the deflection. Let it be $\boldsymbol{\theta}$.
6. Insert the key K2, also and without changing the value of R, adjust the value of S, such that
7. deflection in the galvanometer reduces to exactly half the value obtained in step 5 i.e. $\theta/2$.
8. Note the value of resistance S.
9. Repeat step 4 to 7 three times taking out different values of R and adjusting S every time.
10. Take one cell of the battery and find its E.M.F. by a voltmeter by connecting +ve of the
11. voltmeter with +ve of the cell and –ve of voltmeter with –ve of the cell. Let it be E.
12. Make connections as in circuit diagram.
13. Adjust the value of R to obtain a certain deflection $\boldsymbol{\theta}$ (say 30 divisions) when the circuit is
14. closed.
15. Note the values of resistance R and deflection $\boldsymbol{\theta}$.
16. Repeat the steps 9 to 13 with both cells of the battery.
17. Find the figure of merit k using the formula.

Calculation

Galvanometer resistance G,

$$G = \frac{RS}{R - S}\ (\Omega)$$

Figure of merit K,

$$K = \frac{E}{(R + G)\theta}(amp/div)$$

Result

Figure of merit of the galvanometer were determined.

10. Determination of Earth's magnetic field using field along the axis of a coil

Aim

To study variation of magnetic field with distance on the axis of a circular coil carrying current

Apparatus required

Stewart Gee type galvanometer, battery plug key, commutator, rheostat and ammeter.

Formula

Magnetic field,

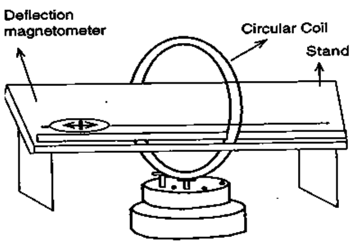
$$B = \frac{\mu_0 n i a^2}{2(x^2 + a^2)^{3/2}}$$

Where;

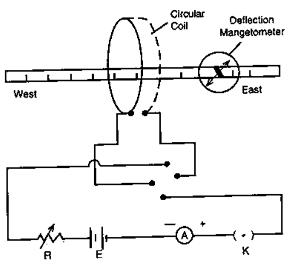
I = current passing through the coil

X = distance of the point from the center of the coil

Experimental setup

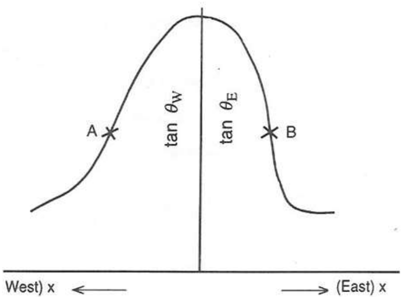


Stewart & Gee's apparatus



Arrangement for the measurement of magnetic field along the axis of a current carrying coil

Model graph



Observation

$B_H = 0.38x10^{-4}$ Tesla

$\mu_0 = 4\pi X10^7$

Current I = amp.

n =

Table

S.No	Position of magnet	Distance X	Deflection				Average θ	Tan θ	B = BH tanθ	B =
			θ_1	θ_2	θ_3	θ_4				
1.	Left (-) west of the coil									
2.	Right (+) east of the coil									

Procedure

1. The circuit is constructed as shown in fig. The primary adjustments of the instrument are made.
2. The coil of the instrument is set along the magnetic meridian. The aluminum pointer is made to read 0^0 - 0^0 with no current. The ends of the coil are connected to the commutator and through it to the battery rheostat and ammeter.
3. When the circuit is closed with the plug key, a current flow through the circular coil. A magnetic field is produced on the axis of the coil.
4. The magnetic needle in the compass is subjected to the horizontal component earth's magnetic field (H) and magnetic field (F) due to the circular coil carrying current. Those two magnetic fields are acting at right angles to each other.
5. The magnetic needle dings along the direction of resultant magnetic field. The magnetic needle is deflected through an angle θ from the direction of (H) the Horizontal component of earth's magnetic field. Then we get the equation

   B = BH tanθ
6. The current in the circuit is adjusted such that the deflection lies between 30^0 to 60^0 using the rheostat.
7. The compass box is displaced by 5cm or 10cm along the horizontal seal of the deflection of the needle is measured at every distance by reading both ends of the pointer. Let the readings be θ1 and θ2. The readings θ3 and θ4 are observed after reversing the direction of current.
8. The experiment is repeated for points on the other side of the coil. If θ is the average of the four deflection readings tan θα B.
9. A graph is drawn with tan θ along x-axis. This graph shows the variation of magnetic field on the axis of circular coil with distance. It is symmetrical about y-axis and the magnetic field is maximum at the center of the coil.

Calculation

$$B = \frac{\mu_0 n i a^2}{2(x^2 + a^2)^{3/2}}$$

Result

The variation of earth's magnetic field with distance on the axis of a circular coil carrying current is verified.

11. Characterization of Zener diode

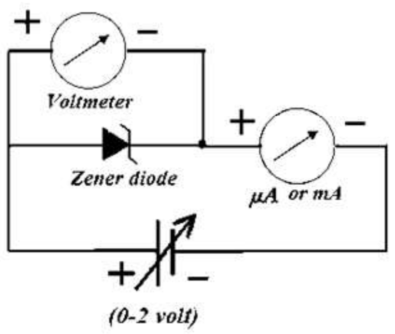
Aim

To draw the V-I characteristic of Zener diode

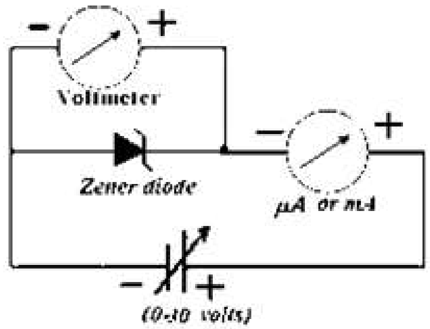
Apparatus required

Zener diode, voltmeter (0-2volt), voltmeter (0-30 volt), mili-ammeter, microammeter, variable source (0-2 volt and 0-30 volt).

Experimental setup

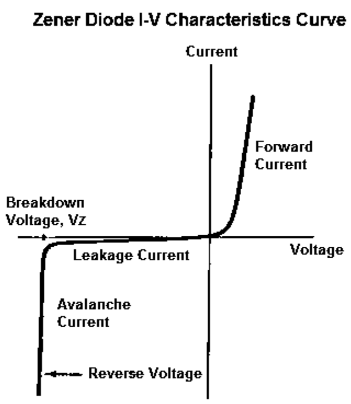


Zener diode forward bias



Zener diode reverse bias

Model graph



Observation

Table 1 - Zener diode in Forward bias

S.No	Forward voltage (V)	Forward current (I)
1.		
2.		
3.		

Table 2 - Zener diode in Reverse bias

S. No	Forward voltage (V)	Forward current (I)
1.		
2.		
3.		

Procedure

1. Connect the circuit as shown
2. Vary the voltage and note down the corresponding current values.
3. Tabulate the different forward current obtained for different forward voltages.
4. Repeat the steps for reverse bias as well.
5. Plot the graph between I and V.

Calculation

The knee voltage and the Zener break down voltage can be calculated via the graph.

Result

The I-V characteristics of the Zener diode were studied by the graph.

12. Construction of Zerner / IC regulated power supply

Aim

To construct a regulated power supply using the Zener diode.

Apparatus required

Zener diode, Bread board, Resistor (1K ohm), Connecting wires, Ammeters (0-10mA, 0-100 μ A), DC power supply (0-30V), 10 K ohm pot, multimeter.

Formula

Line regulation = $\left[\frac{V_2 - V_1}{V_2}\right] \times \mathbf{1}$

= %

Load regulation = $\left[\frac{V_{NL} - V_{FL}}{V_{NL}}\right] \times \mathbf{100}$

= %

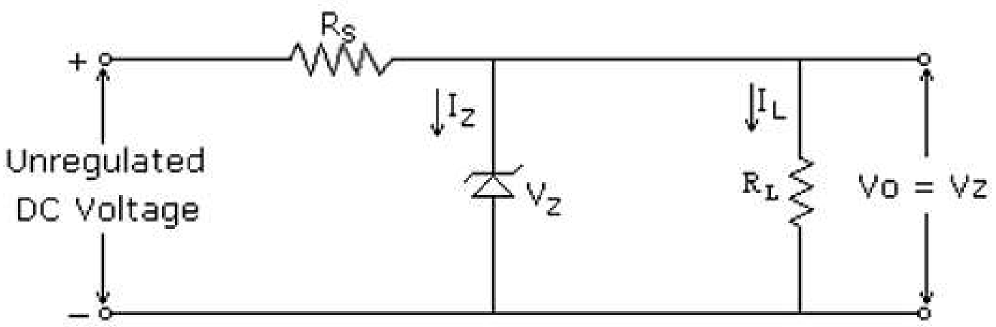
Where;

V_2, V_1 = Voltage out and Voltage in respectively

V_{NL} = Voltage no load

V_{FL} = Voltage full load

Experimental setup



Observation

Table 1 - Line regulation

$R_L = 1K\Omega$

V_{in}	V_{out}
1	
2	
.	
.	
15	

Table 2 - Load regulation

Vin = 10V

R_L	V_{out}
1k	
2k	
.	
.	
10k	

Procedure

1. Identify the components required and make the connections on bread board as per circuit diagram.
2. Note down the no load voltage of circuit.
3. Vary V_{in} in steps of 1V & tabulate voltmeter and ammeter reading
4. Plot the graphs for V_{in} Vs V_L& Find % line regulation
5. Identify the components required and make the connections on bread board as per circuit diagram.
6. Note down the no load voltage of circuit.
7. Vary R_L in steps of 1KΩ & tabulate voltmeter and ammeter reading
8. Plot the graphs for V_L Vs I_L& Find % load regulation.

Calculation

Line regulation = $\left[\frac{V_2 - V_1}{V_2}\right] \times 100$

Load regulation =$\left[\frac{V_{NL} - V_{FL}}{V_{NL}}\right] \times 100$

Result

Line regulation = %

Load regulation = %

13. Construction of AND, OR, NOT gates using diodes and transistor

Aim

To construct the AND, OR, NOT gates using diodes and transistor and verify the logic using truth table.

Apparatus required

Digital Electronics Trainer Kit, IC Tester, Diodes, Transistors, Resistor (1KΩ).

Formula

OR Gate

$$(\mathbf{Y_1}) = \mathbf{A + B}$$

AND Gate

$$(\mathbf{Y_2}) = \mathbf{A.B}$$

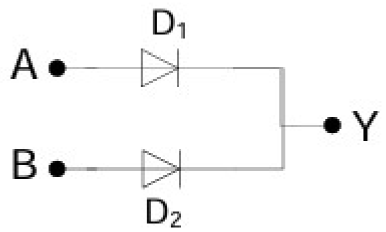
NOT Gate

$$(\mathbf{Y_3}) = \overline{\boldsymbol{A}}$$

Experimental setup

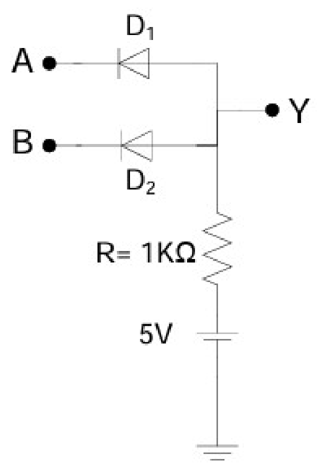
OR Gate

Y_1 = A+B



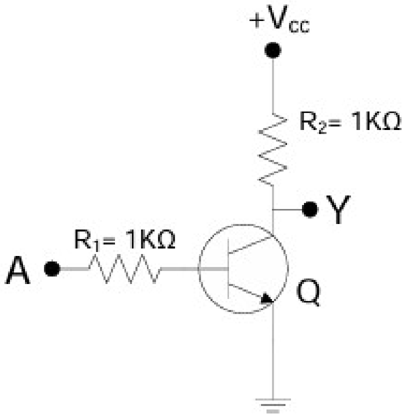
AND Gate

Y_2 = A.B



NOT Gate

$$Y_3 = \bar{A}$$



Observation

Table

A	B	Y_1	Y_2	Y_3
0	0			
0	1			
1	0			
1	1			

Procedure

1. Place the components of the circuit shown in figure OR gate on the trainer board and link the connections correctly.
2. Use the data switches for input and LEDs for output.
3. Power on the trainer board.
4. Observe the outputs for different input configurations and fill in the data table.
5. Follow procedure 1 to 4 for circuit of figure AND Gate
6. Follow procedure 1 to 4 for circuit of figure NOT Gate

Calculation

OR Gate (Y_1) $= A+B$

AND Gate(Y_2) $= A.B$

NOT Gate (Y_3) $= \bar{A}$

Result

AND, OR, NOT gates were constructed using diodes and transistor and verified the logic using truth table.

14. NOR gate as a universal building block

Aim

To verify the NOR gate as a universal building block

Apparatus required

IC 7400, IC 7402, Digital Trainer Kit, Bread Board

Formula

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

$AND\ gate:\ \ Y = A.B$

$$OR\ gate:\ \ Y = A + B$$

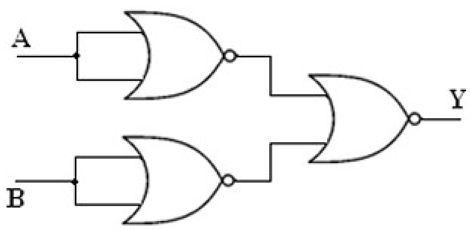
$$NAND\ gate: Y = \overline{A.B}$$

$$Ex - NO\quad gate: Y = \overline{A \oplus B}$$

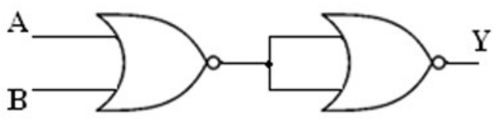
Experimental setup

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

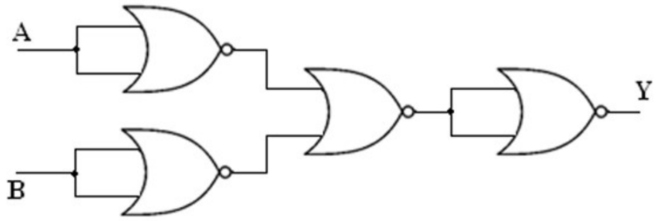
$\boldsymbol{AND\ gate:\ Y = A.B}$



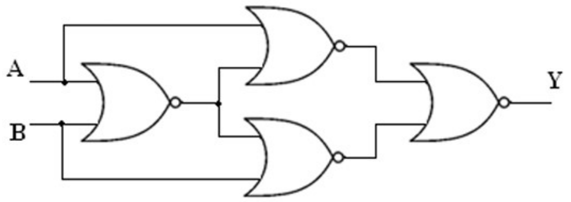
$$\boldsymbol{OR\ gate:\ \ Y = A + B}$$



$$NAND\ gate: Y = \overline{A.B}$$



$$Ex - NOR\ gate: Y = \overline{A \oplus B}$$



Observation

Table

$$NOT\ gate: Y = \overline{A}$$

A	Y
0	1
1	0

AND gate: $Y = A.B$

A	B	Y
0	**0**	0
0	**1**	0
1	**0**	0
1	**1**	1

$$OR\ gate:\ Y = A + B$$

A	B	Y
0	**0**	0
0	**1**	1
1	**0**	1
1	**1**	1

$$NAND\ gate: Y = \overline{A.B}$$

A	B	Y
0	**0**	1
0	**1**	1
1	**0**	1
1	**1**	0

$$Ex - NOR\ gate: Y = \overline{A \oplus B}$$

A	B	Y
0	**0**	1
0	**1**	0
1	**0**	0
1	**1**	1

Procedure

1. Made the connections as the circuit diagram.
2. By applying the inputs, the outputs are observed and the operation is verified with the help
3. of truth table.
4. Repeat the the above steps for all the circuits and note the values

Result

NOR gate as a universal building block by means of truth tables logic verified.