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Q 1. Using the spectrometer, measure the angle of the given prism and angle of minimum deviation. Hence calculate the refractive index of the prism.

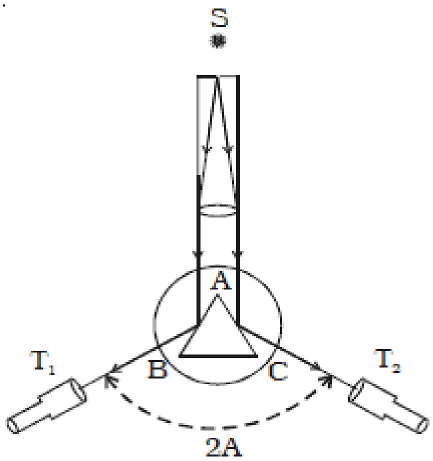
1. Spectrometer I - Refractive index 'μ' of the prism.

FORMULA :

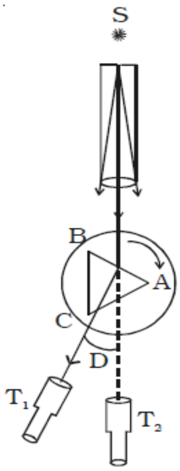
Refractive index of the material of the given prism $\mu = \frac{\sin\frac{A+D}{2}}{\sin\frac{A}{2}}$ Where **A** is the angle of the prism **D** is the angle of minimum deviation

DIAGRAMS: (Not for examination)

To find the angle of Prism



To find the angle of minimum deviation



PROCEDURE:

I. To determine the angle of the prism

1. The preliminary adjustments for telescope, prism and the collimator are done.
2. The slit is illuminated by a sodium vapour lamp. The prism table is mounted vertically.
3. The refracting edge of the prism placed facing the collimator.
4. The image on one side is seen through through the telescope and the vernier readings **(R_1)** are noted.
5. The image on other side is seen through through the telescope and the vernier readings **(R_2)** are noted.
6. **$2A = R_1 \sim R_2$** $\Rightarrow$ hence the angle of the prism 'A' is determined using **$A = \frac{R_1 \sim R_2}{2}$**

II. To determine the angle of minimum deviation

1. The edge of the prism is placed facing away from the collimator.
2. The refracting image is obtained in the telescope. The prism table is slowly rotated.
3. The image moves, then stops and turns back. The position of the image where the image stops and turns back is the minimum deviation.
4. The vernier readings **(R_3)** are noted at this position and the direct ray reading **(R_4)** are noted.
5. **$D = R_3 \sim R_4$** $\Rightarrow$ hence the angle of minimum deviation 'D' is determined using **$D = \frac{R_3 \sim R_4}{2}$**

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6. Refractive index of the prism is calculated using the formula $\mu = \frac{\sin\frac{A+D}{2}}{\sin\frac{A}{2}}$

OBSERVATIONS **i) To find the angle of Prism**

RAY	VERNIER I			VERNIER II		
	MSR	VC	TR = MSR+ (VC×LC)	MSR	VC	TR = MSR+ (VC×LC)
Reading of the image reflected from the one face (R_1)	36^0	13′	$R_1 = 36^0\,13'$	216^0	17′	$R_1 = 216^0\,17'$
Reading of the image reflected from other face (R_2)	$156^0\,30'$	9′	$R_2 = 156^0\,39'$	$336^0\,30'$	11′	$R_2 = 336^0\,41'$
	$2A = R_1 \sim R_2 = 120^0\,26'$			$2A = R_1 \sim R_2 = 120^0\,26'$		

Mean 2A = $120^0\,26'$ **A = $60^0\,13'$**

ii) To find the angle of minimum deviation: **Keep direct ray reading of vernier I as 0^0 and vernier II as 180^0**

RAY	VERNIER I			VERNIER II		
	MSR	VC	TR = MSR+ (VC×LC)	MSR	VC	TR = MSR+ (VC×LC)
Reading of the image in minimum deviation position (R_3)	$39^0\,30'$	20′	$39^0\,50'$	$219^0\,30'$	22′	$219^0\,52'$
Reading of the direct image (R_4)	0^0	0′	0^0	180^0	0′	180^0
	$D = R_3 \sim R_4 = 39^0\,50' - 0^0 = 39^0\,50'$			$D = R_3 \sim R_4 = 219^0\,52' - 180^0 = 39^0\,52'$		

Mean D = $\frac{39\ \ 50' + 39\ 52'}{2} = 39^0\ 51$

Calculations:

1. To find "A"

$2A = R_1 \sim R_2 = 120^0\,26'$ $2A = R_1 \sim R_2 = 120^0\,26'$

AVERAGE A = $\frac{120\ 26' \ + \ 120\ 26'}{2} = \frac{240\ 52'}{2} = 120^0\,26'$ $A = \frac{120\ 26'}{2} = 60^0\,13'$

2. To find "D"

$D = R_3 \sim R_4 = 39^0\,50' - 0^0$ $D = R_3 \sim R_4 = 219^0\,52' - 180^0$

$D = 39^0\,50'$ $D = 39^0\,52'$

Average D = = $\dfrac{39\ 50' + 39\ 52'}{2} = \dfrac{79\ 42'}{2} =$ D = $39^0\ 51'$

3. To find " μ"

$$\mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{60\ 13' + 39\ 51'}{2}\right)}{\sin\left(\frac{60\ 13'}{2}\right)} = \frac{\sin\left(\frac{100\ 4'}{2}\right)}{\sin\left(\frac{60\ 13'}{2}\right)} = \frac{\sin(50\ 2')}{\sin(30\ 6')} = \frac{0.7662}{0.5015} = 1.528$$

μ = 1.528

RESULT:

1. The angle of the prism **A = 60^0 13' (degree)**
2. The angle of minimum deviation **D = 39^0 51'** (degree)
3. Refractive index of the material of the given prism **μ = 1.528 (no unit)**

Q 2. Adjust the grating for normal incidence method using the spectrometer. Assuming the number of lines per unit metre of the grating, determine the wavelength of green, blue and yellow lines of mercury spectrum.

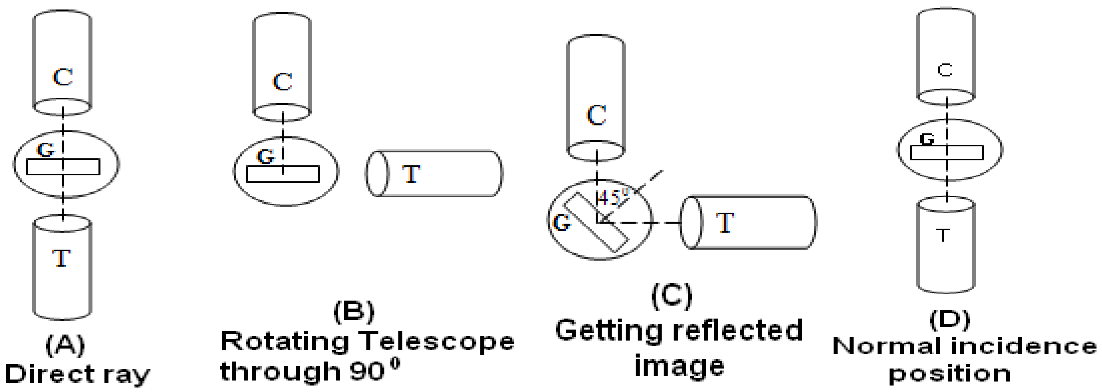
2. Spectrometer II - Grating

FORMULA:

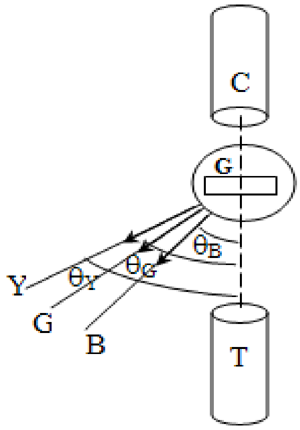
The wavelength (λ) of a spectral line using normal incidence arrangement of the grating is given by $\lambda = \dfrac{\sin\theta}{mN}$

where **'θ'** is the angle of diffraction, **'m'** is the order of diffraction and
N is the number of lines per unit length drawn on the grating

Adjusting the grating for normal incidence: (Not for examination)



Determination of angle of diffraction: (Not for examination)



PROCEDURE:

1. The preliminary adjustments for telescope, prism and the collimator are done. The slit is illuminated by a mercury vapour lamp.
2. By adjusting the prism and the telescope suitably, light is made to fall normally on the grating.
3. The first order diffracted image is obtained in the telescope.
4. Reading **(R_1)** are noted for blue, green and yellow lines.
5. The direc ray reading **(R_2)** is noted and therefore angle of diffraction **$\theta = R_1 \sim R_2$** is found out.
6. The wavelength of the spectral lines are calculated using the formula $\lambda = \frac{\sin\theta}{mN}$

OBSERVATIONS

RAY		VERNIER I (degree)			VERNIER II (degree)		
		MSR	VC	TR = MSR+ (VC×LC)	MSR	VC	TR = MSR+ (VC×LC)
Direct reading		0^0	0	$R_{D1} = 0^0$	180^0	0	$R_{D2} = 180^0$
Diffracted ray	BLUE	15^0	9′	$R_{B1} = 15^0\ 9'$	195^0	11′	$R_{B2} = 195^0\ 11'$
	GREEN	19^0	7′	$R_{G1} = 19^0\ 7'$	199^0	9′	$R_{G2} = 199^0\ 9'$
	YELLOW	20^0	15′	$R_{Y1} = 20^0\ 15'$	200^0	19′	$R_{Y2} = 200^0\ 19'$

TO FIND THE "θ"

Image	Angle of diffraction $R_{D1} \sim R_1$(vernier I)	Angle of diffraction $R_{D2} \sim R_2$(vernier II)	Mean θ
BLUE	$15^0\ 9'$	$15^0\ 11'$	$\theta_B = 15^0\ 10'$
GREEN	$19^0\ 7'$	$19^0\ 9'$	$\theta_G = 19^0\ 8'$
YELLOW	$20^0\ 15'$	$20^0\ 19'$	$\theta_Y = 20^0\ 17'$

m = 1 **N = 6 ×10^5**

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CALCULATIONS:

$R_{D1} \sim R_{B1} = 0^0 \sim 15^0 9' = 15^0 9'$ $\quad$ $R_{D2} \sim R_{B2} = 180^0 \sim 195^0 11'$

$\theta_B = 15^0 9'$ $\quad$ $\theta_B = 15^0 11'$

$$\text{Average } \theta_B = \frac{15\ 9' + 15\ 11'}{2} = 15^0 10'$$

$R_{D1} \sim R_{G1} = 0^0 \sim 19^0 7' = 19^0 7'$ $\quad$ $R_{D2} \sim R_{G2} = 180^0 \sim 199^0 9'$

$\theta_G = 19^0 7'$ $\quad$ $\theta_G = 19^0 8'$

$$\text{Average } \theta_G = \frac{19\ 7' + 19\ 8'}{2} = 19^0 8'$$

$R_{D1} \sim R_{Y1} = 0^0 \sim 20^0 15' = 20^0 15'$ $\quad$ $R_{D2} \sim R_{Y1} = 180^0 \sim 200^0$ 19'

$\theta_Y = 20^0 15'$ $\quad$ $\theta_Y = 20^0 19'$

$$\text{Average } \theta_Y = \frac{20\ 15' + 20\ 19'}{2} = 20^0 17'$$

ORDER OF DIFFRACTION: m = 1 Number of lines per unit metre of grating N = 6 ×10^5

1. $\lambda_B = \frac{\sin\theta_B}{mN} = \frac{15\ \ 10'}{1 \text{ x } 6 \text{ x } 10^5} = \frac{0.2616}{6 \text{ x } 10^5} = \frac{26.16 \text{ x } 10^{-2} \text{ x } 10^{-5}}{6}$ = 4.36 x 10^{-7} m =4360 A^0

2. $\lambda_G = \frac{\sin\theta_G}{mN} = \frac{19\ \ 8'}{1 \text{ x } 6 \text{ x } 10^5} = \frac{0.3277}{6 \text{ x } 10^5} = \frac{32.77 \text{ x } 10^{-2} \text{ x } 10^{-5}}{6}$ = 5.462 x 10^{-7} m = 5462 A^0

3. $\lambda_Y = \frac{\sin\theta_Y}{mN} = \frac{20\ 17'}{1 \text{ x } 6 \text{ x } 10^5} = \frac{0.3466}{6 \text{ x } 10^5} = \frac{34.66 \text{ x } 10^{-2} \text{ x } 10^{-5}}{6}$ = 5.776 x 10^{-7} m = 5776 A^0

RESULT:

i) wavelength of blue colour λ_B **= 4.36 × 10^{-7}m OR 4360 A^0**

ii) wavelength of green colour λ_G **= 5.462 × 10^{-7}m OR 5462 A^0**

iii) wavelength of yellow colour λ_Y **= 5.776 × 10^{-7}m OR 5776 A^0**

Q 3. Using a metre bridge, find the resistance of the given wire. (Take atleast 5 readings) and hence determine the specific resistance of the material of the wire.

3. Metre bridge

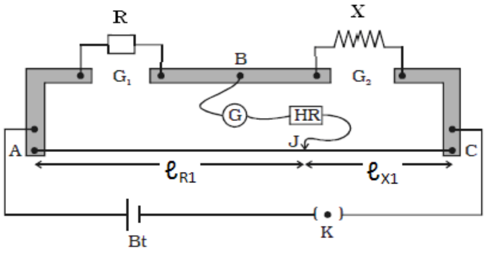
FORMULA:

1. Resistance of the wire **X = R** $\frac{l_x}{l_R}$

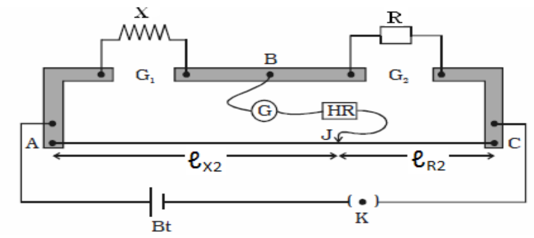
2. Specific resistance of the material of the wire $\rho = \frac{\pi r^2 X}{l}$

Where 'R' is known resistance, l_R is the balancing length of R,
l_x is the balancing length of unknown **X**, **r** is the radius of the wire, l is the length of the wire

CIRCUIT DIAGRAM 1 : Before interchanging



CIRCUIT DIAGRAM 2 : After interchanging



PROCEDURE:

1. The connections are made as shown in the circuit diagram. R = 2 Ω is set in the resistance box. The Jockey is pressed on the metre bridge wire.
2. The point **(J)** where the galvanometer shows zero (null) deflection is noted.
3. The balancing length **AJ** = l_1 is measured and $l_2 = (100 - l_1)$ is calculated.
4. **R** and **X** are interchanged.
5. The earlier procedure is repeated and **AJ** = l_3 is measured and $l_4 = (100 - l_3)$ is calculated.
6. The above steps are repeated for R = 3 Ω, 4Ω, 5Ω and the readings are tabulated.

   The unknown resistance of the given wire is calculated from the formula $X = R\,\frac{l_X}{l_R}$, where $l_R = \frac{l_1+l_3}{2}$ and $l_X = \frac{l_2+l_4}{2}$

7. The specific resistance of the wire is calculated from formula $\rho = \frac{\pi r^2 X}{l}$

OBSERVATIONS **(i) To determine the resistance of the given coil**

S.No	R (ohm)	Balancing length before interchanging		Balancing length after interchanging		Mean		
		ℓ_1 (cm)	$\ell_2 = 100 - \ell_1$ (cm)	ℓ_4 (cm)	$\ell_3 = 100 - \ell_4$ (cm)	$l_R = \frac{l_1+l_3}{2}$ (cm)	$l_X = \frac{l_2+l_4}{2}$ (cm)	$X = R\,\frac{l_x}{l_R}$ (ohm)
1	2	58.4	41.6	42.2	57.7	58.05	41.95	1.45
2	4	72.6	27.4	26.3	73.7	73.15	26.85	1.46
3	6	79.6	20.4	20.1	79.9	74.75	20.25	1.62
4	8	83.5	16.5	15.2	84.8	84.15	15.85	1.79
5	10	85.7	14.3	13.7	86.3	84	14	1.62

Mean $X = \frac{7.94}{5} = 1.588\ \Omega$

(ii) To determine the radius of the coil: LC = 0.01×10^{-3}m ZERO ERROR = +23 ZERO CORRECTION = -23

S.No	PSR	HSC	HSR	CR = PSR+HSR×L.C (mm)
1	0	79	56	0.56
2	0	77	54	0.54
3	0	74	51	0.51
4	0	78	55	0.55

Mean diameter 2r = 0.54 mm

Mean radius r = 0.27 mm 0.27 x 10^{-3} m

S.No	Calculation of l_R	Calculation of l_X	Calculation of X = R $\frac{l_x}{l_R}$
1	$l_R = \frac{l_1+l_3}{2} = \frac{58.4+57.7}{2} = 58.05$	$l_X = \frac{l_2+l_4}{2} = \frac{41.6+42.2}{2} = 41.95$	$2 \times \frac{41.95}{58.05} = 1.45$
2	$l_R = \frac{l_1+l_3}{2} = \frac{72.6+73.7}{2} = 73.15$	$l_X = \frac{l_2+l_4}{2} = \frac{27.4+26.3}{2} = 26.85$	$4 \times \frac{26.85}{73.15} = 1.46$
3	$l_R = \frac{l_1+l_3}{2} = \frac{79.6+79.9}{2} = 74.75$	$l_X = \frac{l_2+l_4}{2} = \frac{20.4+20.1}{2} = 20.25$	$\frac{l_x}{l_R} = 6 \times \frac{20.25}{74.75} = 1.62$
4	$l_R = \frac{l_1+l_3}{2} = \frac{83.5+84.8}{2} = 84.15$	$l_X = \frac{l_2+l_4}{2} = \frac{16.5+15.2}{2} = 15.85$	$8 \times \frac{15.85}{84.15} = 1.79$
5	$l_R = \frac{l_1+l_3}{2} = \frac{85.7+86.3}{2} = 84$	$l_X = \frac{l_2+l_4}{2} = \frac{14.3+13.7}{2} = 14$	$10 \times \frac{14}{84} = 1.62$
			Mean X = 1.588 Ω

Calculation of specific resistance ρ:

$$\rho = \frac{\pi r^2 X}{l} = \frac{3.14 \times 0.27 \times 10^{-3} \times 0.27 \times 10^{-3} \times 1.588}{1}$$

$$= \frac{3.14 \times 1.588 \text{ x } 0.27 \times 0.27 \times 10^{-6}}{1}$$

$$= \frac{3.14 \times 1.588 \text{ x } 0.27 \times 0.27 \times 10^{-6}}{1}$$

$$= \frac{4.99 \text{ x } 0.0729 \times 10^{-6}}{1}$$

$$= \frac{3.14 \times 1.588 \text{ x } 0.27 \times 0.27 \times 10^{-6}}{1}$$

$$= \frac{0.3638 \times 10^{-6}}{1} = 0.3638 \times 10^{-6}$$

$$\rho = 3.638 \times 10^{-7} = 3.64 \times 10^{-7}$$

RESULT:

Resistance of the wire **X = 1.588 Ω**

Specific resistance of the material of the wire ρ **= 3.64 x 10^{-7} Ωm**

Q 4. Compare the e.m.f s of the given two primary cells using potentiometer. Take atleast 6 readings.

4. POTENTIOMETER – COMPARISON OF emf OF TWO CELLS

FORMULA:

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

E_1 emf of primary cell 1 (Lechlanche cell), l_1 is the balancing length for cell 1

E_2 emf of primary cell 2 (Daniel cell), l_2 is the balancing length for cell 2

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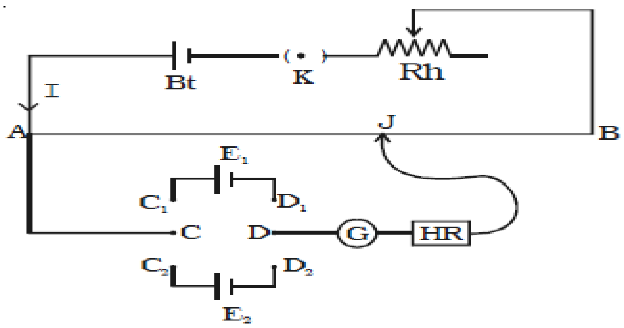
CIRCUIT DIAGRAM:



PROCEDURE:

1. The connections are made as shown in the circuit diagram. The circuit is checked for opposite side deflections.
2. Using DPDT switch the Leclanche cell is included in the secondary circuit. The jockey is pressed on the potentiometer wire.
3. The point **(J)** where the galvanometer wire shows full scale deflection is noted.
4. The balancing length **AJ =** l_1 is measured.
5. Using **DPDT** switch the Daniel cell is included in the secondary circuit.
6. The above steps are repeated and the balancing length l_2 is measured.
7. By varying the rheostat values l_1 , l_2 are measured and the readings are tabulated.
8. The ratio of **emf** of the given two primary calls are calculated using the formula $\frac{E_1}{E_2} = \frac{l_1}{l_2}$

OBSERVATIONS:

S.No	balancing length for Lechlanche cell	balancing length for Daniel cell	$\frac{E_1}{E_2} = \frac{l_1}{l_2}$
	l_1 cm	l_2 cm	
1	576	422	1.360
2	569	440	1.293
3	453	335	1.352
4	448	333	1.346
5	451	334	1.350
6	460	340	1.352
		Mean $\frac{E_1}{E_2}$	1.337

CALCULATIONS:

$\frac{E_1}{E_2} = \frac{546}{422}$ = 1.360	$\frac{E_1}{E_2} = \frac{448}{333}$ = 1.346

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$\frac{E_1}{E_2} = \frac{569}{440} = 1.293$	$\frac{E_1}{E_2} = \frac{451}{334} = 1.350$
$\frac{E_1}{E_2} = \frac{453}{335} = 1.532$	$\frac{E_1}{E_2} = \frac{460}{340} = 1.352$
Mean $\frac{E_1}{E_2} = \frac{1.360+1.293+1.532+1.346+1.350+1.352}{6} = \frac{8.233}{6} = 1.3721$	

RESULT: The mean ratio of emf of the two cells = **1.3721** (no unit)

Q 5. Determine the value of the horizontal component of magnetic induction of the earth's magnetic field using the tangent galvanometer. (take atleast 4 readings)

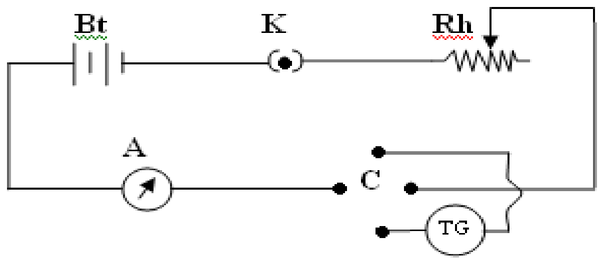
5. Tangent Galvanometer – Determination of B_H

FORMULA:

$$B_H = \frac{\mu_0 n}{2a}\left(\frac{I}{tan\theta}\right)$$

B_H - horizontal component of earth's magnetic field, μ_0 – permeability of free space
n – number of turns, I – current, a – radius of coil
θ - mean deflection produced in TG

CIRCUIT DIAGRAM:



PROCEDURE:

1. The connections are made as shown in the circuit diagram. The preliminary adjustments of the tangent galvanometer are done.
2. For a current of **0.6** , the readings θ_1, θ_2 are noted in tangent galvanometer.
3. The commudator is reversed, and the readings θ_3, θ_4 are noted in tangent galvanometer. The readings are tabulated.
4. Now the mean deflection $\theta = \frac{\theta_1 + \theta_2\ \theta_3 + \theta_4}{4}$ is calculated.
5. By changing the values of current '**I**' in T.G the $\theta_1, \theta_2, \theta_3, \theta_4$ are measured and tabulated.
6. The circumference of the circular coil (2πa) is measured and from which '**2a**' is calculated.
7. The horizontal component of earth's magnetic field is calculated from the formula $B_H = \frac{\mu_0 n}{2a} \times \frac{I}{tan\theta}$

OBSERVATIONS:

S.No	Current I (A)	Deflection of T.G. (degree)				mean θ	Tan θ	$\frac{I}{\tan\theta}$
		θ_1	θ_2	θ_3	θ_4			
1	0.6	32^0	32^0	31^0	31^0	31^0 30'	0.61238	0.9792
2	0.8	40^0	40^0	39^0	39^0	39^0 30'	0.8243	0.9705
3	1	46^0	46^0	44^0	44^0	$45^0$30'	1.0176	0.9823
4	1.2	51^0	51^0	50^0	50^0	50^0 30'	1.2131	0.9892
								Mean 0.9803

CALCULATIONS :

Circumference of the coil **(2πa) = 49.8 × 10^{-2} m** ⇒ 2a = $\frac{49.8 \times 10^{-2}}{2\pi}$ **= 0.1586 m**

$\frac{I}{\tan\theta} = \frac{0.6}{0.6128} = 0.9792$	$\frac{I}{\tan\theta} = \frac{1}{1.0176} = 0.9823$
$\frac{I}{\tan\theta} = \frac{0.8}{0.8243} = 0.9705$	$\frac{I}{\tan\theta} = \frac{1.2}{1.2131} = 0.9892$

Mean $\frac{I}{\tan\theta} = \frac{0.9792+0.9705+0.9823+0.9892}{4} = \frac{3.9212}{4} = \mathbf{0.9803},$ $[4\pi = 4 \times 3.14 = 12.56]$

$$B_H = \frac{\mu_0 n}{2a}\left(\frac{I}{\tan\theta}\right) = \frac{4\pi \times 10^{-7} \times 5 \times 0.9803}{0.1586}$$

$$= \frac{12.56 \times 5 \times 0.9803 \times 10^{-7}}{0.1586} = \frac{62.8 \times 0.9803\ 10^{-7}}{0.1586}$$

$$= \frac{61.56 \times 10^{-7}}{0.1586} = 388.146 \times 10^{-7} = 3.88 \times 10^{-5} \text{ Tesla}$$

RESULT:

The horizontal component of earth's magnetic field **(B_H) = 3.88 x 10^{-5} Tesla**

Q 6. Dermine the frequency of A.C using sonometer (Take 4 readings)

6. SONOMETER – FREQUENCY OF AC

FORMULA:-

The frequency of the A.C main $n = \frac{1}{2} \times \frac{\sqrt{T}}{l} \times \frac{1}{\sqrt{m}}$

where **T** is the tension of the sonometer wire, **ℓ** is the resonating length, **m** is the linear density of the wire

PROCEDURE:

1. The ends of the sonometer wire wire are connected to a suitable power supply of 6 V A.C.
2. A magnet is held at the centre of the wire.
3. The wire is subjected to a suitable load of 0.1 kg
4. Two movable bridges are placed under the wire.
5. A paper rider is placed on the wire between the bridges.
6. The bridges are adjusted until the rider flutters and falls down now the distance l_1 between the bridges is measured.
7. The same procedure is repeated again and distance l_2 is measured. The average of l_1 and l_2 is l
8. The experiment is repeated for different loads and the readings are tabulated.
9. The radius of the sonometer wire **(r)** is measured. The linear density of the wire is **$m = \pi r^2 \rho$**, where ρ is its density.
10. The frequency of the A.C main is calculated from the formula $n = \frac{1}{2} \times \frac{\sqrt{T}}{l} \times \frac{1}{\sqrt{m}}$

OBSERVATIONS:

S.No:	Load	Length of the vibrating segment		Mean	T = Mg	$\sqrt{T}$	$\frac{\sqrt{T}}{l}$
	M (gram)	ℓ_1(cm)	ℓ_2(cm)	ℓ (cm)	(newton)		
1.	100	26.7	26.3	26.5	0.98	**0.99**	3.736
2.	150	33	31	32	1.47	**1.212**	3.788
3.	200	36.5	39.5	38	1.96	1.4	3.624
4.	250	40	42	40	41	1.565	3.796

Mean $\frac{\sqrt{T}}{l}$ = 3.736

(ii) To determine the radius of the sonometer wire

LC = 0.01×10^{-3}m   ZERO ERROR = +2 divisions   ZERO CORRECTION = -2 divisions

S.No	PSR	HSC	HSR(mm)	CR = PSR+(HSR×L.C)(mm)
1	0	47	0.45	0.45
2	0	49	0.47	0.47
3	0	45	0.43	0.43
4	0	47	0.45	0.45
			Mean 'd'	0.456

Radius r = 0.228 $\times$ 10^{-3} m

CALCUATIONS:

Diameter of the wire d = 0.456 mm

Radius of the wire r = $\frac{d}{2}$ = 0.228 $\times 10^{-3}$m

Density of the steel wire (ρ) = 8500 kgm^{-3}

Linear density m = $\pi r^2 \rho$ = 3.14 x 0.228 $\times 10^{-3}$ x 0.228 $\times 10^{-3}$ x 8500 = 13.80 x 10^{-4} kg

$\sqrt{m}$ = 3.724 x 10^{-2} $\frac{1}{\sqrt{m}}$ = 0.269 x 10^2 = 26.9

T = mg= 0.1×9.8 = 0.98	$\sqrt{T}$ = 0.99	ℓ= 26.5 x 10^{-2}	$\frac{\sqrt{T}}{l} = \frac{0.99}{26.5 \times 10^{-2}}$ = **3.736**
T = mg = 0.15×9.8 =1.47	$\sqrt{T}$ = 1.212	ℓ= 32 x 10^{-2}	$\frac{\sqrt{T}}{l} = \frac{1.212}{32 \times 10^{-2}}$ = **3.788**
T = mg = 0.2×9.8 =1.96	$\sqrt{T}$ = 1.4	ℓ= 38 x 10^{-2}	$\frac{\sqrt{T}}{l} = \frac{1.4}{38 \times 10^{-2}}$ = **3.624**
T = mg = 0.25×9.8 =2.45	$\sqrt{T}$ = 1.565	ℓ= 41 x 10^{-2}	$\frac{\sqrt{T}}{l} = \frac{1.565}{41 \times 10^{-2}}$ = **3.796**

Mean $\frac{\sqrt{T}}{l} = \frac{3.736+3.788+3.624+3.796}{4} = \frac{14.944}{4}$ = 3.736

$\frac{\sqrt{T}}{l}$ = 3.736 $\frac{1}{\sqrt{m}}$ = 0.269 x 10^2 = 26.9

$$n = \frac{1}{2} \times \frac{\sqrt{T}}{l} \times \frac{1}{\sqrt{m}} = \frac{1}{2} \times 3.736 \times 26.9 = 50.25$$

RESULT :

The frequency of the ac main **n = 50.25 Hz**

Q 7. i) By doing suitable experiment, draw the forward bias characteristic curve of a junction diode and determine its forward resistance

ii) By performing an experiment, draw the characteristic curve of the given zener diode and determine its breakdown voltage.

7. Junction diode and Zener diode

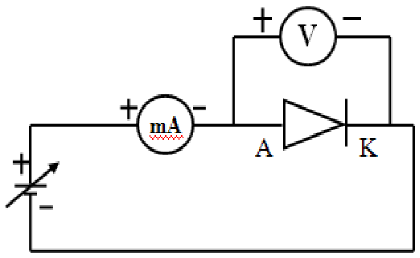
FORMULA:

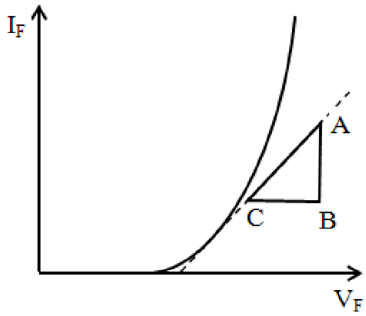
Forward resistance of the PN junction diode $R_f = \frac{\Delta V_f}{\Delta I_f}$

ΔV_f is the forward voltage, ΔI_f is the forward current

CIRCUIT DIAGRAMS

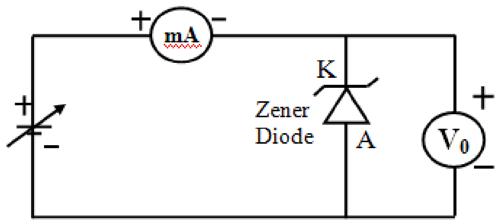
I . JUNCTION DIODE - FORWARD BIAS

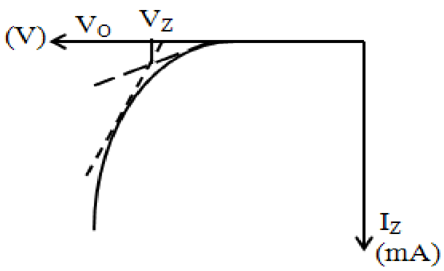




$$R_f = \frac{\Delta V_f}{\Delta I_f} = \frac{BC}{AB}$$

II . ZENER DIODE – REVERSE BIAS





PROCEDURE:

I . Junction diode (Forward bias)

1. The connections are made as shown in the circuit diagram.
2. For various forward voltages V_F, the forward current I_F is measured and the readings are tabulated.
3. A graph is plotted by taking V_F along X –axis and I_F along Y – axis.
4. The forward voltage of the diode is calculated from reciprocal of the slope of the graph using the formula $R_f = \frac{\Delta V_f}{\Delta I_f}$

II . Junction diode (Forward bias)

1. The connections are made as shown in the circuit diagram.
2. For various voltageV_0 , the corresponding zener current I_z is measured and the readings are tabulated.
3. A graph is plotted by taking V_0 along X –axis and I_z along Y – axis.
4. Zener breakdown voltage is calculated from the graph.

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OBSERVATIONS:

Junction diode forward bias

S.No:	V_F (V)	I_F (mA)
1	0.1	0
2	0.2	0
3	0.3	0
4	0.4	0
5	0.5	1.1
6	0.65	4.8
7	0.7	17.4
8	0.8	10.5
9	0.9	31
10	1.0	51

Zener diode -reverse bias

S.No:	Vo (V)	I_Z (mA)
1	5.1	0.1
2	5.2	0.1
3	5.3	0.1
4	5.4	0.1
5	5.5	0.4
6	5.6	9
7	5.7	12.8
8	5.8	15.8
9	5.9	25.2
10	6.0	31

Zener breakdown voltage is 5.6 volt

CALCULATIONS:

$$R_f = \frac{\Delta V_f}{\Delta I_f} = \frac{BC}{AB} = \frac{0.08}{7 \text{ x } 10^{-3}} = \frac{80}{7} = 11.4\ \Omega$$

RESULT:

i) The forward resistance of the junction diode **= 11.4 Ω**

ii) The zener breakdown voltage **= 5.6 volt**

Q 8. Construct a suitable circuit with the given NPN transistor in CE mode. Draw the input characteristic and output characteristic curves. Find the input impedance and output impedance.

8. Common Emitter NPN Transistor Characteristics I

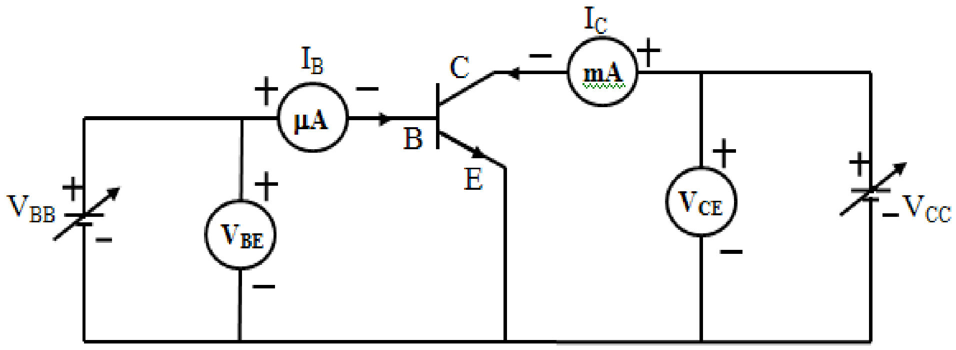
FORMULA:

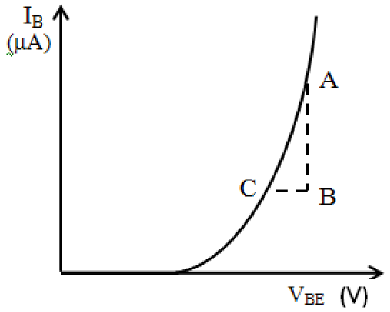
1. input impedance $r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)$ **2. output impedance** $r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)$

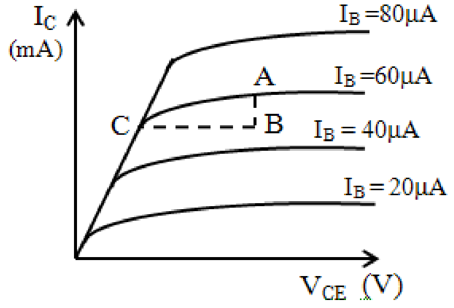
where ΔV_{BE} is the change in base emitter voltage, ΔI_B is the change in base current

ΔV_{CE} is the change in collector emitter voltage, ΔI_C is the change in collector current

CIRCUIT DIAGRAM:







$$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right) = \frac{BC}{AB}$$

$$r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right) = \frac{BC}{AB}$$

PROCEDURE:

1. **INPUT CHARACTERISTICS:**
   1. The connections are made as shown in the circuit diagram.
   2. V_{CE} is kept constant at **5 V**, I_B is set at **20 μA** and V_{BE} is noted.
   3. I_B is increased in steps of **20 μA** and V_{BE} is noted and the readings are tabulated.
   4. A graph is plotted by taking V_{BE} along X – axis and I_B along y – axis.
   5. The input impedance is calculated from the reciprocal of the slope of the curve using the formula $r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)$

2. **OUTPUT CHARACTERISTICS:**
   1. The connections are made as shown in the circuit diagram.
   2. I_B is set at **20 μA** and V_{BE} is noted and the readings are tabulated.
   3. For various values of V_{CE}, I_C is noted and I_B is set at **40 μA.**
   4. For various values of V_{CE}, I_C is noted and the readings are tabulated.
   5. A graph is plotted by taking V_{CE} along X – axis and I_C along y – axis.
   6. The output impedance is calculated from the reciprocal of the slope of the curve using the formula $r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)$

OBSERVATIONS:

INPUT CHARACTERISTICS

V_{CE} = 5V

S.No:	V_{BE} (V)	I_B (mA)
1	0.1	0
2	0.2	0
3	0.3	0
4	0.4	0
5	0.5	0
6	0.6	3
7	0.7	37
8	0.8	107
9	0.9	170
10	1.0	245

OUTPUT CHARACTERISTICS

I_B = 20μA, 40μA, 60μA, 80μA

S.No	Vo (V)	I_C (mA)	I_C (mA)	I_C (mA)	I_C (mA)
1	0.1	0.9	0.9	1	1.3
2	0.3	2.2	2.4	2.6	2.6
3	0.5	4	4.2	4.6	4.8
4	0.7	5.5	6.1	6.4	6.5
5	0.9	6.7	7.8	8.1	8.4
6	1	7	9.2	9.9	10.2
7	2	7.3	12.6	18	19.4
8	3	7.6	13.3	19.2	25.4
9	4	7.7	14	20.6	27
10	5	7.7	15	20.7	28

CALCULATIONS:

$$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right) = \frac{1}{slope} = \frac{BC}{AB}$$

$$= \frac{0.14 \text{ volt}}{85 \text{ x } 10^{-6}} = \frac{140000}{85} = 1647\ \Omega$$

$$R_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right) = \frac{1}{slope} = \frac{BC}{AB}$$

$$= \frac{2.2 \text{ x } 10^{-3}}{1} = 2.2 \text{ x } 10^{-3}\ \Omega$$

RESULT:

1. The input and output characteristic curves of the transistor in CE configuration are drawn.
2. The input impedance **r_i = 1647 Ω**
3. The output impedance **$r_0 = 2.2 \text{ x } 10^{-3}\ \Omega$**

Q 9. Construct a suitable circuit with the given NPN transistor in CE mode. Draw the output characteristic and transfer characteristic curves. Find the output impedance and current gain.

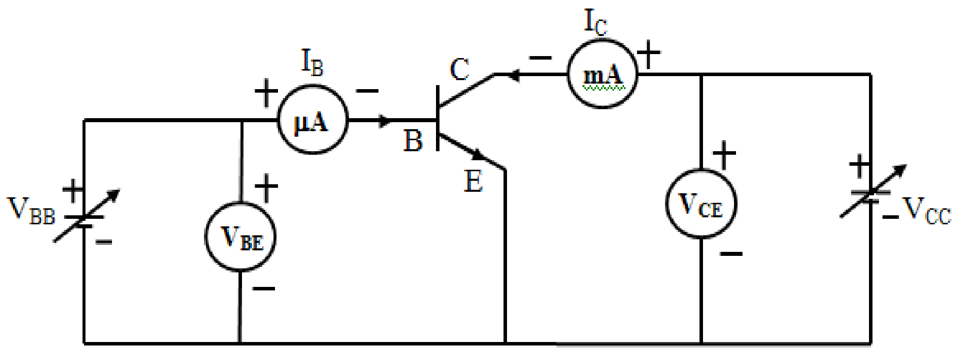
9. Common Emitter NPN Transistor Characteristics II

FORMULA:

1. output impedance $r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)$ 2. Current gain $\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)$

where ΔI_B is the change in base current, ΔV_{CE} is the change in collector emitter voltage, ΔI_C is the change in collector current

CIRCUIT DIAGRAM:



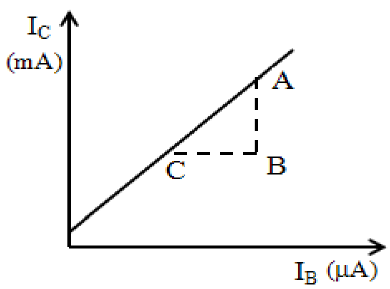
PROCEDURE:

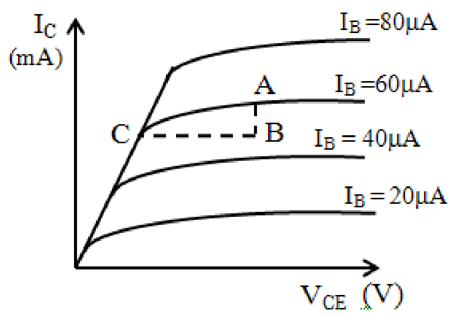
1. OUTPUT CHARACTERISTICS:

1. The connections are made as shown in the circuit diagram.
2. I_B is set at **20 µA** and V_{BE} is noted and the readings are tabulated.
3. For various values of V_{CE}, I_C is noted and I_B is set at **40 µA.**
4. For various values of V_{CE}, I_C is noted and the readings are tabulated.
5. A graph is plotted by taking V_{CE} along X – axis and I_C along y – axis.
6. The output impedance is calculated from the reciprocal of the slope of the curve using the formula $r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)$

2 .TRANSFER CHARACTERISTICS:

1. V_{CE} is kept constant at **5 V**, I_B is set at **50 µA** and I_C is noted.
2. I_B is increased in steps of **50 µA** and I_C is noted, the readings are tabulated.
3. A graph is plotted by taking I_B along X – axis and I_C along y – axis.
4. The current gain is calculated from the reciprocal of the slope of the curve using the formula $\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)$





$$\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right) = \frac{AB}{BC}$$

$$r_0 = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right) = \frac{BC}{AB}$$

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OBSERVATIONS:
OUTPUT CHARACTERISTICS

I_B = 20μA, 40μA, 60μA, 80μA

S.No :	Vo (V)	I_C (mA)	I_C (mA)	I_C (mA)	I_C (mA)
1	0.1	0.9	0.9	1	1.3
2	0.3	2.2	2.4	2.6	2.6
3	0.5	4	4.2	4.6	4.8
4	0.7	5.5	6.1	6.4	6.5
5	0.9	6.7	7.8	8.1	8.4
6	1	7	9.2	9.9	10.2
7	2	7.3	12.6	18	19.4
8	3	7.6	13.3	19.2	25.4
9	4	7.7	14	20.6	27
10	5	7.7	15	20.7	28

TRANSFER CHARACTERISTIC (V_{CE} = 5V)

S.NO	I_B (μA)	I_C (mA)
1	20	7.4
2	40	15.1
3	60	21.7
4	80	28.5
5	100	35.3
6	120	41.5

CALCULATIONS:

$$r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right) = \frac{1}{slope} = \frac{BC}{AB}$$

$$= \frac{2.2 \text{ x } 10^{-3}}{1} = 2.2 \text{ x } 10^{-3}\ \Omega$$

$$\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right) = \frac{AB}{BC}$$

$$= \frac{13 \text{ x } 10^{-3}}{40 \text{ x } 10^{-6}} = \frac{13000}{40} = 325$$

RESULT:

1. The output and transfer characteristic curves of the transistor in CE configuration are drawn.
2. The output impedance $r_0 = 2.2 \text{ x } 10^{-3}\ \Omega$
3. The current gain $\beta = 325$

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Q 10. Using IC 741, construct i) an inverting amplifier ii) summing amplifier study their performance

10. OPERATIONAL AMPLIFIER I

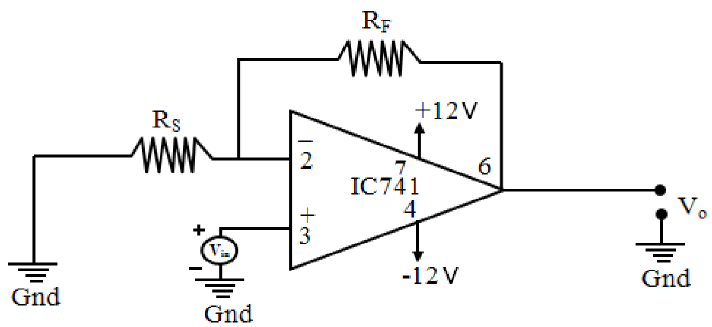
FORMULA :

i) Voltage gain of the inverting amplifier, $A_V = -\left(\frac{V_O}{V_{in}}\right) = -\left(\frac{R_f}{R_s}\right)$

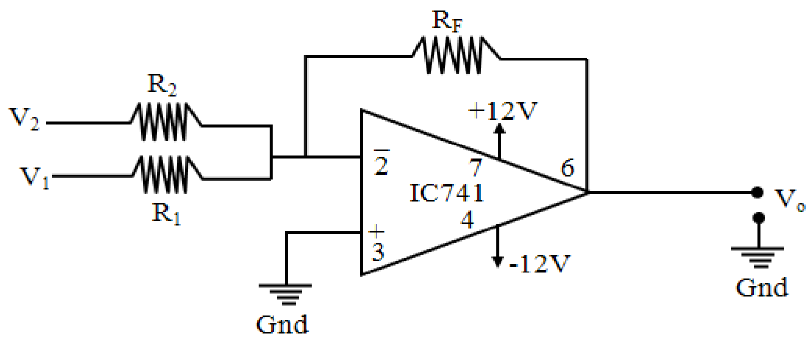
ii) The output voltage of the inverting summing amplifier, $V_0 = -(V_1 + V_2)$

Where V_0 output voltage, V_{in}, V_1 and V_2 are the input voltages, R_f and R_s are the external resistances

CIRCUIT DIAGRAM : 1 . Inverting amplifier



CIRCUIT DIAGRAM : 2 . Summing amplifier



PROCEDURE: 1. INVERTING AMPLIFIER:-

1. Connections are made as shown in the circuit diagram.
2. R_S is kept at 10 KΩ, R_F is kept at 22 KΩ.
3. For various input voltages V_{in} , the corresponding output voltages V_0 is measured and the readings are tabulated.
4. Second Set of readings is taken by keeping V_{in} = 1 V and Rs = 10 KΩ and changing R_F as 10 KΩ,22 KΩ,33 KΩ & 47 KΩ.
5. The voltage gain calculated as : Experimental gain $A_V = -\left(\frac{V_O}{V_{in}}\right)$ and the theoretical gain $A_V = -\left(\frac{R_f}{R_s}\right)$
6. The experimental value is compared with the theoretical value and the inverting action is verified.

2. SUMMING AMPLIFIER:-

1. Connections are made as shown in the circuit diagram.
2. R_1, R_2 and R_F are kept as 10 K Ω.

3. For various values of V_1 and V_2 the corresponding output voltage Vo is measured and the readings are tabulated.
4. The experimental value is compared with the expected output voltage **$V_0 = -(V_1 + V_2)$.**
5. Thus the summing action of the amplifier is verified.

OBSERVATION: 1 . Inverting amplifier

SET	S.NO	R_s (Ω)	R_f (Ω)	V_{in}(V)	V_{out}(V)	Experimental Gain $A_V = \left(\frac{V_O}{V_{in}}\right)$	Theoretical Gain $A_V = -\left(\frac{R_f}{R_s}\right)$
I	1	10K	22K	1	-2.28	-2.28	-2.2
	2	10K	22K	1.5	-3.34	-2.22	-2.2
	3	10K	22K	2	-4.41	-2.23	-2.2
	4	10K	22K	2.5	-5.4	-2.16	-2.2
II	1	10K	10K	1	-1.04	-1.04	-1.0
	2	10K	22K	1	-2.2	-2.2	-2.2
	3	10K	33K	1	-3.8	-3.8	-3.3
	4	10K	47K	1	-4.74	-4.74	-4.7

OBSERVATION: 2 . Summing amplifier

$R_1 = R_2 = R_f = 10K\Omega$

S.NO	V_1 (Volt)	V_2 (Volt)	Experimental Output voltage V_0 (Volt)	Theoretical output voltage $V_0 = -(V_1 + V_2)$ (Volt)
1	1.0	0.5	1.6	-1.5
2	1.0	1.0	2.1	-2.0
3	1.0	1.5	2.6	-2.5
4	1.0	2.0	3.1	-3.0

CALCULATIONS:

1. INVERTING AMPLIFIER

Experimental gain	Theoretical gain
$A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{-2.28}{1} = -2.28$	$A_V = -\left(\frac{R_f}{R_s}\right) = \frac{-22}{10} = -2.2$
$A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{-3.34}{1.5} = -2.2$	$A_V = -\left(\frac{R_f}{R_s}\right) = \frac{-22}{10} = -2.2$
$A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{-4.42}{2} = -2.205$	$A_V = -\left(\frac{R_f}{R_s}\right) = \frac{-22}{10} = -2.2$

$A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{-5.4}{2.5}$ = -2.16	$A_V = -\left(\frac{R_f}{R_s}\right) = \frac{-22}{10}$ = -2.2
$A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{-1.04}{1}$ = -1.04	$A_V = -\left(\frac{R_f}{R_s}\right) = \frac{-10}{10}$ = -1
$A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{-2.2}{1}$ = -2.2	$A_V = -\left(\frac{R_f}{R_s}\right) = \frac{-22}{10}$ = -2.2
$A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{-3.8}{1}$ = -3.8	$A_V = -\left(\frac{R_f}{R_s}\right) = \frac{-3.3}{10}$ = -3.3
$A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{-4.74}{1}$ = -4.74	$A_V = -\left(\frac{R_f}{R_s}\right) = \frac{-4.7}{10}$ = -4.7

2. SUMMING AMPLIFIER

1) $V_o = -(V_1 + V_2)$ = - (1 + 0.5) = -1.5 volt
2) $V_o = -(V_1 + V_2)$ = - (1 + 1) = - 2 volt
3) $V_o = -(V_1 + V_2)$ = - (1 + 1.5) = - 2.5
4) $V_o = -(V_1 + V_2)$ = -(1 + 2.5) = -3 volt

RESULT :

i) The inverting amplifier is constructed using OP-AMP and gain is determined.
ii) The summing amplifier is constructed and the output voltage is found to be the sum of the applied input voltages

Q 11. Using IC 741, construct i) non- inverting amplifier ii) summing amplifier study their Performance.

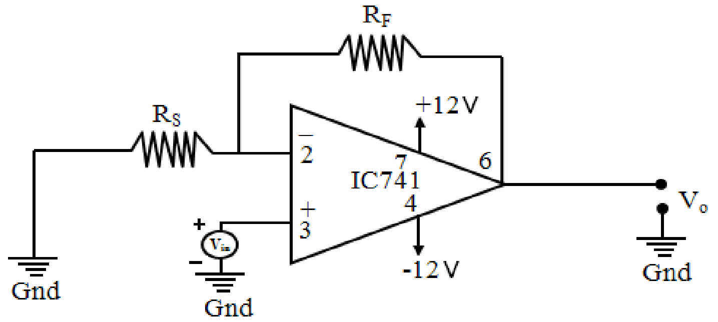
11. OPERATIONAL AMPLIFIER II

FORMULA :

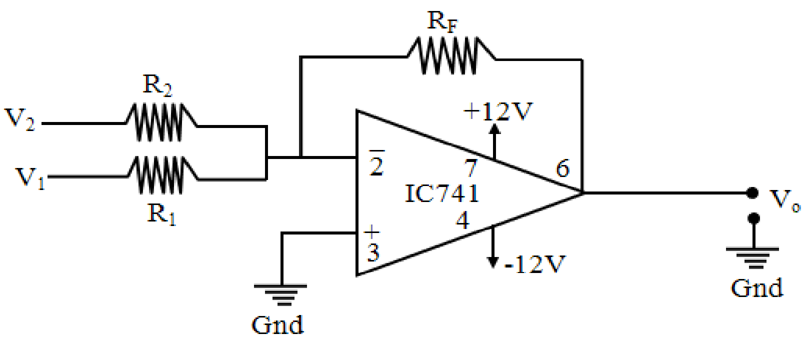
1. Voltage gain of the non-inverting amplifier, $A_V = \left(\frac{V_O}{V_{in}}\right) = 1 + \left(\frac{R_f}{R_s}\right)$
2. The output voltage of the inverting summing amplifier, $V_0 = -(V_1 + V_2)$

Where V_0 output voltage, V_{in}, V_1 and V_2 are the input voltages, R_f and R_s are the external resistances

CIRCUIT DIAGRAM : 1 . non-inverting amplifier



CIRCUIT DIAGRAM : 2 . Summing amplifier



PROCEDURE:

1. NON-INVERTING AMPLIFIER:-

1. Connections are made as shown in the circuit diagram.
2. R_S is kept at 10 KΩ, R_F is kept at 10 KΩ.
3. For various input voltages V_{in} , the corresponding output voltages V_0 is measured and the readings are tabulated.
4. Second Set of readings is taken by keeping V_{in} = 1 V and Rs = 10 KΩ and changing R_F as 10 KΩ,22KΩ,33 KΩ & 47 KΩ.
5. The voltage gain calculated as : Experimental gain $A_V = \left(\frac{V_O}{V_{in}}\right)$ and the theoretical gain $A_V = \left(\frac{R_f}{R_s}\right)$
6. The experimental value is compared with the theoretical value and the non-inverting action is verified.

2. SUMMING AMPLIFIER:-

1. The circuit is wired as shown in the diagram using OP AMP IC 741, The values of R_1, R_2 and R_F are kept as 10 K Ω.
2. The input voltages are kept as V_I = 1V and V_2 = 0.5V and the output voltage Vo is measured using the digital voltmeter
3. Then the experiment is repeated for different sets of values for V_1 and V_2.
4. Theoretical output voltage is found from $V_0 = -(V_1 + V_2)$. Since this is equal to experimental output voltage the summing action of the amplifier is verified.

OBSERVATION: 1 . Non-Inverting amplifier

SET	S.NO	R_s (Ω)	R_f (Ω)	V_{in}(V)	V_{out}(V)	Experimental Gain $A_V = \left(\frac{V_O}{V_{in}}\right)$	Theoretical Gain $A_V = 1 + \left(\frac{R_f}{R_s}\right)$
I	1	*10K*	*10K*	1.0	2.3	2.3	*3.2*
	2	*10K*	*10K*	1.5	2.96	1.97	*3.2*
	3	*10K*	*10K*	2.0	4.2	2.1	*3.2*
	4	*10K*	*10K*	2.5	5.0	2	*3.2*
II	1	*10K*	*10K*	1.0	1.97	1.97	*2.0*
	2	*10K*	*22K*	1.0	3.2	3.2	*3.2*
	3	*10K*	*33K*	1.0	4.25	4.25	*4.3*
	4	*10K*	*47K*	1.0	5.67	5.67	*5.7*

OBSERVATION: 2 . Summing amplifier

$R_1 = R_2 = R_f = 10K\Omega$

S.NO	V_1 (Volt)	V_2 (Volt)	Experimental Output voltage V_0 (Volt)	Theoretical output voltage $V_0 = -(V_1 + V_2)$ (Volt)
1	1.0	0.5	1.6	-1.5
2	1.0	1.0	2.1	-2.0
3	1.0	1.5	2.6	-2.5
4	1.0	2.0	3.1	-3.0

CALCULATIONS: 1. NON-INVERTING AMPLIFIER

Experimental gain	Theoretical gain
1) $A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{2.30}{1} = 2.30$	$A_V = 1 + \left(\frac{R_f}{R_s}\right) = 1 + \frac{10}{10} = 2$
2) $A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{2.96}{1.5} = 1.97$	$A_V = 1 + \left(\frac{R_f}{R_s}\right) = 1 + \frac{10}{10} = 2$
3) $A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{4.2}{2} = 2.1$	$A_V = 1 + \left(\frac{R_f}{R_s}\right) = 1 + \frac{10}{10} = 2$
4) $A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{5.0}{2.5} = 2$	$A_V = 1 + \left(\frac{R_f}{R_s}\right) = 1 + \frac{10}{10} = 2$
5) $A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{1.97}{1} = 1.97$	$A_V = 1 + \left(\frac{R_f}{R_s}\right) = 1 + \frac{10}{10} = 1 + 1 = 2$
6) $A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{3.2}{1} = 3.2$	$A_V = 1 + \left(\frac{R_f}{R_s}\right) = 1 + \frac{22}{10} = 1 + 2.2 = 3.2$
7) $A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{4.25}{1} = 4.25$	$A_V = 1 + \left(\frac{R_f}{R_s}\right) = 1 + \frac{33}{10} = 1 + 3.3 = 4.3$
8) $A_V = \left(\frac{V_O}{V_{in}}\right) = \frac{5.65}{1} = 5.65$	$A_V = 1 + \left(\frac{R_f}{R_s}\right) = 1 + \frac{47}{10} = 1 + 4.7 = 5.7$

2. SUMMING AMPLIFIER

1) $V_o = -(V_1 + V_2) = -(1 + 0.5) = -1.5$ volt
2) $V_o = -(V_1 + V_2) = -(1 + 1) = -2$ volt
3) $V_o = -(V_1 + V_2) = -(1 + 1.5) = -2.5$
4) $V_o = -(V_1 + V_2) = -(1 + 2.5) = -3$ volt

RESULT :

1. The non-inverting amplifier is constructed using OP-AMP and gain is determined.
2. The summing amplifier is constructed and the output voltage is found to be the sum of the applied input voltages

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Q 12. Using appropriate ICs study the truth table of logic circuits OR, AND, NOT, NOR, NAND, and EX-OR.

12. INTEGRATED LOGIC GATE CIRCUITS

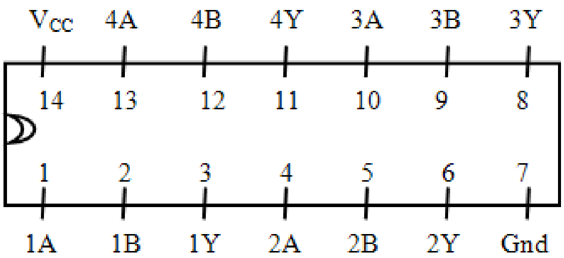
FORMULA:

1. OR function **Y =A + B** When any one input or all inputs are true, output-is-true
2. AND function **Y = A.B** Only when all inputs are true, output is true
3. NOT function **Y =** $\bar{A}$ Output is the complement of input
4. NOR function **Y =** $\overline{A+B}$ Only when all inputs are false, output is true
5. NAND function **Y=**$\overline{A\cdot B}$ When any one of the inputs is false, output is true
6. EXOR function $Y = A \oplus B = A\bar{B} + \bar{A}B$ Only when the inputs are different, output is true

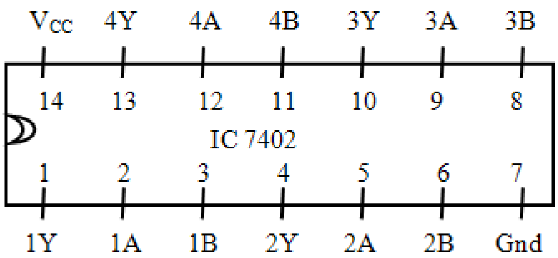
Where **A** and B are inputs and **Y** is the output.

1. **PIN DIAGRAMS:**

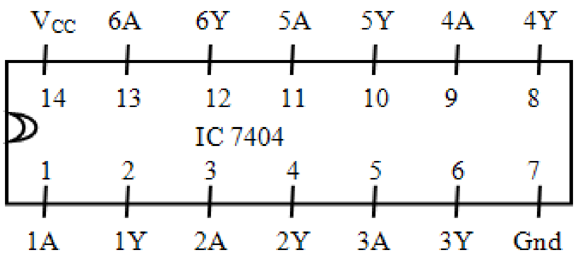
1) For IC's 7400 (NAND), 7408(AND), 7432(OR) & 7486(EX-OR)



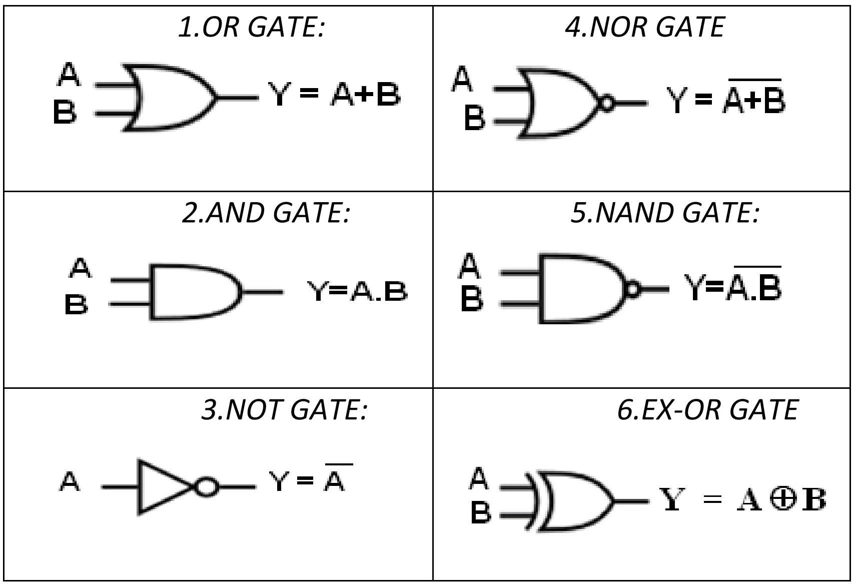
2) For IC 7402(NOR) - Quad 2 input



3) Hex inverter NOT (7404)



CIRCUIT DIAGRAMS:



PROCEDURE TABLE:

S.No	Gate	Boolean Expression	IC Number	IC pin configuration			
				Input	Output	+5V	Ground
1	OR	$Y = A + B$	IC 7432	1, 2	3	14	7
2	AND	$Y = AB$	IC 7408	1, 2	3	14	7
3	NOT	$Y = \overline{A}$	IC 7404	1	2	14	7
4	NOR	$Y = \overline{A + B}$	IC 7402	2,3	1	14	7
5	NAND	$Y = \overline{A \cdot B}$	IC 7400	1, 2	3	14	7
6	EX-OR	$Y = A \oplus B$	IC 7486	1, 2	3	14	7

Where **A** and **B** are inputs and **Y** is the output.

PROCEDURE:

1. IC 7400 is placed on the board.
2. The two logic select input switches are connected to the input pins.
3. The output pin is connected to the logic level indicator LED.
4. For various input combinations, the output LED is checked.
5. If the LED is OFF, the output is logic '0'
6. If the LED is ON, the output is logic '1'
7. The output is verified for all possible combinations of the inputs as in the truth table.
8. The above steps are verified for all remaining ICs.
9. Thus the logic function of the logic gates are verified using ICs.

OBSERVATIONS: Truth tables

1. OR gate

S.No	Input A	Input B	Output y = A+B
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	1

2. AND gate

S.No	Input A	Input B	Output y = A.B
1	0	0	0
2	0	1	0
3	1	0	0
4	1	1	1

3. NOT gate

S.No	Input A	Output y = $\overline{A}$
1	0	1
2	0	0

4. NOR gate

S.No	Input A	Input B	Output y = $\overline{A + B}$
1	0	0	1
2	0	1	0
3	1	0	0
4	1	1	0

5. NAND gate

S.No	Input A	Input B	Output y = $\overline{A.B}$
1	0	0	1
2	0	1	1
3	1	0	1
4	1	1	0

6. EX-OR gate

S.No	Input A	Input B	Output y = $A \oplus B = A\overline{B} + \overline{A}B$
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	0

CALCULATIONS

1. **OR gate**

Input A	Input B	Output y = A+B
0	0	0 + 0 = 0
0	1	0 + 1= 1
1	0	1 + 0 = 1
1	1	1 + 1 = 1

2. **AND gate**

Input A	Input B	Output y = A.B
0	0	0 . 0 = 0
0	1	0 . 1= 1
1	0	1 . 0 = 1
1	1	1 . 1 = 1

3. **NOT gate**

Input A	Output y = $\overline{A}$
0	1
0	0

4. **NOR gate**

Input A	Input B	Output y = $\overline{A+B}$
0	0	0 + 0 = 1
0	1	0 + 1= 0
1	0	1 + 0 = 0
1	1	1 + 1 = 0

5. **NAND gate**

Input A	Input B	Output y = $\overline{A.B}$
0	0	0 . 0 = 1
0	1	0 . 1= 1
1	0	1 . 0 = 1
1	1	1 . 1 = 0

6. **EX-OR gate**

Input A	Input B	Output y = $A \oplus B = A\overline{B} + \overline{A}B$
0	0	$0\overline{0} + \overline{0}0 = 0$
0	1	$0\overline{1} + \overline{1}0 = 1$
1	0	$1\overline{0} + \overline{1}0 = 1$
1	1	$1\overline{1} + \overline{1}1 = 0$

RESULT:

The performance of digital gates **OR, AND, NOT, NOR, NAND** and **EX-OR** are verified using IC chips.

External Practical Examination weightage of marks:

1. **Formula 2 mark, explanation of terms in the formula 2 mark = 4 mark**
2. **Simplified procedure = 6 marks. If involved with circuit diagram for procedure 3 mark and for circuit diagram 3 mark = 6 mark**
3. **For observations (Tabular columns) = 10 mark**
4. **Calculations = 8 mark**
5. **For correct result with unit 2 mark**

$\Rightarrow$ **4 + 6 + 10 + 8 + 2 = 30 marks.**