V.P. & R.P.T.P.SCIENCE COLLEGE
PHYSICS DEPARTMENT

VALLABH VIDYANAGR

6^{TH} SEMESTER B.Sc. PHYSICS
US06CPHY07/08/09
PRACTICAL MANUAL BOOK

DECEMBER 2017

V.P. & R.P.T.P. SCIENCE COLLEGE

VALLABH VIDYANAGAR

6h Semester B.Sc. Physics 2017-18

Courses;

US06CPHY07: Electricity, Magnetism and Nuclear Physics

US06CPHY08: Analog and Digital Circuits

US06CPHY09 : Optics, Solid State Physics and Numerical Analysis

Books Recommended:

1. Advanced Practical Physics for Students B L Wosnop and H T Flint, Methuen and Co. Ltd., London
2. B.Sc. Practical Physics, C L Arora, S.Chand & Co. Ltd., New Delhi
3. Advanced Practical Physics, M S Chauhan and S P Singh, Pragati Prakashan, Meerut
4. Advanced Practical Physics, S L Gupta and V Kumar, Pragati Prakashan, Meerut
5. An advanced course in practical Physics, D Chattopadhyay and P C Rakshit, New Central Book agency Pvt. Ltd.

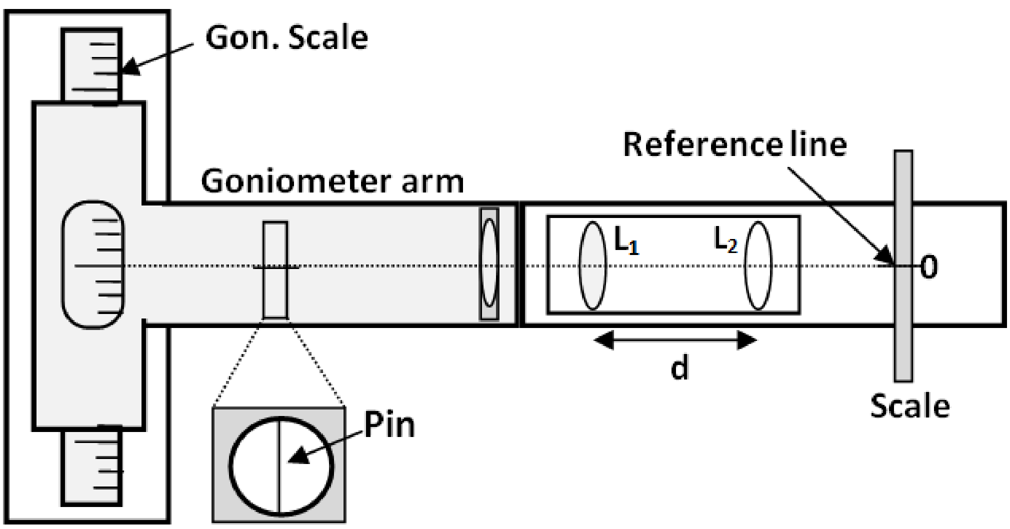
EXP. NO.	**SEARL'S GONIOMETER**	**DATE: …………..**
1	(Variable Distance)	

Aim:	To find the equivalent focal length (F) of a Two lens system for different distance (d) between the lenses. Draw a graph of 1/F → d and from it calculate the distance at which the system will work as a plane parallel plate.
Apparatus:	Scale, two convex lenses, Goniometer, Mirron, Pin, Lamp.

Procedure:

1. Place the plane mirror with the Goniometer arm and ensure that arm scale reading is at the centre.
2. Adjusting the object pin to remove the parallax between object pin and its image in plane mirror.
3. Remove the mirror and position the lens arm and set the distance between the lenses (say 10 cm).
4. Remove the parallax between object pin and blue line on the scale
5. Now setting the object pin on first line (h= 0.1 cm) on LHS of the blue line record the corresponding reading on goniometer scale as (a).
6. Repeat for h ranging from 0.2 cm, 0.3 cm… 0.5 cm on LHS.
7. Now setting the object pin on first line (h= 0.1 cm) on RHS of the blue line record the corresponding reading on goniometer scale as (b).
8. Repeat for h ranging from 0.2 cm, 0.3 cm… 0.5 cm on RHS.
9. Now change the distance between lenses (say 8 cm) and repeat the experiment (step-4 to 6).
10. Perform the calculations as per the observation table.
11. Draw a graph of 1/F → d and from it calculate the distance at which the system will work as a plane parallel plate.

Goniometer arrangement:



Observation Table:

Distance Between	Obs. No.	Scale Reading	Goniometer Reading	**h'** = (a-b)/2	Focal Length	**Mean** Focal	

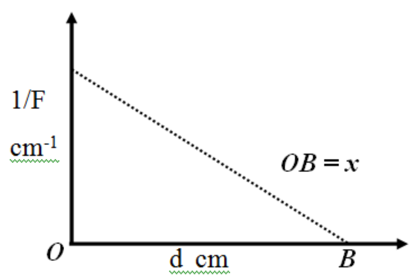
Two Lenses **d cm**		**h cm**	LHS **a cm**	RHS **b cm**	**cm**	**F** = (h/h')l **cm**	Length **F cm**	**1/F** **cm^{-1}**
	1	0.1						
	2	0.2						
10	3	0.3						
	4	0.4						
	5	0.5						
	1	0.1						
	2	0.2						
8	3	0.3						
	4	0.4						
	5	0.5						
	1	0.1						
	2	0.2						
6	3	0.3						
	4	0.4						
	5	0.5						
	1	0.1						
	2	0.2						
4	3	0.3						
	4	0.4						
	5	0.5						
	1	0.1						
	2	0.2						
2	3	0.3						
	4	0.4						
	5	0.5						

Graph and Calculations:

The equivalent focal length of the lens system is given by the relation :

$$\frac{1}{F} = \frac{1}{F_1} + \frac{1}{F_2} - \frac{x}{F_1 F_2}$$

Putting 1/F=0, we get $x = F_1 + F_2$. The distance x is theoretical distance between lenses at which system work as a plane parallel plate. OB = x is the distance at which the system will work as a plane parallel plate.



Result:

The distance x is the theoretical distance between the lenses at which system work as a plane parallel plate is _______cm

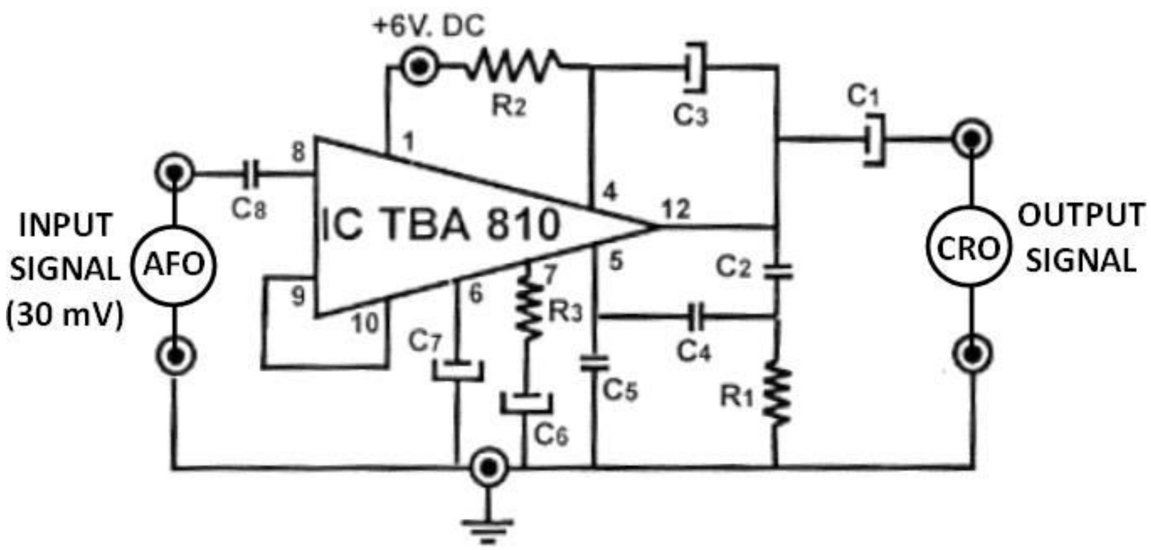
EXP. NO. 2 **POWER AMPLIFIER** (OPAMP IC TBA 810) **DATE: …………..**

Aim:	To study the frequency response of an audio power IC operational amplifier.
Apparatus:	Power amplifier circuit using IC TBA 810, Resistors, Capacitors, Audio Frequency Oscillator(AFO), Cathode ray Oscilloscope/ voltmeter, Connecting Wires.

Procedure:

1. Connect the Audio Frequency Generator output to the input of the circuit as shown.
2. Connect the CRO at the output terminals of the circuit as shown.
3. Switch ON the instruments.
4. Apply a sine wave (of V_i= 30mV peak to peak) and 100 Hz as an input signal.
5. Observe the output wave shape on CRO and note down the peak to peak amplitude (V_o) of the output signal in the observation table.
6. Increase the input signal frequency towards 10 kHz in appropriate steps and note down the corresponding V_o in observation table.
7. Complete the measurements as per the observation table.
8. Determine the gain A of the amplifier and convert it in dB.
9. Plot the frequency response curve i.e. graph of gain in dB (Y-axis) against logf (X-axis).
10. Determine the bandwidth of the amplifier.

Circuit Diagram:



Observation Table:

Input signal voltage V_{in} = 30 mV (peak to peak) =0.03V

Obs. No.	Frequency Hz	V_{out} Volt	Gain $A = V_{out}/V_{in}$	Gain in dB A_{dB} =20logA	logf
1	100				

2	200				
3	300				
4	400				
5	500				
6	1000				
7	2K				
8	3K				
9	4K				
10	5K				
11	6K				
11	7K				
11	8K				
11	9K				
11	10K				
12	20K				
13	30K				
14	40K				
15	50K				

Graph and Calculations:

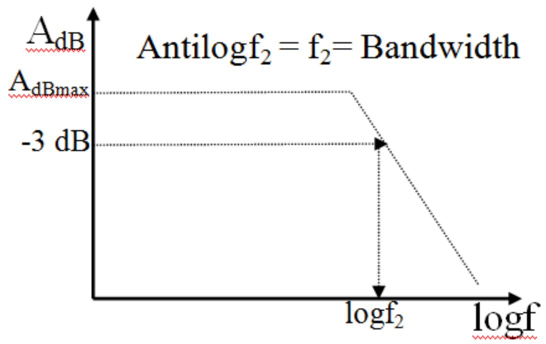
Plot the graph of logf against A_{dB}.

$A_{dB\ max}$ = ……

($A_{dB\ max}$ - 3dB) = ………………..,

$\log f_2$ = …

Bandwidth=antilogf_2 =…….. KH_Z



Result:

The bandwidth of the given audio power amplifier is = ………….. KHz.

EXP. NO. 3 **PLANCK CONSTANT BY LED (LIGHT EMITTING DIODE)** **DATE: …………..**

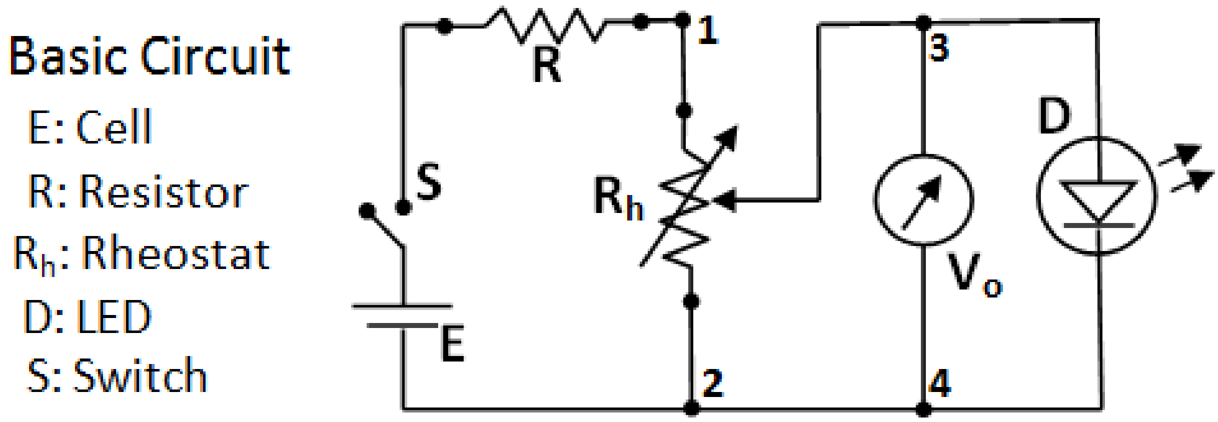
Aim: To determine the value of Planck constant (*h*) by using the Light Emitting Diodes (LEDs).

Apparatus: LEDs of different colour, DC supply, CRO, Rheostat, Resistance Box, DC voltmeter, Connecting wires.

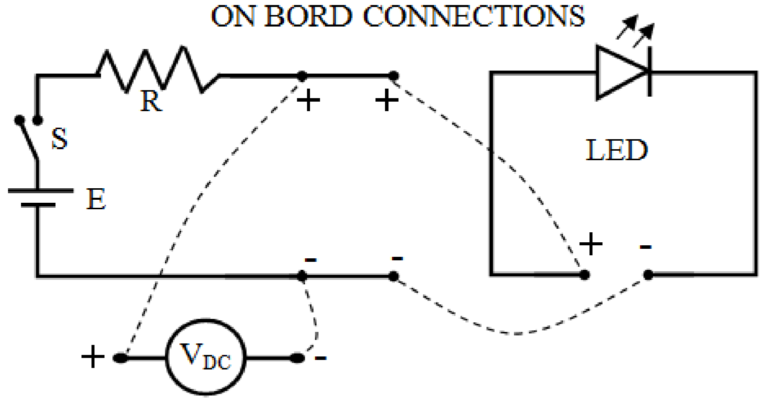
Procedure:

1. Connect the main cord to AC mains. **(Do not switch it ON but keep it OFF).**
2. Connect +ve terminal of power supply (1) to +ve terminal of DC voltmeter (3) and connect -ve terminal of power supply (2) to -ve terminal of DC voltmeter (4). **Set the voltmeter range to 20V**.
3. Connect +ve and –ve terminal of power supply (1 & 2) to + ve and –ve terminal of RED LED on the board respectively.
4. Now switch ON the AC mains and using switch (S), switch ON the power supply on the board.
5. Now increase the DC voltage slowly by variable resistance pot and observe the RED LED connected in the circuit. Stop as soon as LED just start to emit light. At this moment note the value of applied DC voltage shown in the DC voltmeter as the threshold voltage V_t for Red LED.
6. Disconnect the + ve and –ve terminals of LED and switch OFF power supply.
7. In this way repeat step-3 to 6 and connect other LEDs to measure their threshold voltages.
8. From the observation table plot the graph and perform necessary calculations using given formula to determine the value of Planck constant h.

Circuit Diagram:



THEORY: - Light-emitting diodes (LEDs) convert electrical energy into light energy. They emit radiation (photons) of visible wavelengths when they are "forward biased" (i.e. when the voltage between the p side and the n-side is above the "turn-on" voltage). This is caused by electrons from the "n" region in the LED giving up light as they fall into holes in the "p"region. If we measure the minimum voltage (threshold voltage) Vt required to cause current to flow and photons to be emitted, and we know (or measure) the wavelength of the emitted photons and use it to calculate the photon energy h ν from the relation, $h\nu = h(c/\lambda) = eV_t$.



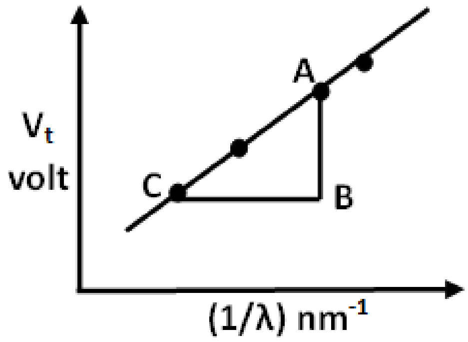
Observation Table:

Obs. No.	Color of LED	Wavelength λ nm	(1/ λ) nm^{-1}	Threshold Voltage V_t volt
1	Blue	470		
2	Green	525		
3	Yellow	580		
4	Orange	630		
5	Red	700		

Graph and Calculations: The photon energy is

$$h\nu = h\frac{c}{\lambda} = eV_t$$

$$\text{where } h = \text{Planck constant},$$
$$\nu = \text{frquency of photon},$$
$$c = \text{velocity of light} = 3 \times 10^8 \ m/s$$
$$e = \text{charge of electron} = 1.6 \times 10^{-19}\ C$$
$$\lambda = \text{wavelength of photon}.$$
$$\therefore h = \frac{e V_t \lambda}{c}$$



$$\text{From the graph slope} = \frac{AB}{BC} = \frac{V_t}{1/\lambda} = \ \ldots\ldots\ldots.$$

$$\therefore h = \frac{1.6 \times 10^{-19} \times V_t \times \lambda}{3 \times 10^8} = h = \frac{1.6 \times 10^{-19}}{3 \times 10^8} \times slope = \cdots\ldots\ldots$$

$$\text{Percentage error in } h = \frac{\text{Calculated Value} - \text{Standard value}}{\text{Standard value}} \times 100\ \%$$

=............................ x 100% = ... %

- *Standard value of h = 6.63 x 10^{-34} Js*

Results:

The calculated value of Planck constant is *h* =............& it is with error of ......%.

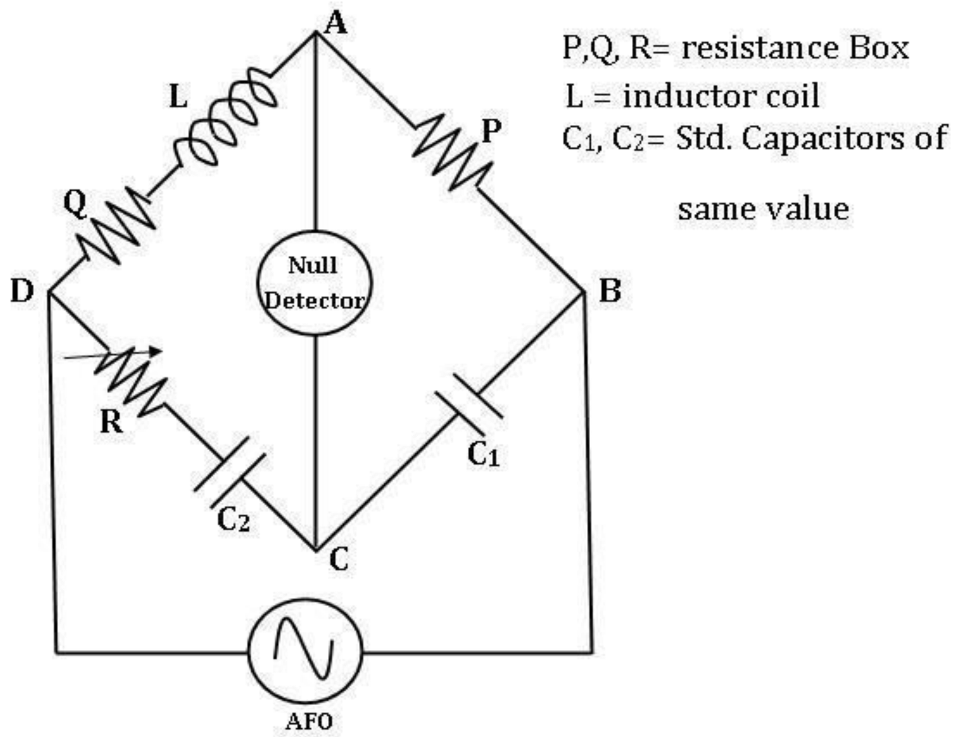
EXP. NO. 4 **L BY OWN'S BRIDGE** **DATE: ....**

Aim:	To determine the self-inductance (L) of a coil using owns bridge.
Apparatus:	Inductor coil, Resistance Boxes (Two 10,000 ohm box), two standard capacitors, null detector (voltmeter), AFO, Connecting wires.

Procedure:

1. Make electrical connections as shown in the circuit diagram.
2. Select certain value of P (say 400 Ω) and calculate corresponding value of Q using the given formula.
3. Set this value of Q and balance the bridge using variable resistance R.
4. When the bridge is balanced i.e. voltage across point A and B is zero or minimum note the value of this balancing resistance R.
5. Repeat the step 2 to 4 of the experiment for six more different values of P.
6. Using the given formula determine the self-inductance of the given inductor coil.

Circuit Diagram:



Observation Table:

Here Q = [P x (C_1/C_2) –S] Ω, where S = resistance of inductor coil=……. Ω

Obs. No.	Resistance P Ω	Resistance $Q = [P \times (C_1/C_2) - S]$ Ω	Balancing Resistance R Ω	Inductance $L = PRC_1$ H	Mean L H
1					
2					
3					
4					
5					
6					
7					

Calculations:

C_1 = ………….. μf

C_2 =……………. μf

Resistance $Q = [P \times (C_1/C_2) - S]$ Ω

Inductance of the given coil is $L = PRC_1$

Results:

The self-inductance of the given inductor coil is L = ………….. H

EXP. NO. 5 LIGHT DEPENDANT RESISTOR (LDR) DATE: …………..

Aim: To study the characteristics of a Light Dependent Resistor (LDR).

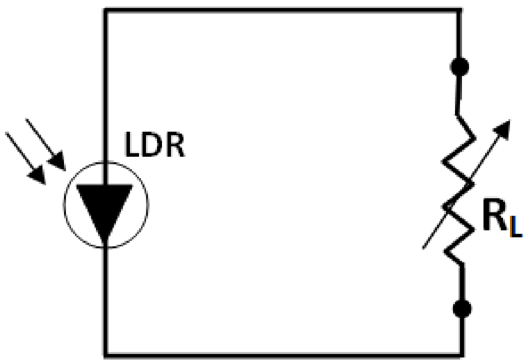
Apparatus: Light Source, LDR, Resistance Box, Connecting wires.

Procedure:

1. Connect the LDR and the Load resistance as shown in the circuit diagram.
2. Keep distance (d) of 100 cm between the LDR and the light source.
3. Note down the distance *d* and corresponding resistance R in the observation Table.
4. Now, decrease the distance *d* by 5 cm and note the corresponding resistance in the observation Table.
5. Similarly, set the *d* as per the observation table and note corresponding resistance in the observation Table.
6. Perform the required calculations and complete the observation table.
7. Plot a graph of lnR against lnI.
8. Determine the values of parameters m from the slope and K from intercept of the graph.
9. Verify the equality of ratio of intensities and ratio of corresponding resistances.

Circuit Diagram:

LDR: Light Dependent Resistor
R_L: Load Resistor



THEORY: - A photoresistor or light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity. A photoresistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

Observation Table:

Obs. No.	Distance d cm	Resistance R Ω	Intensity of light $I = (1/d^2)$	lnR	lnI
1	100				
2	95				

3	90				
4	85				
5	80				
6	75				
7	70				
8	65				
9	60				
10	55				
11	50				
12	45				
13	40				
14	35				
15	30				
16	25				

Calculations:

The intensity I of the light is,

$I \propto \frac{1}{d^2} \quad \therefore\ I = K\ \frac{1}{d^2}$ $,where\ K\ is\ constant\ of\ proportionality.$

$For\ K = 1,\ \ we\ have\ I = \dfrac{1}{d^2}.$

The resistance R is given by, $R = \ K\, I^{-m}, \quad \therefore \ln R = \ln K - m \ln I$

For K=1, lnK = 0. $\therefore \ln R = -m \ln I$

$we\ can\ write\ \ \ln R_1 = -m \ln I_1\ and \quad \ln R_2 = -m \ln I_2$

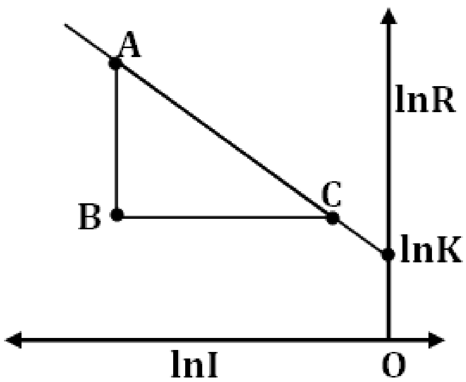
$$\therefore \ln R_2 - \ln R_1 = -m \ln I_2 - (-m \ln I_1)$$

$$\therefore \ln R_2 - \ln R_1 = -m\,(\ln I_2 - \ln I_1)$$

$$\therefore \ln \frac{R_2}{R_1} = -m \ln \frac{I_2}{I_1}$$

$$\therefore \frac{R_2}{R_1} = \left[\frac{I_2}{I_1}\right]^{-m}$$

$$\therefore \frac{R_2}{R_1} = \left[\frac{I_1}{I_2}\right]^{m}$$



From Graph:

m =Slope = AB/BC = ………..

ln$K$ = …….. K = antiln$K$ =……

Results:

For given LDR the constants m =……………… and K =………..

EXP. NO. 6 **WEIN BRIDGE OSCILLATOR** **DATE: …………..**

Aim: To study the Wein Bridge Oscillator Circuit.

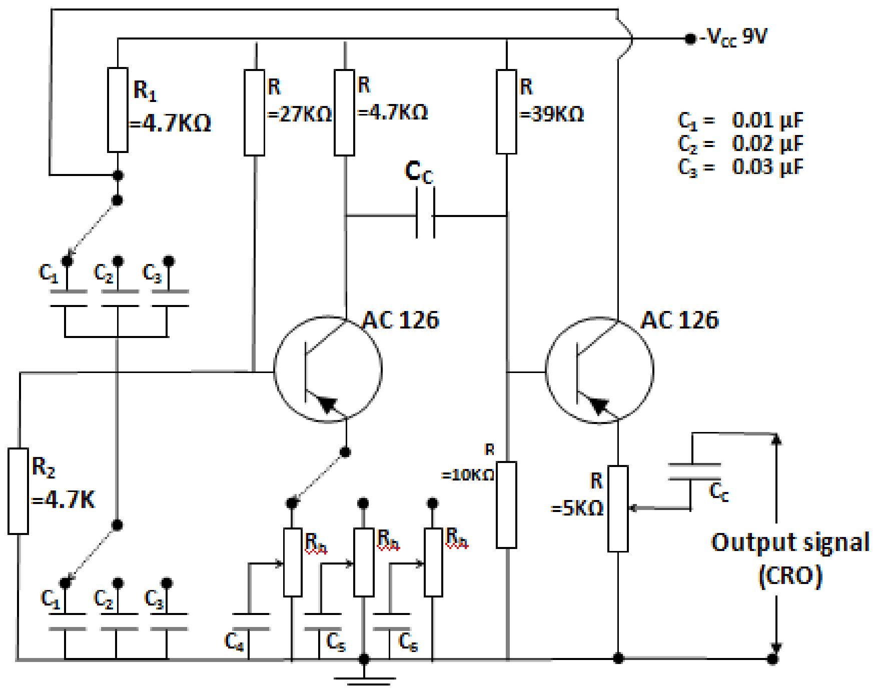
Apparatus: Power Supply, Resistors, Capacitors, Transistors(AC126), CRO, Connecting wires.

Procedure:

1. Connect the CRO at the output terminals of the circuit as shown.
2. Use the value of $R_1=R_2=R$ as given.
3. Connect the Capacitor (C_1) using the selector switch.
4. Using the gain contol knob (Rh_1) set the proper gain so that a sine wave is obtained on the CRO.
5. Measure the time period of the output sine wave and record it.
6. Determine the frequency of the output sine wave.
7. Similarly select the other Capacitors (C_2 and C_3) using the selector switch and using gain contol knob (Rh_1 & Rh_1) respectively, set the proper gain so that a sine wave is obtained on the CRO.
8. Measure the time period of the output sine wave and record it.
9. Determine the frequency of the output sine wave.
10. Compare the theoretically calculated frequency of the oscillation with the measured/observed frequencies
11. Write your conclusions.

Note: Trace any one generated output sine wave on a paper and attach it.

Circuit Diagram:



Observation Table:

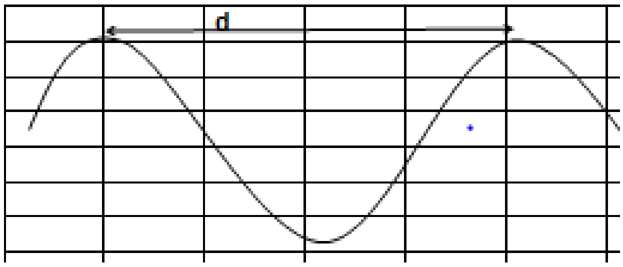
Obs. No	Resistance $R=R_1=R_2$ KΩ	Capacitance C μF	No. of Divisions d	Time Scale T	Time Period T= d x t	Observed Freq. F_0 =(1/T)	Theoretical Freq. F_{th} Hz

				ms/div	sec	Hz	
1	4.7						
2	4.7						
3	4.7						

Calculations:

Frequency of oscillation is

$F_{th} = 1/(2\pi \text{ RC})$.



Observfed Frequency of oscillation is

$F_o = 1/T$, where T = Time Period = no. of division on X-axis (d) x time scale (t)

Result:

The given oscillator circuit generates the frequency of …….., …….. , & …… Hz.

EXP. NO. 7 **BISTABLE MULTIBRRATOR** **DATE: …………..**

Aim: To Study Bistable multivibrator circuit.

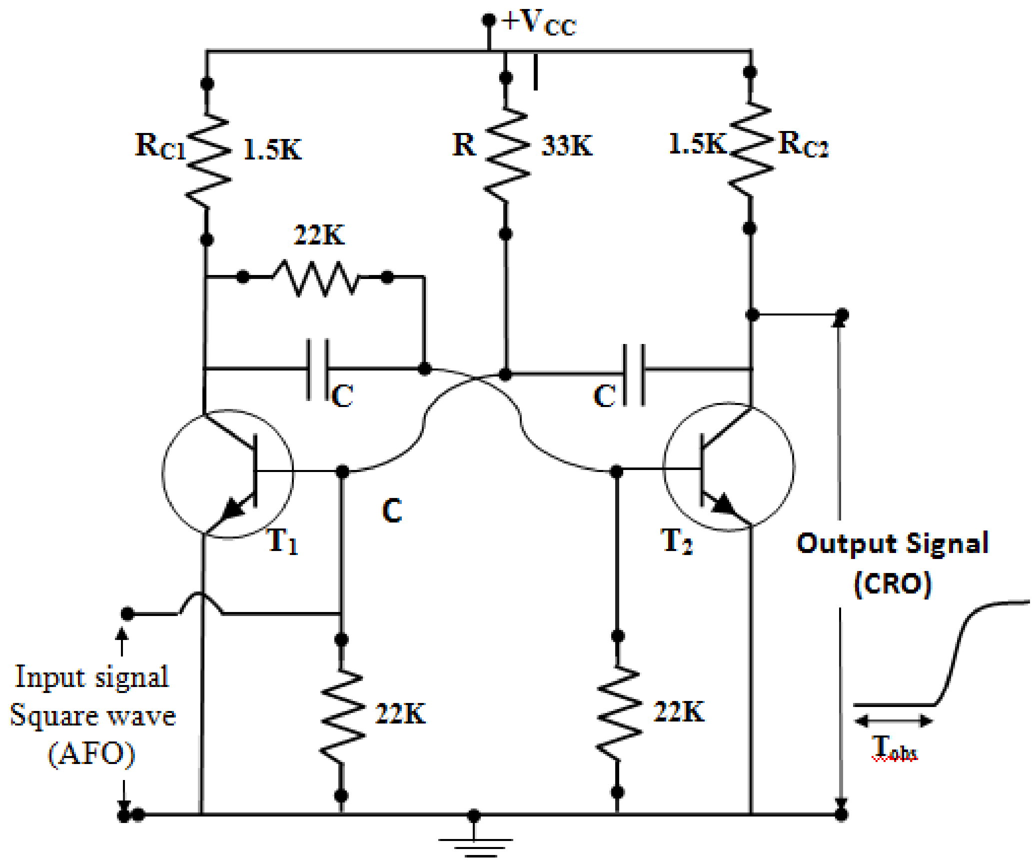
Apparatus: Power Supply, Resistors, Capacitors, Transistors(BC547), CRO, Connecting wires, Frequency Generator (AFO).Scale, two convex lenses, Goniometer, Mirron, Pin, Lamp.

Procedure:

1. Connect the AFO output to the input of the circuit as shown.
2. Connect the CRO at the output terminals of the circuit as shown.
3. Apply a square wave of 2V with frequency shown in observation table.
4. Measure the time period of the output square wave signal and record it.
5. Determine the frequency of the output square wave signal.
6. Similarly apply the other frequencies and determine the frequency of corresponding output square wave signals.
7. Compare the input and output frequencies and determine the mode of the circuit as either NORMAL or BISTABLE.

NOTE: Trace one of the input signal and its output square wave signal on a paper and attach it.

Circuit Diagram:



Observation Table:

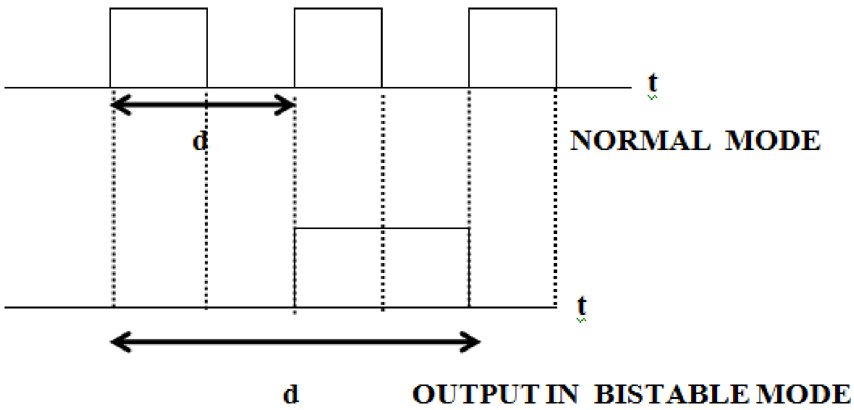
Obs. No	Applied Frequency F_0 Hz	No. of division d	Time Scale t ms/div	Time Period T= d x t sec	Observed Frequency F_0 =(1/T) Hz	Mode ***Normal or Bistable***
1	700					

2	800					
3	900					
4	1000					
5	1100					
6	1200					
7	1300					

- *In normal mode, observed frequency F_o will be nearly same as input frequency and in bistable mode, observed frequency F_o will be half of the input frequency.*

Calculations:

Time Period T = no. of division on X-axis (d) x time scale (t)



Result:

The given circuit triggers to bistable mode at input signal of …….. Hz .

EXP. NO. 8 **HALL EFFECT MEASUREMENTS - II (CONSTANT PROBE CURRENT)** **DATE: …………..**

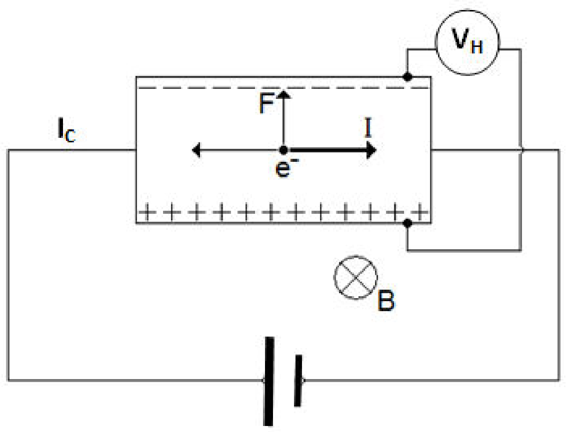
Aim: To study Hall Effect and to determine; (1) Hall coefficient (R_H) and (2) Carrier Concentration (η) of a given material.

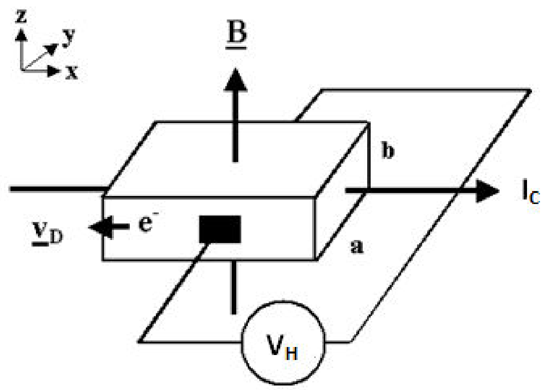
Apparatus: Hall effect Set-up, (Ammeter,Voltmeter, Coils,Semiconductor Material probe , Power Supply).

Procedure:

1. Check the Hall effect measurement set-up for proper connections.
2. Switch ON the set-up kit. Set-up zero correction if required using zero adjust knob.
3. Keep the current selector switch in (0-100 mA) range. Using the knob apply a probe current I_C (say 40 mA) to the probe.
4. Now shift the current selector switch in (0-500 mA) range. Using the knob, apply a magnetization current I_m (say 50 mA) to the coils to set-up a certain magnetic field (say 256 Gauss for this set-up) across the sample.
5. Measure the Hall voltage produced.
6. Now, increase magnetization current to 100, 150…… upto 500 mA to increase the magnetic field and measure the corresponding Hall voltage produced.
7. Repeat the experiment for other values of Probe current as per the obs. table.
8. Draw the necessary graph and perform the calculations.
9. Using the given formula determine the Hall coefficient and Carrier concentration for the given material and express their mean values in results.

Circuit Diagram & Hall effect phenomenon :





Observation Table:

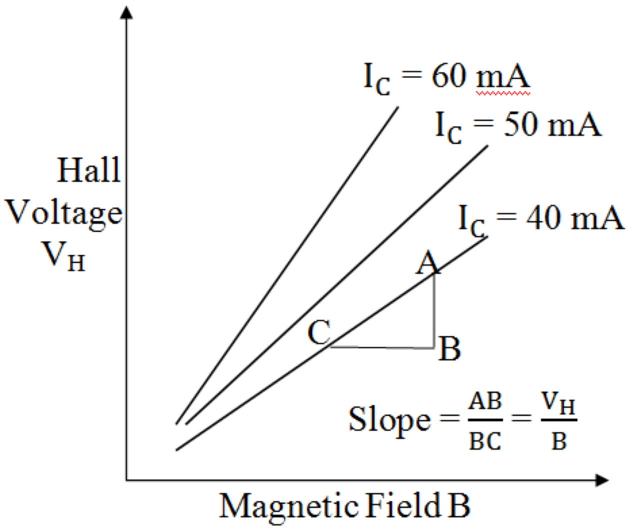
Obs. No.	Magnetization Current I_m mA	Magnetic Field Gauss	Hall Voltage V_H in mV for Probe current		
			I_c = 40 mA	I_c = 40 mA	I_c = 40 mA
1	50	256			
2	100	438			
3	150	630			
4	200	830			

5	250	1028			
6	300	1216			
7	350	1425			
8	400	1529			
9	450	1795			
10	500	1984			

Graph and Calculations:

Thickness of the Hall Plate **t** = 0.014 cm

Electron charge e = 1.6×10^{-19} Coul



1. Hall Coefficient:

$$R_H = \frac{V_H \times t}{B \times I_C} \times 10^8 \ \frac{cm^3}{Coul.}$$

$$= \frac{t}{I_C} \times \text{ slope} \times 10^8 \ \frac{cm^3}{Coul.}$$

=……………………..

= ____________ $\frac{cm^3}{Coul.}$

2. Carrier Concentration:

$$\eta = \frac{1}{R_H \ x \ e} \quad \frac{charges}{cm^3} = \ \dots\dots\dots$$

$$= \ \dots\dots\dots\dots \quad \frac{charges}{cm^3}.$$

Results:

For the given material, 1. Hall Coefficient, R_H = ……………..

2. Carrier concentration, η = ……

EXP. NO. 9 **e/m OF ELECTRON BY MAGNETRON METHOD** **DATE: ………….**

Aim: To determine the value of e/m of electron by Mgnetron method.

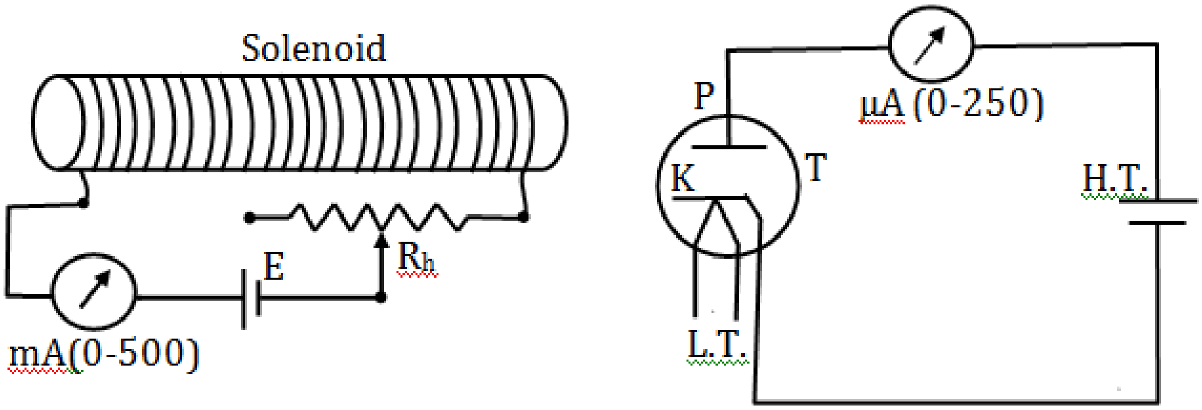
Apparatus: Solenoid, Rheostate, , Ammeter (0-500 mA and 0-250 µA) Voltmeter, Magnetron Tube with Power supply, Battery(0-24V).

Procedure:

1. Connect the solenoid circuit and magnetron tube circuit as shown in the diagram.

2. The position of the magnetron tube should be at the centre of the solenoid.
3. From the power supply apply anode potential V of certain value (say 2V).Apply a solenoid current I_s (say 50 mA) using the rheostat to set-up magnetic field within solenoid.
4. Note the corresponding plate current.
5. Now increase the solenoid current I_s (to 100 mA) and measure the corresponding anode plate current I_a.
6. In this manner, increase the solenoid current I_s (to 150, 200…500 mA) and measure the corresponding plate current.
7. Repeat step 3 to 6 for two different values of anode potential (say V=1 & 4 V).
8. Plot the graphs (on same scale) and determine the values of critical current I_c from each graph (i. e. for each anode potential V).
9. Perform the calculations as per formula and determine the value of critical magnetic field H_c for each anode potential V.
10. Using given relation determine value of e/m of electron for each anode potential V.
11. Mention the mean value of e/m as your result.

Circuit arrangement:



E: Battery (0-24V)
Rh: Rheostat
T: Magnetron Tube
K: Cathode P: Plate
L.T.: Low Tension supply
H.T.: Low Tension supply

Observations: 1. No.of turns per cm length of the solenoid = n = 37.3

2. Radius of the anode = R_a = 0.625 cm

Observation Table:

Obs. No.	Solenoid Current I_s		Anode Current I_a	
	mA	x 10^{-3}A	µA	x 10^{-6} A
1	50			
2	100			

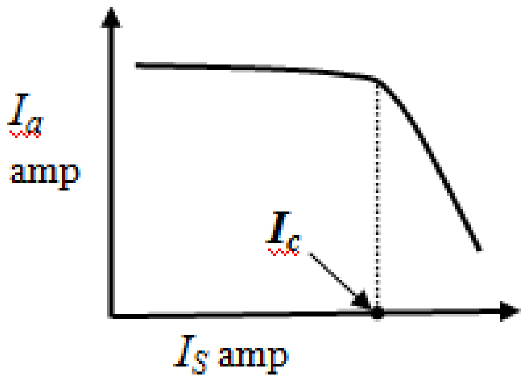
3	150			
4	200			
5	250			
6	300			
7	350			
8	400			
9	450			
10	500			

Graph and Calculations:
Formula:
The critical magnetic field Hc is given by;

$$H_c = \frac{4\,\pi\,n\,I_c}{10} = \frac{4\,\pi\,(37.3)\,I_c}{10}$$

Where I_c is critical current determined from graph.

$$H_c = \text{...............}$$



The ratio e/m is given by;

$$e/m = \frac{8\,x\,V}{H_c^2\;x\;R_a^2} \times 10^8 \quad emu/gm$$

$$\therefore\; e/m = \frac{8\,x\,(\qquad)}{(\qquad\qquad)^2\,x(0.625)^2} \times 10^8 \quad emu/gm = \text{......................}\; emu/gm$$

Result:
For the electron ,the ratio e/m = ………. emu/gm.

EXP. NO. 10 **SQUARE WELL POTENTIAL** **DATE: …………..**
(Energy eigen values of a proton)

Aim: To determine the Energy Eigen values of a proton in a one-dimensional square well potential.

Apparatus: Scientific Calculator

Given Problem: A proton of mass $m_p = 1.67 \times 10^{-27}$ kg is inside a one dimensional box of potential having depth V_o=30 MeV & half width a = 4×10^{-15} meter. Consider that the particle has potential energy function in the shape of a square well with vertical sides. Find the Energy Eigen values of the proton.

Procedure:

1. From the given data, find $\Delta = \hbar^2/2m_pa^2$, where $\hbar$=1.0544×10^{-34} J-sec, ($\hbar$= Planck's constant h /2π), m_p= mass of proton and a =half width of the potential well.
2. Find (Δ/Vo) and convert it into eV. Determine $(\Delta/Vo)^{1/2}$.
3. Determine the values of βa, |cos(βa)| and |sin(βa)| as per the observation table.
4. Plot |cos(βa)| against βa on a graph paper (which gives a curve).
5. Plot |sin(βa)| against βa (which gives a curve) on the same graph paper .
6. Plot $(\Delta/V_o)^{1/2}\beta a$,against βa on the same graph (which gives a straight line).
7. For the intersection points of the curves and the straight find the values of (β_n a) as shown in graph. [β = βn (n = 0,1,2,…)].
8. Find the corresponding allowed energy eigen values for each of $\beta_n a$ using the relation, $E =[(\beta_n a)^2 (\Delta/Vo) - 1)]V_o$ and tabulate your results.

Note: Students are required to perform the experiment with V_0= 30 MeV & mention results accordingly.

- **Following sample example is given to understand the procedure only.**

SAMPLE CALCULATIONS:

Suppose for such as above proton ; mass of proton of $m_p = 1.67 \times 10^{-27}$ kg,
Potential depth V_o=25 MeV = 25 x 10^6 eV , half width a = 4×10^{-15} meter.

$$\Delta = \frac{(h/2\pi)^2}{2m_pa^2} = \frac{(6.602\,x10^{-34}/2x3.14)^2}{2\,x\,1.6x10^{-27}x\,(4\,x\,10^{-15})^2} = 2.06\,x10^{-13}$$

$$\therefore \frac{\Delta}{V_0} = \frac{2.06\,x10^{-13}}{25x10^6} = 8.24\,x10^{-21}\,J$$

$$\therefore \text{In } eV, \qquad \frac{\Delta}{V_0} = \frac{8.24\,x10^{-21}\,J}{1.6\,x10^{-19}} = 0.0515\,eV$$

$$\therefore \quad \left(\frac{\Delta}{V_0}\right)^{1/2} = (0.0516)^{1/2} = 0.226$$

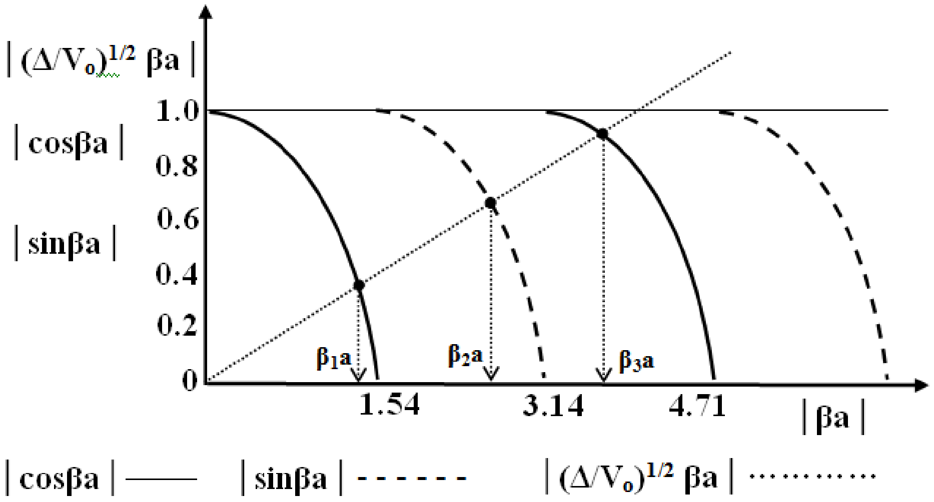
Observation Table:

- Calculate |cos(βa)| for 0 to π/2, π to 3π/2, 2π to 7π/2…..and
- Calculate |sin(βa)| for π/2 to π, 3π/2π to 2π,…..

No.	βa	|cos(βa)|	|sin(βa)|	$(\Delta/V_o)^{1/2}$ βa
1	0.1 x π/2 = 0.157	0.987	-	0.035
2	0.2 x π/2 =		-	
3	0.3 x π/2 =		-	
…	……..		-	
…	1 x π/2= 1.57	0	-	0.356
…	1.1 x π/2= 1.727	-	0.987	0.392
…	……..	-		

…	2 x π/2= 3.14	-	0	0.71
…	2.1 x π/2= 3.297	0.987	-	0.75
…	……….		-	
…	5 x π/2= 7.85	0	-	1.78

Graph & Calculations:



The n^{th} energy eigen value $E_n = [(\beta_n a)^2 (\Delta/V_o) - 1)]V_o$ MeV.
First intersection point gives, $\beta_1 a = 1.256$.
Hence, $E_1 = [(1.256)^2 x(0.0515) -1)] \times 25 = -22.96$ MeV.
Similarly we can calculate E_2 and $E_3$for other intersection points.
Note: Students are required to perform the experiment with V_0= 30 MeV .

Results:

Energy Level	*$\beta_n a$ for (V_0=25Mev)*	$\beta_n a$ for (V_0=30Mev)	*Eigen value (for V_0=25Mev) MeV*	Eigen value (for V_0=30 Mev) MeV
0	*0*	0	*E_0 = -25.00*	E_0 =
1	*1.256*		*E_1 = -22.96*	E_1 =
2	*2.512*		*E_2 =-16.85*	E_2 =
3	*3.768*		*E_3 =-6.67*	E_3 =

EXP. NO. 11 **FABRY PEROT ETALON** **DATE: …………..**

Aim: To determine the thickness of a air film between the plates of a Fabry Perot Etalon.

Apparatus: Fabry Perot Etalon, Spectrometer, Condensing lens, Reading lamp, Sodium lamp.

Procedure:

1. Adjust the telescope of the spectrometer for parallel rays.
2. Now arrange the aperture of source, the centre of the lens the center of F.P. etalon and centre of the objective of the telescope at the same heights and co-linear.
3. Focus the core of the rays from convex lens at the middle of the F.P. etalon plates.

4. The circular rings will be observed through the telescope.
5. Adjust by the leveling screws of prism table and the telescope till the pattern is symmetric and travelling in the field of view.
6. Coincide the vertical cross wire at the middle of the n^{th} bright ring on the left hand side and note down the spectrometer reading.
7. Now again adjust the cross wire on $(n-1)^{th}$ ring and note down the reading. Take the reading till the cross wire crosses the centre of the pattern and up to the middle of n^{th} ring on the right hand side.

Theory:

The etalon essentially consist of two plane parallel, optical and semi silvered glass plates which are fixed at a suitable distance. The outer surface are made slightly wedge shaped. So that any interface pattern due to these surfaces may fall out of view. The interference of light which is reflected and transmitted at the plane parallel boundaries of a thick plate of a media, from the fringes. This type of interference fringes are known as Haidinger fringes because they were first described by Haidinger.

If t is distance between two plates, the path difference between any two consecutive transmitted beams is $2t\cos\theta$ and corresponding phase difference is given by ,

$$\emptyset = \frac{2\pi}{\lambda} \times 2t\cos\theta$$

Two transmitted beams interfere constructively or distractively depending on their relative path difference.

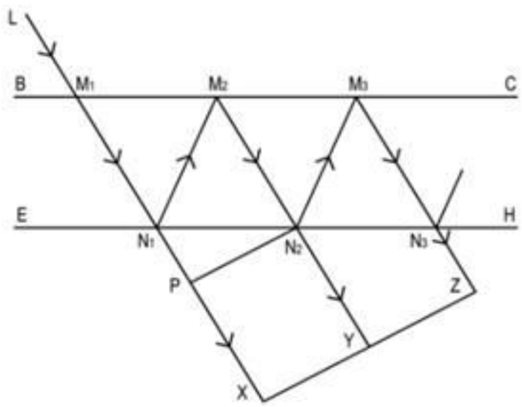
For constructive interference, we have the path difference

$$2\mu t\cos\theta = n\lambda \quad \text{(for maxima)}$$

Here n = the order of rings; μ = the refractive index of medium between etalon plates.

For air μ = 1, so we have, $2t\cos\theta = n\lambda$

Ray diagram:



Observation Table:

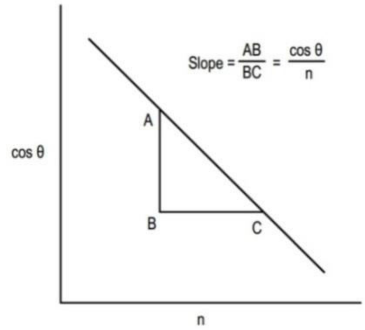
Obs No.	No of rings n	Spectrometer reading		Angular displacement $\theta' = a \sim b$	Angular radius	$\cos\theta$
		L.H.S	R.H.S			

		a	b	(angular diameter)	$\theta = \frac{\theta'}{2}$	
1	15					
2	14					
3	13					
4	12					
5	11					
6	10					
7	9					
8	8					
9	7					
10	6					
11	5					

Graph and Calculations:

Plot the graph $\cos\theta \rightarrow n$ and find out the slope 'm' of the graph

$$slope\ \ m = \frac{AB}{BC} = \frac{\cos\theta}{n}$$



Using the following relation calculate the thickness 't' of the air film in the F.P. etalon.

$$2t\cos\theta = n\lambda$$

where $\lambda = 5893\ A^{o}$ for Sodium light.

$$\therefore t = \frac{\lambda}{2} \cdot \frac{n}{\cos\theta} = \frac{\lambda}{2 \times slope} = \frac{5893\ x\ 10^{-8}}{2 \times slope} = \ \ldots\ldots\ldots\ldots\ cm$$

Result:

The thickness of the air film i.e. separation between the plates of the given Fabry-Perot etalon is t = __________ cm

EXP. NO. 12 **LVDT CHARACTERISTICS (Linear Variable Differential Transducer)** **DATE: …………..**

Aim: To study the characteristics of a LVDT (Linear Variable Differential Transducer).

Apparatus: LVDT Set-up kit, (Audio frequency generator, Voltmeter, LVD transformer, displacement meter, resistors, rheostat), CRO.

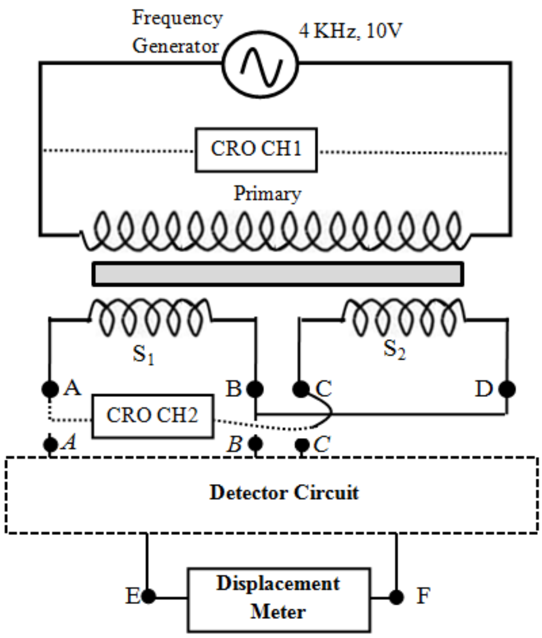
Procedure:

1. Connect the LVDT kit to the AC mains and switch it ON.
2. Connect the First Channel of dual trace CRO to the output of the sine wave oscillator on the kit board and observe sine wave of ~ 4 KHz frequency on CRO. Set the amplitude of this signal at maximum (~10V pp).
3. Now apply this sine wave to the primary (input) of the LVDT by connecting

input terminals of primary to the output terminals of the sine wave oscillator.

4. Now connect the output of the LVDT i.e. terminal A and C to the second Channel of dual trace CRO. You should observe same sine wave but with 180^0 phase shift.
5. Note the amplitude (voltage) of this signal which is the output of LVDT when shaft (i.e. core is at right end)) is not shifted.
4. Now slowly shift the position of the LVDT shaft at different positions (d) as per observation table Part 1 and record the amplitude of the corresponding output signal (V_0). Observe the Null point and phase of the output signal.
5. Plot the graph of displacement (d) against output voltage V_o.
6. Now connect the output terminals A, B and C of the LVDT to the LVDT Detector circuit as shown. Calibrate the output of the LVDT to 210 mm by adjusting the output potentiometer of the detector circuit.
7. Connect the output of the LVDT Detector circuit i.e. terminal E and F to the displacement indicator digital meter.
8. Now slowly shift the LVDT shaft and set different positions (D mm) using displacement indicator meter and record output voltage V'_o in mV for each displacement as per observation table Part-II.
9. Plot graph of displacement d' (mm) against V'_o in mV and check the linearity.
10. Determine the residual voltage of the given LVDT.

Circuit Diagram:



Observation Table: Displacement = d mm and Output = V_0 volt

Part 1

Obs. No.	d mm	Output V_0 volt
1	20	
2	18	
3	16	
4	14	
5	12	
6	10	
7	8	
8	6	
9	4	
10	2	
11	0	

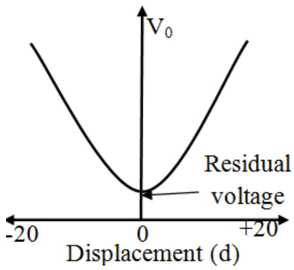
Obs. No.	d mm	Output V_0 volt
12	-2	
13	-4	
14	-6	
15	-8	
16	-10	
17	-12	
18	-14	
19	-16	
20	-18	
21	-20	

Part 2

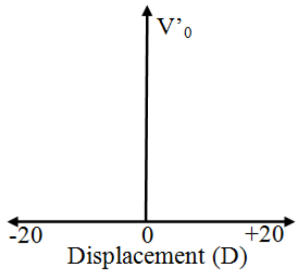
Obs. No.	Displacement meter reading D mm	V_0' volt
1	20	
2	15	
3	10	
4	5	
5	0	
6	-5	
7	-10	
8	-15	
9	-20	

Graph :

Plot the graph of d against V_0 (Part 1)



Plot the graph of D against V_0' (Part 2)



Results:

The residual voltage of the given LVDT is……………. .

EXP. NO. 13 UNIJUNCTION TRANSISITOR (UJT) CHARACTERISTICS DATE: …………..

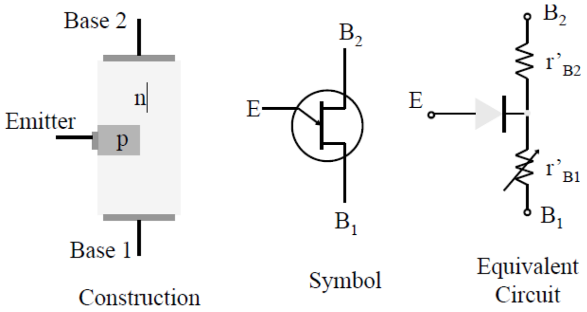
Aim: To determine the characteristics of a UJT.

Apparatus: Regulated Power Supply (0-30V, 1A), UJT 2N2646, Resistors 10kΩ, 47Ω, 330Ω, Multimeters ,Connecting Wires.

Procedure:

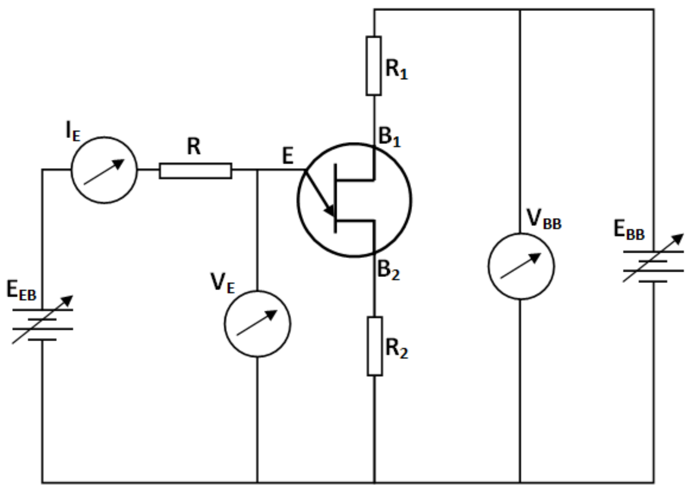
1. Connect the circuit as shown in circuit diagram.
2. First set the $V_{BB} = 0$.
3. Set the current I_E at 0.1mA and record the corresponding voltage V_E.
4. Now increase the I_E to 0.2mA and record corresponding voltage V_E .
5. In this way, perform the experiment as per the observation table
6. Draw the characteristic curve as shown using the observation table.

UJT Parameters:



- *UJT has only one pn junction. It has an emitter and two bases, B1 and B2.*
- *r'_{B1} and r'_{B2} are internal dynamic resistances.*
- *The interbase resistance, $r'_{BB} = r'_{B1} + r'_{B2}$.*
- *r'_{B1} varies inversely with emitter current, I_E*
- *r'_{B1} can range from several thousand ohms to tens of ohms depending o*

Circuit Diagram

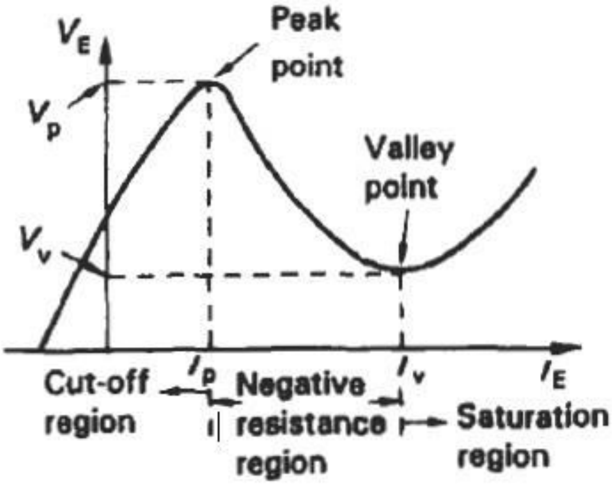


Observation Table:

Sr. No.	Emitter Current I_E mA	Emitter Voltage V_E volt		
		$V_{BB} = 0V$	$V_{BB} = ...\ V$	$V_{BB} = ...V$
1	0			
2	0.01			
3	0.02			
…	…			
	0.1			
	0.15			
	0.2			
	0.25			

	0.3			
	…			
	0.5			
	0.6			
	…			
	1.0			
	1.5			
	2.0			

Graph and Calculations: The photon energy is



Results:
The characteristics of the given UJT are obtained, plotted and studied.

EXP. NO. 14 **OPAMP APPLICATIONS** **DATE: …………..**

Aim: To study the application of operational amplifier as an adder and as a multiplier.

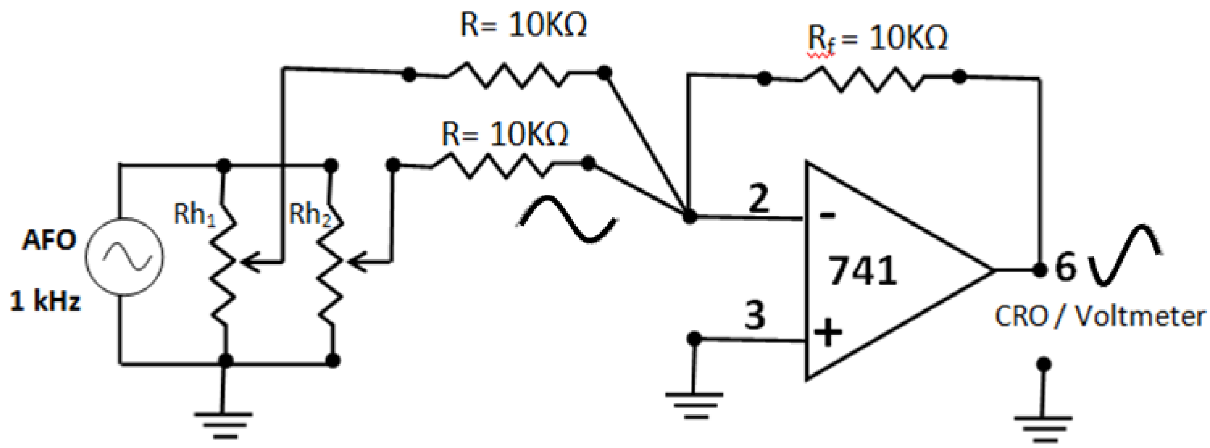
Apparatus: Power Supply, Resistors, Capacitors, IC 741, CRO, Connecting wires, Frequency Generator (AFO),

Procedure:

1. Connect the AFO output in parallel to the rheostat 1 and 2 as shown.
2. Connect 10KΩ resistor between variable of Rh1 and input terminal 2.
3. Connect another 10KΩ resistor between variable of Rh_2 and input terminal 2.
4. Connect the feedback resistor (R_f) of 10KΩ between the output (terminal- 6) and the input (terminal-2) of the circuit as shown. Connect the terminal-3 of the input to the ground. Ground the Rheostats also as shown.
5. Apply a sine wave of 1 kHz , 4V from the AFO .
6. Check the input voltages V_1 , V_2 and output voltage V_0 using a Voltmeter.
7. Connect the CRO channel-1 to display V_1 and Channel-2 to display V_0.

8. Set the input voltages V_1 and V_2 as per observation Table 1 and measure V_O.
9. Observe the waveforms on the CRO.
10. Compare the measured output voltage Vo with the calculated value.
11. Similarly set input voltages V_1 and V_2 as per Obs. Table 1 and measure V_0,
12. To study the circuit as a multiplier, keep R_f of 20KΩ and repeat the experiment as per part 2.Complte the observations as per observation Table 2.
13. Trace one of the input and its output wave signal on a paper and attach it.

Circuit Diagram



OP AMP IN INVERTING MODE

Observation Table:

Obs. No	Input voltage volt		PART 1:ADDER WHEN R_F = 10K		PART 2:MULTIPLIER WHEN R_F = 20K	
			Output V_o		Output V_o	
	V_1	V_2	Measured	Calculated	Measured	Calculated
1	1	4				
2	2	4				
3	3	1				
4	4	2				
5	5	1				

Calculated Output voltage V_0 Volt = $V_o = \frac{R_F}{R}(V_1 + V_2)$

Results:
The application of operational amplifier as an adder and as a multiplier studied.

EXP. NO. 15 **OPAMP PARAMETERS** **DATE: …………..**

Aim:	To determine the parameters of an operational amplifier.
Apparatus:	Power Supply, Resistors, Capacitors, IC 741, CRO, Connecting wires, Frequency Generator (AFO),

Procedure:

Circuit Diagram

Observation Table:

Calculations:

Results:

EXP. NO. 16 **HIGH RESISTANCE BY LEAKAGE** **DATE: …………..**

Aim:	To determine the value of a high resistance by the method of leakage using Ballistic Galvanometer.
Apparatus:	Ballistic Galvanometer, Damping key, Simple keys, Dry cell, Resistor, Capacitor , Connecting wires.

Procedure:

1. Make electrical connections as shown in the circuit diagram.
2. First, charge the capacitor C for a fixed time (say 30 sec) by pressing key K_1.(This time is referred as charging time).
3. Now release key K_1 and immediately press the key K_3 so that current from capacitor passes through Ballistic Galvanometer. Record the deflection of the Ballistic Galvanometer on Scale as direct deflection d_1.
4. When required use damping key to set the deflection of B.G. at null position.
5. Repeat step-2 and 3 for three times and determine mean d_1.
6. Now, charge the capacitor C for a fixed time (say 30 sec) by pressing key K_1.(This time is referred as charging time).
7. Now release key K_1 and immediately press the key K_2 for 5 sec so that current leakages through resistor R. (This time is referred as time of leakage).

8. Now release the key K_2 and immediately press key K_3 so that current from capacitor passes through Ballistic Galvanometer. Record the deflection of the Ballistic Galvanometer on scaleas d_2.
9. In this way, repeat the step-2 to 4 for different time of leakages as mentioned in the observation table keeping same charging time.
10. Record your observation and plot the graph of log (d_1/d_2) against Time (t).
11. Perform the calculations using given formula and determine R.

Circuit Diagram:

B.G. : Ballistic Galvanometer

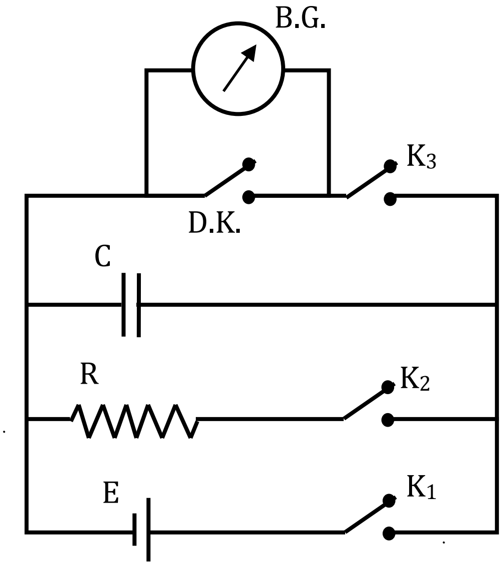
D.K. : Damping Key

C : Capacitor

R: High Resistor

E: Battery (1.5 V)

K_1, K_2, K_3 : Simple keys



Observation Table:

Direct deflection through B.G. (d_1):

1. d_1 = __________mm, 2. d_1 = _________mm, 3. d_1 = __________mm,

Mean direct deflection: d_1 = _____________mm.

Obs. No.	Time of leakage t sec	Deflection Scale d_2 mm	d_1/d_2	$\log_{10}(d_1/d_2)$
1				
2				
3				
4				
5				
6				
7				
8				

9				
10				

Calculations:

The value of capacitor C = ………..

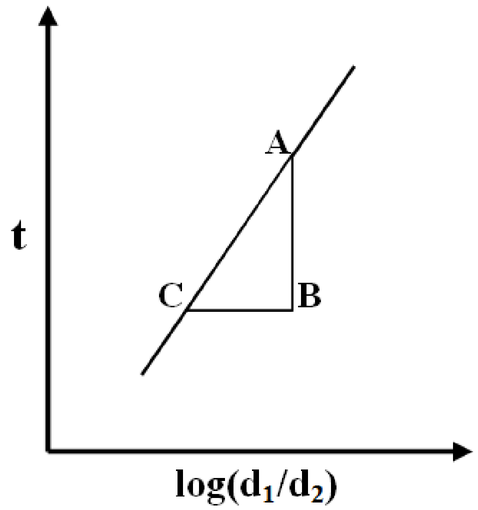
The High Resistance R :

$$R = \frac{t}{2.303\ C} \times \frac{1}{\log\left(\frac{d_1}{d_2}\right)}$$

$$\text{Since slope} = \frac{AB}{BC} = \frac{t}{\log\left(\frac{d_1}{d_2}\right)}$$

$$\therefore R = \frac{\text{slope}}{2.303 \times C} = \ldots\ldots\ldots\ldots$$

$$= \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad M\Omega$$



Results:

The value of Unknown High Resistance R = ……….. MΩ

EXP. NO. 17 4 BIT BINARY COUNTER DATE:……

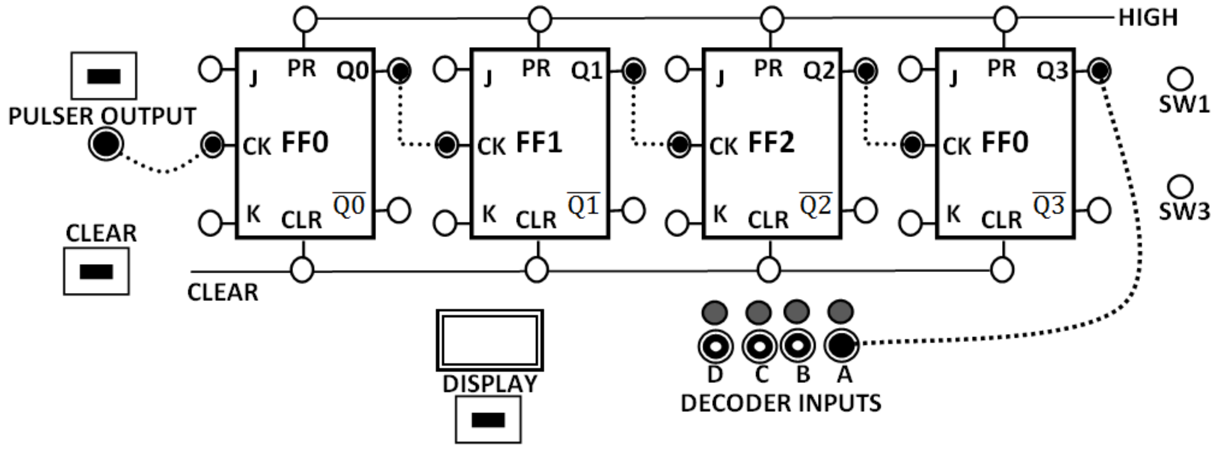
Aim:	To design and study 4-bit binary ripple or Asynchronous or serial (i) UP counter and (ii) DOWN counter.
Apparatus:	JK FFs(Flip-flops), Clock Pulsar, LEDs, Binary to Decimal Decoder.

Procedure:

1. Connect the Pulsar output to the clock input CK of First JK FF i.e. FF0.
2. Connect the output Q0 of First JK FF (FF0) to the clock input CK of second JK FF i.e.FF1.
3. Similarly connect the output Q1 of FF1 to the clock input CK of FF2 and output Q2 of FF2 to the clock input CK of FF3.
4. Now preset all FFs by pressing SW1 switch.
5. Apply HIGH (or 1) inputs to both J and K inputs of all FFs by pressing SW3 switch on the board.
6. Connect the output Q0 of FF0 to the Decoder input A.
7. Similarly connect Q1, Q2, Q3 of FF1, FF2, FF3 to the Decoder inputs B, C and D respectively.
8. Switch ON the board. Press the Decoder switch to ON position.
9. Now press CLEAR switch to clear all FFs.
10. All the LEDs on the output Qs should OFF and $\bar{Q}$ s should be ON. The display will show 0.

11. Now press the PULSER switch once to apply the First CLOCK pul.
12. Note down the positions of the Qs and decimal number on display in the observation Table.
13. Similarly apply 2nd , 3rd … 16th CLOCK pulses and perform the experiment.
14. Draw the timing diagram from the Table.
15. For DOWN counter connect $\overline{Q}$ to next FFs CK and perform the experiment.

Circuit Diagram for 4 bit binary UP Counter:



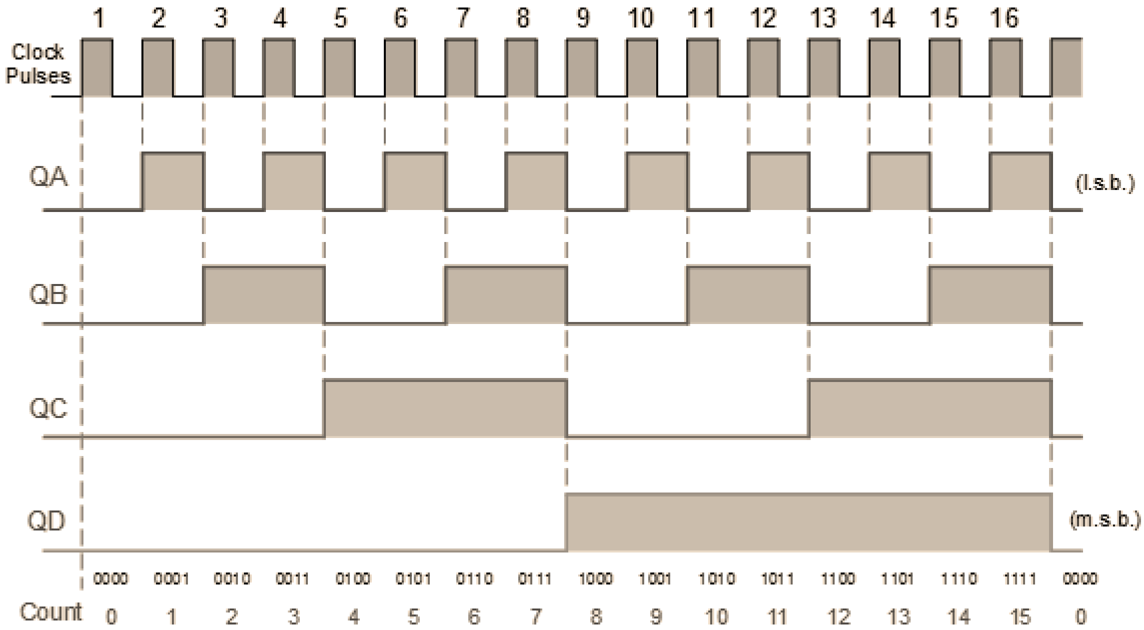
Note: Make connections shown by dotted line only.

Observation Table:

CLOCK PULSE Number	UP Counter			DOWN Counter		
	OUTPUT FFs Q = Q3Q2Q1Q0	Decoder OUTPUT Q' = DCBA OFF=0 ON=1	Decoder Display (Decimal Equivalent)	OUTPUT FFs Q= Q3Q2Q1Q0	Decoder OUTPUT Q' = DCBA OFF=0 ON=1	Decoder Display (Decimal Equivalent)
1	00000	0000	0	1111	1111	15
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

15						
16						

TIMING DIAGRAM:



RESULT:
The 4 bit binary UP and DOWN counters are studied.

EXP. NO. 18 BABINET COMPANSATOR DATE:……

Aim:

Apparatus:

EXP. NO. 19	RESISTIVITY BY CAREY-FOSTER BRIDGE METHOD	DATE: …………..

Aim:	Determination of the specific resistance of the constantan wire by using the Carey Foster's Bridge method.
Apparatus:	Carey Foster's Bridge Testing Unit, Two resistances of equal value (10Ω) , Patch cords, Mains Cord.

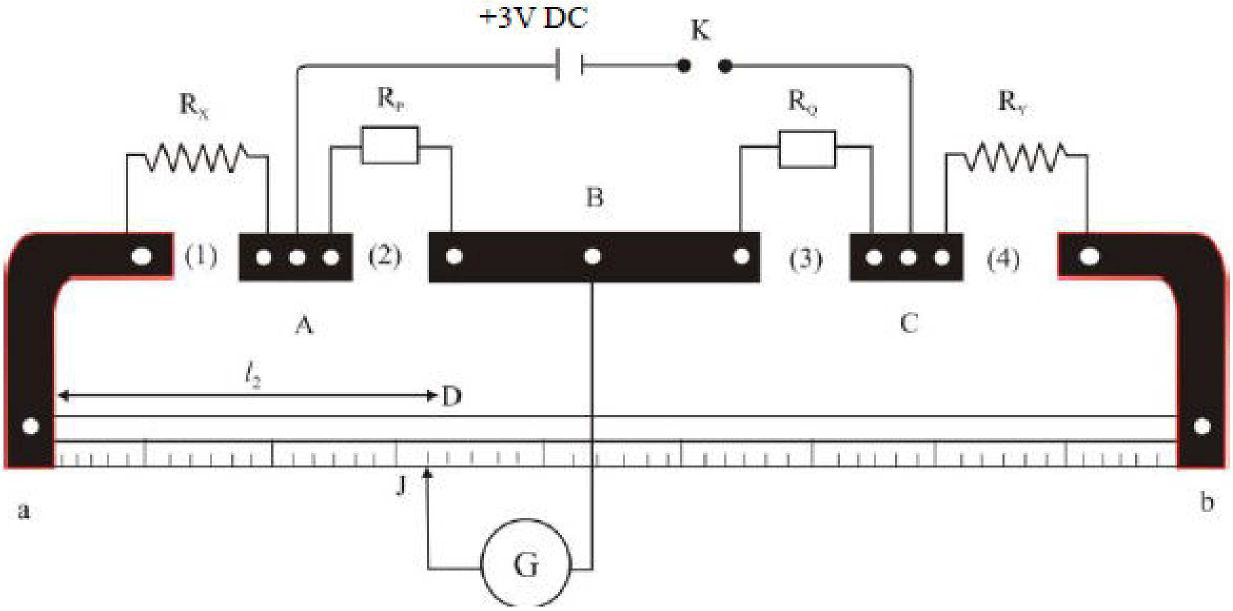
Procedure:

1. Connect the given resistances R_P and R_Q (10Ω) in gaps 2 and 3.
2. Connect resistances R_X and R_Y in gap A(1) and A(4).
3. Set the value of both resistances R_X and R_Y equals to zero.
4. Connect the DC power supply between the point A and C of bridge.
5. Connect the galvanometer between point B and jockey (j)as shown in figure.
6. Switch ON main power supply and switch ON +3V DC power supply.
7. Touch the jockey (j) on the wire at the end a, and point out the direction of deflection of galvanometer. Now touch the jockey at the second ends of wire b. If the deflection is reversed, it means the connections are correct.
8. Now move the jockey at the middle on the bridge wire and find the null point (zero deflection on galvanometer). Note this reading on scale as x cm.
9. Now exchange the both resistances R_X and R_Y and again find the null point on galvanometer. Note the reading on the bridge scale as y cm.
10. Now find the applied correction δl by subtracting y from x.
11. Set the value of resistance R_X is zero and varies the value of resistance R_Y.
12. Find the null point on the bridge wire (zero deflection on galvanometer) by keeping RY equal to 1Ω, 2Ω, 3Ω,…………etc. and note the reading of l_1

and l_2 on bridge scale and follow the table.

13. Using the given formula determine the value of resistivity of the given wire

Circuit Diagram:



Observation Table:

Balance point with (R_Y =0) in left gap and (R_X =0) in right gap, x = ……cm

Balance point with (R_Y =0) in right gap and (R_X =0) in left gap, y = ..…..cm

Correction to be applied (x-y)= δl =…….cm

Obs. No.	R_Y Ohm	Position of balance point with unknown resistance in		Shift $(l_1 - l_2)$ cm	Correct Shift d = (l_1-l_2) - δl	Resistance per cm R'= R_Y/d
		Left gap l_1 cm	Right gap l_2 cm			
1	1					
2	2					
3	3					
4	4					
5	5					
6	6					
7	7					

Mean R' = ……….….. Ohm

Calculations:

Length of the wire l =…………..….cm

Area of cross-section A= 8.54 x 10^{-4} cm^2

Total resistance of the bridge wire **R = R'x l =   ………..ohm**

The specific resistance i.e. resistivity of the wire,

$$\boldsymbol{\rho = \frac{l}{A}R = \ \dots\dots\dots\dots\dots..\ ohm\cdot cm}$$

Results:

The resistivity of the wire **ρ** = ……….. Ω cm

EXP. NO. 20	E BY MILLIKAN'S OIL DROP EXPERIMENT	DATE: …………..

Aim:	To determine the charge of electron by Millikan's Oil drop method
Apparatus:	Millikan's Oil drop experiment Unit, Power Supply (0-300V DC), stop watch, Olive Oil.

Procedure:

For the calibration of the graduated scale of eye-piece, focus the microscope on standard scale. Measure the distance between two consecutive divisions of graduated scale.

Insert the pin in central hole of upper plate. Illuminate the pin in such a way that the edge of the pin, when focused in microscope, shines in slightly dark back-ground. Now remove the pin and spray oil in the chamber. Observe the droplets through microscope. These drop-lets are charged due to the friction effect at the nozzle of atomizer. These drop-lets shine like a twinkling star in the dark background.

Connect the upper plate to positive terminal of power supply through key and lower plate to negative terminal of power supply. On applying electrical field, some droplets move in upper direction and some in downward direction. Select one droplet from the whole lot and observe its motion under gravitational field and electrical field.

Now switch off the electrical field and allow the droplet to move under the gravitational field only. Measure the time T_1 to travel specific distance (i.e. 50 divisions on graduated scale of eye-piece) in normal upward direction. Now apply electrical field again and measure time T_2 for the same droplet to travel the same distance (i.e. 50 divisions). Hence calculate the velocities v_1 and v_2 for gravitational and electrical field respectively. Calculate charge Q on droplet using following formula.

$$Q = 6\pi\eta^{2/3} \times \left[\frac{9}{2}\frac{v_1}{(\rho-\sigma)g}\right]^{1/2} \times \frac{(v_1+v_2)\times 300 \times d}{V}$$

Where,

η= Coefficient of viscosity of air=1.830×10^{-4} poise

ρ= Density of oil=0.92 gm/cm^3

σ = Density of air = 0.001293 gm/cm^3

d = Distance between two parallel plates of Millikan's chamber= 0.68 cm

V = Applied voltage = 200 volts and 250 volts

Precautions:

1. Do not try to touch the plates when DC potential is applied.
2. Do clean the glass slides before starting the experiment.
3. Do not spray oil unnecessarily.
4. In the case of winter keep the automiser in the SUN for a while for its free flow.
5. Do not on DC supply unnecessarily.

Observation Table:

Pot. Diff. Bet. Plates V volt	No. Of Obs.	Time to travel 50 divisions		Terminal Velocity of droplet		Charge Q e.s.u.	Unit charge $n = \frac{Q}{e_{apx}}$	Charge of electron
		Gravt. Field T_1 sec.	Ele. Field T_2 sec.	Gravt. Field v_1 cm/sec	Ele. Field v_2 cm/sec			
200V	1							
	2							
	3							
	4							
250V	1							
	2							
	3							
	4							

Calculations:

Terminal velocity in gravitational field $v_1 = \frac{D}{T_1} = \frac{0.1625\text{cm}}{T_1}$

Terminal velocity in electric field $v_2 = \frac{D}{T_2} = \frac{0.1625cm}{T_2}$

The total charge Q on droplet

$$Q = 6\pi\eta^{2/3} \times \left[\frac{9}{2}\frac{v_1}{(\rho - \sigma)g}\right]^{1/2} \times \frac{(v_1 + v_2) \times 300 \times d}{V}$$

Result:

The charge of electron = __________ e.s.u.

EXP. NO. 21 **MICHELSON INTERFEROMETER (dλ - MEASUREMENTS)** **DATE: …………..**

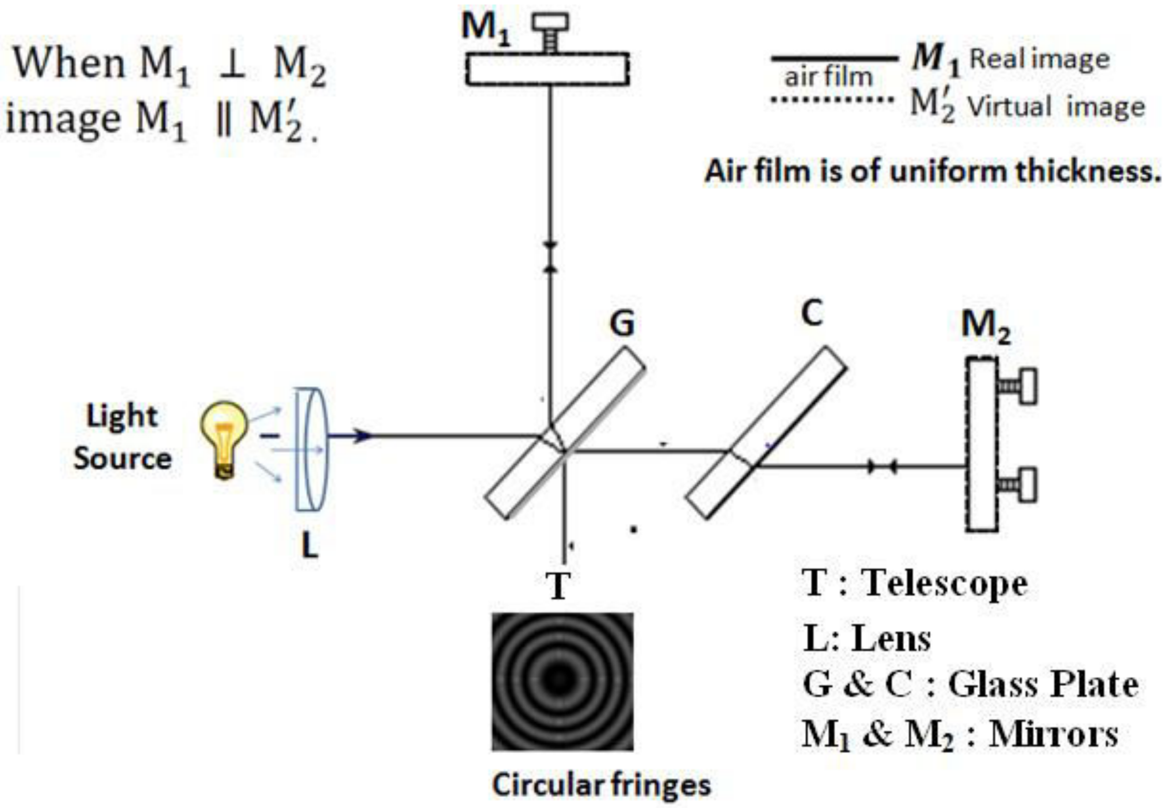
Aim: To determine the wavelength difference **(dλ)** of sodium doublet using Michelson's Interferometer.

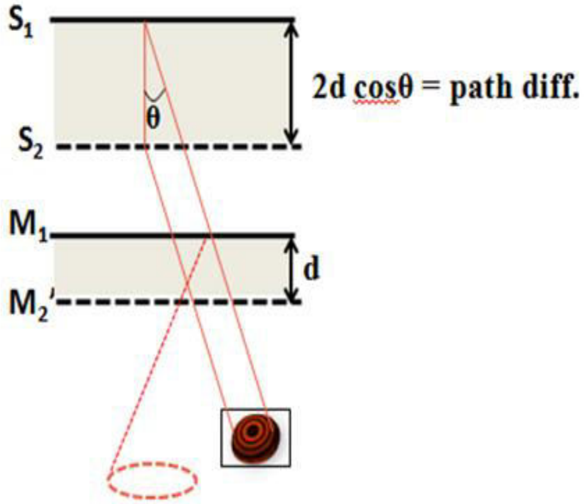
Apparatus: Michelson Interferometer, Sodium Light Source, convex lens, object-pin.

Procedure:

1. Set the Interferometer for circular fringes.
2. Now very slowly move the mirror M_1 and observe the variation of intensity of the fringes.
3. Set the M_1 for minimum intensity of the fringes and record its position as initial reading (X_1).
4. Now again slowly move the M_1 untill the intensity reaches to maximum and again becomes minimum.
5. Record this position of M_1 as final reading (X_2).
6. Also record this position of M_1 as initial reading for next step. (i.e $X_2 = X_1$ For next reading)
7. Now slowly move the M_1 untill the intensity reaches to maximum and again becomes minimum.
8. Record this position of M_1 as final reading (X_2).
9. Repeat the above method for further readings.
10. Calculate the d using the given formula.

Construction and Ray Geometry:





Observation Table:

Least Count of Michelson's Interferometer = **0.00001 cm**

Obs. No	Initial reading of Interferometer When Intensity is Minimum **X_1 cm**	Final reading of Interferometer When Intensity is Minimum **X_2 cm**	Difference Between two Consecutive Minima **$t = x_2 - x_1$**	Mean **t cm**	Wavelength difference $d\lambda = \frac{\lambda^2}{2\times t}$ Å
1					

2					
3					
4					
5					

Calculations:

$$d\lambda = \frac{\lambda^2}{2\times t} = \ldots\ldots\ldots\ldots = \ldots\ldots\ldots \text{Å}$$

Mean Wavelength difference dλ = …………

Results:

The difference in wavelengths of Sodium doublet is dλ =……….. Å

EXP. NO. 22 **DETERMINATION OF LATTICE PARAMETERS (electron diffraction ring pattern)** **DATE: …………..**

Aim: To determine the lattice parameters of a crystal system from an electron diffraction ring pattern.

Apparatus: electron diffraction ring pattern photograph , Scale, Calculator.

Procedure:

1. Place the scale on electron diffraction pattern photograph and measure the diameters of rings for different accelerating voltage (60 kV, 80 kV ,100 kV).
2. From the given relations; Planck's constant h = λ P and the wavelength of electrons λ =R.d/L, calculate inter-planner spacing d = hL/RP (in 10^{-8} cm).

Data:

1. Distance of Photographic plate from the specimen: L = 23 cm,
2. Mass of an electron: m = 9.1×10^{-28} gm
3. Charge of an electron: e = 1.6×10^{-19}coulomb
4. Planck's constant h = 6.626176×10^{-27} erg sec

Accelerating Voltage V Volts	Momentum $P = \sqrt{meV/150}$(gm.cm/sec)	1/P sec/(gm.cm)	A = hL/P sec/(gm.cm)
60×10^3			

$80x10^3$			
$100x10^3$			

Observation Table: 1, 2 and 3 ON NEXT PAGE

Results:

Note: Measure diameters by considering inner ring as first ring

Observation Table: 1 For accelerating voltage V = 60 KV (Note: Measure diameters by considering inner ring as first ring).

Ring no	Scale reading		Ring diameter	Original ring diameter	Radius of the ring	Inter planer spacing	Inter planer spacing			$a^2 = Nd^2$	Miller Indices
	LHS A cm	RHS B cm	D'=A-B cm	D=d'/4.4 Cm	R=D/2 cm	d = A/R in 10^{-8} cm	d A^0	d^2 $(A^0)^2$	N	$(A^0)^2$	(h k l)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Note: Find out (h k l) from equation: $N = h^2 + k^2 + l^2$.

Result: Mean a^2=____________$(A^0)^2$, Lattice Constant a = ____________ A^0