V P & R P T P Science College

Vallabh Vidyanagar

S Y BSc Semester IV 2018-19

Subject: Physics

US04CPHY03 Practical Record Book

Name:____

Roll No:_________ **Batch:**_______**Division:** _____

Day:_________ **Timing:** __________**to**________

SET: 1

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Note: Students have to collect apparatus from lab peon for practical*: 1, 6 and 7 and return in working order after completing the experiment.
Note: Students have to pay bracket charges for any damage of apparatus.

Experiment No- ____	Date ___-___-201__

Kater's Reversible Pendulum (variable knife edge)

Aim: To determine the value of acceleration due to gravity (g) using Kater's pendulum.

Apparatus: Kater's pendulum, stop watch, telescope, pin.

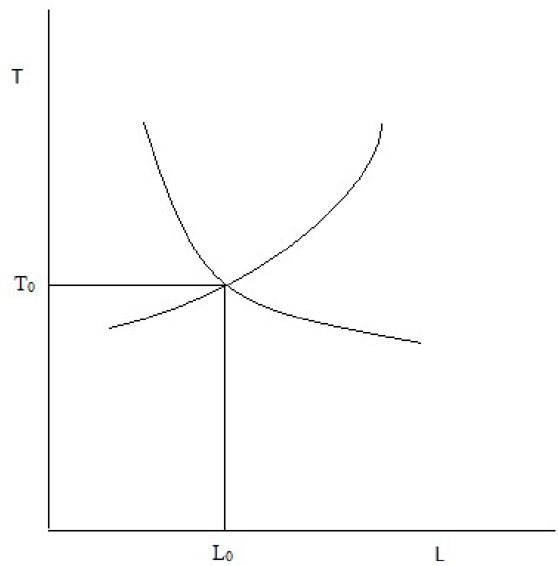
Procedure:

1. Fix the distance between two knife edges k_1 and k_2 90 cm.
2. Keep the metal bob down and measure time t_1 for 25 oscillations.
3. Calculate periodic time 'T_1'.
4. Now keep wooden bob down and measure time t_2 for 25 oscillations.
5. Calculate periodic time 'T_2'.
6. Now repeat for distance 80 cm, 70 cm, 60 cm and 50 cm.
7. Draw a graph of T_1 and T_2 with distances. From intercept of both graphs determine L_0 and T_0. Calculate acceleration due to gravity from the given formula.

Observation Table:

Obs. No.	Distance between two knife edges D cm	Time for 25 oscillations		Periodic time $T_1 = \frac{t_1}{25}$ sec.	Periodic time $T_2 = \frac{t_2}{25}$ sec.
		Metal bob down t_1 sec.	Wooden bob down t_2 sec.		
1	90				
2	80				
3	70				
4	60				
5	50				

Graph:



Calculations:

Acceleration due to gravity is given by $g = 4\pi^2 \frac{L_0}{T_0^2}$ cm/sec^2

Results: The value of acceleration due to gravity (g) =__________cm/sec^2

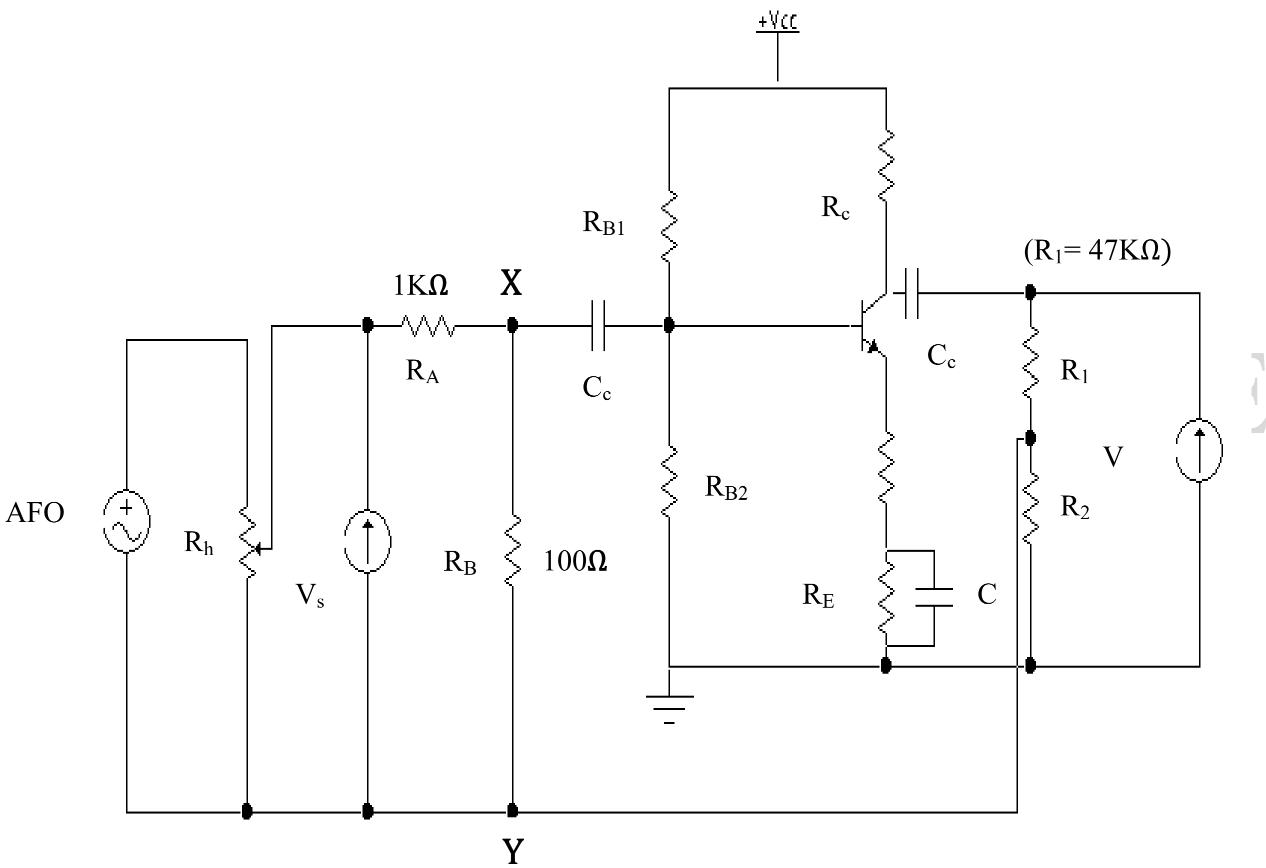
Teacher's Signature	Date :					1	

Experiment No- _____	Date ___-___-201__
Negative Feedback Amplifier	

Aim: To verify the relation $A_f = A/(1 + A\beta)$ in case of negative series voltage feedback.

Apparatus: Signal generator, Power Supply, Multimeter, etc.

Circuit Diagram:



Here V_s is a signal voltage and V_i is a input voltage between X and Y.

Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. Keep Resistance = 0Ω for amplifier without feedback.
3. Now keep source voltage V_S = 0.5V, 0.6V…1V and measure output voltage V_o for each V_S. Calculate open loop gain A.
4. Now keep V_S = 1V constant and increase resistance R_2 = 100Ω, 200Ω, … 800Ω and measure output voltage V_o.

5. Calculate closed loop gain A_f for each resistance R_2 and compare it with calculated A_f.

Observations Table: 1

Open loop gain (Amplifier without feedback)

R_A =__________Ω, R_B=__________ Ω, Keep R_2 = 0 Ω.

Note: Convert value of resistances in ohm: Ω only.

Obs No	V_S Volt	$V_i = V_S\left(\frac{R_B}{R_A+R_B}\right)$ Volt	V_o Volt	$A = \frac{V_o}{V_i}$	$Mean\ A$
1	0.5 V				
2	0.6 V				
3	0.7 V				
4	0.8 V				
5	0.9 V				
6	1.0 V				

Observations Table: 2

Closed loop gain (Amplifier with feedback with R_1 = 47KΩ)

R_A =__________ Ω, R_B=__________ Ω,Keep V_s = 1 V.

Note: Convert value of resistances in ohm: Ω only.

Obs No	$R_2 \Omega$	V_o Volt	$\beta = \frac{R_2}{R_1 + R_2}$	$V_i = V_S \frac{R_B}{R_A + R_B}$ Volt	$A_f = \frac{V_o}{V_i}$	$A_f = \frac{A}{(1 + A\beta)}$
1	100Ω					
2	200Ω					
3	300Ω					
4	400Ω					
5	500Ω					
6	600Ω					
7	700Ω					
8	800Ω					

Calculations:

Results: Experimental gain and calculated gain with feedback are nearly equal.

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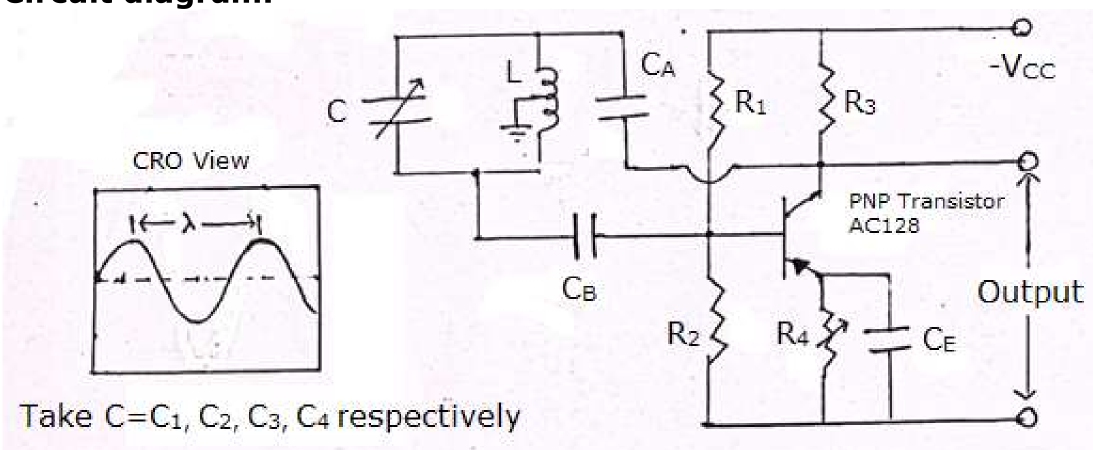
Experiment No- ____ **Date ___-___-201__**

Hartley Oscillator

Aim: To determine frequency of the Hartley oscillator.

Apparatus: PNP Transistor, Inductors, Capacitors, Resistances, Power supply, CRO.

Circuit diagram:



Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. For capacitor C_1, obtain stationary sine wave pattern in CRO by varying potentiometer.
3. Measure wavelength of sine wave λ_1. Repeat it for capacitor C_2 and C_3.
4. Calculate frequency $f_{Obs}$and compare with the theoretical frequency f_T.

Observation Table:

Inductance L = ______ mH =_________H

Obs. No	*Capacitance in 10^{-9} F*	λ cm	t Sec/cm	$T = \lambda \times t$ Sec	$f_{Obs} = \frac{1}{T} Hz$	$f_T = \frac{1}{2\pi\sqrt{LC}}$ Hz
1	C_1 =					
2	C_2 =					
3	C_3=					
4	C_4=					

[**Note:** 1nF=10^{-9} F, 1 mH=10^{-3} H]

Calculations:

Result: For C_1

Theoretical Frequency of Hartley Oscillator $f_T =$ ________Hz

Observed Frequency of Hartley Oscillator $f_{Obs} =$ ________Hz

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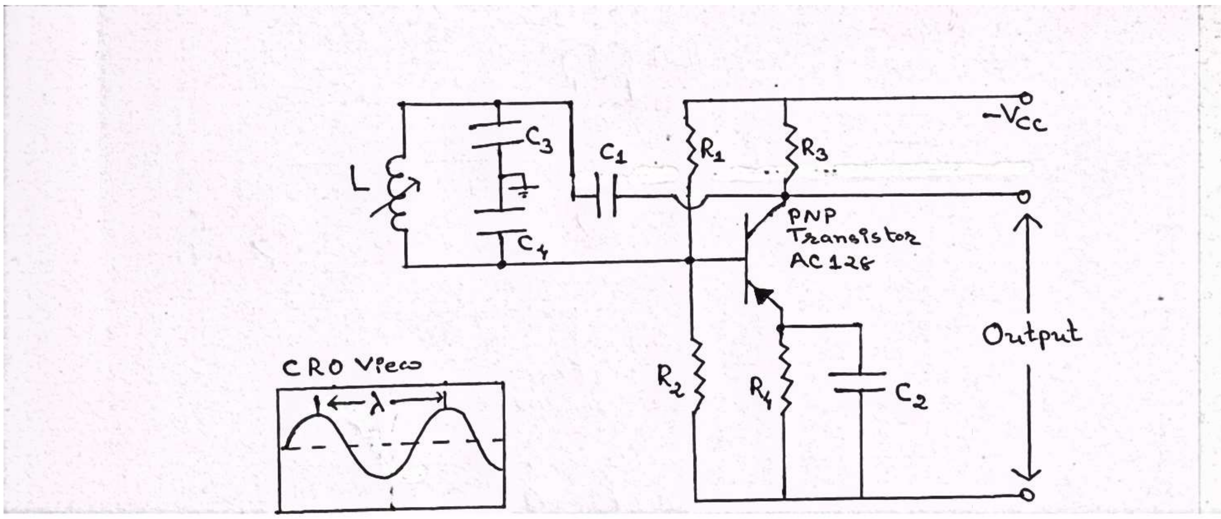
Colpitt's Oscillator

Aim: To determine frequency of the Colpitt's oscillator.

Apparatus: PNP Transistor, Inductors, Capacitors, Resistances, Power supply, CRO.

Circuit Diagram:



Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. For inductor L_1, obtain stationary sine wave pattern in CRO by varying potentiometer.
3. Measure wavelength of sine wave λ_1. Repeat it for inductor L_2 and L_3.
4. Calculate frequency f_{Obs} and compare with the theoretical frequency f_T.

Observation Table:

Capacitance C= _______pF = _________F

Obs. No	*Inductance in* $10^{-3}H$	λ cm	t Sec/cm	$T = \lambda \times t$ Sec	$f_{obs} = \frac{1}{T} Hz$	$f_T = \frac{1}{2\pi\sqrt{LC}}$ Hz
1	L_1=					
2	L_2=					
3	L_3=					

[**Note:**1 mH = 10^{-3}H, 1 pF = 10^{-12} F]

Calculations:

Result: For L_1

Theoretical Frequency of Colpitt's Oscillator $f_T =$ ________ Hz

Observed Frequency of Colpitt's Oscillator $f_{Obs} =$ ________ Hz

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Experiment No- ____ **Date ___-___-201__**

Impedance by voltage drop method

Aim: To determine the impedance of the given series LCR circuit by voltage drop method.

Theory:

Resistance is essentially *friction* against the motion of electrons. It is present in all conductors to some extent (except *super*conductors!), most notably in resistors. When alternating current goes through a resistance, a voltage drop is produced that is in-phase with the current. Resistance is mathematically symbolized by the letter "R" and is measured in the unit of ohms (Ω).

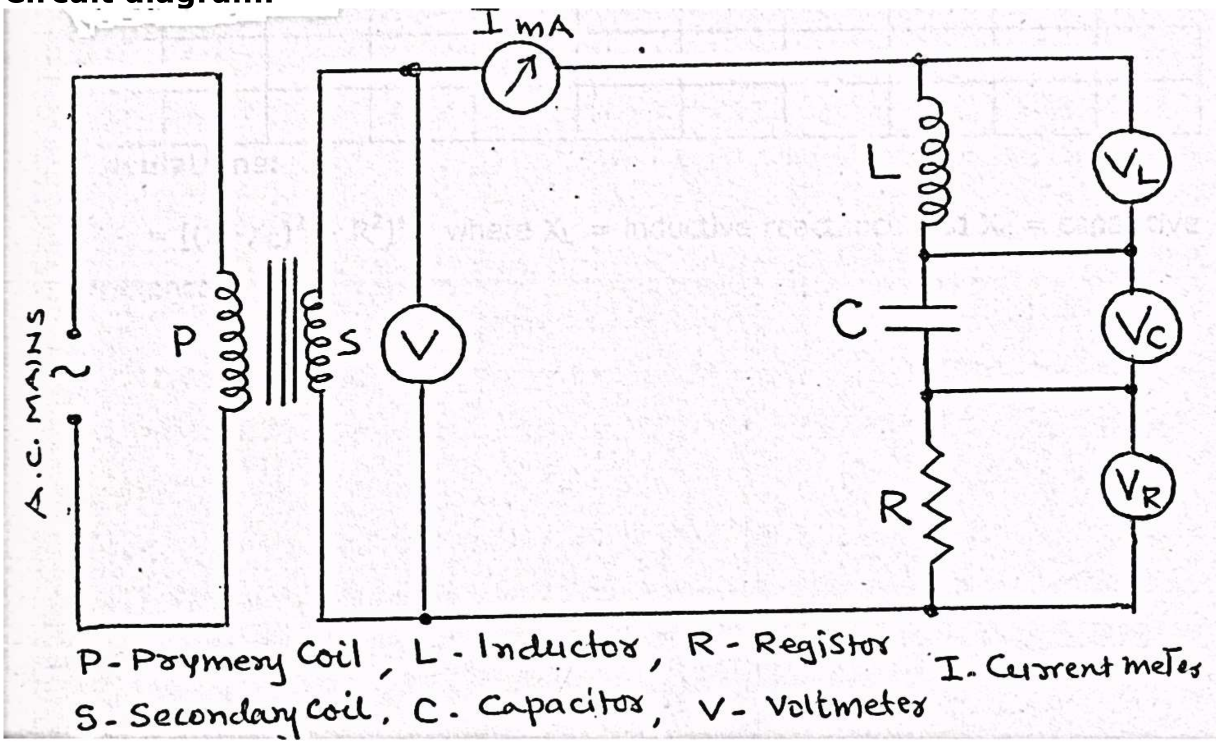
Reactance is essentially *inertia* against the motion of electrons. It is present anywhere electric or magnetic fields are developed in proportion to applied voltage or current, respectively; but most notably in capacitors and inductors. When alternating current goes through a pure reactance, a voltage drop is produced that is 90^o out of phase with the current. Reactance is mathematically symbolized by the letter "X" and is measured in the unit of ohms (Ω).

Impedance is a comprehensive expression of any and all forms of opposition to electron flow, including both resistance and reactance. It is present in all circuits, and in all components. When alternating current goes through an impedance, a voltage drop is produced that is somewhere between 0^o and 90^o out of phase with the current. Impedance is mathematically symbolized by the letter "Z" and is measured in the unit of ohms (Ω), in complex form.

Perfect resistorspossess resistance, but not reactance. Perfect inductors and perfect capacitorspossess reactance but no resistance. All components possess impedance.The impedance phase angle for any component is the phase shift between voltage across that component and current through that component. For a perfect resistor, the voltage drop and current are *always* in phase with each other, and so the impedance angle of a resistor is said to be 0^o. For an perfect inductor, voltage drop always leads current by 90^o, and so an inductor's impedance phase angle is said to be $+90^o$. For a perfect capacitor, voltage drop always lags current by 90^o, and so a capacitor's impedance phase angle is said to be -90^o.

Apparatus: Step down transformer, capacitor, inductor, resistor, volt meters, ammeter (mA range).

Circuit diagram:



Procedure:

1. Connect a series combination of LCR circuit to output of a step down transformer as shown in circuit diagram.
2. Connect a voltmeter between secondary terminals of step down transformer to measure input voltage **V**, imparted to LCR circuit. Also measure current **I**, using an ammeter.
3. For different values of circuit voltage **V**, measure potential differences $\mathbf{V_L}$, $\mathbf{V_C}$ and $\mathbf{V_R}$ developed across **L**, **C** and **R** respectively.
4. Compare observed impedance of circuit $\mathbf{Z_{Obs}}$ and calculated impedance $\mathbf{Z_{Calc}}$.

Observation Table:

Obs. No.	V Volt	$I' mA$	$I = I' x 10^{-3}$ Amp	V_L Volt	$X_L = \frac{V_L}{I} \Omega$	V_C Volt	$X_C = \frac{V_C}{I} \Omega$	V_R Volt	$R = \frac{V_R}{I} \Omega$	$Z_{Obs} = \frac{V}{I} \Omega$	$Z_{Calc} \Omega$
1											
2											
3											
4											
5											
6											
7											

Calculations:

$$Z_{Calc} = [(X_L - X_C)^2 + R^2]^{1/2}$$

where $X_L = \frac{V_L}{I}$ = inductive reactance and $X_C = \frac{V_C}{I}$ = capacitive reactance

Calculations:

Result: Z_{Obs} and Z_{Calc} are nearly equal.

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	Stefan's Index

Aim: To determine Stefan's index using Stefan's radiation law.

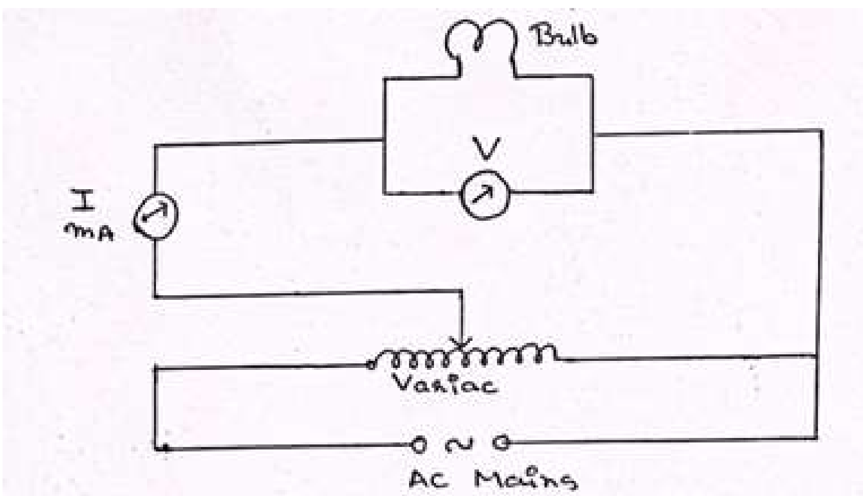
Apparatus: Variac, Bulb, AC Voltmeter, AC Ammeter

Stefan-Boltzmann law:

The thermal energy radiated by a blackbody radiator per second per unit area is proportional to the fourth power of the absolute temperature.

$\frac{P}{A} = \sigma T^4 \frac{j}{m^2 s}$, Here $\sigma = 5.6703 \times 10^{-8}\ watt/m^2K^4$

Circuit Diagram:



Procedure:

1. Connect the circuit as shown in diagram.
2. Apply different potential difference across the filament and measure corresponding current passing through filament.
3. Vary potential difference at interval of 20 Volt.
4. Do not apply potential difference greater than 160 Volt.
5. Convert the current into Ampere and calculate power.

Observation Table:

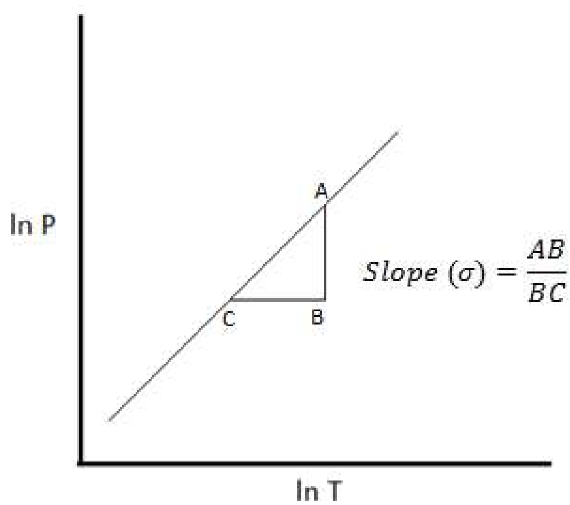
Obs No.	$V\ volt$	$I'mA$	$I = \frac{I'}{1000}\ Amp$	$R = \frac{V}{I}\ \Omega$	$Power$ $P = V \cdot I\ Watt$	$T°K$	$\ln P$	$\ln T$
1	20							
2	40							
3	60							
4	80							
5	100							
6	120							
7	140							
8	160							

Note: Potential difference across filament: V, current passing through filament: I', resistance of filament: R and Temperature of the filament: $T = 9.397 \times [R^{0.7936}]$ and ln is a natural log.

Calculations:

Temperature of Filament: $T = 9.397 \times [R^{0.7936}]$

Graph:



Results: The value of Stefan's index σ is __________.

Experiment No- ____ **Date ___-___-201__**

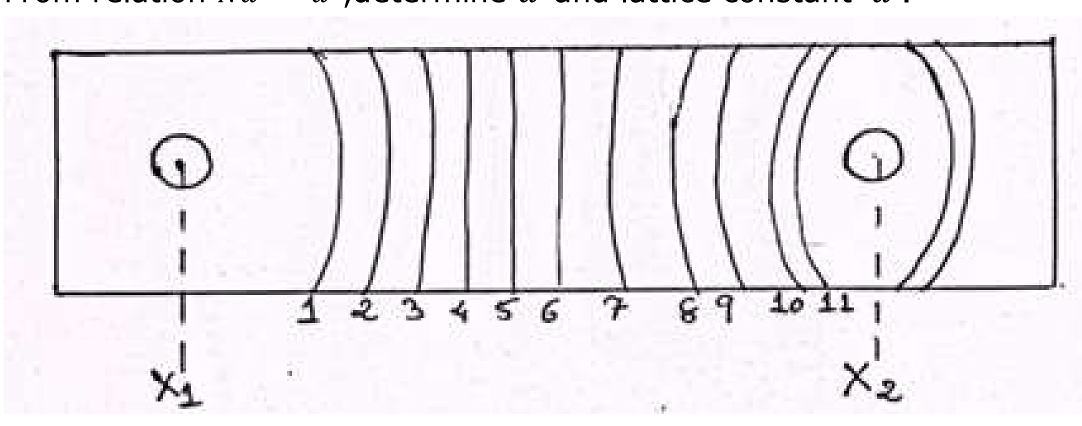
Miller Indices

Aim: To determine the Miller indices (h k l) of reflections of FCC recorded by powder method and determine the value of lattice parameter.

Apparatus: Powder pattern film, scale, magnifying lens.

Procedure:

1. Label the diffraction lines between $\theta_1 = 0^\circ$ and $\theta_2 = 180^\circ$ on the given photographic film.i.e. forward region and backward reflection region.
2. Select the pair of lines in the forward region and other pair of lines in the backward reflection region belonging to the same diffraction cone.
3. Measure the distance of two lines in the same diffracted cone in mm & determine diffraction pattern centers θ_1 and θ_2.
4. Position of each line is measured in mm, i.e. S_1.
5. Determine the distance of each line from $\theta_1 = 0^\circ$ i.e. $S_0 = S_1 - \theta_1$ and enter in column 3.
6. From that calculate inter-planner spacing d of the planes and d^2.
7. Now write values of d^2 for each line in Observation Table: 2 and calculate Nd^2 for different values of N starting from 1 to 27. (Note: Calculate Nd^2 till its value is approximately equals to 16.)
8. Select the value of N in such a way that the product Nd^2 is approximately constant around 16 and it satisfy two conditions.
   (i) $N = h^2 + k^2 + l^2$. Here h, k, l are called Miller indices.
   (ii) For FCC h, k, l must be all even numbers or all odd numbers. (**Note: Combination of even and odd numbers of h, k, l is not allowed for FCC.**)
9. Determine h, k, l from relation: $N = h^2 + k^2 + l^2$ and write in last column of Table: 1.
10. From relation $Nd^2 = a^2$, determine a^2 and lattice constant 'a'.



Observations:

1. Wavelength of X-rays: λ = 1.542 x 10^{-8} cm = 1.542 A°
2. X_1 = ________mm for $\theta_1 = 0^{\circ}$
3. X_2 = ________mm for $\theta_2 = 180^{\circ}$
4. X = $X_1 - X_2$ =_________mm for $\theta_1 - \theta_2 = 180^{\circ}$
5. $c = \frac{180}{(X_1 - X_2)} \frac{^{\circ}}{mm}$ =________$\frac{^{\circ}}{mm}$

Observations Table: 1

Note: Take all observations in mm scale only.Start observations with reference to X_1 (Keep two close lines in pattern on right side).

Line No.	Line reading S_1 mm	$S_0 = S_1 - X_1$ mm	Corrected reading S = (S X c) $^{\circ}$	Angle $\theta = (S/2)^{\circ}$	sinθ	Inter planner spacing $d = \frac{\lambda}{2\sin\theta} A^{\circ}$	d^2 $(A^{\circ})^2$	N	$a^2 = Nd^2$ $(A^{\circ})^2$	Mean a^2 $(A^{\circ})^2$	Miller indices (h k l)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											

Note: h, k, l must be all even numbers or all odd numbers for FCC. Where $N = h^2 + k^2 + l^2$

Observations Table: 2

Line	Nd^2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1																												
2																												
3																												
4																												
5																												
6																												
7																												
8																												
9																												
10																												
11																												

Calculations:

Results:

1. Lattice parameter a = ___________A°

   (Standard value of a = 4.039 A° and number of particles in unit cell of FCC = 4)

2. Atomic radius $r = \frac{\sqrt{2}}{4}a$ = __________A°

3. Volume of unit cell V = a^3 = ________$(A^{\circ})^3$

4. Mass per unit particle = $a^3 \boldsymbol{\rho} /4$ = __________amu

($\boldsymbol{\rho}$=2.702 for Aluminium)

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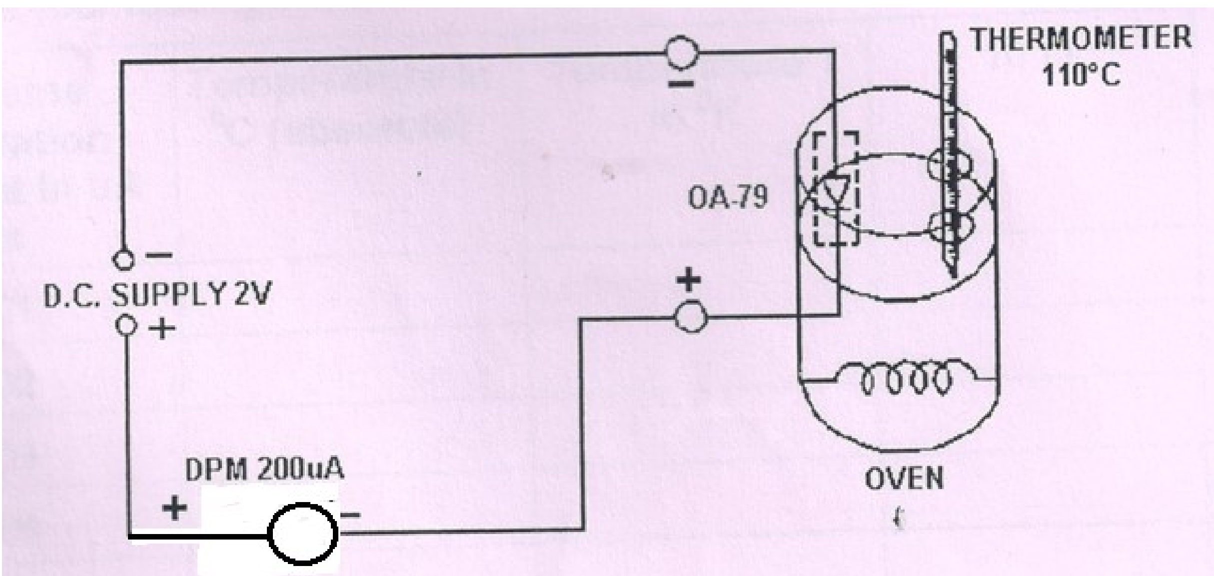
Energy bandgap (E_g) of the semiconductor diode

Aim: To determine the width of forbidden energygap of semiconductor diode (Ge).

Apparatus: Panel Board with P-N junction diode, power supply, digital micro ammeter and oven, Thermometer.

Energy gap: it refers to the energy difference (in electron volts) between the top of the valence band the bottom of the conduction band in insulators and semiconductors.

Circuit:



Procedure:

1. Connect the circuit as shown in the figure. Plug the two leads to the diode in the socket, Red plug in +Ve socket and Black plug in –Ve socket, so that the diode is reversed biased.
2. Insert the thermometer in the hole of the oven.(The diode OA-79 is already kept in the other hole of the oven.)
3. Now put the power ON/OFF switch to ON position and see that the jewel light is glowing.

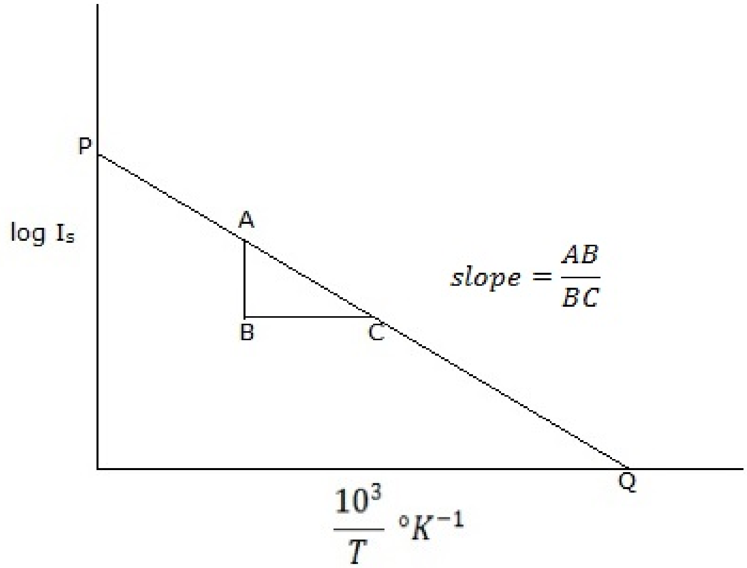
4. Now put the 'OVEN' switch to 'ON' position and allow the temperature of the oven to increase up to 95°C. As soon as the temperature reaches 95°C switch off the oven.
5. When the temperature becomes stable around 90°C, start taking readings of temperature and current. The temperature reading should be taken in steps of 5°C.i.e. 90°C, 85°C….35°C.
6. Plot the graph of log $I_s \rightarrow 10^3/T$(Take log I_s on Y-axis and $10^3/T$ on X-axis), which should be a straight line cutting both the X-axis and Y-axis. Determine the slope of the line. Using given formula find out energy gap (ΔE)of diode.

$$E_g = \frac{slope\ of\ the\ line}{5.036} = \_\_\_\_\_ eV$$

Observation Table:

Obs. No.	Temperature of diode t °C	T= (t +273) °K	$\frac{10^3}{T}$ °K^{-1}	Reverse Saturation Current I_s μA	log I_s
1	90°C				
2	85°C				
3	80°C				
4	75°C				
5	70°C				
6	65°C				
7	60°C				
8	55°C				
9	50°C				
10	45°C				
11	40°C				
12	35°C				

Graph:



Calculations:

$$\log I_S = constant - 5.036 \cdot E_g \left(\frac{10^3}{T}\right)$$

From the graph of $\log I_S \rightarrow \frac{10^3}{T}$, $slope = \frac{\log I_S}{\frac{10^3}{T}}$ $or\ slope = 5.036 \cdot E_g$

$$E_g = \frac{slope\ of\ the\ line}{5.036} = \_\_\_\_\_\_ eV$$

Result: The band gap of material of semiconductor diode is E_g = _____ eV.

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Numerical Integration

Aim: Use Simpson's $\frac{1}{3}$rd rule to compute the following integrals numerically.

Apparatus: Scientific Calculator, Plain Papers, Graph Papers, Pencil etc.

Theory:

Simpson's 1/3rd rule:

The method is credited to the mathematician **Thomas Simpson** (1710–1761) of Leicestershire, England. Simpson's rule can be derived by approximating the integrand $f(x)$ by the quadratic interpolant $P(x)$. In numerical analysis, **Simpson's rule** is a method for **numerical integration**, the numerical approximation of **definite integrals**. Specifically, it is the following approximation: for any given continuous function $y = f(x)$,

$$\int_a^b f(x)dx \approx \frac{b-a}{6}\left[f(a) + 4f\left(\frac{a+b}{2}\right) + f(b)\right]$$

If the interval of integration $[a, b]$ is in some sense "small", then Simpson's rule will provide an adequate approximation to the exact integral. By small, what we really mean is that the function being integrated is relatively smooth over the interval $[a, b]$. For such a function, a smooth quadratic interpolant like the one used in Simpson's rule will give good results.

However, it is often the case that the function we are trying to integrate is not smooth over the interval. Typically, this means that either the function is highly oscillatory, or it lacks derivatives at certain points. In these cases, Simpson's rule may give very poor results. One common way of handling this problem is by breaking up the interval $[a, b]$ into a number of small subintervals. Simpson's rule is then applied to each subinterval, with the results being summed to produce an approximation for the integral over the entire interval. This sort of approach is termed the *composite Simpson's rule*.

Suppose that the interval $[a, b]$ is split up in 'n' subintervals with n-even numbers. Then the composite Simpson's rule is given by,

$$\int_a^b f(x)dx \approx \frac{h}{3}\left[f(x_0) + 2\sum_{j=1}^{\frac{n}{2}-1} f(x_{2j}) + 4\sum_{j=1}^{n} f(x_{2j-1}) + f(x_n)\right]$$

Where, $x_j = a + jh$, (for $j = 0, 1, 2, \dots. n-1, n$) with $h = \frac{(b-a)}{n}$,here his known as step length.If $x_0 = a$and $x_n = b$, the above formula can be written as,

$$\int_a^b f(x)dx \approx \frac{h}{3}[f(x_0) + 4f(x_1) + 2f(x_2) + 4f(x_3) + 2f(x_4) + \cdots + 4f(x_{n-1}) + f(x_n)]$$

We can write this approximation as,

$$I_S = \frac{h}{3}[Y_0 + 4Y_1 + 2Y_2 + 4Y_3 + 2Y_4 + \cdots..+2Y_{n-2} + 4Y_{n-1} + Y_n],$$

Or

$$I_S = \frac{h}{3}[(Y_0 + Y_n) + 4(Y_1 + Y_3 + \cdots + Y_{n-1}) + 2(Y_2 + Y_4 + \cdots + Y_{n-2})]$$

Procedure:

1. Compute value of integral for a given function between the given limits by **Analytical Method**.
2. To compute value of integral by **Numerical Method**, calculate step size using relation $h = \frac{(b-a)}{n}$. Here a, b, n are lower limit, upper limit and number of steps (or subintervals) respectively. Here n must be even number.
3. For $y = f(x)$, calculate $y_0, y_1, y_2 \dots.. y_n$for values $x_0, x_1, x_2 \dots.. x_n$ and prepare Data Table.
4. Using Simpson's 1/3rd formula evaluate value of integral: I_S for a given function.
5. In **Graphical Method**, plot a graph of $y = f(x) \rightarrow x$ and determine area between the curve and X-axis (Area under the curve) between limits $x_n = b$ and $x_0 = a$.

   $$Area\ under\ the\ curve = (Total\ squares) X\ (Area\ of\ one\ unit\ square)$$

   $$Total\ squares = (Whole\ squares + Fractional\ squares)$$

   This area under the curve gives value of integral for the given function.
6. Write the results of integral computed by all three methods in the table.
7. Compute any three to four integrals given in the exercise by above three methods.

Exercise:

1. $\int_0^1 x^2\,dx$	2. $\int_0^2 e^x\,dx$	3. $\int_0^1 (x^2+3x)^2\,dx$	4. $\int_0^\pi \cos x\,dx$	5. $\int_1^3 \ln x\,dx$
6. $\int_0^2 \sqrt{x}\,dx$	7. $\int_0^1 \sin x\,dx$	8. $\int_0^{\frac{\pi}{3}} \tan x\,dx$	9. $\int_0^1 \sin^{-1} x\,dx$	10. $\int_0^1 \log x\,dx$

Example:1

Find the value of given function $y = f(x) = x^2$

$\therefore \quad I_S = \int_0^1 x^2\, dx$

(a) Analytical method:

Let, $I_S = \int_0^1 x^2\, dx = \left[\frac{x^3}{3}\right] = \left[\frac{1^3}{3}\right] = 0.333333 \approx 0.33$

(b) Numerical method:

(i)Calculation of a Step Size: We know that, Step Size$\mathrm{h} = \frac{(b-a)}{n}$, here upper limit$\mathrm{b} = 1$, lower limit $\mathrm{a} = 0$ and total number of observations$\mathrm{n} = 10$.

So, $\mathrm{h} = \frac{(b-a)}{n} = \frac{(1-0)}{10} = 0.$

(ii)Data table: (From given function $y = f(x)$)

i	0	1	2	3	4	5	6	7	8	9	10
X_i	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Y_i	0.0	0.01	0.04	0.09	0.16	0.25	0.36	0.49	0.64	0.81	1.0

(iii) Formula:

$$I_S = \frac{h}{3}[Y_0 + 4Y_1 + 2Y_2 + 4Y_3 + 2Y_4 + 4Y_5 + 2Y_6 + 4Y_7 + 2Y_8 + 4Y_9 + Y_{10}]$$

$$I_S = \frac{h}{3}[(Y_0 + Y_{10}) + 4(Y_1 + Y_3 + Y_5 + Y_7 + Y_9) + 2(Y_2 + Y_4 + Y_6 + Y_8)]$$

Substituting values of $Y_i$from the table,

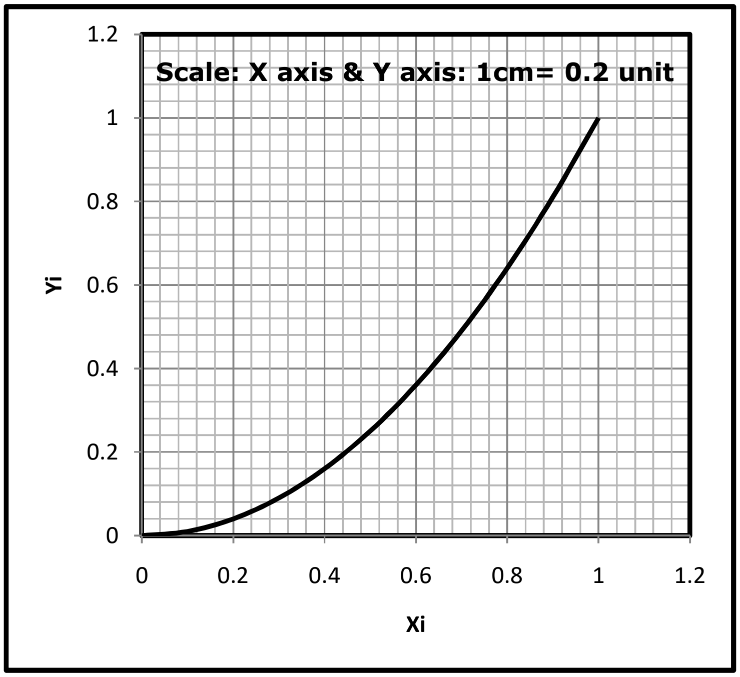
$$\therefore I_S = \frac{0.1}{3}[(0.0 + 1.0) + 4(0.01 + 0.09 + 0.25 + 0.49 + 0.81) + 2(0.04 + 0.16 + 0.36 + 0.64)]$$

$$\therefore \mathrm{Is} = \frac{0.1}{3}[(1.0) + 4(1.65) + 2(1.2)]$$

$$\therefore \mathrm{Is} = \frac{0.1}{3}[(1.0) + (26.4) + (2.4)] = \frac{0.1}{3} \times 10 = 0.333333 \approx 0.3$$

(c) Graphical method:

X_i	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Y_i	0.0	0.01	0.04	0.09	0.16	0.25	0.36	0.49	0.64	0.81	1.0



Total squares = (Whole squares + Fractional squares) = (26+7) = 33

Now, Area under the curve = (Total squares) X (Area of one unit square)

= (33) X (0.01) = 0.33

Example:2

Calculations:

Results:

No.	$\int_a^b f(x)dx$	Value of Integral by		
		Analytical Method	Numerical Method	Graphical Method

Teacher's Signature	**Date:**					**1**	