Engineering Physics Laboratory Manual

For B.E. I/II Semester

As per Visvesvaraya Technological University Syllabus

Name of the Student : ____________________________

Section and Branch : ____________________________

Roll No. or USN : ____________________________

Conceived, Prepared and Designed by
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Laboratory Instructions

1. The students should bring the laboratory manual, observation book, calculator etc., for each practical class.
2. The students should come to the laboratory with a good preparation to conduct the experiment.
3. Laboratory attendance will form a part of the internal assessment marks.
4. The recording of the details of the measurements, tabulation of readings and calculations must be first done in the observation book. The student should get the same acknowledged by the concerned teacher. Later the observations have to be transferred to the manual and again it should be signed by the concerned teacher. The student must submit the record in the following week for correction.
5. Any student failing to get the results evaluated in the same laboratory class will lose the Internal Assessment Marks for that experiment.
6. The student shall be responsible for the apparatus issued and shall take necessary precautions in using them.
7. At the end of the semester, a laboratory test will be conducted.
8. Strict discipline should be maintained inside the laboratory.

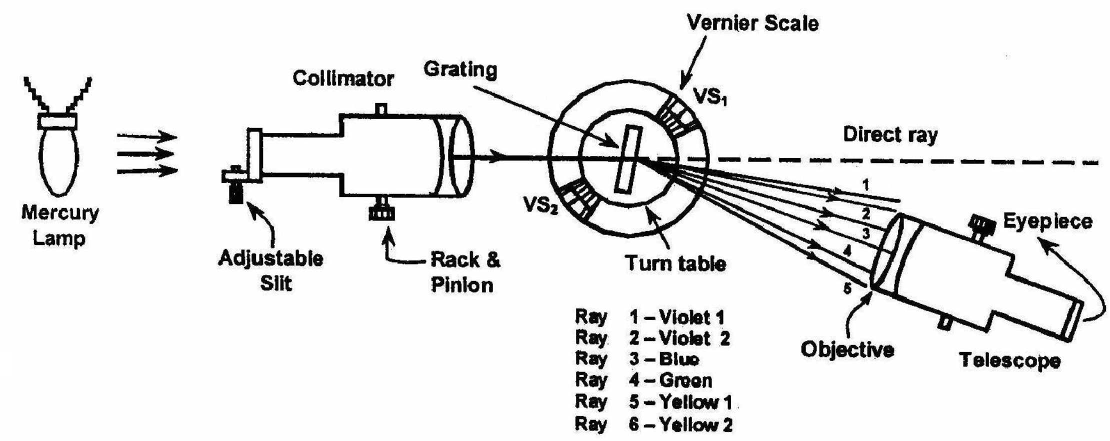
Index Sheet

Sl. No.	Name of the Experiment	Date		Marks (Max 10)	Signature (Student)	Signature (Staff)
		Conduction	Repetition			
1	Diffraction grating					
2	Transistor characteristics					
3	Zener diode characteristics					
4	Stefan's law					
5	Fermi energy					
6	Series and Parallel LCR Circuits					
7	Planck's constant					
8	Energy gap of a semiconductor					
9	Dielectric constant					
10	B-H Curve					
11	Ultrasonic interferometer (Demo)					
Average						

Note :-

- If the student repeats the experiment in the regular lab session due to unsatisfactory results then the maximum marks is 8.
- If the student fails to attend the lab, he/she will be allowed to conduct the experiment however no help is provided and the maximum marks will be 5.

Observations:



Spectrometer Arrangement – Oblique Incidence

$$\text{Least Count} = \frac{\text{Value of one Main Scale Division}}{\text{Total No. of Vernier Scale Divisions}} = \text{——} = \quad m$$

N = Number of Lines per meter on Grating = _______________

$$\text{Grating Constant} = C = \frac{1}{N} = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_} \; m$$

Direct Reading: R_0 = MSR + (CVSD x LC) =

Spectral Lines	*Spectrometer Readings*			*Angle of min. deviation D= R~R_0 (deg)*	*Wavelength of the color λ(m)*
	MSR	*CVD*	*Total Reading R=MSR +(CVSD x LC)*		
Yellow$_2$					
Yellow$_1$					
Green					
Blue					
Violet$_1$					

Calculations:

1. Diffraction Grating

Aim: To determine the wavelength of the prominent spectral lines of the mercury spectrum using a diffraction grating.

Apparatus: Spectrometer, spirit level, mercury lamp, grating, magnifying lens *etc*.

Formula: The wavelength of a spectral line is given by,

$$\lambda = \frac{2C\,Sin\left(\frac{D}{2}\right)}{n} \quad m$$

λ : wavelength of the spectral line (m)
N : number of lines per meter on grating
C : grating constant = $1/N$ (m)
D : angle of minimum deviation for a spectral line (degree)
n : order of the spectrum ($n = 1$)

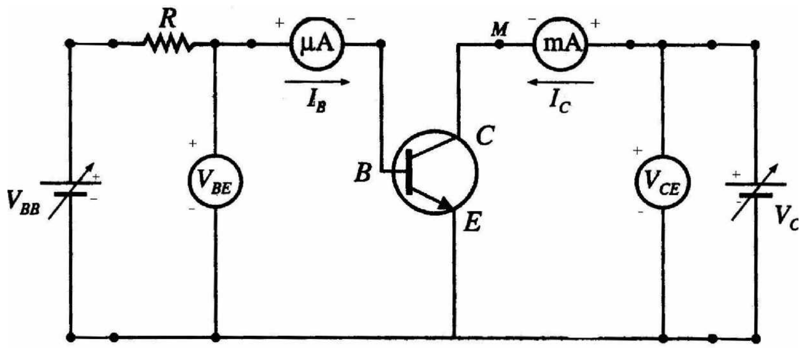
Procedure: Preliminary adjustments are done for the spectrometer. The spectrometer is placed in front of the sodium vapor lamp and its position is so adjusted that the collimator slit is illuminated with sodium light which is confirmed by viewing the slit through the collimator. The telescope is brought in line with the collimator. The rack and pinion arrangement of the collimator is adjusted until clear image of the slit is seen through the telescope. The grating is mounted on the grating table using grating holder. The telescope is rotated either to the right or to the left until the spectral lines of first order spectrum are seen. Now the grating is set to the minimum deviation position. The vertical crosswire of the telescope is set to one of the edges of $Yellow_2$ line. The spectrometer reading is noted. The same is repeated for $Yellow_1$, Green, Blue and Violet lines by adjusting the crosswire for the same side edges (R). The Central Bright Maximum is focused. The vertical cross wire is set on the Central Bright Maximum and the reading is noted (the Direct Reading R_0). The readings are tabulated. The difference in the reading R and R_0 for the each color gives the angle of minimum deviation (D) for the corresponding color. The grating constant is determined given the value of number of lines per meter on the grating. The wavelength of the spectral line is calculated using the formula.

$$\lambda = \frac{2C\,Sin\left(\frac{D}{2}\right)}{n} \quad m$$

Result: The wavelengths of the spectral lines in the mercury spectrum are,

$Yellow_2$: ________ *m*,
$Yellow_1$: ________ *m*,
Green : ________ *m*,
Blue : ________ *m*,
$Violet_1$: ________ *m*.

Observations:



Input Characteristics

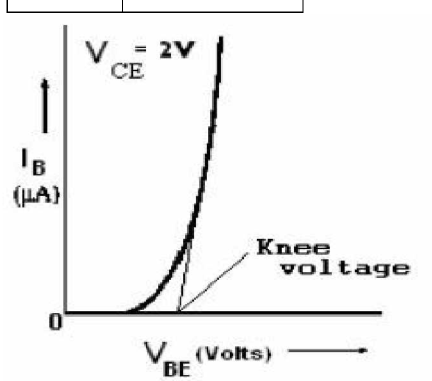
Dependence of I_B on V_{BE} at constant V_{CE}

V_{BE} (V)	V_{CE} = 2V
	I_B (μA)

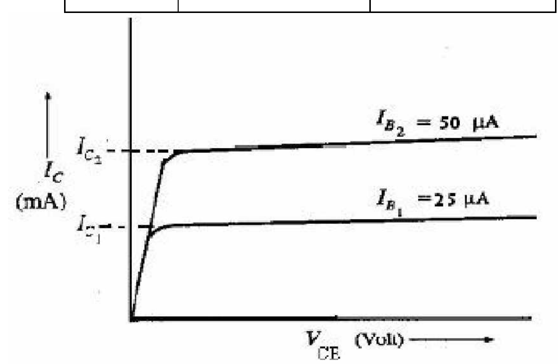
Output Characteristics

Dependence of Ic on V_{CE} at constant I_B

V_{CE} (V)	I_{B1} = 25 μA I_C (mA)	I_{B2} = 50 μA I_C (mA)



INPUT CHARACTERISTICS



OUTPUT CHARACTERISTICS

Calculations:

Knee voltage for Base Emitter Junction =V_K=_____V

Current Amplification Factor: $\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{I_{C2} - I_{C1}}{I_{B2} - I_{B1}}$ = =________

Current Gain in CB Mode: $\alpha = \frac{\beta}{1+\beta}$ = =________

2. Transistor Characteristics

Aim: To study the Common Emitter input and output I–V characteristics of the given transistor and hence to determine the knee voltage and the transistor parameters β and α .

Apparatus: Transistor, variable DC power supply, micro-ammeter, milli-ammeter, voltmeter.

Formula: Current Amplification Factor $\beta = \frac{\Delta I_C}{\Delta I_B}$

Where ΔI_C - Change in collector current in mili ampere

ΔI_B - Change in base current in micro ampere

DC current gain in CB mode $\alpha = \frac{\beta}{1+\beta}$

Procedure: The emitter, base and collector terminals of a transistor are identified. The measuring electrical Instruments are checked for good working conditions. The circuit connections are made as shown in the diagram. For every characteristic, before the circuit is closed, the potentiometer knobs must be set to read the minimum.

Input characteristics

The collector emitter voltage V_{CE} is set to 2V by varying the biasing voltage V_{CC} and is kept constant. Then the base emitter voltage V_{BE} is increased from zero in suitable steps by varying the biasing voltage V_{BB} and corresponding base current I_B is noted from the micro-ammeter. All readings are tabulated. A plot of I_B verses V_{BE} is made. The Knee voltage is measured by taking the X-intercept of the extrapolated linear portion of the curve.

Output characteristics

The base current I_B is set to 25μA by varying the voltage V_{BB}. Then the collector emitter voltage V_{CE} is varied in suitable steps from zero to 5V and the corresponding collector currents I_C are recorded from the mili-ammeter. The procedure is repeated for I_B = 50μA by adjusting V_{BB}. The readings are tabulated. A plot of I_C versus V_{CE} is made for each value of I_B. I_{C1} and I_{C2} are determined from the output characteristics. The current amplification factor β and current gain α are calculated using the above formula.

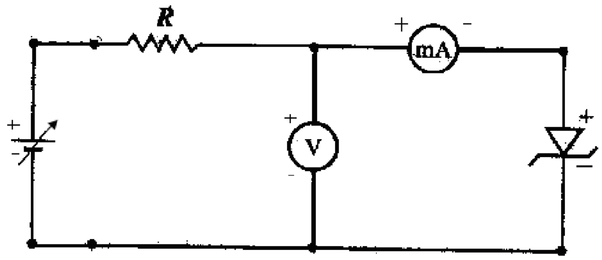
Result:

Knee voltage = ... V

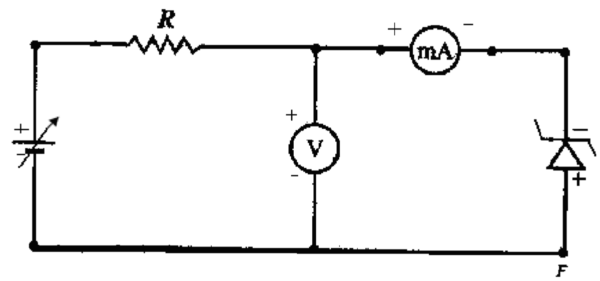
Current Amplification Factor β =........

Current gain in CB mode α = ...

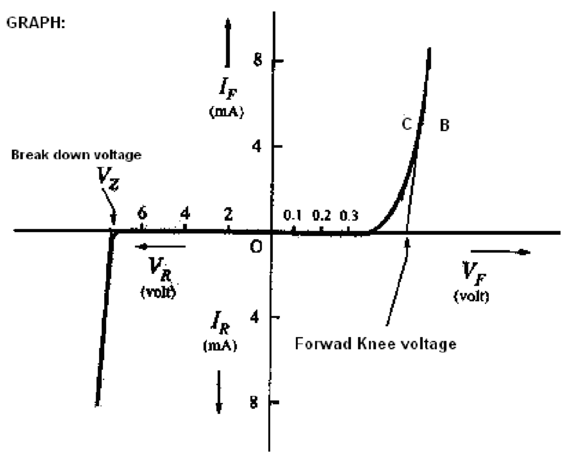
Observations:



FORWARD BIAS



REVERSE BIAS



From Graph:

The Forward knee voltage (V_k) = ... V

The Zener breakdown voltage (V_z) = ... V

Forward Bias	
V_F in V	I_F mA

Reverse Bias	
V_R in V	I_R mA

3. Zener Diode Characteristics

Aim: To study the I-V characteristics of a Zener diode, and hence determine the Knee voltage and Breakdown voltage.

Apparatus: Zener diode, Power supply, voltmeter and ammeter.

Procedure: The N-Type and P-Type sections of the given zener diode are identified. The black band marked on the zener diode represents N-type section. The measuring electrical instruments are checked for good working conditions. The circuit connections are made as shown in the diagram. For every characteristic, before the circuit is closed, the potentiometer knobs must be set to read minimum.

Forward Bias

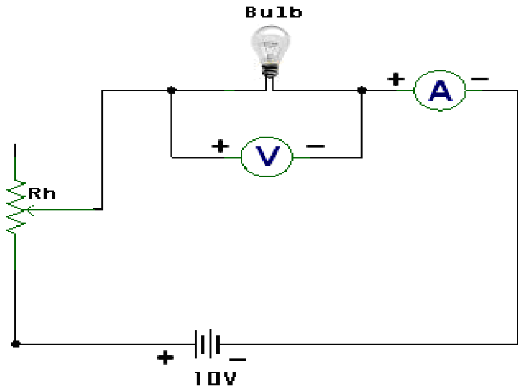
The P-type section and the N-type section of the zener diode are connected to the positive and negative terminals of the battery respectively. The power supply is switched on and the applied forward voltage V_f is increased in suitable steps from zero volt to a maximum of 1V and the corresponding currents through the diode are noted. The readings are tabulated. A plot of I_f versus V_f is made in the first quadrant choosing a suitable scale. Knee voltage (V_k) is calculated from the X-intercept is obtained by extrapolating the linear portion of the curve.

Reverse Bias

The P-type section and the N-type section of the zener diode are connect to the negative and positive terminals of the battery respectively. The power supply is switched on and the applied reverse voltage V_r is increased in suitable steps from zero volt to a maximum of 5V and the corresponding reverse currents (I_r) through the diode are noted. The readings are tabulated. A plot of I_r Vs V_r is made in the third quadrant choosing a suitable scale. Breakdown voltage V_B is calculated from the X-intercept is obtained by extrapolating the linear portion of the curve.

Result:
The Forward knee voltage (V_k) = ... V
The Zener breakdown voltage (V_z) = ... V

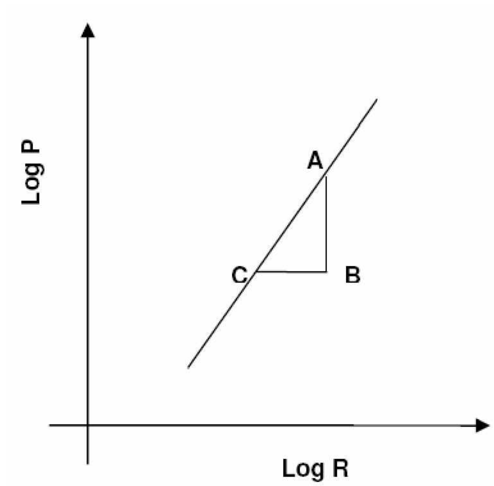
Observation:



Trail No.	V volt	I ampere	$R = \frac{V}{I}$ Ω	$P = VI$ watt	$\log_{10} P$	$\log_{10} R$
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Calculation:

The slope of the curve $= S = \frac{AB}{BC} =$.......................



4. Stefan's Law

Aim: To verify Stefan's law of Black-body radiation by studying the variation power dissipated across the bulb as a function of resistance.

Apparatus: Electric bulb, rheostat, power supply, voltmeter and ammeter etc.

Formula: $E = \sigma T^4$

E is the rate at which the energy emitted from the unit surface area of a Black-Body Wm^{-2}.

σ is Stefan's constant $Wm^{-2}K^{-4}$.

T is the Absolute temperature in K.

Procedure: The electrical connections are made as shown in the circuit diagram. The rheostat is adjusted so that a maximum value of resistance is incorporated in the circuit. The voltage source is set to a maximum 12 V. The voltage across the bulb is varied in suitable steps by varying the rheostat and the corresponding current is also noted. Using the data of V and I the power (P) dissipated across the bulb and the resistance of the bulb filament (R) are determined. Log P and Log R are also determined. The readings are tabulated. A plot of Log P versus Log R is made. The plot must be a straight line. The Slope of the curve is determined which verifies the Stefan's law of black- body radiation.

[Note: The bulb in the experiment is analogous to a blackbody. The bulb emits radiation when heated electrically so as a black body when heated. Thus the power dissipated across the bulb (P) is nothing but the emissive power (E). Higher the temperature (T) of the filament higher will be the resistance resulting in high dissipation of energy. Thus 'T' could be replaced by 'R' in the Stefan's law. Thus we get

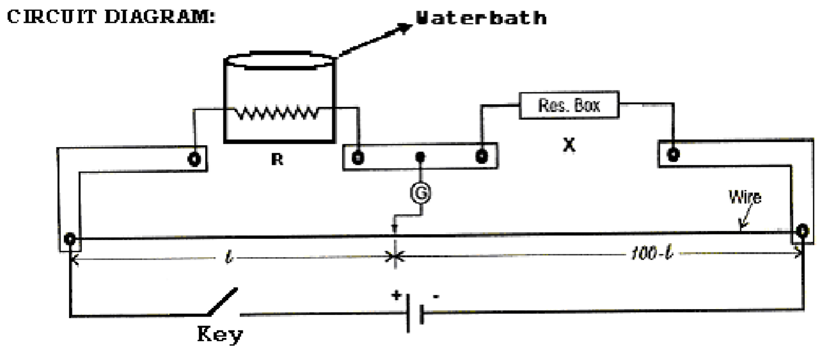
$P \propto R^4 \Rightarrow P = CR^4$ Here is C is a constant of proportionality, taking Logarithm on both the sides we get

$$Log\,P = Log\,C + 4\,Log\,R$$

This is of the form Y= c + m X. Thus the slope of the curve obtained by plotting Log P against Log R verifies Stefan's law of Black body radiation.]

Result: The slope of the straight line is given by .... and hence the Stefan's law is verified.

Observation:



Length of the copper wire $L =$............. m
Diameter of the copper wire d=................m
Radius of the Copper wire r=.............m
Density of copper $\rho = 8960\ Kg/m^3$

Area of cross section of copper wire $A = \Pi r^2 =$ m^2

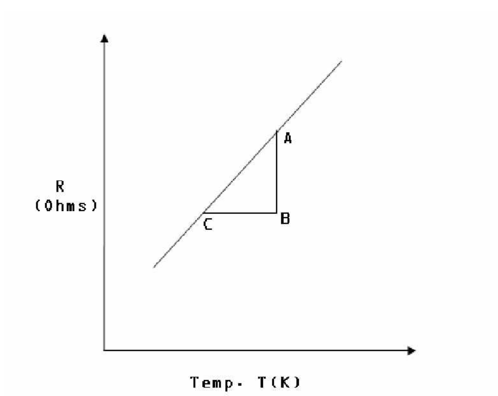
Trial No.	Temperature in ^{0} C	Temperature T $= (t+273)$ K	Balancing length(l) cm	Resistance $R = \frac{Xl}{(100-l)} \Omega$
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Slope of the curve from the graph

$$S = \frac{AB}{BC} =$$

$$E_f = \frac{1.36\times10^{-15}}{1.6x10^{-19}} \sqrt{\frac{\rho AS}{L}}\ eV$$

=



= .... eV

5. Fermi Energy

Aim: To determine the Fermi energy of copper using meter bridge.

Apparatus: Meter Bridge, copper coil, connecting wires, thermometer, galvanometer, power supply, water bath etc.

Formula:

$$E_f = \frac{1.36\times10^{-15}}{1.6x10^{-19}}\sqrt{\frac{\rho AS}{L}} \quad eV$$

Where, E_f – Fermi energy of copper (*eV)*

ρ – Density of copper (*Kgm*$^{-3}$)

A – Area of cross section (*m*$^{-2}$)

L – Length of copper wire (*m)*

S – Slope $\left(\frac{AB}{BC}\right)$ of the curve plotted R versus T

Procedure: The circuit connections for the meter bridge are made as shown in the circuit diagram. The Copper coil immersed in water bath is connected across the first gap of the meter bridge and a standard resistance box across the second gap. The plug key in the circuit is closed and a suitable resistance (X) is unplugged to obtain balancing length around 50 cm.

The Copper coil is uniformly heated with the help of water bath. The temperature of the Copper coil is increased up to 95°C and then allowed to cool. As the temperature of the coil reduces, the balancing length is determined for every 4°C reduction in temperature from 90°C. The resistance of the coil at a given temperature is determined using the formula

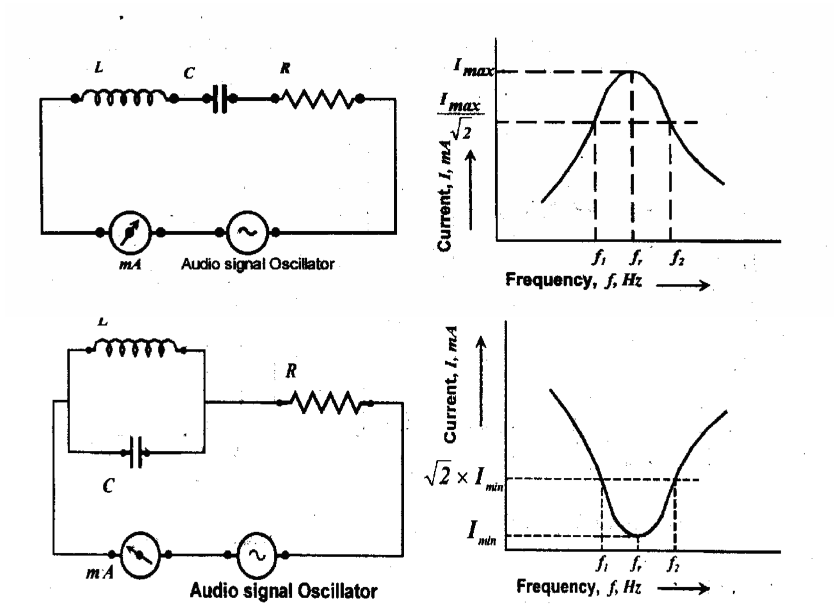
$$R = \frac{Xl}{(100-l)}\Omega$$

The readings are tabulated. A plot of Resistance of the Copper coil as a function of Temperature is made from the experimental data. The slope (S) of the curve is determined. Given the diameter (d) of the circular cross-section of the Copper wire is determined. Given the length of the copper wire (L) and Density of Copper (ρ)the Fermi energy is calculated using the formula.

$$E_f = \frac{1.36\times10^{-15}}{1.6x10^{-19}}\sqrt{\frac{\rho AS}{L}}\ eV$$

Result: Fermi energy of the copper wire is E_f =..............eV

Observation: **Series and Parallel L-C-R circuits**



Resistance R = ………… Ω; Capacitance of capacitor= C = ………… μF

Frequency f KHz	Series	Parallel
	Current (I) mA	Current (I) mA

Series Circuit:

Resonance frequency f_r = ………….Hz

Inductance $L = \frac{1}{4\pi^2 f_r^2 C}$ =

= ……………… H

Bandwidth $\Delta f = f_2 - f_1$

= ………………….Hz

Quality Factor $Q_f = \frac{f_r}{f_2 - f_1}$

= ………………….

Parallel Circuit:

Resonance frequency f_r = ………….Hz

Inductance $L = \frac{1}{4\pi^2 f_r^2 C}$ =

= ……………… H

6. Series and Parallel Resonance

Aim: To study the frequency response of a series and parallel LCR circuits and hence the determination of Coefficient of self induction of the inductor used, resonant frequency, band width, and quality factor of the circuit

Apparatus: An audio signal generator, Resistor, capacitor, inductor and milli-ammeter.

Formula: Coefficient of self Induction $L = \frac{1}{4\pi^2 f_r^2 C}$ H

Here C is capacitance of the capacitor in F, and f_r is the resonant frequency in Hz.

Bandwidth $\Delta f = f_2 - f_1$ Hz

Here *f1* and *f2* are the lower and upper cutoff frequencies or half power frequencies in Hz.

Quality Factor $Q_f = \frac{f_r}{f_2 - f_1}$

Procedure:

Series LCR circuit

Circuit connections are made as shown in the figure. The AC signal generator is switched on. The current is measured as a function of frequency from 100Hz to 20 KHz in suitable steps. The readings are tabulated. A plot of Current against Frequency is plotted. The frequency corresponding to maximum current (Resonant frequency) is determined from the graph. The co-efficient of self inductance is calculated using the above formula. The Band width and Quality factor are determined using the values of Half power frequencies determined as shown in the model graphs.

Parallel LCR circuit

Circuit connections are made as shown in the figure. The AC source is switched on. The current is measured as a function of frequency from 100Hz to 20 KHz in suitable steps. The readings are tabulated. A plot of Current against Frequency is plotted. The frequency corresponding to maximum current (Resonant frequency) is determined from the graph. The co-efficient of self inductance is calculated using the above formula.

Result:

Series LCR:

Resonance Frequency (f_r)=.................. Hz

Inductance $(L) =$ ....H

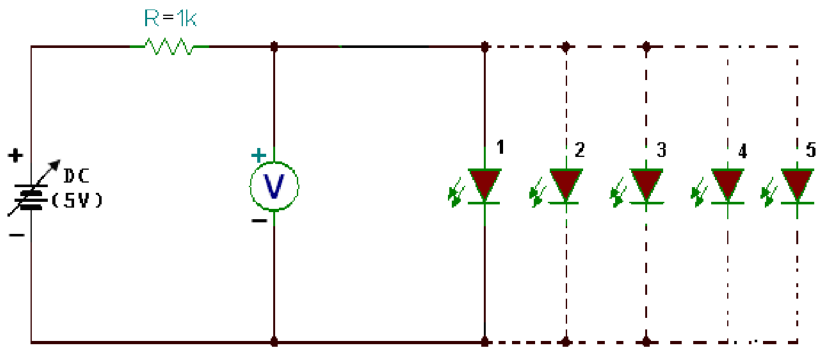
Bandwidth $(\Delta f) =$.............. Hz

Quality Factor $(Q_f) =$..................

Parallel LCR:

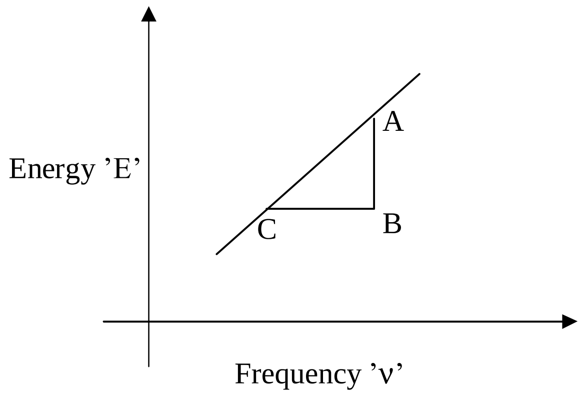
Resonance Frequency (f_r)=................... Hz

Inductance $(L) =$ .... H



Observation:

LED	Color	Wavelength (λ in m)	Turn-On Voltage (V_T in V)	Energy of Radiation $E = eV_T$ (J)	Frequency of the Radiation $\nu = C/\lambda$ (Hz)
1					
2					
3					
4					
5					



The Slope of the Curve = Planck's constant = $h = \frac{AB}{BC}$ =………………. =……………….....Js

7. Planck's Constant

Aim: To determine the Planck's constant using light emitting diodes.

Apparatus: Light Emitting Diodes of 5 different wavelengths, power supply and multimeter.

Formula: $E = h\nu$

Here E is the energy of the photon, J

h is Planck's constant, Js

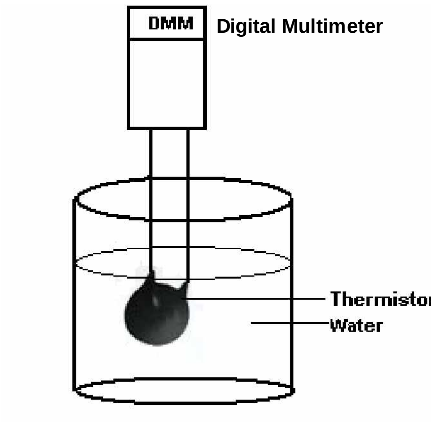
ν is the frequency of the radiation s^{-1}.

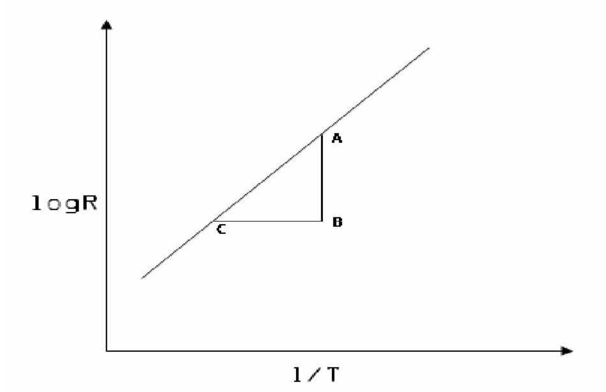
Procedure: Circuit connections are made as shown in the circuit diagram. Power supply is switched on after ensuring that the potentiometer knob is set to zero. Voltage across the first LED is increased gradually until it just glows. The color of the light emitted and Turn-On voltage (V_T) are noted. This is repeated for the other four LEDs. Energy of the light radiation is calculated using the equation $E = e\,V_T$. Here 'e' is the charge on electron 1.6×10^{-19}C. The frequency of the light radiation is determined using $\nu = C\lambda$. Here 'C' is the velocity of light (3×10^{8} ms^{-1}) and 'λ' is the wavelength of light emitted. The readings are tabulated. A plot of energy against frequency is made. According to Planck's Quantum theory the energy and frequency relationship for the radiation is given by $E=h\nu$. Here 'h' is Planck's constant. Thus, the slope of the curve gives the Planck's constant.

[Note: LED is P-N junction made of heavily doped transparent semiconductor. When it is forward biased, if the applied voltage is higher than the knee voltage then electrons and holes from N and P sections recombine in the depletion region resulting in the emission of photons. Thus LED glows with characteristic wavelength which depends on the composition and condition of the semiconductor material used. When the applied voltage is equal to the turn on voltage the LED just glows and the energy of the photons emitted is equal to the energy acquired by the electron from the electric field. Thus energy of the photon can be calculated from the turn on voltage knowing the wavelength of the emitted radiation a plot of energy versus frequency can be made. Thus the Planck's constant can be determined.]

Result: The Planck's Constant is given by______________

Observations:





Sl. No.	Temperature t ^{0}C	Temperature in T(kelvin)	Resistance R in(Ω)	Log R	$\frac{1}{T}$ K^{-1}
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Boltzmann's constant $K = 1.38\times10^{-23}\ JK^{-1}$

$$E_g = \frac{2.303\times 2K\times S}{1.601\times10^{-19}} \quad eV$$

=

=……………………….. eV

8. Energy Gap of a Semiconductor

Aim: To determine the Energy gap of the semiconductor.

Apparatus: Thermistor, power supply, resistor, voltmeter and milli-ammeter.

Formula:

$$E_g = \frac{2.303 \times 2K \times S}{1.601 \times 10^{-19}} \quad eV$$

Where, E_g = Energy gap of given semiconductor, eV

K = Boltzman's constant, 1.38 x 10^{-23} JK^{-1}

S = Slope of the graph.

Procedure: The circuit connections are made as shown in the figure. An Ohmmeter is connected across the thermistor and the resistance of the thermistor at the room temperature is noted. Then the thermistor is immersed in water bath and heated to a temperature of 95°C. Then while cooling the resistance of the thermistor is noted from Ohmmeter for different temperatures starting from 90°C till 60°C for every 4°C reduction in temperature. The readings are tabulated. A plot of Log R versus 1/T is made. Slope (S) of the curve is determined. The energy gap of the given semiconductor is calculated using the formula.

$$E_g = \frac{2.303 \times 2K \times S}{1.601 \times 10^{-19}} eV$$

[Note: Thermistors are made of semiconductors. The variation of resistance (R) of a thermister with temperature (T) is given by

$$R = R_0 e^{\frac{E_g}{2KT}} \text{ Taking } Log_{10} \text{ on both the sides}$$

$$Log\, R = Log\, R_0 + \frac{E_g}{2KT} Log\, e$$

$$\Rightarrow Log\, R = Log\, R_0 + \frac{E_g}{2K} Log\, e \frac{1}{T}$$

A plot of Log R versus 1/T must be a straight line with slope

$$S = \frac{E_g}{2K} Log\, e$$

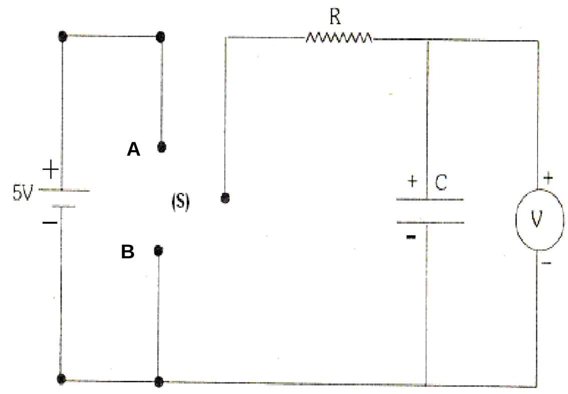
$$\therefore E_g = \frac{2KS}{Loge} = 2.303 \times 2KS \quad J$$

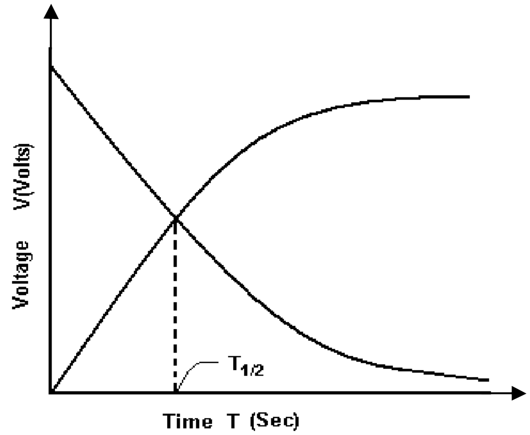
$$E_g = \frac{2KS}{Log\, e} = \frac{2.303 \times 2KS}{1.6 \times 10^{-19}} \quad eV$$

]

Result: Energy gap of the material given semiconductor is, E_g =............ eV

Observations:





Length of the dielectric material = l = ...m
Breadth of the dielectric material = b = ...m
Thickness of the dielectric material = d = ...m
Area of the dielectric material, $A = l \times b =$ ....m^2
Permittivity of free space = $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

Time T sec	R=............Ω, C=.............µF Voltage across Capacitor (V)	
	Charging	Discharging
`		

From graph:

$T_{1/2}$ = ...s

Dielectric constant of the dielectric Material is given by= $K = \dfrac{dT_{1/2} \times 10^{-6}}{0.693\varepsilon_0 AR}$

K=

K=

9. Dielectric Constant

Aim: To determine the dielectric constant of the dielectric material of the given capacitor by the method of charging and discharging.

Apparatus: Power supply, capacitor, resistor, voltmeter etc.

Formula: Dielectric constant of the dielectric material

$$K = \frac{dT_{1/2} \times 10^{-6}}{0.693\varepsilon_0 AR}$$

Here d = Thickness of dielectric material (m)

$T_{½}$ = Time require for 50% charge or discharge (s)

A = area of the dielectric material (m^2)

$R =$ Resistance of resistor in series with the capacitor (Ω)

Procedure: The terminals of the capacitor are shorted using a wire to remove the charges that are already stored.

Charging mode: Circuit connections are made as shown in the figure. The voltage across the capacitor for time T=0 is noted as zero. The Toggle switch is closed to position A to initiate charging of the capacitor and simultaneously a timer is started. The voltage (V) across the capacitor is noted for every 5 second until the voltage across the capacitor becomes almost constant. The readings are tabulated.

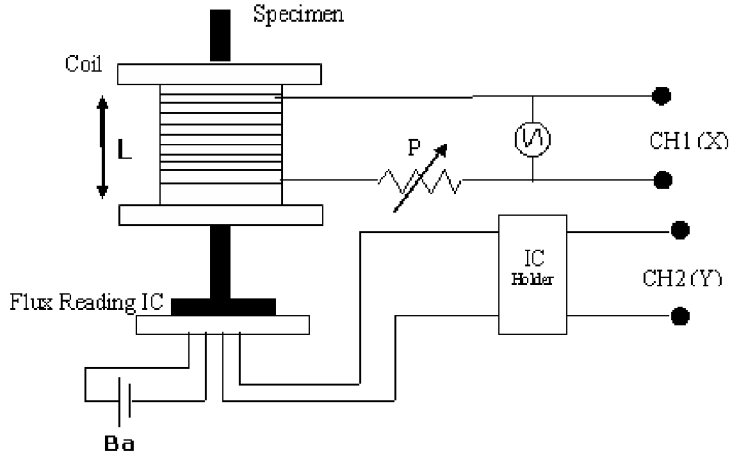
Discharging mode: The stop-clock is reset to zero. The voltage across the capacitor corresponding to time T=0 is noted. Now the toggle switch is closed to position B to initiate discharging of the capacitor and simultaneously the timer is started. The voltage (V) across the capacitor is noted for every 5 second until the voltage across the capacitor becomes almost constant. The readings are tabulated.

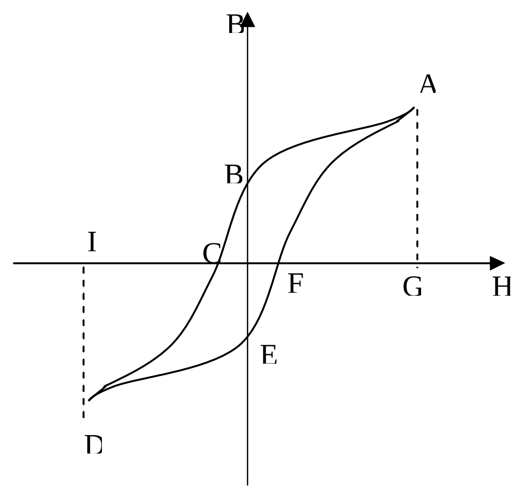
A plot of Voltage (V) against Time (T) is made on the same graph for both charging and discharging of the capacitor. Two intersecting curves are obtained as shown in the figure. The time corresponding to the intersection of the curves called $T_{½}$ is determined. It is the time required to charge a capacitor to a value half the maximum amount of charge. Given the length (l) and breadth (b) of the dielectric material the area (A) is calculated. Given its thickness (T), the dielectric constant of the material of the given capacitor is calculated using the formula

$$K = \frac{dT_{1/2}}{0.693\varepsilon_0 AR}$$

Result: Dielectric constant of the dielectric material is, $K =$

Observation:





Point	H	B
A		
B		
C		
D		
E		
F	`	

Vertical gain set in CRO= S_V= V/cm
OC (H co-ordinate of point C) =

Horizontal Vertical gain set in CRO = S_H = V/cm

OB (B co-ordinate of point B) =

Length of the coil = L=0.033 m, Number of turns= 300, P= 65 Ω

Area of the Hysteresis loop = A =........................sq. cm

Energy Loss= $E = \frac{0.5N}{P\ L} S_v S_H A$ = J/cycle/m^3

Coercive field = $H_C = \frac{N(OC)S_H}{P\ L}$ = $A\ turns\ m^{-1}$

Remnant Induction= $B_0 = 0.5\,(OB)S_V$ = $Wb\,m^{-2}$

10. B-H Curve

Aim: To study Hysteresis property of the given magnetic material and hence to determine a) Energy loss /cycle/ unit volume b) Remnant Flux Density and c) Coercive Field Strength.

Apparatus: Specimen, B-H Curve tracer unit, Cathode Ray Oscilloscope (CRO).

Formula:

Energy loss is determined using the formula $E=\frac{0.5N}{P\ L}S_v\, S_H\, A$ J/ per cycle/unit volume,

Where N is the Number of turns in the coil (300), P is the resistance in series with the coil (65Ω), L = Length of the coil (0.033m) and S_H and S_V are the horizontal, vertical sensitivities of the CRO and A= Area of the loop.

The Coercive field is determined from the formula $H_C=\frac{N(OC)S_H}{P\ L}$ $A\ turns\ m^{-1}$

The Remnant flux density = $B_0=0.5\,(OB)S_V$ $Wb\,m^{-2}$

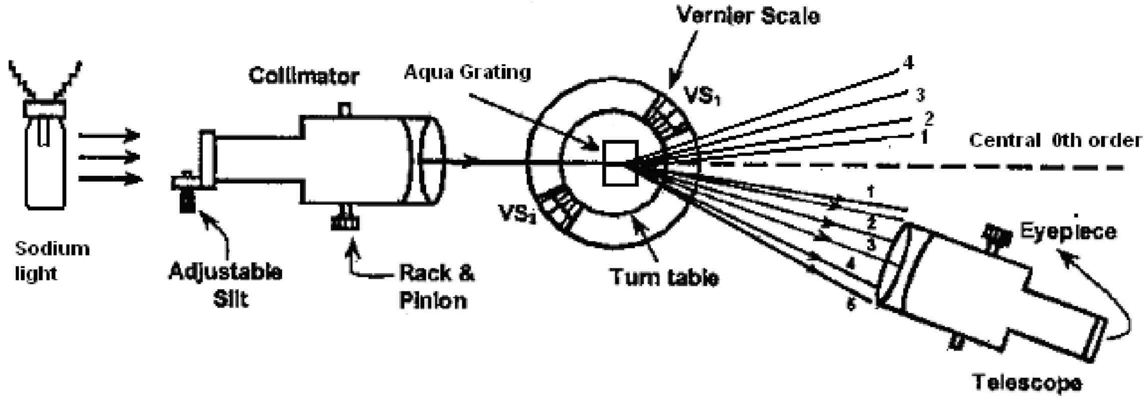
Procedure: Initially the following settings are made for CRO. The CRO is switched on and is set to X-Y mode. The bright spot is adjusted to the centre of the display with the help of Horizontal and Vertical shift knobs. Both the channels (X-Channel (Horizontal,CH1) and Y-Channel (Vertical, CH2) are set to AC mode.

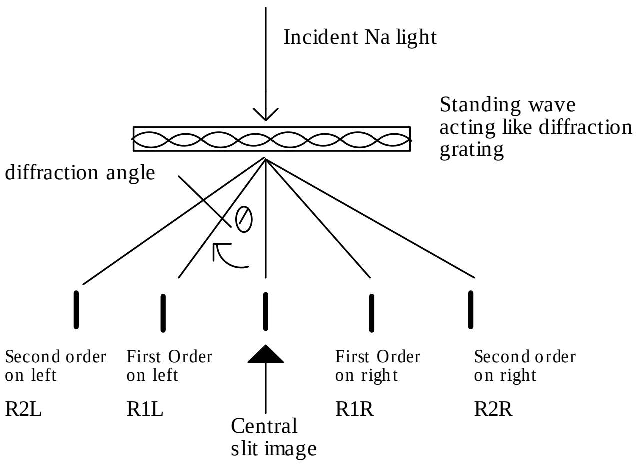
One terminal of the magnetizing coil is connected to point C of the main unit and the other terminal to any of the point between V_1 to V_3 (V_3 is recommended). Outputs X & Y of the main unit are connected respectively to CH1 & CH2 of the CRO. IC probe and the Supply (P.S) are connected to the main kit. The main kit is switched on. The resistance (P) is set for maximum value with the help of the given knob. With no specimen, the horizontal gain of the C R O is adjusted until a convenient X deflection is obtained on the CRO display. Specimen is inserted through the coil such that it touches only the probe at the centre not the conducting tracks. The Y gain of the CRO is adjusted to get appropriate Loop. Trace the loop on the graph paper by reading coordinates of the points A, B, C, D, E, F on the loop in CRO and area of the loop is measured.

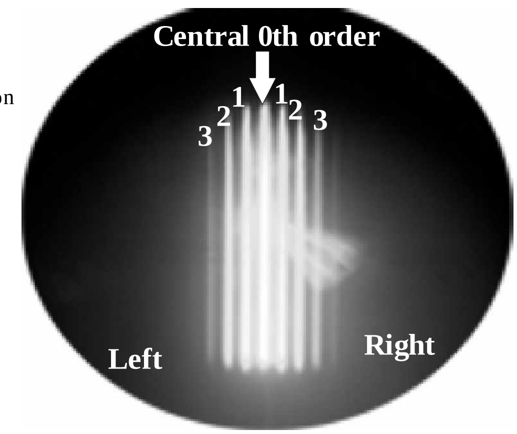
a) Energy loss is determined using the formula $E=\frac{0.5N}{P\ L}S_v\, S_H\, A$ J/ per cycle/unit volume,
b) OC is measured from the graph. The Coercive field is determined from the formula $H_C=\frac{N(OC)S_H}{P\ L}$ $A\ turns\ m^{-1}$
c) OB is measured from the graph. The Remnant flux density is determined using the formula $B_0=0.5\,(OB)S_V$ $Wb\,m^{-2}$

Result: The Energy loss in the specimen= ....J/cycle/cubic meter
The Remnant Induction=..................Wb m^{-2}
The Coercive field = ...A turns m^{-2}

Observation:







Liquid	Spectral Order (n)	Spectrometer reading(deg)		Angular separation $2\theta_n{}^o$	Angle of diffraction $\theta_n{}^o$	Wavelength λ (m)	Ultra sound Velocity (m/sec)
		$R_{nL}{}^o$	$R_{nR}{}^o$				
H_2O	2						
	1						
CCl_4	2						
	1						

Wavelength of the sodium light = $5893A^o$

Frequency of the ultrasound =

Wavelength of ultrasound, $\lambda' = \dfrac{n\lambda}{\sin\theta}$ m

=

Velocity of ultrasound, $V = f\lambda'$ ms^{-1} =

11. Ultrasonic Interferometer

Aim: To determine the velocity of ultrasonic waves in the given liquid.

Apparatus: Spectrometer, aqua grating, a quartz crystal, high voltage high frequency sine wave transmitter, Carbon tetra chloride (CCl_4) or drinking water and sodium vapor light.

Formula: $V = f\lambda'$ m/sec Where $V -$ Velocity of the ultrasound in liquid (m/sec)

$f -$ Frequency of the ultrasound wave (Hertz).

$\lambda' -$ Wavelength of ultrasound wave (m).

$\lambda' = \frac{n\lambda}{\sin\theta}$ m Where $n -$ Order of the spectrum

$\lambda -$ Wavelength of sodium light (m)

$\theta -$ Angle of diffraction (deg)

Procedure: Preliminary adjustments are done for the spectrometer. The spectrometer is placed in front of the sodium vapor lamp. The spectrometer position is so adjusted that the collimator slit is illuminated with sodium light and is confirmed by viewing the slit through the collimator. The telescope is brought in line with the collimator. The rack and pinion arrangement of the collimator is adjusted until clear image of the slit is seen through the telescope. The Aqua grating is mounted on the grating table. The transmitter output is connected to the crystal using D-type connector provided along with the experimental setup.. The frequency is tuned to get the diffraction bands. The Aqua grating is set to the minimum deviation position. The central bright maximum, first order diffraction band on the left side (R_{1L}), first order diffraction band on the right side (R_{1R}), second order diffraction band on the left side (R_{2L}), second order diffraction band on the right side (R_{2R}) are identified in the diffraction pattern. The vertical cross wire is set on the second order diffraction band on the left side (R_{2L}) as shown in figure and the spectrometer reading is noted. Similarly spectrometer readings for the first order diffraction band on the left side (R_{1L}), first order (R_{1R}) and second order (R_{2R}) diffraction bands on right side are noted. The angular separation for the second order spectral line is calculated using the equation $2\theta_2 = R_{2R} - R_{2L}$. Wave length of the ultra sound is calculated using the equation

$$\lambda' = \frac{n\lambda}{\sin\theta_2} \text{ m}$$

Velocity of ultrasound is calculated using equation V = $f\lambda'$ m/s. Similarly the velocity of the ultrasound for the first order spectral line can be calculated using the angular separation $\theta_1 = R_{1R} - R_{1L}$ and wavelength.

Result: Velocity of ultrasonic sound =V= ___________ ms^{-1}.

Sample Viva-Voce Questions

1. DIFFRACTION GRATING

2. Define least count of a measuring instrument?
3. What is diffraction? Mention different types of diffraction.
4. Mention the difference between diffraction and interference.
5. What is the constraint on the dimension of the obstacle or slit to diffract light?
6. What is diffraction grating?
7. What is meant by grating constant?
8. Define wavelength?
9. Define spectrum? What is a spectrometer?
10. What are the components of the spectrometer?
11. Explain the function of collimator and telescope in a spectrometer?
12. Explain why the grating is set to minimum deviation position before taking readings?
13. Distinguish between spectrum due to diffraction grating and prism.
14. Can we use the optical grating for the diffraction of X-Rays?

14. What is meant by order of the spectrum?
15. Which type of diffraction is used for this experiment?
16. Is it possible to determine the wavelength of monochromatic radiation same technique?

2. TRANSISTOR CHARACTERISTICS

1. What is transistor?
2. What are the regions (layers) present in transistor?
3. Mention the types of transistor.
4. What does the arrow in the transistor symbol indicate?
5. Explain the different configurations of a transistor?
6. Explain the Input, output and Transfer characteristics of a transistor.
7. Why the common emitter configuration used to study the characteristics of transistor?
8. Define Biasing?
9. What is biasing rule of transistor?
10. What type of device is a transistor?
11. Explain the role of load line in a transistor circuits.

10. What are the applications of transistor?
11. Define α and β of a transistor.
12. What is the meaning $\alpha = 0.99$ for a transistor?

3. V-I CHARACTERISTICS OF ZENER DIODE

1. What is a semiconductor?
2. What are valance band and conduction band?
3. Define energy gap?
4. Explain the types of semiconductors.
5. What is doping. What are the advantages of doping.
6. What is barrier potential?
7. What is depletion region?
8. What are the types of biasing?
9. What is zener diode?
10. Compare Junction diode and Zener diode?

10. What is breakdown voltage?
11. Explain avalanche and zener break down mechanisms?
12. What is the significance of Breakdown voltage?
13. What are the applications of zener diode?

4. DIELECTRIC CONSTANT

1. What are dielectric materials? Define dielectric constant of a material.
2. What is the Physical meaning of Dielectric constant?
3. Define Polarization. What are different mechanisms of Polarization?
4. Name some of the Dielectric materials? Mention its uses?
5. What is a capacitor? Mention the different types of capacitors?
6. Mention the type of capacitor used in the experiment.
7. Explain the term T ½
8. What is the role of the resistor in the circuit?
9. Define Farad.

5. FERMI ENERGY

1. What is Fermi energy?
2. Define absolute temperature?
3. Why resistance increases as a function of temperature?
4. Why does the galvanometer show zero deflection at balancing length?
5. Define electron volt.
6. What is Fermi factor?
7. How does Fermi energy vary in different types of semiconductors?
8. How does balancing length vary as a function of temperature and why?
9. What is meant by Fermi temperature?
10. What are the factors on which Fermi energy depend?

6. SERIES AND PARALLEL RESONANCE CIRCUITS

1. What is an inductor?
2. Define resistance?
3. Define is impedance, Inductive reactance and capacitive reactance.
4. Define is impedance offered by inductance in an AC circuit?
5. Define is impedance offered by capacitance in an AC circuit?
6. Explain acceptor and rejecter circuits?
7. Explain resonance in electrical circuits.
8. Define the natural frequency of an LCR circuit.
9. What is the total impedance in LCR circuit? How does it vary with frequency in case of both Series and Parallel LCR circuits.
10. What is potential difference across the resistor at resonance?
11. Define Q factor. Enumerate its importance.
11. Define bandwidth?
11. What are the conditions for resonance in the case of parallel resonance circuit?
14. What are the applications of LCR resonant circuits?

7. PLANK'S CONSTANT

1. What is LED?
2. How does LED emit the light?
3. Why does LED emit the light in forward bias only?
4. What is knee voltage?
5. What is turn-on Voltage? Describe its use in determining the energy of the radiation emitted by the LED?
6. Why does knee voltage different for different color LED?
7. How does Knee voltage vary with wavelength?
8. Explain Planck's radiation law.
9. Describe the importance of Planck's constant.
10. Explain the principle of the experiment.

8. ENERGY GAP OF A THERMISTOR

1. What is semiconductor?
2. What is Thermistor?
3. What is positive temperature coefficient?
4. What is energy gap?
5. Define absolute temperature?
6. Explain the variation of resistance of a semiconductor with temperature.
7. How do you differentiate between a conductor, semiconductor and an insulator based on band theory of solids?
10. What are intrinsic and extrinsic semiconductors?
11. What do you mean by doping?
12. What are N-type and P-type semiconductors?

9. STEFANS LAW

1. What is a black body?
2. Define emissive power and absorptive power of a blackbody?
3. State Stefan's law.
4. Define radiation?
5. What is a perfect black body?
6. Identify the black- body in this experiment? Give reason.
7. Explain the distribution of energy in a black body radiation spectrum.
8. Define resistance and power.
9. Explain the verification of Stefan's law.

10.B.H.CURVE

1. What is magnetic field?
2. Define magnetizing force (H)?
3. Define magnetic induction (B)?
4. Define Tesla
5. Define Magnetic Hysteresis?
6. Mention the types of magnetic materials
7. What is Coercivity?
8. What is Retentivity?
9. What is relative permeability?
10. What is Hysterisis loss?
11. What is relative permeability?
12. What is magnetic susceptibility?
13. Distinguish Hard and Soft Magnetic Materials.