Manonmaniam Sundaranar University,
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OPEN AND DISTANCE LEARNING (ODL) PROGRAMMES

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

B. Sc. Physics
Course Material

Physics Practical III
JMPHP3

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PHYSICS PRACTICAL – III

JMPHP3

Minimum of Six Experiments from the list

1. CALIBRATION OF LOW RANGE VOLTMETER USING POTENTIOMETER

Aim

To calibrate the given low range voltmeter using potentiometer and to draw the calibration curve.

Apparatus Required

Potentiometer, Low range voltmeter (0-3V), Accumulator, Plug key, rheostat, Daniel cell, High resistance, Galvanometer, Jockey and Connecting wires etc.,

Formula

$$\text{Calibrated Voltage } V' = 1.08\frac{l}{l_0}(volt)$$

S. No.	Parameter	Explanation	Unit
1.	l_0	Balancing length corresponding to e.m.f of Daniel cell	m
2.	l	Balancing length for different voltmeter reading	m

Circuit Diagrams

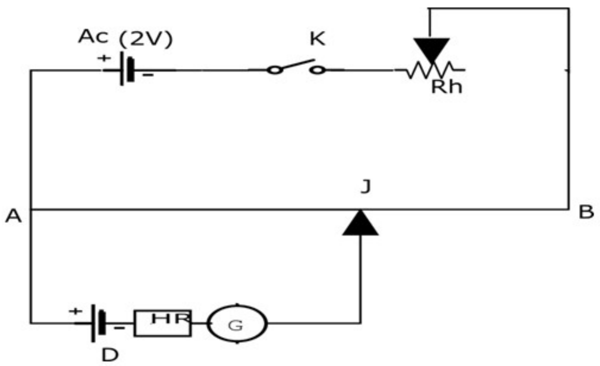


Fig. 1. Standardisation of Potentiometer

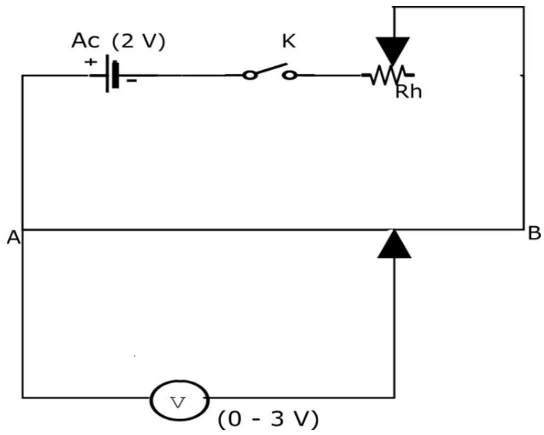
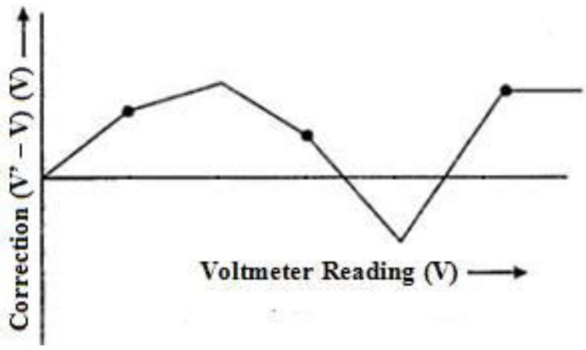


Fig. 2: Calibration of Voltmeter

Model Graph



Observation

Table: 1 To calibrate the given low range Voltmeter

Length of the wire balancing the e.m.f of the Daniel Cell (l_0) = -------------x10^{-2} cm

S.No.	Voltmeter Reading (V) volt	Balancing Length (l) m	Calculated Voltmeter Reading $V^{|} = 1.08\frac{l}{l_0}(volt)$	Correction ($V^{|}$ - V)

Procedure

1. Make connections as in Fig.1. Connect positive terminal of accumulator with potentiometer end A. Connect the negative terminal of accumulator in series with key, rheostat and potentiometer end B. End A of potentiometer is connected in series with daniel cell, high resistance, galvanometer and jockey.
2. Switch on the accumulator (2 V) and daniel cell.
3. Slide the jockey on the potentiometer till the galvanometer shows null deflection. Measure this balancing length of daniell cell (l_0).
4. Make connections as shown in Fig. 2. Connect positive terminal of accumulator with potentiometer end A. Negative terminal of accumulator is connected in series with key, rheostat and potentiometer end B. Connect the low range voltmeter and jockey in series with potentiometer end A. Switch on the accumulator (2 V)
5. Set 0.1 V in the voltmeter by sliding the jockey on the potentiometer and note the balancing length (l). Repeat the experiment for different values of voltages and note down the corresponding balancing lengths.
6. Calculate V' by using the formula given and record the correction value.
7. Plot a graph by taking voltmeter reading (V) along X axis and correction along Y axis.

Result

The given low range voltmeter was calibrated using potentiometer and the calibration curve was drawn.

2. CALIBRATION OF AMMETER USING POTENTIOMETER

Aim

To calibrate the given ammeter using potentiometer and to draw the calibration curve.

Apparatus Required

Potentiometer, Ammeter, Accumulators (2 V, 6 V), 2 Plug keys, 2 Rheostats, Daniel cell, High resistance, Galvanometer, Connecting wires etc.,

Formula

The current I' will be calculated by,

$$I' = \frac{E_0}{R}\frac{l}{l_0}(ampere)$$

S. No.	Parameter	Explanation	Unit
1.	E_0	emf of standard cell	volt
2.	R	Standard resistance	Ω
3.	l_0	Balancing length corresponding to e.m.f of Daniel cell	m
4.	l	Balancing length for different ammeter reading	m

Circuit Diagram

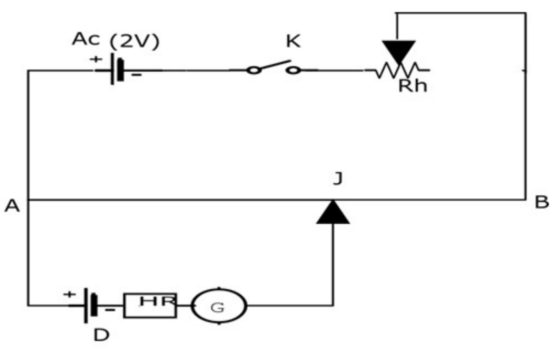


Fig. 1 Primary Circuit

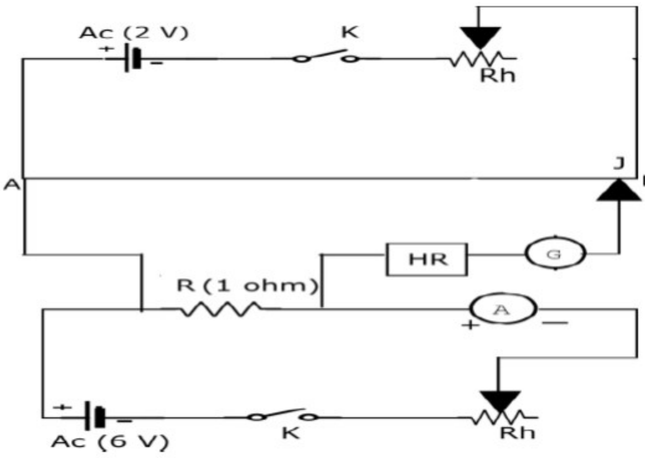
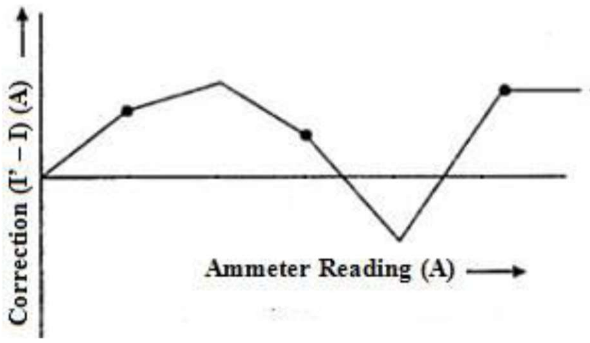


Fig. 2 Secondary Circuit

Model Graph



Observation

e.m.f of Daniel Cell (E_0) = 1.08 V

Standard resistance (R) = ------------- ohm

Balancing length for e.m.f of Daniel cell (l_0) = ---------x10^{-2} m

S.No.	Ammeter Reading (I) (mA)	Balancing Length (l) m	Calculated Ammeter Reading $I' = \frac{E_0}{R}\frac{l}{l_0}(mA)$	Correction (I' - I)

Procedure

1. Make connections as in primary circuit. Connect positive terminal of accumulator with potentiometer end A. Connect the negative terminal of accumulator in series with key, rheostat and potentiometer end B. End A of potentiometer is connected in series with daniel cell, high resistance, galvanometer and jockey.

2. Switch on the accumulator (2 V) and daniel cell.

3. Slide the jockey on the potentiometer till the galvanometer shows null deflection. Measure this balancing length for daniel cell ($l0$).

4. Make connections as shown in secondary circuit. Connect positive terminal of

accumulator to end A of the potentiometer. Connect negative terminal of accumulator in series with key, rheostat and potentiometer end B. Connect the standard resistance in series with ammeter, rheostat, key and accumulator (6 V). Connect the same end of standard resistance in series with high resistance and jockey. Connect the other end of standard resistance with potentiometer end A.

5. Switch on the two accumulators (2 V and 6 V).

6. Set some current value in the ammeter by adjusting the rheostat. Slide the jockey on the potentiometer till the galvanometer shows null deflection and note down the balancing length (l). Repeat the experiment with different values of current and note down the corresponding balancing lengths.

7. Calculate I' by using the formula given and record the correction value.

8 Plot a graph by taking ammeter reading (I) along X axis and correction I' along Y axis.

Result

The given ammeter was calibrated using potentiometer and the calibration curve was

drawn.

3. CAREY- FOSTER'S BRIDGE – COIL RESISTANCE AND SPECIFIC RESISTANCE

Aim

To find the resistance of a given coil using Carey Foster's bridge and hence to determine the specific resistance of the coil

Apparatus Required

Carey Foster's bridge, Given coil, Two standard resistance of 1Ω each, Fractional Resistance Box, Two Dial (0.1Ω -1 Ω), (1Ω-10 Ω) Resistance Box, Lechlanche Cell, Plug Key, Galvanometer, High Resistance, Jockey.

Formula

1. Resistance per meter of bridge wire

$$P = \frac{R}{l_1 - l_2} \Omega m^{-1}$$

2. Resistance X of the coil

$$X = R + P(l_2 - l_1)\Omega$$

3. Specific Resistance of the coil

$$\rho = X \frac{\pi r^2}{L} \Omega m$$

S. No.	Parameter	Explanation	Unit
1.	R	Resistance of the coil	Ω
2.	P	Resistance per meter of the bridge wire	Ωm^{-1}
3.	l_1	Balancing length (AJ_1)	m
4.	l_2	Balancing length (AJ_2)	m
5.	X	Resistance of the coil	Ω
6	L	Length of the coil	m
7.	R	Radius of the coil	m

Circuit Diagram

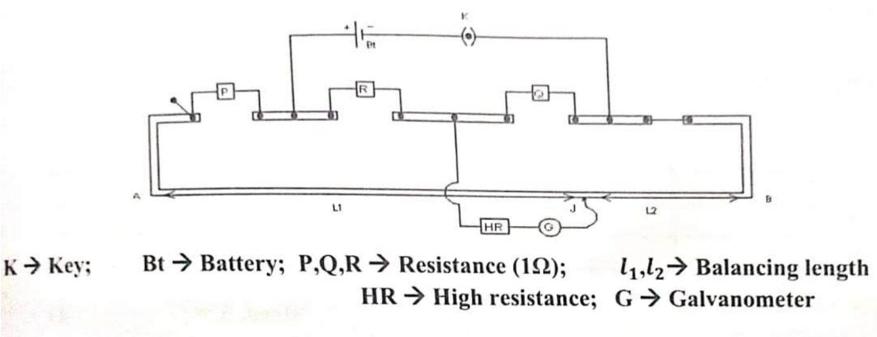


Fig. 1 : Determination of the resistance per meter of the bridge wire

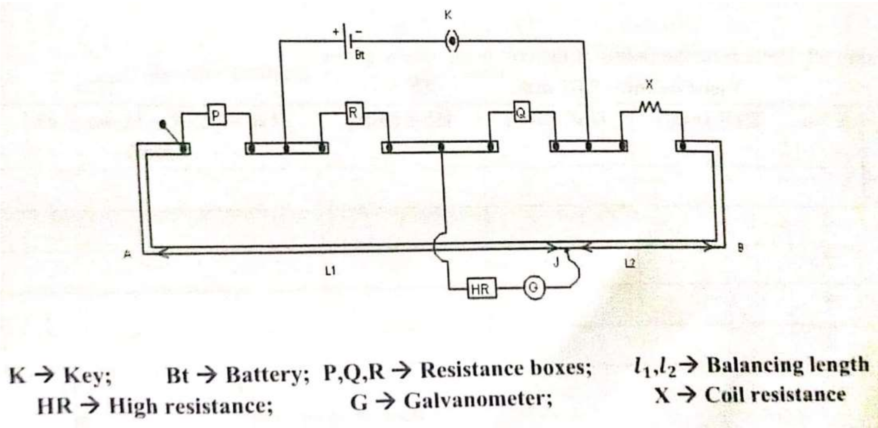


Fig. 2 : Determination of the resistance X of the coil

Observation

Table 1 : Determine the resistance per meter of the bridge wire

S. No.	R (Ω)	l_1 (cm)	l_2 (cm)	$P = \frac{R}{l_1 - l_2} \times 10^{-2} \Omega m^{-1}$
1				
2				
3				
4				
5				

Mean P = -----------Ωm^{-1}

Table 2 : Determine the resistance X of the coil

S. No.	R (Ω)	l_1 (cm)	l_2 (cm)	$X = R + P(l_2 - l_1)\Omega$
1				
2				
3				
4				
5				

Mean X = -----------Ω

Table 3 : Determine the radius of the coil using screw gauge

Least Count = 0.01 mm Z.E = mm Z. C = mm

S. No.	PSR (mm)	HSC (Mm)	HSR (mm)	TR= (PSR+HSR) ±ZC (mm)
1				
2				
3				
4				
5				

d=--------------mm

Radius of the coil r = ------------mm

Procedure

Determination of resistance per meter of bridge wire

1. In Carey- Foster's Bridge, the fractional resistance box R is connected in between the extreme gap and a copper strip is connected across right extreme gap.
2. Two equal resistance P and Q each of 1 Ω are included in inner gaps. The circuits with battery and galvanometer is completed as shown in fig.1
3. Now to start with a resistance of 0.1 Ω is unplugged from R and the balancing length l_1 (AJ_1) for which galvanometer shows null deflection is determined.
4. The experiment is repeated by interchanging the resistance R and the copper strip.
5. The balancing length l_2 (AJ_2) for null deflection is determined.
6. The resistance per meter of the bridge wire is given by $P = \frac{R}{l_1 - l_2} \Omega m^{-1}$

Determination of resistance X of the coil

1. Coil of unknown resistance X is connected as shown in the fig. 2
2. With suitable resistance R, the balancing length l_1 (AJ_1) for null deflection is found.
3. The resistance R is adjusted to get the balancing length is approximately equal to 50 cm
4. Now R is changed about the previous value and the experiment is performed for different values of resistance R and the corresponding length l_1 is measured in each case
5. The experiment is repeated by interchanging the coil X and resistance box R
6. The observations are noted and tabulated. Resistance of the coil is calculated by using the formula $X = R + P(l_2 - l_1)\Omega$
7. For certain values of R ($l_1 > l_2$) and for some other values ($l_1 > l_2$). As the balancing length always moves towards higher resistance side (l_1 - l_2) may be either negative or positive.
8. In both cases, the sign must be maintained throughout the calculations.

Calculation

Specific Resistance of the coil $\rho = X \frac{\pi r^2}{L} \Omega m$

By substituting the value of X, r, L, ρ is calculated

Result

1. Resistance per meter of the bridge wire P = --------------- Ωm^{-1}

2. Resistance of unknown coil X = --------------- Ω

3. Specific resistance of the coil ρ = --------------- Ωm

4. DETERMINATION OF FIGURE OF MERIT OF BG OR SPOT GALVANOMETER

Aim

To determine the figure of merit of the given ballistic galvanometer by the method of charging and discharging a capacitor

Apparatus Required

Ballistic Galvanometer (BG), two standard resistance boxes, standard condenser, charge-discharge key

Formula

The figure of merit of the BG is given by

$$k = \frac{EC\left(\frac{Q}{\theta}\right) \times \frac{1}{1+\frac{\lambda}{2}}}{P+Q} (C/mm)$$

$$\lambda = \frac{2.303}{10} \log \frac{\theta_1}{\theta_{11}}$$

S. No.	Parameter	Explanation	Unit
1.	E	emf of the cell	Volt
2.	C	Capacity of the condenser	μF
3.	P, Q	Resistance in the boxes	Ω
4.	θ	Kick produced in BG	mm
5.	λ	Logarithm decimal	No unit
6	θ_1	Deflection of the first throw	div.
7.	θ_{11}	Deflection of eleventh throw	div.

Circuit Diagram

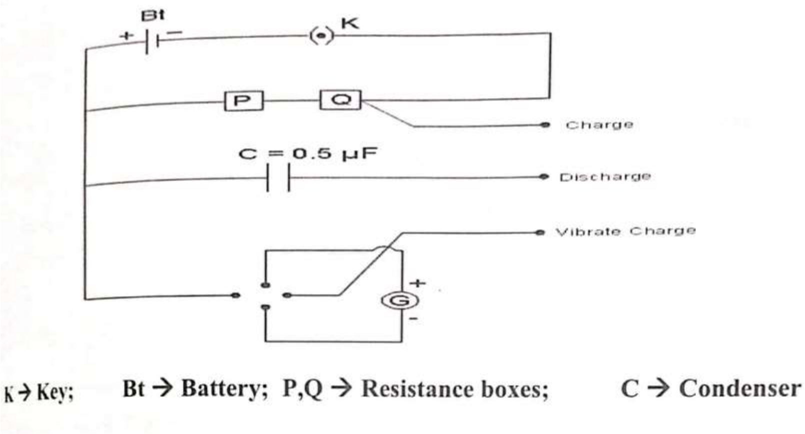


Fig. 1: To find the ratio $\frac{Q}{\theta}$

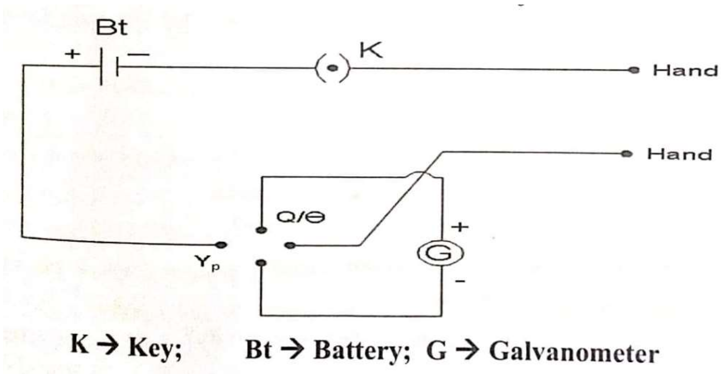


Fig. 2: To find θ_1 and θ_{11}

Observation

Table 1: To find the ratio Q/θ

E = 2 V C=0.5 µF P+Q = 10000 Ω

S. No.	Q (Ω)	P (Ω)	Kick produced (div.)			Q/θ Ω/div
			Left	Right	Mean	
1.						
2.						
3.						
4.						
5.						

Mean Q/θ =-----------------Ω/div

Table 2: To find first and eleventh throw

S. No.	θ_1 (div.)	θ_{11} (div.)
1		

Procedure

1. The preliminary adjustments of given ballistic galvanometer are made so that the suspension coil of the galvanometer executes free oscillation.
2. When no charge is passed the vertical cross wire in reflected light spot is adjusted to coincide with zero division
3. The circuit is made as shown in the figure. Battery is connected in series with resistance boxes P and Q through a plug key K.
4. The potential difference across P is applied to a condenser C through charge-discharge key when the current lever N is passed against the terminal charge. The condenser gets charged by the potential difference of P. On releasing the key, the lever contacts the terminated discharge condenser is discharged through BG
5. A suitable resistance say 1000 Ω is unplugged in P and 9000 Ω in Q, such that P+Q = 10000 Ω. Closing the plug key K, the contact lever N is pressed against the terminal charge for about 60 seconds to charge the condenser
6. By releasing the charge-discharge key, a sudden kick is produced one side of the zero division in the BG
7. Reversing the commutator and beginning the high speed to coincide with zero division, the experiment is performed to charge and discharge the condenser
8. The kick θ is observed in the opposite side and hence means kick with P= 1000 Ω and Q=9000Ω is calculated
9. Experiment is repeated by taking P=2000 Ω, Q = 8000 Ω, such that P+Q = 10000 Ω and the readings are tabulated

Calculation

$$\text{(i)} \quad \lambda = \frac{2.303}{10} \log \frac{\theta_1}{\theta_{11}}$$

$$\text{(ii)} \quad k = \frac{EC\left(\dfrac{Q}{\theta}\right) \times \dfrac{1}{1+\dfrac{\lambda}{2}}}{P+Q} (C/mm)$$

Result

The figure of merit of given Ballistic Galvanometer by the method of charging and discharging

k = ----------- C/mm

5. BALLISTIC GALVANOMETER – COMPARISON OF EMF'S – E1 / E2

Aim

To compare the emf's of two cells (i.e. Daniel and Lechlanche cells) using Ballistic Galvanometer

Apparatus Required

Ballistic Galvanometer, Daniel Cell, Leclanche cell, Double Pole Double Throw (DPDT) switch, Commutator, Plug Key, Charge – Discharge key

Formula

$$\frac{E_1}{E_2} = \frac{\theta_1}{\theta_2}$$

S. No.	Parameter	Explanation	Unit
1.	θ_1	Kick produced for the Daniel cell of emf (E_1)	V
2.	θ_2	Kick produced for the Leclanche cell of emf (E_2)	V
3.	E_1, E_2	emf of Daniel and Leclanche cell respectively	V

Circuit Diagram

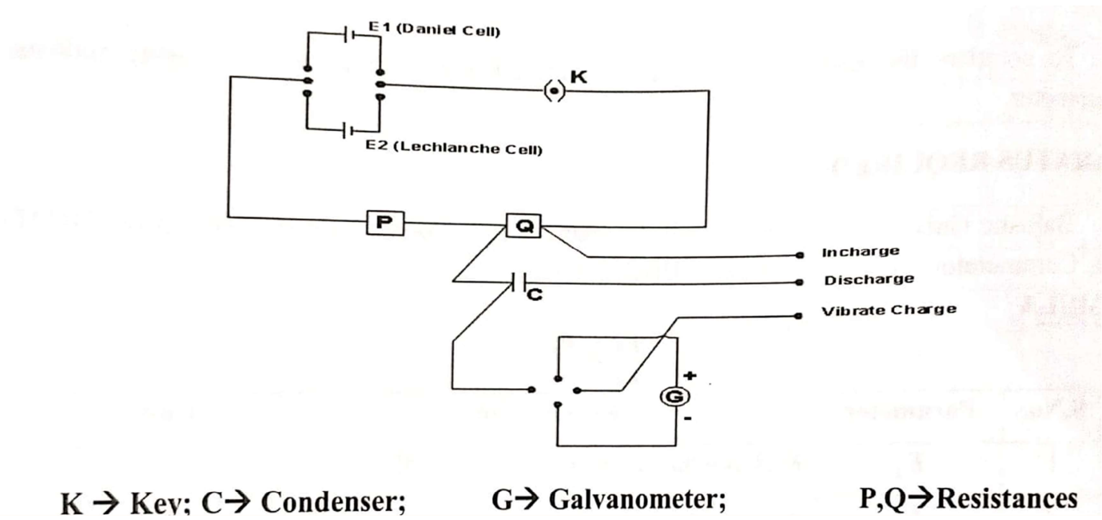


Fig. 1. Experimental setup

Observation

Table 1: Kick produced in Ballistic Galvanometer

E_1 = 1.08 V, E_1 = 1.5 V, $\frac{E_1}{E_2} = 0.72V$

P (Ω)	Q (Ω)	Kick produced for the battery of emf E_1 (V)			Kick produced for the battery of emf E_2 (V)			$\frac{\theta_1}{\theta_2}$
		Left (div.)	Right (div.)	Mean (div.)	Left (div.)	Right (div.)	Mean (div.)	
1000	9000							
2000	8000							
3000	7000							
4000	6000							
5000	5000							

Procedure

1. The circuit is made as shown in the fig. 1
2. To start with a resistance of 1000 Ω is introduced in P and 9000 Ω is introduced in Q so that P+Q = 10000 Ω.
3. DPDT switch is thrown to one side so that the Lechlanche cell of emf E_1 is connected using the key k, the circuit is closed
4. The charge-discharge key is pressed for about a minute so that condenser is charged to the potential developed across P.
5. On releasing the key the condenser discharge through the BG.
6. The first throw is noted. The commutator is reversed, experiment is repeated and mean throw is determined.

Calculation

When P = 1000 Ω, Q = 9000 Ω

$\frac{\theta_1}{\theta_2} =$

Result

The ratio of emf of Daniel and Lechlanche cell is determined

(i) By calculation $\frac{E_1}{E_2} =$ (ii) By experiment $\frac{\theta_1}{\theta_2} =$

6. SERIES RESONANCE CIRCUIT

Aim

To study the frequency response of an LCR series circuit and hence determine: Resonant frequency (f_r), Self-inductance (L) of the coil and Quality factor (Q-factor)

Apparatus Required

Inductor, Capacitor, Resistance, Audio Frequency Oscillator (AFO), milli ammeter

Formula

Self-inductance of the given coil

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

Parameter	Explanation	Unit
L	Self-inductance of the coil	Henry
f	Resonant frequency of the coil	Hertz
C	Capacitance of the circuit	μF

Circuit Diagram

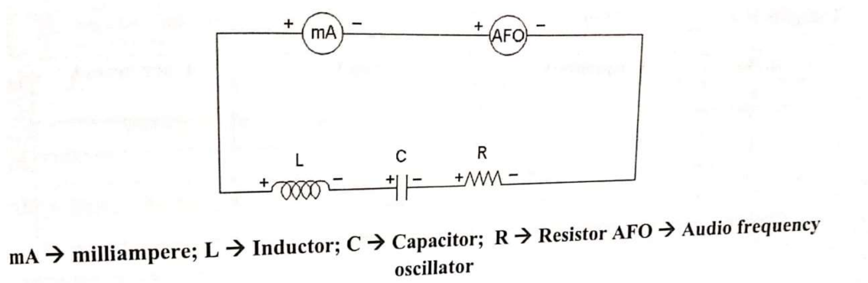


Fig. 1 : Experimental Setup

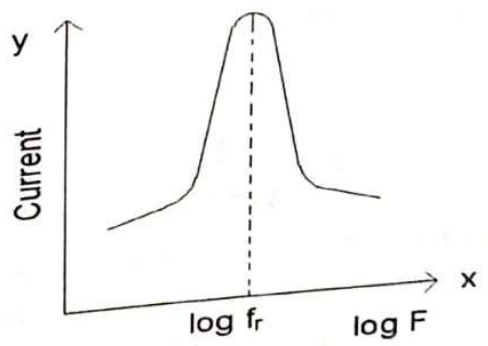


Fig. 2: Model graph

Observation

Table 1:

R = -------------Ω

S. No.	Frequency f	Log f	Current (mA)
1			
2			
3			
4			
5			

R = -------------Ω

S. No.	Frequency f	Log f	Current (mA)
1			
2			
3			
4			
5			

Procedure

1. **Setup the Circuit:** Connect the milliammeter, audio frequency oscillator (AFO), inductor, capacitor, and resistor in series as per the circuit diagram.
2. **Vary the Frequency:** Gradually vary the frequency (f) of the AFO and observe the current displayed on the milliammeter.
3. **Identify Resonance:** Note the frequency at which the current is maximum. This is the resonant frequency of the circuit.
4. **Repeat the Experiment:** Change the resistance (R) and repeat the experiment for different values.

Calculation

Capacitance Value C= ---------------μF

Ohmic resistance of the coil r =-----------ohm

Resonant frequency f_r = --------------------- Hertz

To determine L

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

To determine Q-factor

$$Q = \frac{2\pi f_r L}{r}$$

Result

The frequency response of LCR series circuit is studied.

1. Resonant Frequency (f_r): ________________ Hz
2. Self-Inductance (L): ________________ H
3. Quality Factor (Q): ________________

7. OWEN'S BRIDGE – DETERMINATION OF SELF-INDUCTANCE OF THE COIL

Aim

To determine the self-inductance of the given two coils using Owen's bridge and find the effective self-inductance of the two coils connected in series and in parallel

APPARATUS REQUIRED

Resistor, Inductor, Capacitors, Ear phone. AF oscillator (Audio frequency).

FORMULA

$$L = PRC \text{ Henry}$$

S. No.	Parameter	Explanation	Unit
1	L	Self-inductance of the coil	Henry
2	P	Resistance value in the arm AD such that P=Q	Ω
3	C	Capacitance value of the capacitor C_1 such that $C_1=C_2$	μF
4	R	Resistance value to be included in R to balance the bridge	Ω

Circuit Diagram

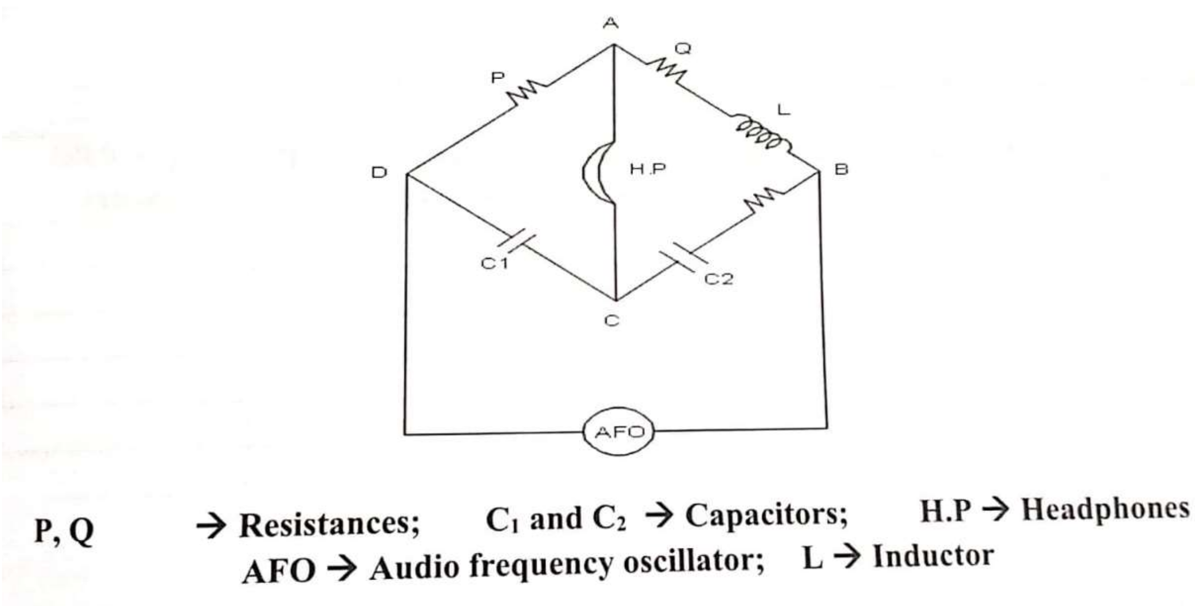


Fig. 1: Experimental Setup

Observation

Table 1: To find L_1 : $C_1=C_2=C$

S. No.	Resistance value in P = Q (Ω)	Resistance value included in R to balance the bridge (Ω)	L_1 =PRC Henry
1			
2			
3			
4			
5			

Mean =

Table 2 : To find L_2 : $C_1=C_2=C$

S. No.	Resistance value in P = Q (Ω)	Resistance value included in R to balance the bridge (Ω)	L_2 =PRC Henry
1			
2			
3			
4			
5			

Mean =

Procedure

1. **Set Up the Circuit:** Arrange the circuit as shown in the diagram.
2. **Balance the Bridge:** Adjust resistances P and Q such that P=Q. Choose suitable values for capacitors C_1 and C_2 such that $C_1=C_2$.
3. **Minimize Sound:** Adjust the resistance R until the sound in the earphone becomes zero or minimum.
4. **Record Observations:** Note the values of P, R, and C.
5. **Repeat for Different Conditions:** Repeat the experiment with different values of P, keeping C constant.
6. **Determine Self-Inductance:**Calculate the self-inductance L_1 of the first coil. Repeat the same procedure to determine L_2 for the second coil.
7. **Effective Self-Inductance:** Connect the two coils in series and parallel, and calculate the effective self-inductance using the same method.

Calculation

L_1 = L_2 =

$L_s = L_1+L_2$

$$L_P = \frac{L_1 L_2}{L_1 + L_2}$$

RESULTS

1. Self-inductance of Coil 1 (L_1): __________ Henry.
2. Self-inductance of Coil 2 (L_2): __________ Henry.
3. Effective self-inductance in series: __________ Henry.
4. Effective self-inductance in parallel: __________ Henry.

8. ANDERSON'S BRIDGE – SELF – INDUCTANCE OF THE COIL

Aim

To determine the self-inductance of a inductor coil using Anderson's Bridge

Apparatus required

Capacitor, Resistance box, Inductance box, Galvanometer, DC source, AC source, Headphone

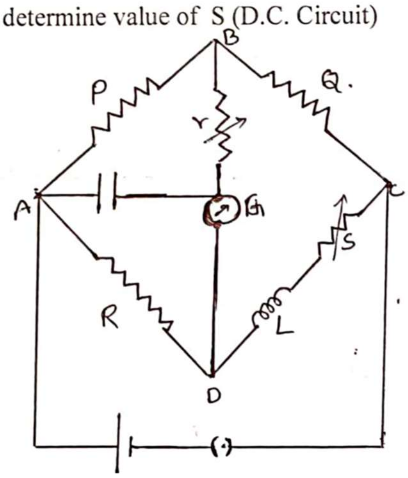
Formula

$$L = CR(P + 2r)$$

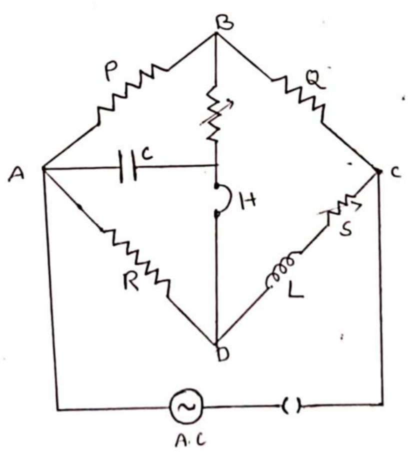
S. No.	Parameter	Explanation	Unit
1	L	Self-inductance of the coil	Henry
2	P	Resistance value in the arm AB such that P=Q	Ω
3	C	Capacitance value of the capacitor	μF
4	r	Resistance value to be included in r to balance the bridge	Ω

Circuit Diagram

Circuit Diagram to determine value of S (D.C. Circuit)



Circuit Diagram to determine value of r (A.C. Circuit)



Observation

Value of resistance P = Q = Ω

Value of resistance R = Ω

Value of S (when DC source is used) when galvanometer shows zero deflection

i. Ω ii. Ω iii. Ω mean S = Ω

To determine the value of **r**

Capactiance (µF)	Value of r when sound in headphone is minimum (Ω)	Self-Inductance (mH)

Mean L = mH

Procedure:

1. **Set Up the Circuit:** Connect the components as per the Anderson's Bridge circuit diagram.The unknown inductance (L) and its resistance (S) are connected in one arm of the bridge. C (standard capacitor) and r (variable resistor) are placed in the auxiliary arm.
2. **Adjust Input Signal:**Connect the AC source to the bridge. Choose a suitable frequency (usually 1 kHz) for the signal generator.
3. **Initial Adjustment:**Start with approximate values of P, Q, R and S. Ensure the standard capacitor (C) is correctly connected and its value is known.
1. **Achieve Bridge Balance:** Using the null detector (headphones or a galvanometer), adjust S and achieve a null condition (minimum or zero sound in headphones, or zero deflection on the galvanometer).
2. **Record Balancing Values:** Once the bridge is balanced, note the values of P, Q, R, S and C.
3. **Calculate Self-Inductance (L):**Use the formula to calculate L.
4. **Repeat for Accuracy:**Repeat the procedure for different values of r to verify the consistency of the results.

Result

Self-Inductance of a given coil = mH