Bharati

Practical PHYSICS

Note Book

MJC-4 Physics.

Certificate

Name : .... Class : ....

Roll No. : ....Exam. No. : ....

Institution : ....

This is certified to be bonafide work of the student in the .... Laboratory during the academic year 20 .

No. of practicals certified .... out of ....in the subject of ....

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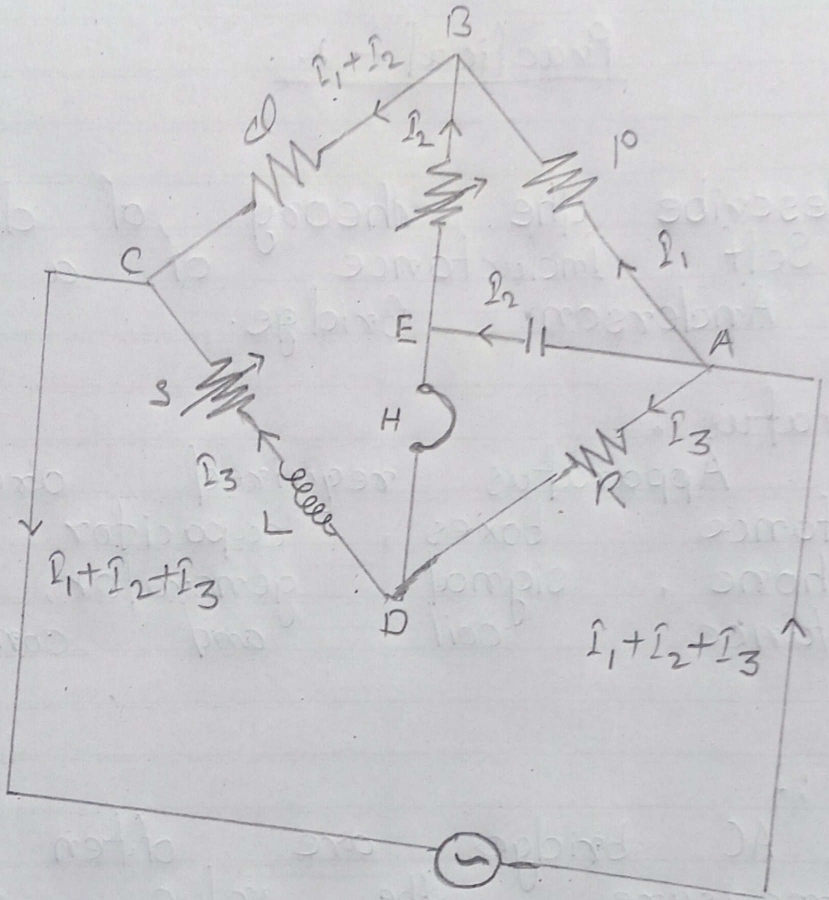
(N.B. : The candidate is expected to retain his/her journal till he/she passes in the subject.)

Practical - 2

* Aim :-
Describe the theory of determination of Self Inductance of a coil by Anderson Bridge.

* Apparatus :
Apparatus required are resistance boxes, capacitor headphone, signal generator, inductance coil and connection wire.

* Theory :-
AC bridges are often used to measure the value of unknow impedance (Self/mutual inductance of inductors or capacitance of capacitors accurately).


B
I_1+I_2
Q
I_2
P
I_1
C
I_2
E
A
S
H
I_3
I_3
R
L
$I_1+I_2+I_3$
D
$I_1+I_2+I_3$

A large number of AC bridges are available and Anderson's Bridge is an AC bridge used to measure self inductance of the coil. It is a modification of Wheatstones Bridge. It enables us to measure the inductance of a coil using capacitor and resistors and does not require repeated balancing of the bridge. The connections are shown in fig: 1

The bridge is balanced by a steady current by replacing the headphone H by moving coil galvanometer and A.C source by a battery. This is done by adjusting the variable resistance. r After a steady balance has been obtained. inductive balance is obtained by using the AC source and headphone.

The condition for ~~blan~~ balance is that potentials of the terminals D and E are same. Then the current flowing through branch AB is I_1 through AE and EB is I_2. The current flowing through branches AD and DC is I_3, while that through BE is $I_1 + I_2$. No current flows through branch DE.

* Circuit Details :-

Consider the mesh ABCDA

$$I_1 P + (I_1 + I_2) Q - I_3 (jL\omega + S) - I_3 R = 0$$

$$I_1 (P + Q) + I_2 Q = I_3 (S + R + jL\omega) \quad \text{--- (1)}$$

The shows that potential drop along ABC is equal to that along ADC

Consider the mesh ABEA, there is no e.m.f

$$I_1 P - I_2 r - \frac{I_2}{jC\omega} = 0$$

$$I_1 P - I_2 \left(r + \frac{1}{jC\omega}\right) = 0 \quad \text{—— (2)}$$

Consider the mesh AEDA.

$$\frac{I_2}{jC\omega} = I_3 R \quad \text{—— (3)}$$

i.e. potential difference from A to E is equal to that from A to D
from (3) we get,

$$I_2 = j I_3 C\omega R \quad \text{—— (4)}$$

Now substitute the value of I_3 from (1) in (4)

$$I_2 \left[\frac{S + R + jL\omega}{jC\omega R} - \sigma\right] = I_2 [P + \sigma] \quad \text{—— (5)}$$

Dividing ⑤ by ②

$$\frac{I_1(P+Q)}{I_1 P} = \frac{I_2\left[\frac{S+R+jL\omega}{jC\omega R} - Q\right]}{I_2\left[r + \frac{1}{jC\omega}\right]}$$

$$\Rightarrow \frac{P+Q}{P}\left[r + \frac{1}{jC\omega}\right] = \frac{R+S+jL\omega - jC\omega RQ}{jC\omega R} \quad \text{——} ⑥$$

Multiply and divide by R in the L.H.S of ⑥ and rearrange,

$$\frac{(P+Q)R}{P}\left[\frac{rjC\omega+1}{jC\omega R}\right] = \frac{R+S+jL\omega - jC\omega RQ}{jC\omega R}$$

$$\Rightarrow PR + RQ + jPrC\omega R + jQrC\omega R = PR + PS + jL\omega P - PRjC\omega Q$$

$$\Rightarrow RQ + j(P+Q)RC\omega r = PS + j[L\omega - RC\omega Q]P \quad \text{——} ⑦$$

Equating real parts on both sides of ⑦

$$\boxed{\frac{R}{S} = \frac{P}{Q}} \quad \text{——} ⑧$$

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~~Equating real parts~~

Equating (8) represents the condition for balancing of the bridge.

Equating imaginary parts on both sides of (7)

$$L = \frac{RC\,[Pr + Qr + PQ]}{P} \quad \text{--- (9)}$$

Substituting: $S = \frac{RQ}{P}$

from (8) and (9) gives us.

$$L = C\,[RQ + r(R+S)] \quad \text{--- (10)}$$

At this condition of balancing there is minimum sound in the headphone.

further we can make $P = Q$

$$L = CR(P + 2r) \quad \text{--- (11)}$$

The inductive reactance can be calculated by

$$X_L = 2\pi f L$$

NO.	Resistance $R(\Omega)$	Resistance $Q(\Omega)$	Resistance $P(\Omega)$	Variable $S(\Omega)$	variable Resistance $r(\Omega)$	Inductance $L(H)$
1.	200	200	200	200	50	0.0009
2.	200	200	200	200	55	0.0010
3.	200	200	200	200	60	0.0011
4.						

Calculation

Given that

$R = 200\Omega$, $Q = 200\Omega$, $S = 200\Omega$, $r = 50\Omega$
$C = 1\times10^{-8} F$

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$L = C[RQ + r(R+S)$

$\Rightarrow L = 1\times10^{-8}[(200\times200) + 50(200+200)]$

$\Rightarrow L = 1\times10^{-8}[40000 + 20000]$

$\Rightarrow L = 1\times10^{-8} \times 60000$

$\Rightarrow L = 6\times10^{-4}\,H = 0.0006\,H$

$$\boxed{L = 0.0006\,H}$$

$X_L = 2\pi f L$

$\Rightarrow X_L = 2\times3.14\times1000\times0.001$

$\Rightarrow X_L = 6.28\,\Omega.$

Result

$L \approx 1\times10^{-5}\,H$

and $X_L \approx 6.28\,\Omega$

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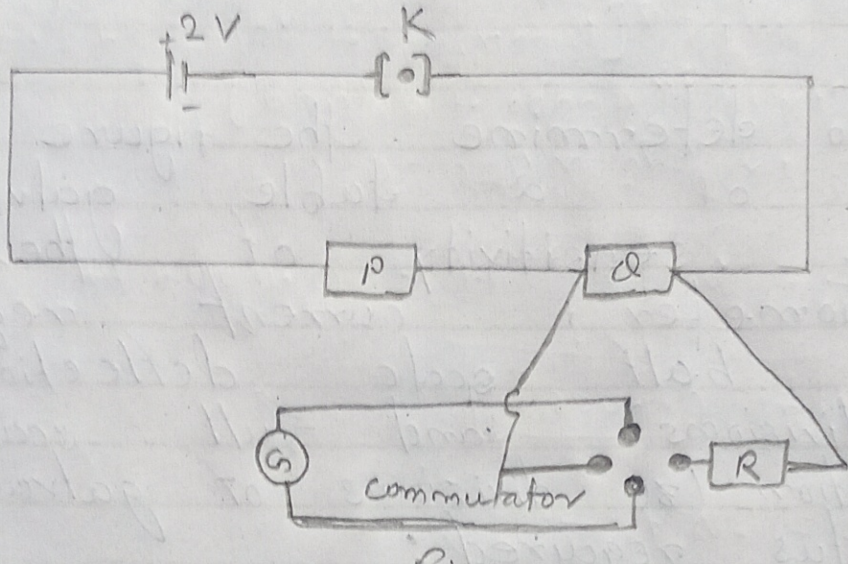
Expt - 2.

* Aim :-
To determine the figure of merit of a table galvanometer, voltage sensitivity of the galvanometer, current required for half scale deflection (15 divisions) and full scale deflection (30 divisions of galvanometer

* Apparatus required:
Battery (2V), three resistance boxes, key, commutator, table galvanometer, connecting wires, etc.

* Circuit :-
A battery of emf 2V is connected in series with two resistance boxes P and Q through a key K. A resistance box R is connected in parallel from the



Figure

two terminals of Q through the commutator. A table galvanometer is connected from the other two terminals of the commutator.

* formula:-

(i) figure of merit of galvanometer

$$= \frac{E}{(P+Q)} \cdot \frac{1}{G} \cdot \frac{Q}{\theta} \text{ amperes/div}$$

Where, E = emf of the battery
P and Q = resistance in r box
G = galvanometer
θ = deflection observed.

(ii) Current required for half scale deflection = 15 x figure of merit (ampere)

(2) Current required for full scale deflection = 30x figure of merit (amperes)

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(3) Voltage sensitivity of the galvanometer
= G x figure of merit (volt/div)

S.No.	P (Ω)	Q (Ω)	Deflections (div) θ_1	θ_2	Mean θ	R for half deflection R_1 Ω	R_2 Ω	Mean R (Ω)	R = G (Ω)	Q/θ (Ω/div)
1	982	18	27	28	27.5	85	80	82.5	82.5	0.65
2	985	15	23	23	23	80	82	81.0	81.0	0.65
3.	988	12	20	19	19.5	80	87	83.5	83.5	0.62
4.	991	09	16	15	15.5	83	82	82.5	82.5	0.58
5.	994	06	11	10	10.5	83	85	84.0	84.0	0.57

$$\text{Mean} = \frac{0.65 + 0.65 + 0.62 + 0.58 + 0.57}{5}$$

Mean (Q/θ) = 0.61 Ω/div

G = 8.27 Ω ≈ 83 Ω

(1) $K = 14.7 \mu A/div$ (2) $I_{half} = 2.2 \times 10^{-4} A$

(3) $I_{full} = 4.4 \times 10^{-4} A$. $G \times K = 1.22 \times 10^{-3}$ V/div

Ans

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