B. Sc. Part II

Paper IV

Current electricity

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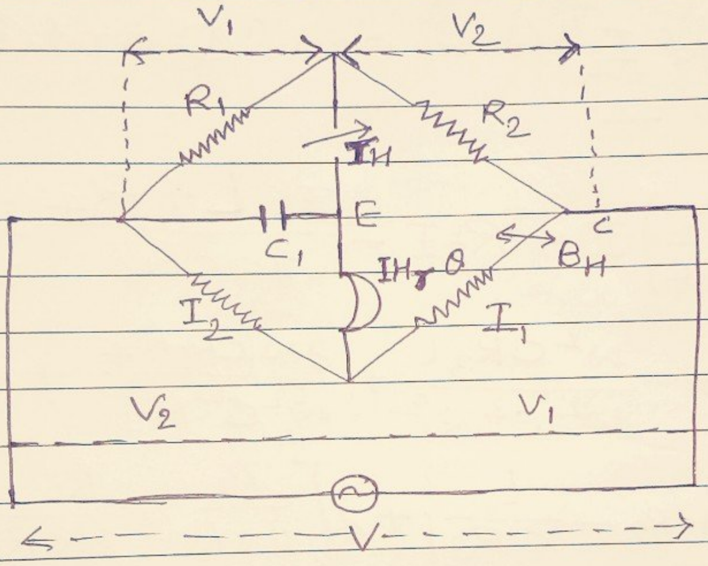
Dr. Shiva Kant Mishra
Dept of Physics HDJC
Current electricity.

Anderson's bridge method for the determination of inductance of a coil :-

Anderson bridge is most accurate for the measurement of self induction in terms of standerd capacitance. The circuit arrangement is shown in figure.



At the balance condition of the bridge, the current flowing through head phones becomes zero, i.e. $I_H = 0$.

In this situation applying Kirchoff's law to the loop circuit ABEA we have –

$$R_1 I_1 = r + \frac{1}{j\omega C} I = 0$$

or $$R_1 I_1 - \left(r + \frac{1}{j\omega C}\right) I = 0$$

or $$I_1 = \frac{\left(r + \frac{1}{j\omega C}\right) I}{R_1} = 0 \qquad \text{—— (1)}$$

Again applying Kirchoff's law to loop Circuit AEDA we have $\frac{1}{jwc} I - R_3 I_2 = 0$

or $I_2 = \frac{I}{jwcR_3}$ —— ②

Again applying Kirchoff's law to loop Circuit BCDB we have

$R_2(I_1 + I) - (jwL + R_4) I_2 + I_r = 0$ —— ③

Putting I_1 and I_2 form equ^n ① and ② in equ^n ③, we have —

$$\frac{R_2}{R_1}\left(r + \frac{1}{jwc}\right) I + R_2 I - \frac{jwL + R_4}{jwcR_3} I + Ir = 0$$

or $\frac{R_2}{R_1} r + R_2 + r - \frac{w^2 CR_3 L}{w^2 C^2 R_3^2} + \frac{jw CR_3 R_4}{w^2 C^2 R_3^2} + \frac{R_2}{jwcR_3} = 0$

or $\left\{\left(\frac{R_2}{R_1} + 1\right) r + R_2 - \frac{L}{CR_3}\right\} + j\left[\frac{R_1}{wcR_3} + \frac{R_2}{WCR_1}\right] = 0$

Now equating real and imaginary Parts

$$\left(1 + \frac{R_2}{R_1}\right) r + R_2 - \frac{L}{CR_3} = 0$$

or $L = CR_3\left[\left(1 + \frac{R_2}{R_1}\right) r + R_2\right]$ —— ④

and $\frac{R_4}{w'CR_3} - \frac{R_2}{wCR_1} = 0$

or $\frac{R_1}{R_2} = \frac{R_3}{R_4}$ —— ⑤

equation ④ and ⑤ is required Condition for The balance of bridge.

Now by adjusting R_4 the balance condition (5) can be obtained and ondjusting r the balance condition (4) can be obtained.

Therefore by adjusting r and putting the value R_1, R_2, R_3 and C in equ^n (5) we may calculate self inductance L.

From equ^n (4) and (5) it is also clear that the condition of the balance is independent from the source frequency.

For the condition of balance it is necessary that $L > CR_2R_3$ otherwide r will be $-ve$.

In the experiment we always take $R_1 = R_2$ therefore for condition of balance $R_3 = R_4$.

In this situation self inductance will be $L = CR_3(2r + R_2)$

The accurate value of L will be obtained only when the bridge is sensitive for the sensitivity of the bridge $C = \frac{L}{2R_4^2}$ or $\frac{c}{L} = 2R_4^2$

Now on taking $R_3 = R_4$ we have

$$L/C = 2R_3^2 = R_3(2r + R_3)$$

or $2R_3 = 2r + R_2$

or $R_3 = \frac{2r + R_2}{2} = r + \frac{R_2}{2} = R_4$

Thus we may say that for the sensitivity and balance of the bridge R_4 and r should be adjusted.