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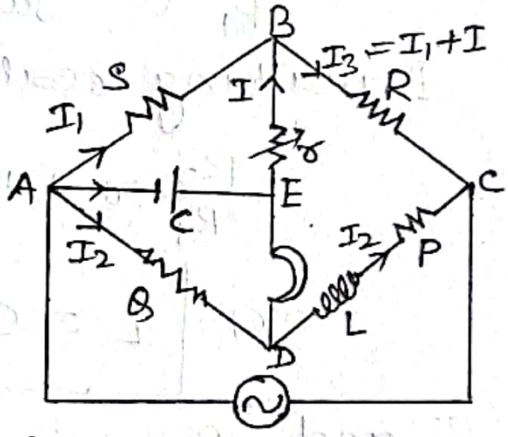
B.Sc (Part-II) Hons
Paper – IV

Value of 'L' using A.C. Bridge

Anderson's Bridge :- This is one of the most common bridges for accurate measurement of inductance. In this method the self inductance is expressed in terms of a standard capacitor.



The connections are shown in figure. At first a battery and a moving coil galvanometer are used to obtain a balance for steady currents by adjusting the resistance in the four arms of the bridge as usual. Next an A.C source and a pair of head phones (H.P) are used and the A.C. balance is obtained by adjusting non-inductive resistance r in series with the capacitor C.

At the time of balance the potential at E is equal to the potential at D. Applying Kirchhoff's laws we have for mesh ABEA

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

for mesh AEDA,

$$I\left(\frac{1}{j\omega C}\right) - R_3 I_2 = 0 \quad \text{——— (2)}$$

and for mesh

$$R_2(I_1 + I) - (j\omega L + R_4) I_2 + I r = 0 \quad \text{——— (3)}$$

from equation(1)

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

and from equation(2)

$$I_2 = \left(\frac{1}{j\omega C}\right)\frac{I}{R_3}$$

Substituting these values of I_1 and I_2 in eqn(3) we have,

$$\frac{R_2}{R_1}\left(r + \frac{1}{j\omega C}\right)I + R_2 I - \frac{(j\omega L + R_4)}{j\omega C \cdot R_3} + Ir = 0$$

Equating real and imaginary parts, we get

$$\frac{R_2}{R_1}r + R_2 - \frac{L}{CR_3} + r = 0$$

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

$$\text{and } \frac{R_2}{R_1 \omega C} - \frac{R_4}{R_3 \omega C} = 0$$

$$\text{or, } \frac{R_2}{R_1} - \frac{R_4}{R_3} = 0$$

$$\text{or, } \frac{R_2}{R_1} = \frac{R_4}{R_3}$$

$$\text{or, } \boxed{\frac{R_1}{R_2} = \frac{R_3}{R_4}} \quad \text{——— (5)}$$

These Condition are independent of frequency of the Source and Can be Satisfied independently of each other by adjusting R_4 in eqn (5) and r in equation(4). Equation(4) shows that the A.C balance is possible only when $L > CR_2R_3$ otherwise r will be negative. It is best to use $R_1 : R_2 = 1:1$. Then the above equation reduce to

$$R_3 = R_4 \text{ and } L = CR_3(2r + R_2) \quad \text{——— (6)}$$