LECTURE SERIES-03

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Anderson's Bridge: This is one of the most accurate bridge for the measurement of self inductance interms of a standard capacitance. In this bridge a variable non-inductive resistance r is put in the detector arm, and the capacitor is connected across S and r, P, Q, R and S are the resistance, L is the self inductance of the coil and C is the standard capacitance of the capacitor. The complete circuit diagram of the bridge is shown in fig.(1)

Applying Kirchhoff's Law in the loop ABEA.

$$SI_1 - rI - \frac{I}{j\omega C} = 0$$

or $$SI_1 - I\left(r + \frac{I}{j\omega C}\right) = 0$$

or $$SI_1 = I\left(r + \frac{1}{j\omega C}\right)$$

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

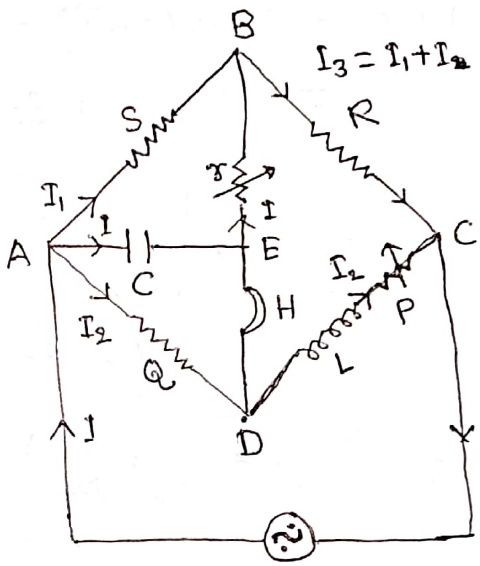

Fig.(1)

From loop, AEDA,

$$\left(\frac{1}{j\omega C}\right)I - QI_2 = 0$$

$$\therefore I_2 = \left(\frac{1}{j\omega CQ}\right)I \quad \text{——— (2)}$$

From mesh BCDB,

$$R(I_1 + I) - (j\omega L + P)I_2 + rI = 0 \quad \text{——— (3)}$$

putting the values of I_1 and I_2 in eq^n (3), we have

$$R\left[I + \frac{\left(r + \frac{1}{j\omega C}\right)I}{S}\right] - (j\omega L + P)\left(\frac{1}{j\omega CQ}\right)I + rI = 0$$

or $\left[\frac{R}{S}r + R - \frac{L}{CQ} + r + \frac{R}{S}\left(\frac{1}{j\omega C}\right) - \left(\frac{1}{j\omega C}\right)\frac{P}{Q}\right] I = 0$ —— (4)

$[\because I \neq 0]$

Equating real and imaginary parts of this equation, we have

$$\frac{R}{S}r + R - \frac{L}{CQ} + r = 0$$

$$\therefore \quad L = CQ\left[r\left(1+\frac{R}{S}\right) + R\right] \quad \text{—— (5)}$$

and $\frac{1}{j\omega C}\cdot\frac{R}{S} - \frac{1}{j\omega C}\cdot\frac{P}{Q} = 0$

$$\therefore \quad \frac{P}{Q} = \frac{R}{S} \quad \text{—— (6)}$$

Hence, we can find L in terms of Q, R, S, r and capacitance C using eqn (5). It is clear from eqn (5), that A.C balance is possible only when $L > CRQ$, otherwise r will be negligible. If $R = S$, then eqn (5) becomes

$$L = CQ(R + 2r) \quad \text{—— (7)}$$

Hence C and r are adjusted for balance. For the bridge to be sensitive, $P = Q$

$$\therefore \quad R = S = \frac{P}{2} \quad \text{and} \quad \frac{L}{C} = \frac{P^2}{2} \quad \text{—— (8)}$$

Vector Diagram: The vecter diagram as shown in fig (2), Here OA represents the p.d between the terminals A and C or the potential vecter for the applied source. If I_2 gives the current in mesh ADC, then $OC = I_2 Q$ and $CD = j\omega L I_2$ and $DA = P I_2$

Hence $DA \parallel OC$, and $CD \perp OC$ or DA

Since E and D are at the same potential, hence

$V_{AE} = V_{AD}$ (In the circuit diagram)

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

Thus I is in quadrature with I_2.

If $CB = rI$, then the vector OB is $S I_1$.

The vector OZ is $R I_3$

$= R(I_1 + I)$

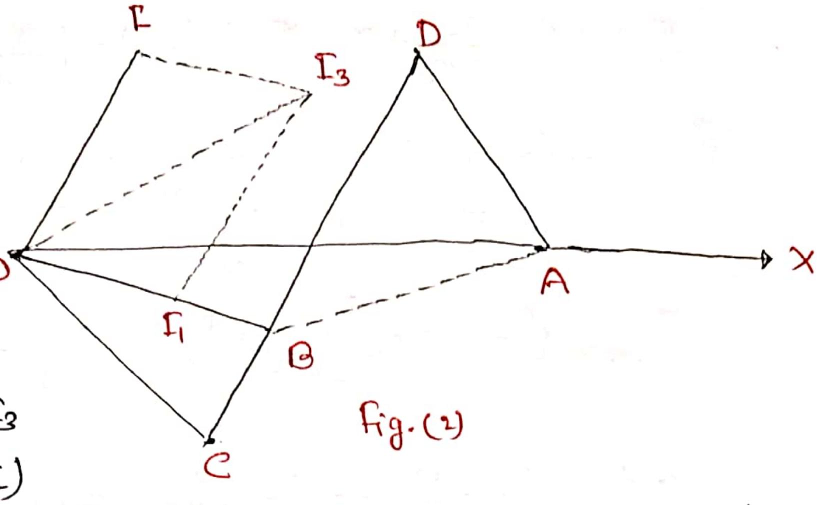

fig. (2)

Thus, we can determine the direction of I_1 and I_3 from the diagram

——X——