B.Sc. Part II

Paper IV

Current electricity

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Current electricity.

Anderson Bridge :-

Anderson bridge is corrected from of Maxwell bridge in which double equilibrium is found by only changing the resistance and the value of standared capacitance is constant. A variable non-inductive resistance r is connected in the detector arm and capacitor C_4 is connected between the R_4 and ends of r, C and F as shown in figure. An one end of detector D is connected on the junction point of C_4 and r and the other end is connected on B.

Let i_1, i_2, i_3 and i_4 are the combines currents in the main arms of bridge and i_r and i_c are the current in the resistance r and capacitance C_4.

In the position of equilibrium, there is no any current in the detector D. By Kirchhoff's 2nd law for the net ABC, BFC and CFE, we get

$$(R_1 + j\omega L) i_1 = r i_r + R_3 i_3 \quad \text{—} \; (1)$$

$$R_2 i_2 = 1/j\omega C_4 \; i_c \quad \text{—} \; (2)$$

$$r i_r + \frac{1}{j\omega C_4} - i_r = R_4 i_4 \quad \text{—} \; (3)$$

Again by Kirchhoff's first law, for B. F and E junctions

$i_1 = i_2$ —— (IV)

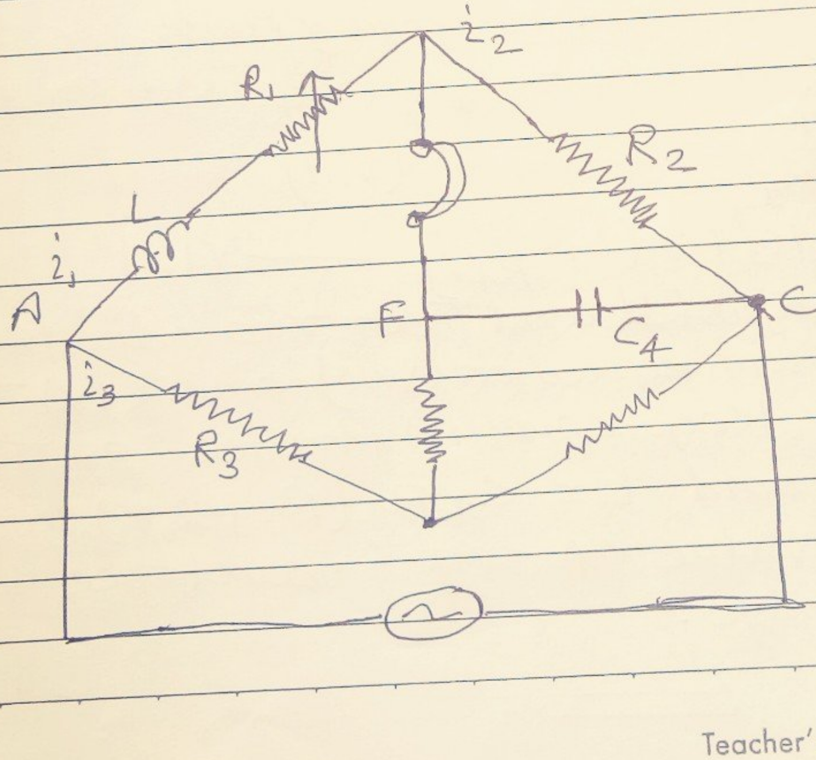
$i_r = i_c$ —— (V)

$i_3 = i_r + i_4 = i_c + i_4$ —— (VI)

Substituting $i_1 = i_2$ and $i_r = i_c$ in equation ① and dividing from equⁿ (ii) we have

$$\frac{(R_1 + j\omega L)\, i_2}{R_2 i_2} = \frac{r i_c + R_3 i_3}{\frac{4}{j\omega C_4} - i_c}$$

or $$\frac{R_1 + j\omega L}{R_2} = \frac{r + R_3 (i_3/i_c)}{1/j\omega C_4} \quad \text{—— (vii)}$$



Substituting $i_1 = i_C$ in equation (vii) by equation (vi), we have

$$\left(r + \frac{1}{j\omega C_4}\right) i_4 = R_4 i_4 = R_4 (i_3 - i_C)$$

or $$\left(r + \frac{1}{j\omega C_4 + R_4}\right) i_4 = R_4 i_3$$

or $$\frac{i_3}{i_C} = \frac{r + \frac{1}{j\omega C_4} + R_4}{R_4}$$

whose value is substituting in equ^n (vii), we have

$$\frac{R_1 + j\omega L}{R_2} = \frac{r + \frac{R_4}{R_4}\left(r + \frac{1}{j\omega C_4 + R_4}\right)}{1/j\omega C_4}$$

or $$\frac{R_1 + j\omega L}{R_2} = \frac{R_3 + j\omega C_4 (r R_4 + R_3 r + R_3 R_4)}{R_4}$$

or $R_1 R_4 + j\omega L R_4 = R_2 R_3 + j\omega C_4 R_2 (r R_4 + R_3 r + R_4)$

Equating separately the real & imaginary parts, we get

$R_1 R_4 = R_2 R_3$ and $L R_4 = C_4 R_2 (r R_4 + R_3 + R_3 R_4)$

or $$\frac{R_1}{R_2} = \frac{R_3}{R_4} \qquad \text{———— (viii)}$$

and $$L = C_4 R_2 \left[R_3 + r\left(1 + \frac{R_3}{R_4}\right)\right] \qquad \text{———— (ix)}$$

First of all, R is adjusted and their r is adjusted and found the equilibrium equation (viii) and (ix) respectively.

R_3 and R_4 may keep equal in practice. In this position $R_1 = R_2$ and $L = C_4 R_2 (R_3 + 2r)$

Thus the value of self inductance is found by Anderson bridge.