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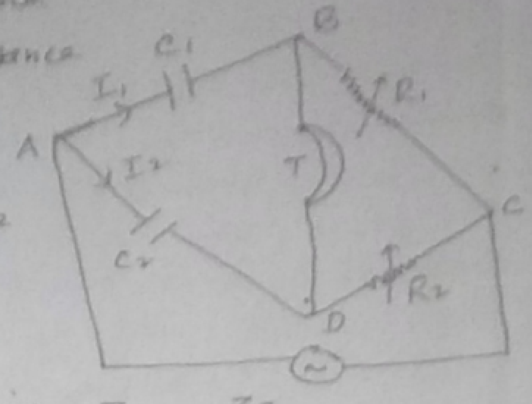
Question: Write short notes on the following :-
(a) De Sauty Bridge (b) Schering Bridge

Ans (a) De-Sauty bridge :-

In this bridge AB arm of the bridge is a perfect capacitor of capacitance C_1. BC arm is a pure resistance. CD-arm is also a pure resistance and DA arm is a capacitor of capacitance C_2



Here $Z_1 = \frac{1}{jWC_1}$, $Z_2 = R_1$

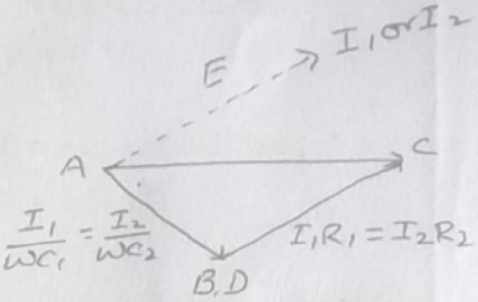
$Z_3 = \frac{1}{jWC_2}$, $Z_4 = R_2$

∴ Balance condition of this bridge is $\frac{Z_1}{Z_2} = \frac{Z_3}{Z_4}$

$$\Rightarrow \frac{\frac{1}{jWC_1}}{R_1} = \frac{\frac{1}{jWC_2}}{R_2} \quad \text{or} \quad \frac{1}{R_1C_1} = \frac{1}{R_2C_2} \quad \text{or} \quad R_1C_1 = R_2C_2 \quad \therefore \frac{C_1}{C_2} = \frac{R_2}{R_1}$$

This bridge is suitable for comparing two capacitances in terms of two non inductive resistances. However, a perfect balance is not possible if there is some resistance of the capacitors, i.e capacitors have some power factors. Here only quadrature components are balanced and in phase components are neglected assuming the capacitors to be perfect.

Vector diagram of bridge:-



Let AC represent the applied p.d to the bridge, i.e the p.d between A and C. Since the two branches are capacitive, the currents through them lead the e.m.f by some angle. So draw a line AE at some angle above AC at A. This is the direction of the branch I_1.

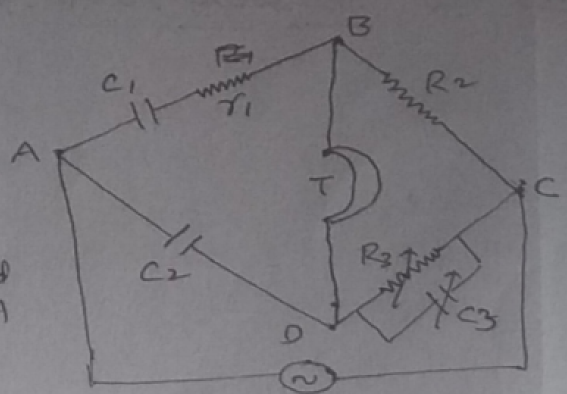
I_1 → current in ABC branch
I_2 → " " ADC "

The p.d across C_1 is I_1/WC_1 and is at right angles to I_1 (current leading the p.d). So draw a line ⊥ to AE in clockwise direction. cut off a length $AB = I_1/WC_1$. join B with C, Then BC obviously represent p.d across R_1.

Since a part in a resistor P.d is in phase with
the current, BC must be parallel to AE. At Balance (1)
D are at the same potential and so D also lies at B in
vector diagram, i.e the current I_2 is also along AE.

(b) **Schering bridge :→**

This bridge is most accurate bridge method for determining capacitances relative to standard capacitor (mica). The test capacitor C_1 having some resistance r_1 is in the first arm AB, the fixed standard capacitor C_2 is in the third arm AD. A variable air capacitor C_3 is placed across the non inductive variable resistance R_3 in the fourth arm DC. The second arm BC is a fixed, non inductive resistance R_2.



Here $Z_1 = r_1 + \frac{1}{j\omega C_1}$, $Z_2 = R_2$, $Z_3 = \frac{1}{j\omega C_2}$, $\frac{1}{Z_4} = \frac{1}{R_3} + \frac{1}{\frac{1}{j\omega C_2}} = \frac{1}{R_3} + j\omega C_3$

This bridge is balanced when

$$\frac{Z_1}{Z_2} = \frac{Z_3}{Z_4} \quad \text{or} \quad \frac{Z_1}{Z_2} = Z_3 \times \left(\frac{1}{Z_4}\right)$$

$$\Rightarrow \frac{r_1 + \frac{1}{j\omega C_1}}{R_2} = \frac{1}{j\omega C_2}\left(\frac{1}{R_3} + j\omega C_3\right)$$

or, $$\frac{r_1}{R_2} + \frac{1}{j\omega C_1 R_2} = \frac{1}{j\omega C_2 R_2} + \frac{C_3}{C_2}$$

Equating real parts

$$\frac{r_1}{R_2} = \frac{C_3}{C_2} \quad \text{or} \quad r_1 = \frac{C_3}{C_2} \times R_2 \quad \text{------} \quad (1)$$

Equating imaginary parts

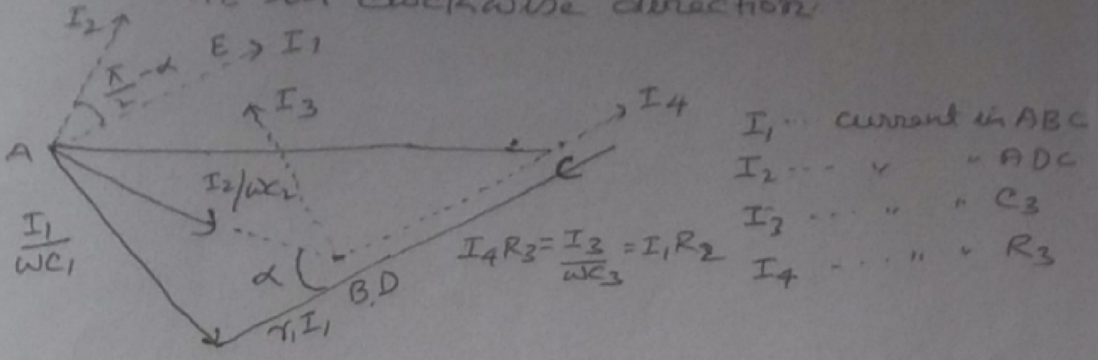
$$C_1 R_2 = C_2 R_3 \quad \text{or} \quad C_1 = \frac{R_3}{R_2} \times C_2 \quad \text{------} \quad (2)$$

The bridge is balanced in two stages, first adjusting C_3 for minimum sound in the head phone and then R_3 is adjusted for no sound in the head phone.

Vector diagram of the bridge :→

Let AC represent the applied voltage to the bridge, i.e the P.d between A and C. Since the branch

ABC is capacitive and current I_1 leads the applied voltage. We draw a line AE at some angle above AC at A. This is then the direction of the branch I_1. The p.d across C_1 is $I_1/\omega C_1$ and is at right angle to I_1 (I_1 leading $I_1/\omega C_1$). So draw a line $\perp$ to AE in clockwise direction.



Then cut off a length $AO = I_1/\omega C_1$. Join O with C. Then OC represents the total voltage across r_1 and R_2. Since the current and voltage across a resistance are in the same phase, OC is essentially parallel to AE. Cut off a length $OB = r_1 I_1$. Then OB represents the voltage across r_1 and BC represents the voltage across R_2. Since B and D are at the same potential and so D also lies at B in the vector ~~dig~~ diagram. Join A and B, then AB is the total voltage across the capacitor C_1 and its innate resistance r_1. Let I_3 be the current through C_3 and I_4 be the current through R_3. Then $DC = I_4 R_3 = \frac{I_3}{\omega C_3}$

Since current leads the e.m.f in a capacitor, I_3 is $\perp$ to BC or DC in the anticlockwise direction.

Power factor of $C_1 = \cos\alpha = \frac{OB}{AD}$