AC Bridge

For DC :- Capacitor act as - open circuit
or we can say that
the resistance is ∞
we can also say that capacitor
blocks DC

:- Inductor act as - Short circuit
or its resistance is 0
we can say that inductor
pases DC without any
attenuation

For AC :- $R \rightarrow R$

Capacitor $\rightarrow$ Capacitance

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

$$\boxed{X_C \propto \frac{1}{f}}$$

Inductor $\rightarrow$ Inductance

$$X_L = \omega L = 2\pi f L$$

$$\boxed{X_L \propto f}$$

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Impedance को हम 2 notation से define कर सकते है → Rectangular form
→ Polar form

→ Rectangular form :-

$2 + 2j$ or $2 - 2j$ & magnitude and phase both are present

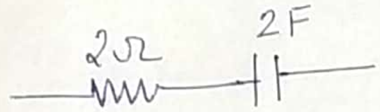
↳ notation with j

$R \rightarrow R$

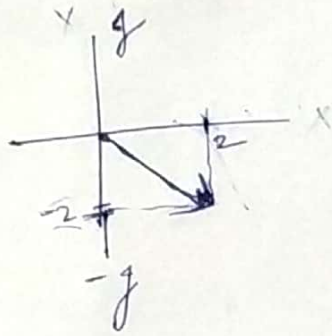
Capacitance $\rightarrow X_C \longrightarrow -jX_C$

Inductance $\rightarrow X_L \longrightarrow +jX_L$

for eq



$\longrightarrow$



$2 - 2j$

Magnitude $\rightarrow \sqrt{2^2+2^2}$
$= \sqrt{8} \Rightarrow 2\sqrt{2}$

phase $\longrightarrow \tan\theta = \frac{-2}{2} = -1$

$\theta = \tan^{-1}(-1)$
$= -\tan^{-1}(1) = -\tan^{-1}(\tan 45) = -45$

$\theta = -ve$ capacitor
$\theta = +ve$ inductor

→ Polar form :-

$Z \angle \theta$

$2\sqrt{2} \angle -45$

$2+2j$ को directly magnitude & phase मे लिखते है तो वह polar form कहलाता है |

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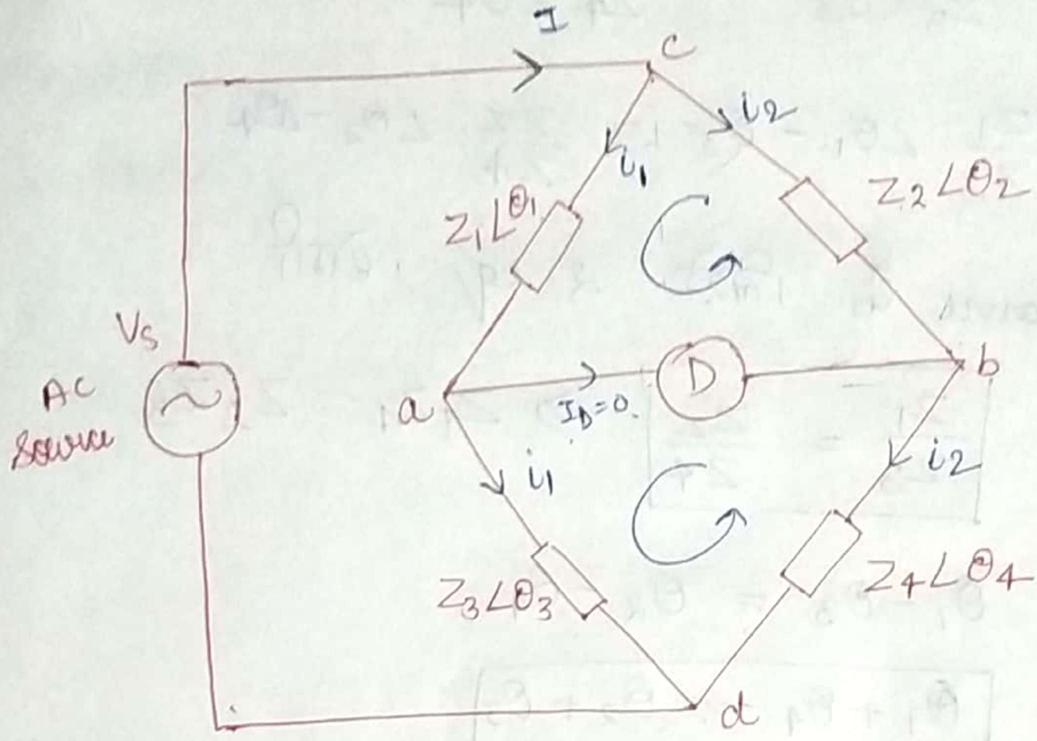
Inductance, Capacitance, Q-factor, frequency यह सभी AC bridges द्वारा acc measure किया जा सकता है।



$Z\angle\theta$

→ impedance का magnitude

→ impedance का phase

In null condition i.e when current in the detector is 0 ($I_D=0$) में point a व b पर voltage same होगी

Applying KVL in c a b c

$$i_1(Z_1\angle\theta_1) + 0 - i_2(Z_2\angle\theta_2) = 0$$

$$i_1(Z_1\angle\theta_1) = i_2(Z_2\angle\theta_2) \quad \text{— (1)}$$

Applying KVL in a d b a

$$i_1(Z_3\angle\theta_3) - i_2(Z_4\angle\theta_4) + 0 = 0$$

$$i_1(Z_3\angle\theta_3) = -i_2(Z_4\angle\theta_4) \quad \text{— (2)}$$

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from eq ① & ② को devide करने पर

$$\frac{Z_1 \angle \theta_1}{Z_3 \angle \theta_3} = \frac{Z_2 \angle \theta_2}{Z_4 \angle \theta_4}$$

$$\frac{Z_1}{Z_3} \angle \theta_1 - \theta_3 = \frac{Z_2}{Z_4} \angle \theta_2 - \angle \theta_4$$

so, Balance के लिये 2 eq होगी

$$\boxed{\frac{Z_1}{Z_3} = \frac{Z_2}{Z_4}} \Rightarrow Z_1 Z_4 = Z_2 Z_3$$

$$\theta_1 - \theta_3 = \theta_2 - \theta_4$$

$$\therefore \quad \boxed{\theta_1 + \theta_4 = \theta_2 + \theta_3}$$

For Rectangular co-ordinate

$$Z_1 = R_1 + jX_1 \qquad Z_3 = R_3 + jX_3$$

$$Z_2 = R_2 + jX_2 \qquad Z_4 = R_4 + jX_4$$

for balanced condition

$$Z_1 Z_4 = Z_2 Z_3$$

$$(R_1 + jX_1)(R_4 + jX_4) = (R_2 + jX_2)(R_3 + jX_3)$$

$$(R_1 R_4 - X_1 X_4) + j(R_1 X_4 + X_1 R_4) = (R_2 R_3 - X_2 X_3) + j(X_2 R_3 + R_2 X_3)$$

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यह eq एक complex eq है और यह तभी satisfy होगी जब इसके दोनो sides के real or imaginary parts अलग - अलग equal हो गे।

∴ Balance के लिये -

$$R_1 R_4 - X_1 X_4 = R_2 R_3 - X_2 X_3 \longrightarrow \text{real part}$$

$$R_1 X_4 + X_1 R_4 = X_2 R_3 + R_2 X_3 \longrightarrow \text{im part}$$

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