

Star - Delta Transformation :-

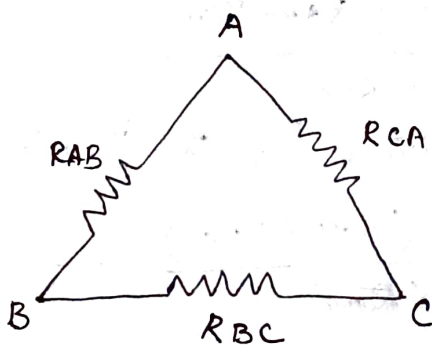
It is very much useful in solving Complex Networks.

Types of Network :

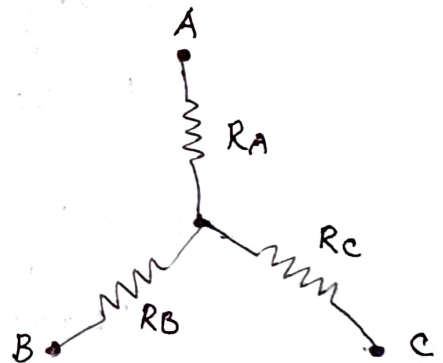
- * Star (Y) Network.
- * Delta (Δ) network.

Delta to Star Transformation Conversion.

Three elements are connected like a delta (Δ), that can be said to be in delta connections.



Delta Network



Star Network.

$R_A = \frac{R_{AB} \times R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$
$R_B = \frac{R_{AB} \times R_{BC}}{R_{AB} + R_{BC} + R_{CA}}$
$R_C = \frac{R_{BC} \times R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$

Proof:-

~~In Delta~~ In Delta, The eqn. resistance of Terminal A & B is,

$$R_{eq} = \frac{R_{AB} (R_{BC} + R_{CA})}{R_{AB} + R_{BC} + R_{CA}} \quad \text{--- (1)}$$

In Star, The eqn resistance of Terminal A & B is

$$R_{eq} = R_A + R_B \quad \text{--- (2)}$$

$$\Rightarrow R_A + R_B = \frac{R_{AB} (R_{BC} + R_{CA})}{\Sigma R_{AB}} \quad \text{--- (3)}$$

|||^{ly} Equating the resistance b/w the terminal B & C

$$R_B + R_C = \frac{R_{BC} (R_{AB} + R_{CA})}{\Sigma R_{AB}} \quad \text{--- (4)}$$

Equating the resistance b/w the terminal C & A.

$$R_C + R_A = \frac{R_{CA} (R_{AB} + R_{BC})}{\Sigma R_{AB}} \quad \text{--- (5)}$$

Subtracting (5) & (4) \Rightarrow

$$R_A - R_B = \frac{R_{AB} (R_{CA} - R_{BC})}{\Sigma R_{AB}} \quad \text{--- (6)}$$

Adding (6) & (3) \Rightarrow

$$2R_A = \frac{R_{AB} (2R_{CA})}{\Sigma R_{AB}}$$

$$R_A = \frac{R_{AB} \cdot R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$$

|||^{ly}

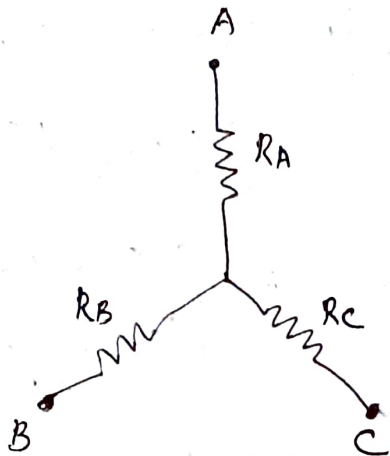
$$R_B = \frac{R_{AB} \cdot R_{BC}}{R_{AB} + R_{BC} + R_{CA}}$$

$$R_C = \frac{R_{BC} \cdot R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$$

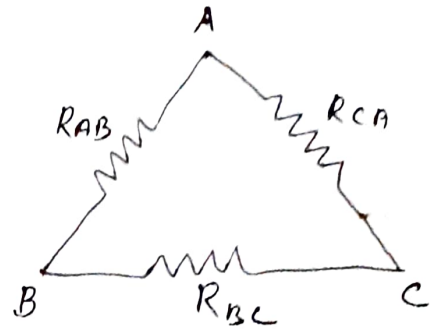
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Star - Delta Transformation or Conversion:-

Three elements are connected like a star (Y), then the circuit said to be in star connection.



Star - Network



Delta Network

$R_{AB} = \frac{R_A \cdot R_B + R_B R_C + R_C R_A}{R_C}$
$R_{BC} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}$
$R_{CA} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_B}$

Proof:-

From Delta to Star equations,
multiply $R_A \& R_B$ eqn

$$R_A R_B = \frac{(R_{AB})^2 R_{BC} R_{CA}}{(\sum R_{AB})^2} \quad \text{--- (1)}$$

Similarly

$$R_B R_C = \frac{(R_{BC})^2 R_{AB} R_{CA}}{(\sum R_{AB})^2} \quad \text{--- (2)}$$

$$R_C R_A = \frac{(R_{CA})^2 R_{BC} R_{AB}}{(\sum R_{AB})^2} \quad \text{--- (3)}$$

Adding 1, 2 & 3 \Rightarrow

$$\begin{aligned}
 R_A R_B + R_B R_C + R_C R_A &= \frac{R_{AB} \cdot R_{BC} \cdot R_{CA} (R_{AB} + R_{BC} + R_{CA})}{(\sum R_{AB})^2} \\
 &= \frac{R_{AB} \cdot R_{BC} \cdot R_{CA} (\cancel{\sum R_{AB}})}{(\sum R_{AB})^2} \\
 &= R_{AB} \left[\frac{R_{BC} R_{CA}}{[\sum R_{AB}]} \right]
 \end{aligned}$$

$$R_A R_B + R_B R_C + R_C R_A = R_{AB} \times R_C$$

$$R_{AB} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_C}$$

Similarly

$$R_{BC} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}$$

$$R_{CA} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_B}$$

frequency Response

Introduction

\Rightarrow AC circuit is said to be in Resonance if the current in the ckt is in phase with applied voltage

\Rightarrow At this condition, the circuit behaves like a pure resistive circuit.

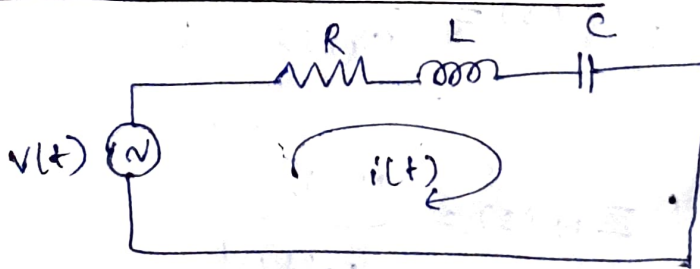
\Rightarrow power factor of the ckt will be unity.

\Rightarrow Voltage & current amplification takes place.

\Rightarrow Inductive Reactance = Capacitive Reactance

$$\boxed{X_L = X_C}$$

Series Resonance Circuit (RLC Series Ckt)



Impedance of RLC Series Ckt,

$$Z = V/I$$

$$Z = R + j(X_L - X_C)$$

At Resonance $X_L = X_C \Rightarrow \omega L = 1/\omega C$

$$X_L = 2\pi f L$$

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

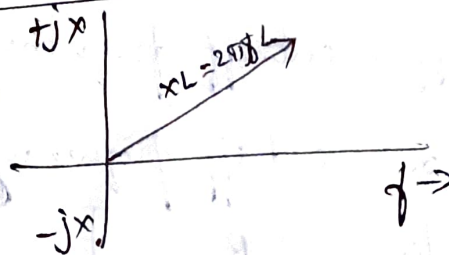
$$2\pi fL = \frac{1}{2\pi fC}$$

$$f_r^2 = \frac{1}{4\pi^2 LC}$$

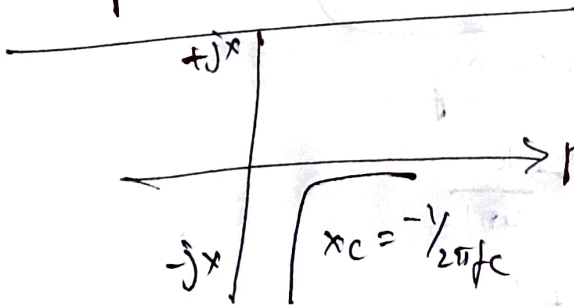
$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$\omega_r = \frac{1}{\sqrt{LC}}$$

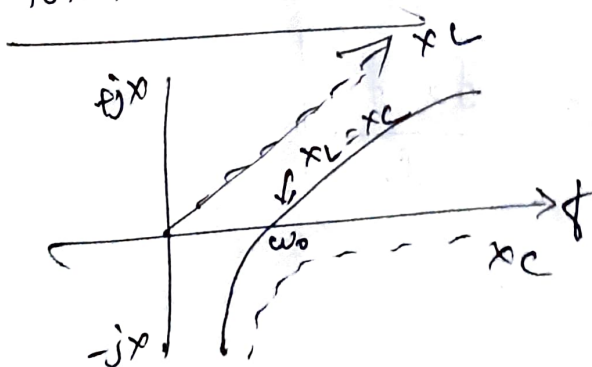
Inductive Reactance Curve (X_L)

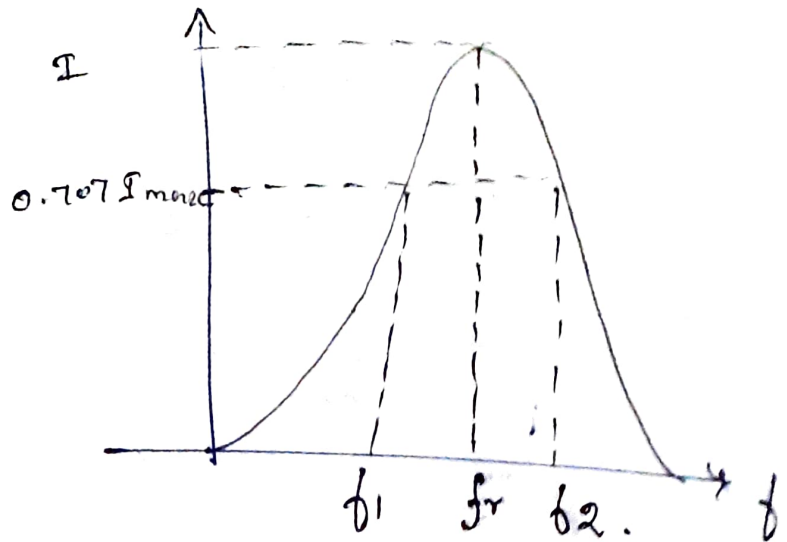


Capacitive Reactance (X_C)



Total reactance





Bandwidth

$$W = f_2 - f_1$$

$$W = R/L$$

$f_2 \rightarrow$ upper cut off frequency

$f_1 \rightarrow$ lower cut off frequency.

$$W = \frac{R}{2\pi L}$$

Half power frequency

$$f_1 = f_r - \frac{R}{4\pi L}$$

$$f_2 = f_r + \frac{R}{4\pi L}$$

Selectivity

$$S = \frac{f_2 - f_1}{f_r}$$

Q-factor

$$Q = 2\pi \times \frac{\text{maximum energy stored per cycle}}{\text{energy dissipated per cycle.}}$$

$$Q = \frac{f_r}{f_2 - f_1}$$

$$\Rightarrow f_2 - f_1 = \frac{R}{2\pi L}$$

Divide both side by f_r

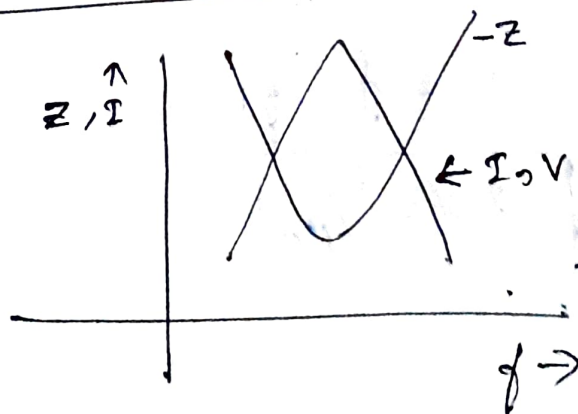
$$\frac{f_2 - f_1}{f_r} = \frac{R}{2\pi f_r L}$$

$$\Rightarrow Q = \frac{X_L}{R} = \frac{2\pi f_r L}{R} = \frac{\omega_r L}{R}$$

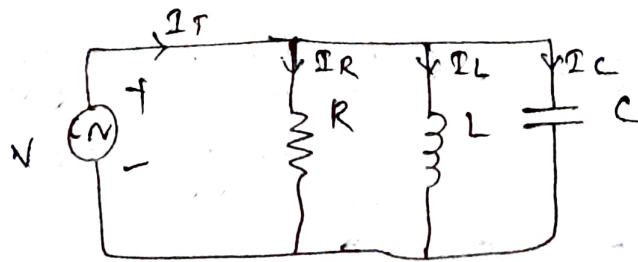
$$\therefore \omega_r = \frac{1}{\sqrt{LC}}$$

$$Q = \frac{1}{R} \sqrt{L/C}$$

Voltage & Current



parallel Resonance circuit :-



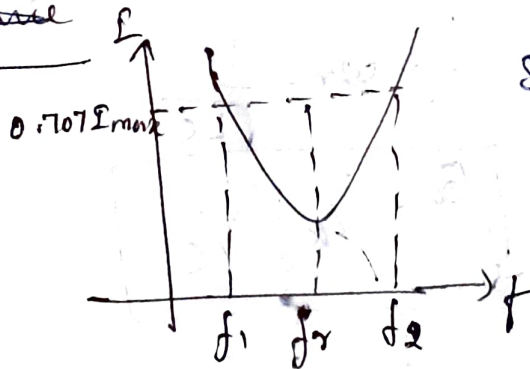
$$Y = G + jB = \frac{1}{R} + j\omega C + \frac{1}{j\omega L}$$

$$= \frac{1}{R} + j \left[\omega C - \frac{1}{\omega L} \right]$$

$$\omega C - \frac{1}{\omega L} = 0$$

$f_r = \frac{1}{2\pi\sqrt{LC}}$
$\omega_r = \frac{1}{\sqrt{LC}}$

Current wave



Selectivity curve.

Band width

$$W = f_2 - f_1$$

$$BW = \frac{1}{RC}$$

(17)

Quality factor :-

$$Q = 2\pi \times \frac{\text{maximum Energy stored / cycle}}{\text{Energy dissipated / cycle}}$$

$$Q = \frac{f_r}{f_2 - f_1}$$

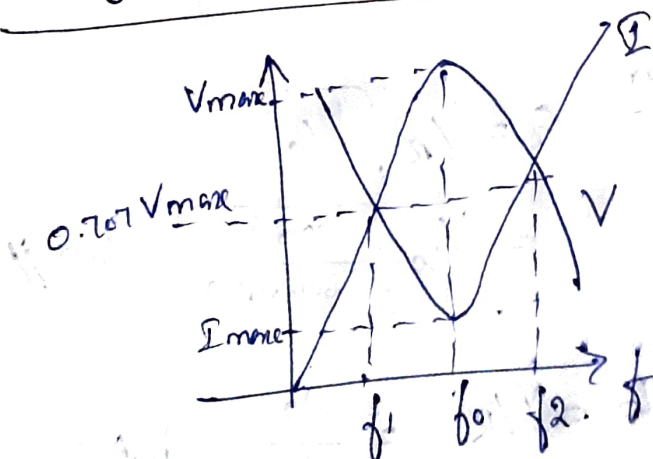
$$Q = 2\pi f_r R C$$

$$Q = \omega_r R C$$

$$\Rightarrow \omega_r = \frac{1}{\sqrt{LC}}$$

$$Q = R \sqrt{C/L}$$

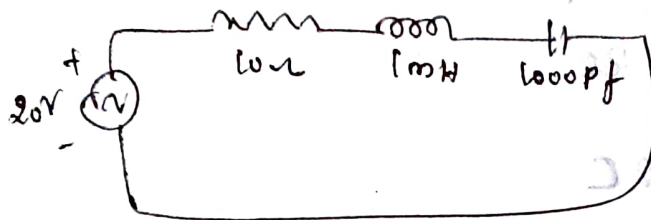
Voltage & current



① ~~Find~~

A RLC Series Circuit, have $R = 10\Omega$
 $L = 1\text{mH}$, $C = 1000\text{pF}$ excited a ac source voltage
 of 20V . find

- f_r
- Q factor
- current & Impedance



$$\textcircled{1} f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$= \frac{1}{2\pi\sqrt{1 \times 10^{-3} \times 1000 \times 10^{-12}}}$$

$$f_r = 159155\text{Hz}$$

② Q factor

$$Q = \frac{1}{R} \sqrt{\frac{L}{C}} \Rightarrow Q = \frac{Z}{R} = \frac{X_L}{R} = \frac{X_C}{R}$$

$$= \frac{1}{10} \sqrt{\frac{1 \times 10^{-3}}{1000 \times 10^{-12}}} = 100 //$$

$$\textcircled{3} I = \frac{V}{Z} = \frac{V}{R} = \frac{20}{10} = 2\text{A} //$$

④ Impedance $Z = R = 10\Omega$

⑤ Voltage across the Resistor

$$V_R = IR$$

$$= 1 \times 10$$

$$= 10\text{V} //$$

$$\cos \phi = \frac{P}{VI}$$

$$\cos \phi = \frac{Z}{Z}$$

$$\cos \phi = 1$$