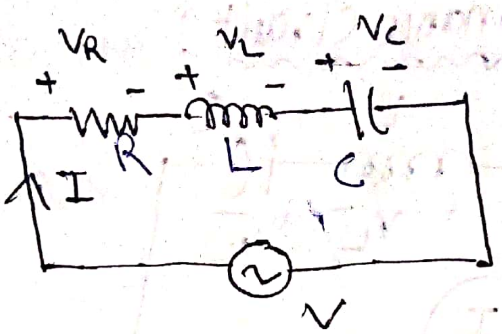


For this, $Z = R + j\left(\omega L - \frac{1}{\omega C}\right)$

impedance → $|Z| = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

At resonance — $\boxed{\omega L = \frac{1}{\omega C}}$

$\boxed{|Z|_{min} = R}$

→ Minimum ~~resistance~~ Impedance is formed at resonance

→ From the circuit $I = \frac{V}{Z}$

→ At resonance $I = \frac{|V|}{|Z|_{min}}$

Note ① if $|Z|_{min}$ is minimum value then I would be maximim.

Therefore $\boxed{I_{max} = \frac{|V|}{|Z|_{min}}}$

→ From the above expression at resonance condition in series RLC circuit → I → maximum
→ $|Z|$ → minimum

$\boxed{I_{max} = \frac{|V|}{|Z|_{min}} = \frac{|V|}{R}}$

⊙ At resonance - across R

$V = IZ$

$$\boxed{|V| = I_{max} R}$$

⊙ At resonance - across L

$V_L = I_{max} X_L = I_{max} \omega_0 L \cdot j$

$|V_L| = |I_{max} \omega_0 L \cdot j| = I_{max} \omega_0 L$

$$\boxed{V_L = I_{max} \omega_0 L}$$ $\{ |j| = 1 \}$

⊙ At resonance - across C

$V_C = I_{max} X_C = I_{max} \cdot \frac{1}{j\omega_0 C}$

$|V_C| = \left| I_{max} \cdot \frac{1}{j\omega_0 C} \right|$

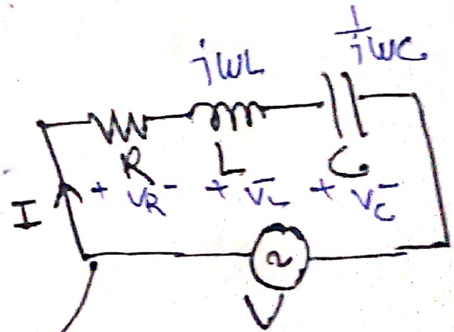
$$\boxed{|V_C| = \frac{I_{max}}{\omega_0 C}}$$

$$\boxed{\omega_0 \to \text{Resonance frequency} = \frac{1}{\sqrt{LC}}}$$

Quality factor or magnification factor:

Qualit factor is dended by Q while magnification factor is denoted by M.

Quality factor (Q): $\left|\frac{V_L}{V}\right| = \left|\frac{V_C}{V}\right|$



$$\boxed{\begin{aligned} V_R &= IR \\ V_L &= I \cdot j\omega L \\ V_C &= \frac{I \cdot 1}{j\omega C} \end{aligned}}$$

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At resonance - current is I_{max} and impedance is Z_{min}.

$$\boxed{\begin{aligned} V_R &= I_{max} \cdot R \\ V_L &= I_{max} \cdot j\omega_0 L \\ V_C &= \frac{I_{max}}{j\omega_0 C} \end{aligned}}$$

$\omega_0 \rightarrow$ resonance frequency

Quality factor at resonance condition -

(i) Q for inductor : $Q_L = \left|\frac{V_L}{V_R}\right|$

$$Q_L = \left|\frac{\cancel{I_{max}} \cdot j\omega_0 L}{\cancel{I_{max}} \cdot R}\right| = \frac{\omega_0 L}{R} \qquad \boxed{\because |j| = 1}$$

$$\boxed{Q_L = \frac{\omega_0 L}{R}}$$

We know that $\omega_0 = \frac{1}{\sqrt{LC}}$ at resonance condition

Put the value of ω_0 in above expression -

$$Q_L = \frac{\omega_0 L}{R} = \frac{1}{\sqrt{LC}} \cdot \frac{L}{R} = \sqrt{\frac{L^2}{LC}} \cdot \frac{1}{R}$$

$$\boxed{Q_L = \frac{1}{R}\sqrt{\frac{L}{C}}}$$

○ Quality factor for capacitor: $Q_C = \left|\frac{V_C}{V_R}\right|$

$$Q_C = \left|\frac{\cancel{I_{max}} \cdot 1}{\cancel{I_{max}} \cdot R \, j\omega_0 C}\right| = \frac{1}{\omega_0 CR} \quad \boxed{\because \left|\frac{1}{j}\right| = 1}$$

$$\boxed{Q_C = \frac{1}{\omega_0 CR}}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$Q_C = \frac{\sqrt{LC}}{1} \cdot \frac{1}{CR} = \sqrt{\frac{CL}{C^2}} \cdot \frac{1}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

$$\boxed{Q_C = \frac{1}{R}\sqrt{\frac{L}{C}}}$$

Therefore,

$$\boxed{Q = Q_C = Q_L = \frac{1}{R}\sqrt{\frac{L}{C}}}$$

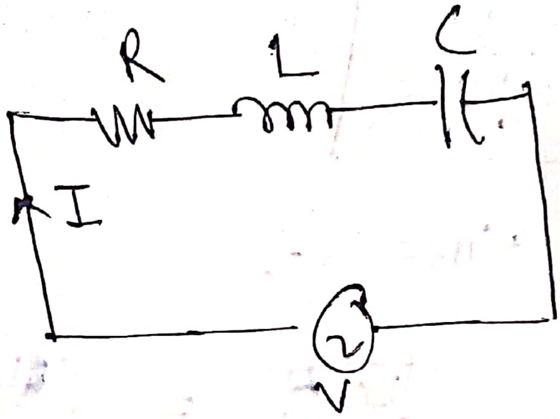
Note: Series resonance circuit is also called as magnification.
at resonance → $|V_L| = |V_C|$ which is cancel to each other only $|V| = V_R$ exists

But $|V_L| > |V|$
$|V_C| > |V|$
or
$|V_L| = |V_C| > |V|$

V_L and V_C are magnified w.r.t. to V

$M = \frac{V_L}{V}$ or $\frac{V_C}{V}$

Bandwidth: Band width represent the range of the frequency for which the power level in the signal is at least half of the maximum power.



We know that $P = V \cdot I$

$$= \frac{V^2}{R}$$

$$= I^2 R$$

At resonance condition $|Z|_{min} = R$, and I_{max}

Therefore $\boxed{\text{power} = I_{max}^2 \cdot R}$

the power does not exist across the L and C due to cancel each other at resonance condition

Half maximum power is defined as

$$\boxed{P = \frac{P_{max}}{2}}$$

$$I^2 R = \frac{I_{max}^2 R}{2}$$

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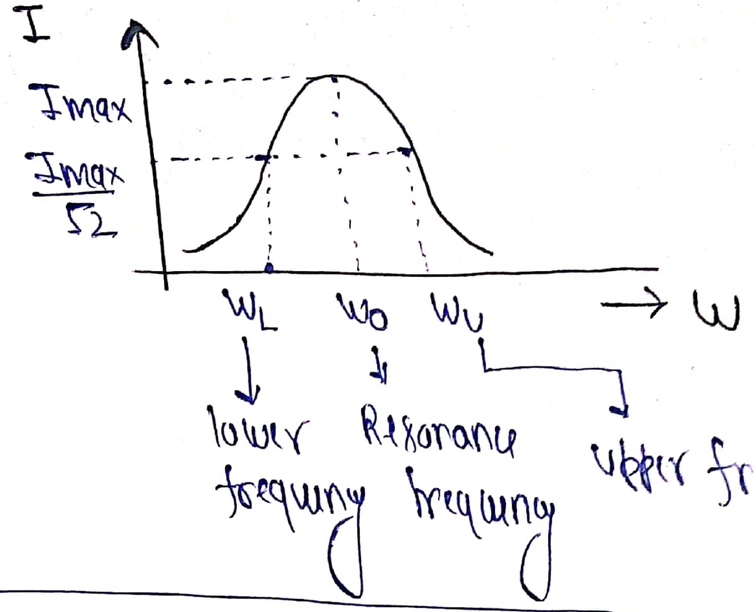
$$\boxed{I = \frac{I_{max}}{\sqrt{2}}}$$



$$\boxed{\text{Band width (BW)} = W_U - W_L}$$

Relation between quality facter and Band width :

$$\boxed{B.W = \frac{W_0}{Q}} \quad \text{or} \quad \boxed{Q = \frac{W_0}{BW}}$$

$W_0 \rightarrow$ resonance frequency $= \frac{1}{\sqrt{LC}}$

$L \rightarrow B.W. = \frac{\cancel{W_0}}{\frac{\cancel{W_0}L}{R}} = \frac{R}{L} \rightarrow$ for inductor

$C \rightarrow BW = \frac{W_0}{\frac{1}{W_0 CR}} = W_0^2 . CR = \frac{1}{L\cancel{C}} . \cancel{C}R = \frac{R}{L}$

$\downarrow$

for capacitor

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