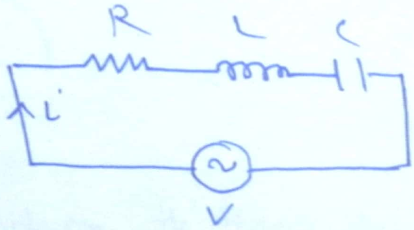
RESONANCE

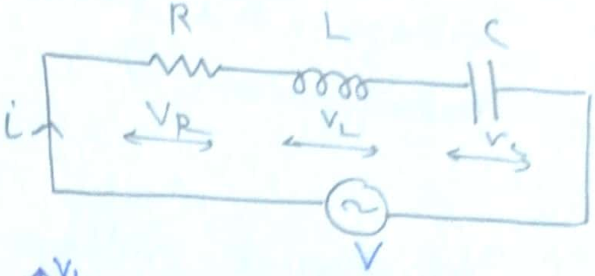


① For occurance of resonance in any ckt, the ckt shauld cosist of two energy storing element

② The ckt is said to be in resonance when current is in phase with saurce valtage.

③ The frequency at which $X_L = X_C$ is called as resonant frequency.

④ Resonant frequency indicate the rate at which energy transformation is done b/w inductor and capacitor.



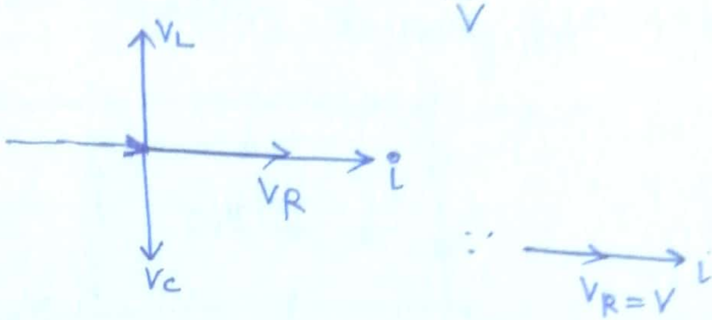
$$V_L = V_C$$

$$IX_L = IX_C$$

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

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

$$\boxed{f_0 = \frac{1}{2\pi\sqrt{LC}}}$$



At Resonance:-

① $Z = R + j(X_L - X_C)$

$Z_{min} = R \quad \because X_L = X_C$

② $I_{max} = \frac{V}{Z_{min}} = \frac{V}{R}$

③ $\cos\theta = 1$ [As V and i are in phase, $\theta = 0$]

power factor = 1

④ $V_R = V$

$V_R \rightarrow$ active component

V_L and $V_C \rightarrow$ Reactive component

⑤ Net reactive Voltage = 0

Voltage Magnification:-

Voltage across inductor and Voltage across capacitor is greater than source voltage. This phenomenon is called as voltage magnification.

Variation of voltage across inductor and capaciter w.r.t frequency:-

$$V_c = I X_c$$

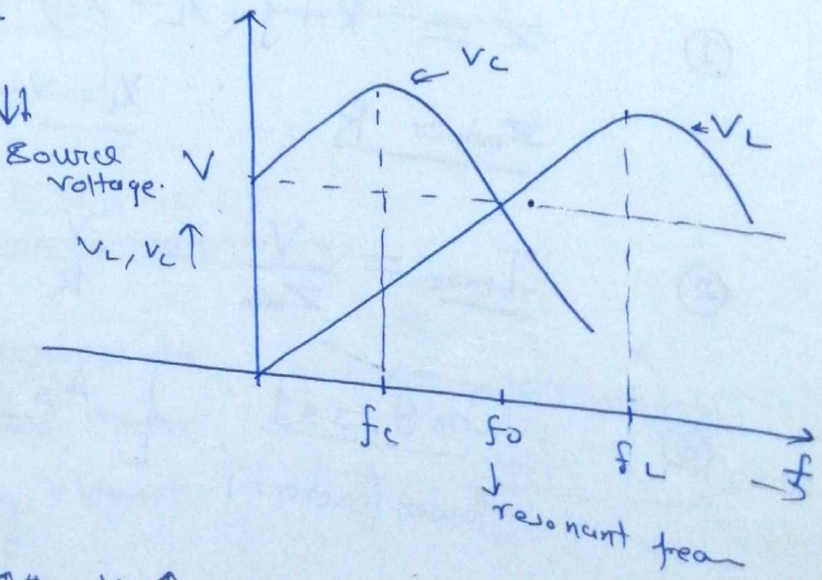
$$X_c = \frac{1}{2\pi f C} \qquad X_L = 2\pi f L$$

$$f = 0 \quad X_c = \infty \quad X_L = 0$$

$$\boxed{V_c = V}$$

$f \uparrow\uparrow$ $X_c \downarrow\downarrow$ $X_L \uparrow\uparrow$ $Z \uparrow\uparrow$ $I \downarrow\downarrow$

$V_c \downarrow\downarrow$



$f\uparrow$ $X_c \downarrow$ $X_L \uparrow$

100 2

$|X| = |X_L - X_c| \downarrow\downarrow$

$Z \downarrow\downarrow$ $I = \frac{V}{Z}$ $I \uparrow\uparrow$ $V_c \uparrow$

$$V_c = I X_c$$

$$V_c = \frac{V}{\sqrt{R^2+(X_L-X_c)^2}} X_c$$

$$V_c = \frac{V\left(\frac{1}{\omega C}\right)}{\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}} \quad \text{—(1)}$$

differentiating w.r.t ω 2 time and equating to 0 we get

$$\boxed{f_c = \frac{1}{2\pi\sqrt{LC}} \sqrt{1-\left(\frac{R^2 C}{2L}\right)}}$$

Case. II

$$V_L = I X_L$$

$$X_L = 2\pi f L$$

$f=0$ $X_c=\infty$ $X_L=0$ $Z=\infty$

$$I=0$$

$$V_L=0$$

$f\uparrow$ $X_c\downarrow$ $X_L\uparrow$ $|X| = (X_L - X_c)\downarrow\downarrow$ $Z\downarrow\downarrow$

$$I\uparrow\uparrow = \frac{V}{Z\downarrow\downarrow}$$

When

$f\uparrow\uparrow$ $X_L\uparrow\uparrow$ $X_c\downarrow\downarrow$ $Z = R + j(X_L - X_c)\uparrow\uparrow\uparrow$

$I\downarrow\downarrow\downarrow$

$$V_L = I X_L$$

$$V_L = \frac{V(\omega L)}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

$$\boxed{f_L = \frac{1}{2\pi\sqrt{LC}} \sqrt{\frac{1}{1 - \left(\frac{R^2 C}{2L}\right)}}}$$

$\frac{r^2}{2}$

Quality factor (Q-factor)

$$Q = \frac{V_L (\text{or}) V_C}{V}$$

$$Q = \frac{V_L}{V} = \frac{V_L}{V_R} = \frac{\text{Reactive component of voltage}}{\text{Active component of voltage.}}$$

$$Q = \frac{V_L}{V_R} = \frac{I X_L}{I R} = \frac{\omega L}{R} = \omega \frac{L}{R}$$

But $\omega = \frac{1}{\sqrt{LC}}$

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

$$Q = \frac{Q_L}{P} = \frac{I^2 X_L}{I^2 R} = \frac{X_L}{R}$$

$Q_L \Rightarrow$ Reactive inductive power

$P =$ active power.

$$Q = \frac{V_c}{V} = \frac{X_c}{R} = \frac{1}{\omega RC}$$

$$Q = 2\pi \frac{\text{max. energy stored in the ckt}}{\text{power dissipation per cycle.}}$$