Alternating Current Mindmap

AC Current:

→ Direction of current changes alternatively.

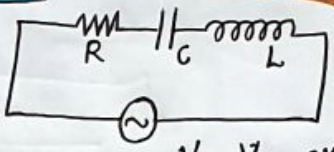
$i = i_0 \sin \omega t$ $\quad V = V_0 \sin \omega t$

$i_{rms} = \frac{i_0}{\sqrt{2}}$ $\quad V_{rms} = \frac{V_0}{\sqrt{2}}$

$i_{avg} = \frac{2i_0}{\pi}$ $\quad V_{avg} = \frac{2V_0}{\pi}$

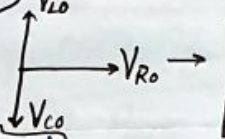
L-C-R Circuit: →

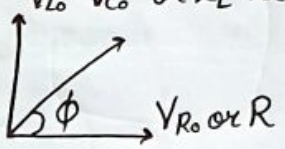
$V_0 = i_0 \sqrt{(X_L - X_C)^2 + R^2}$



$Z = \sqrt{(X_L - X_C)^2 + R^2}$

$V_{rms} = I_{rms} Z$





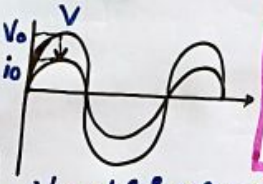
$\langle P \rangle = i_{rms} V_{rms} \cos\phi$

$= \frac{i_0}{\sqrt{2}} \frac{V_0}{\sqrt{2}} \cos\phi$ and $\cos\phi = \frac{R}{Z}$ $\quad \tan\phi = \frac{X_L - X_C}{R}$

R-Circuit: $i = i_0 \sin \omega t$ $\quad V = V_0 \sin \omega t$

$i_0 = \frac{V_0}{R}$, $i_{rms} = \frac{V_{rms}}{R}$

$i_{rms} = \frac{i_0}{\sqrt{2}}$, $V_{rms} = \frac{V_0}{\sqrt{2}}$

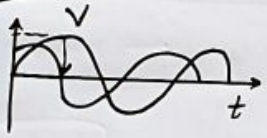


V and i in same phase.

C-Circuit:

$V = V_0 \sin \omega t$ $\quad i = i_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

$i_0 = \frac{V_0}{X_C} = \frac{V_0}{\frac{1}{\omega C}} = \omega C V_0$



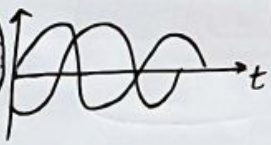
$\langle P \rangle = 0$

→ Current leads voltage by $\pi/2$.

L-Circuit:

$V = V_0 \sin \omega t$ $\quad i = i_0 \sin\left[\omega t - \pi/2\right]$

$i_0 = \frac{V_0}{X_L} = \frac{V_0}{\omega L}$



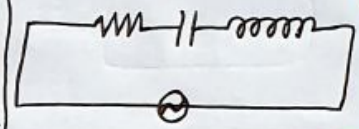
$\langle P \rangle = 0$

→ Voltage leads current by $\pi/2$.

Resonance in L-C-R: →

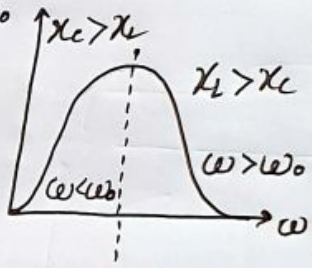
$V = V_0 \sin(\omega t + \phi)$

$i_0 = \frac{V_0}{Z} = \frac{V_0}{\sqrt{(X_L - X_C)^2 + R^2}}$



• Resonant frequency

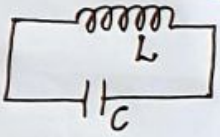
$f_0 = \frac{1}{2\pi\sqrt{LC}}$



→ At resonance
→ $i_0 = max$
→ $X_L = X_C$
→ $Z = R$
→ $\cos\phi = 1$, $\omega_0 = \frac{1}{\sqrt{LC}}$

LC Oscillation →

$q = q_0 \cos \omega t$, $I = -\frac{dq}{dt}$

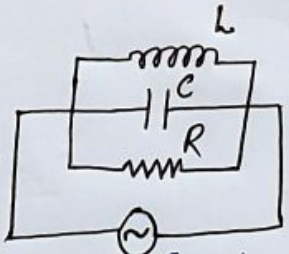


$\omega = \frac{1}{\sqrt{LC}}$ $\quad E = \frac{q^2}{2C} + \frac{1}{2} L I^2$

Parallel L-C-R: →

$I = \sqrt{(I_C - I_L)^2 + (I_R)^2}$

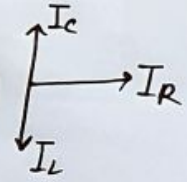
$\frac{1}{Z} = \sqrt{\left[\frac{1}{X_C} - \frac{1}{X_L}\right]^2 + \left[\frac{1}{R}\right]^2}$

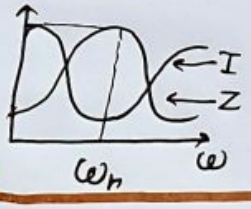


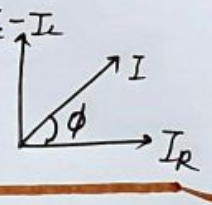
$E = E_0 \sin \omega t$

At resonance

$\omega_r = \frac{1}{\sqrt{LC}}$ and $\phi = 0$



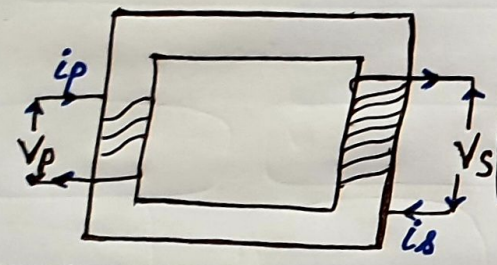




Transformers:→

→ used to change an alternating voltage from one to another.

$$V_s = -N_s \frac{d\phi}{dt}$$



$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$V_p I_p = V_s I_s$

$$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$$

→ $N_s > N_p$ → step up

→ $N_p > N_s$ → step down

→ No loss in flux and energy → Ideal

$$\eta = \frac{P_{out}}{P_{in}} \times 100$$

Quality Factor

$$Q = \frac{\omega_0}{\text{Bandwidth}}$$

$$Q = \frac{\omega_0 L}{R}$$

Efficiency Of Motor

$$\eta = \frac{P_{out}}{P_{in}} = \frac{E}{V}.$$

NEET SLAYER