MASTERJEE CLASSES

AC CIRCUITS

BRAIN MAP

CLASS XII

Series Resonance Circuit

- At resonance: $X_L = X_C \Rightarrow Z_{min} = R$
- Phase difference: $\phi = 0° \Rightarrow \cos\phi = 1$
- Resonant frequency: $\upsilon_0 = \dfrac{1}{2\pi\sqrt{LC}}$

Quality Factor (Q-factor)

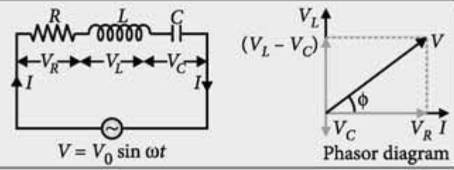
$$Q\text{-factor} = \frac{\text{Resonant frequency}}{\text{Band width}} = \frac{\omega_0}{2\Delta\omega}$$

Parallel Resonance Circuit

- At resonance: $I_C = I_L; Z_{max} = R$
- Phase difference: $\phi = 0° \Rightarrow \cos\phi = 1$
- Resonant frequency: $\upsilon_0 = \dfrac{1}{2\pi\sqrt{LC}}$

Q-factor of Series Resonant Circuit

$$Q\text{-factor} = \frac{V_L}{V_R} \text{ or } \frac{V_C}{V_R} = \frac{\omega_0 L}{R} \text{ or } \frac{1}{\omega_0 CR} = \frac{1}{R}\sqrt{\frac{L}{C}}$$



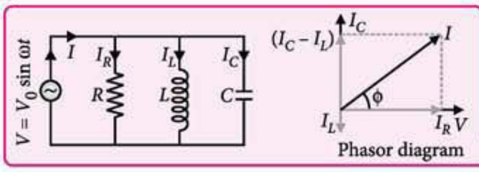
Q-factor of Parallel Resonant Circuit

$$Q\text{-factor} = R\sqrt{\frac{C}{L}}$$

Series *RLC*-Circuit

- Voltage: $V = \sqrt{V_R^2 + (V_L - V_C)^2}$
- Impedance: $Z = \sqrt{R^2 + \left(\omega L - \dfrac{1}{\omega C}\right)^2}$
- Phase difference:

$$\phi = \tan^{-1}\frac{V_L - V_C}{V_R} = \tan^{-1}\frac{X_L - X_C}{R}$$

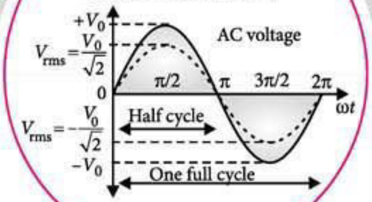


Parallel *RLC* Circuits

- Current: $I = \sqrt{I_R^2 + (I_C - I_L)^2}$
- Phase difference: $\phi = \tan^{-1}\dfrac{(I_C - I_L)}{I_R}$
- Impedance: $Z = 1\Big/\sqrt{\left(\dfrac{1}{R}\right)^2 + \left(\dfrac{1}{X_L} - \dfrac{1}{X_C}\right)^2}$

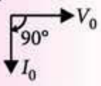
AC VOLTAGE APPLIED TO COMBINED LCR CIRCUITS

ALTERNATING CURRENT AND VOLTAGE

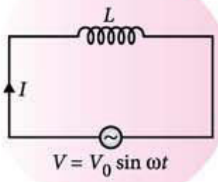


Purely Inductive Circuit

- Voltage: $V = V_0 \sin \omega t$
- Current: $I = I_0 \sin(\omega t - \pi/2)$
- Phase difference: $+(\pi/2)$
- Impedance: $X_L = \omega L$
- Peak current: $I_0 = V_0/X_L$

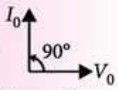


Phasor diagram (Voltage leads current by $\pi/2$)

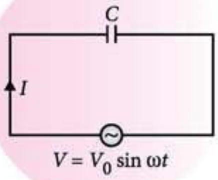


Purely Capacitive Circuit

- Voltage: $V = V_0 \sin \omega t$
- Current: $I = I_0 \sin(\omega t + \pi/2)$
- Phase difference: $-(\pi/2)$
- Impedance: $X_C = 1/\omega C$
- Peak current: $I_0 = V_0/X_C$



Phasor diagram (Current leads voltage by $\pi/2$)

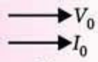


Combined *RL* circuit

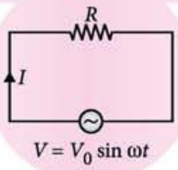
Combined *RC* circuit

Purely Resistive Circuit

- Voltage: $V = V_0 \sin \omega t$
- Current: $I = I_0 \sin \omega t$
- Phase difference: zero
- Impedance: R
- Peak current: $I_0 = V_0/R$

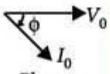


Phasor diagram (Both current and voltage are in same phase)

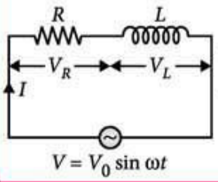


(Series *RL*-Circuit)

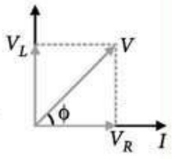
- Applied voltage: $V = \sqrt{V_R^2 + V_L^2}$
- Impedance: $Z = \sqrt{R^2 + 4\pi^2\upsilon^2 L^2}$
- Current: $I = I_0 \sin(\omega t - \phi)$
- Phase difference: $\phi = \tan^{-1}\dfrac{\omega L}{R}$
- Power factor: $\cos\phi = \dfrac{R}{\sqrt{R^2 + X_L^2}}$



Phasor diagram



$V_R = IR,$
$V_L = IX_L$

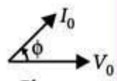


Power in AC Circuit

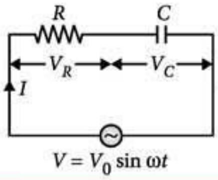
- Power factor: It may be defined as cosine of the angle of lag or lead (*i.e.*, $\cos\phi$)
- Average power (P_{av}):
  $P_{av} = V_{rms} I_{rms} \cos\phi = (V_0 I_0/2)\cos\phi$

(Series *RC*-Circuit)

- Applied voltage: $V = \sqrt{V_R^2 + V_C^2}$
- Impedance: $Z = \sqrt{R^2 + (1/\omega C)^2}$
- Current: $I = I_0 \sin(\omega t + \phi)$
- Phase difference: $\phi = \tan^{-1}(1/\omega CR)$
- Power factor: $\cos\phi = \dfrac{R}{\sqrt{R^2 + X_C^2}}$



Phasor diagram



$V_R = IR,$
$V_C = IX_C$