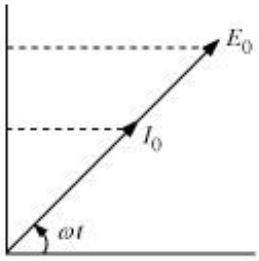
Alternating Current

AC through a resistor:

- When AC flows through a resistor, the voltage and current are in phase with each other.

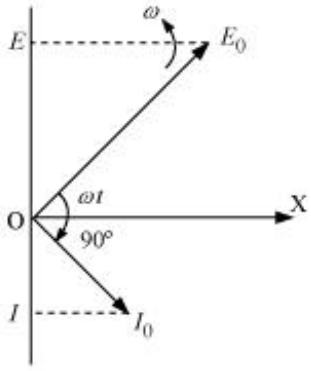


Phasor diagram

AC through an inductor:

- The alternating emf is ahead of alternating current by a phase angle of $\frac{\pi}{2}$.

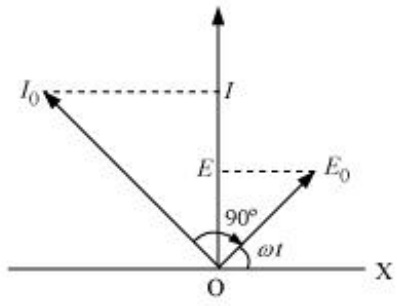
Inductive reactance (X_L):
$X_L = \omega L = 2\pi fL$



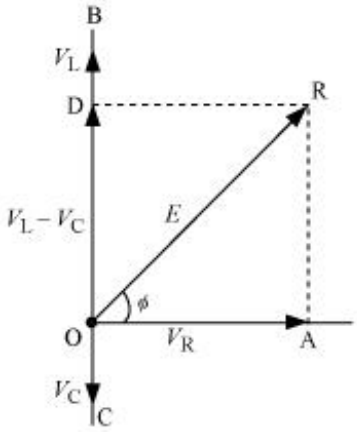
AC through a capacitor:

- The current leads the emf by a phase angle of $\frac{\pi}{2}$.

Capacitive reactance (X_C):
$X_C = \frac{1}{\omega C} = \frac{1}{2\pi fC}$



- **AC through *LCR* series circuit:**



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

$$\tan\Phi = \frac{X_L - X_C}{R}$$

Impedance (*Z*):

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

- **Power in *LCR* circuit:**

$$P_{av} = \frac{E_v{}^2 R}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

Power factor = $\cos\Phi = \frac{R}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$

Resonance

- It is the property exhibited by an LCR circuit.
- At a certain frequency known as resonating frequency(ω_0) the current through the circuit is maximum.
- It occurs at the frequency that can make $X_L = X_C$ or $\omega L = \frac{1}{\omega C}$.

- Impedence of the circuit Z = R.
- resonating frequency $\nu = \frac{1}{2\pi\sqrt{LC}}$
- Quality factor,Q = $\frac{1}{R}\sqrt{\frac{L}{C}}$ is used to measure the sharpness of the resonance.

Power in AC circuit

- In AC circuit the power is given as P = *VI*cosϕ
  - where, *V*= rms value of the voltage
  - *I* = rms value of the voltage
  - cosϕ = power factor = $\frac{true\ power}{apparent\ power}$
  - $\Phi = \tan^{-1}\left(\frac{X_C - X_L}{R}\right)$
- Cases for power factor
  - For purely resistive circuit cosϕ = 1, ϕ= 0
  - For purely capacitive circuit cosϕ = 0, ϕ= $\frac{\pi}{2}$
  - For purely inductive circuit cosϕ = 0, ϕ= $-\frac{\pi}{2}$

LC Oscillations

- When capacitor of capacitance C charged to and inductor of inductance L are connected then:
  - energy stored in C oscillates between L and C.
  - energy of the oscillations is given by $\nu = \frac{1}{2\pi\sqrt{LC}}$.
  - Total energy in L and C every instant remains constan.

- A transformer consists of an iron core, on which are bound a primary coil of N_P turns and a secondary coil of N_S turns. If the primary coil is connected to an AC source, the primary and secondary voltages are related by

$$V_S = \left(\frac{N_S}{N_P}\right)V_P$$

And the currents are related by

$$I_S = \left(\frac{N_P}{N_S}\right)I_P$$

If $N_S > N_P \rightarrow$ The voltage is stepped up $step - up transformer$
If $N_S < N_P \rightarrow$ The voltage is stepped-down $step - down transformer$