- The instantaneous value of alternating emf is given by

  $E = E_0 \sin \omega t$

  Where,

  $E_0 \rightarrow$ Peak value of alternating emf

  $\omega t \rightarrow$ Phase of alternating emf

  Similarly, the instantaneous value of alternating current is given by

  $I = I_0 \sin \omega t$

  Where, $I_0 \rightarrow$ Peak value of alternating current

- The average value or mean value of alternating current over half cycle is given by

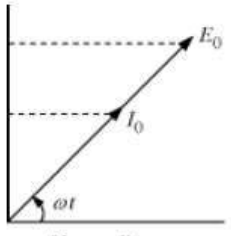
  $$I_m = \frac{2}{\pi} I_0$$

- The root mean square value (rms value) or virtual value of AC is given by

  $$I_v = \frac{I_0}{\sqrt{2}}$$

- **AC through a resistor:**

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



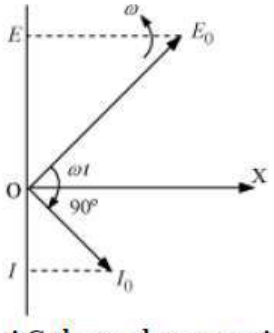
Phasor diagram

- **AC through an inductor:**

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

  Inductive reactance (X_L):

  $X_L = \omega L = 2\pi f L$

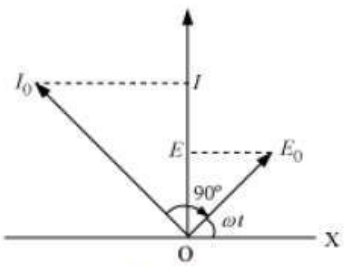


- **AC through a capacitor:**

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

Capacitive reactance (X_C):

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$



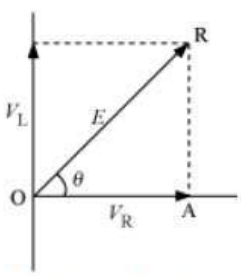
- **AC through *LR* circuit:**

$$E = I\sqrt{R^2 + X_L^2}$$

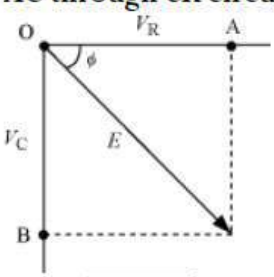
Inductive impedance (Z_L) of *LR* circuit:

$$Z_L = \sqrt{R^2 + X_L^2}$$

$$\tan\phi = \frac{X_L}{R} = \frac{\omega L}{R}$$



- **AC through *CR* circuit:**

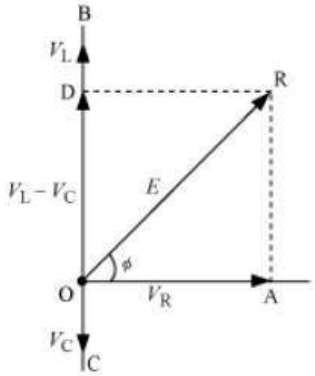


$$E = I\sqrt{R^2 + X_C^{\,2}}$$

Capacitive impedance:

$$Z_C = \sqrt{R^2 + X_C^2}$$

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



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

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

Impedance (Z):

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

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

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

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

- **Resonance:**

An interesting characteristic of a series *LCR* circuit is the phenomenon of resonance. The amplitude of the current is the maximum at the resonant frequency, $\omega_0 = \frac{1}{\sqrt{LC}}$

- **Quality factor:**

The quality factor Q, defined by $Q = \frac{\omega_0 L}{R} = \frac{1}{\omega_0 CR}$, is an indicator of the sharpness of the resonance.

- 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)