

# Alternating Current

**1. Alternating Current (AC)** It is the current which varies in both magnitude as well as direction alternatively and periodically.

$I = I_0 \sin \omega t$  or  $I = I_0 \cos \omega t$  where,  $I_0$  = peak value or maximum value of AC.

**2. Effective Value or rms Value of AC** It is defined as the value of AC over a complete cycle which would generate same amount of heat in a given resistors that is generated by steady current in the same resistor and in the same time during a complete cycle.

$$I_{\text{rms}} = \frac{I_0}{\sqrt{2}} = 0.707I_0$$

The 70.7% of peak value of current gives effective or rms value of AC.

**3. Average or Mean Value of AC** It is defined as the value of AC which would send same amount of charge through a circuit in half-cycle that is sent by steady current in the same time.

$$I_{\text{av}} = \frac{2I_0}{\pi} = 0.637I_0$$

The 63.7% of peak value of AC gives average or mean value of AC.

**NOTE:** In a complete cycle of AC, the mean value of AC will be zero.

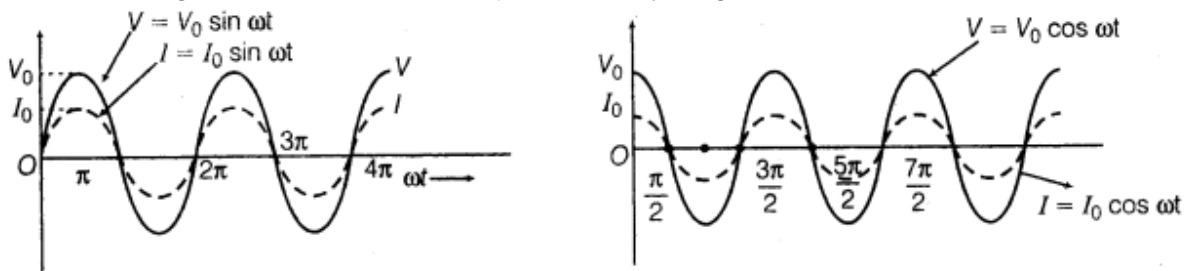
**4. Alternating emf or Voltage** It is the emf which varies in both magnitude as well as direction alternatively and periodically. The instantaneous alternating emf is given by

$$V = V_0 \sin \omega t \quad \text{or} \quad V = V_0 \cos \omega t$$

$$V_{\text{rms}} = \frac{V_0}{\sqrt{2}} = 0.707 \quad \text{or} \quad V_{\text{rms}} = 70.7\% \text{ of } V_0$$

$$V_{\text{av}} = \frac{2V_0}{\pi} = 0.637 \quad \text{or} \quad V_{\text{rms}} = 63.7\% \text{ of } V_0$$

Both AC voltage and AC current are represented by diagrams as shown below:



**5. Inductive Reactance ( $X_L$ )** The opposing nature of inductor to the flow of current is called Inductive reactance.

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

Also for a given inductor,

$$X_L = (2\pi L) f$$

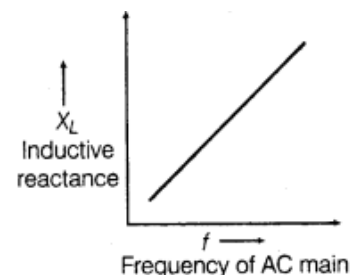
$\Rightarrow$

$$X_L \propto f$$

$\therefore$

$$2\pi L = \text{constant}$$

where,  $L$  = self-inductance.



**6. Capacitive Reactance ( $X_C$ )** The opposing nature of capacitor to the flow of alternating

current is called capacitive reactance.

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

For a given capacitor,

$$X_C = \left(\frac{1}{2\pi C}\right) \cdot \frac{1}{f}$$

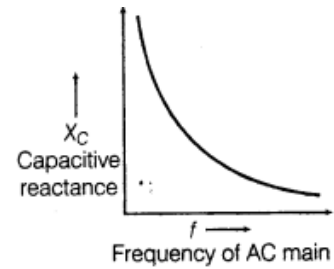
⇒

$$X_C \propto \frac{1}{f}$$

∴

$$\frac{1}{2\pi C} = \text{constant}$$

where,  $C$  = capacitance.



**7. Power** In an AC circuit, both emf and current change continuously w.r.t. time, so in circuit, we have to calculate average power in complete cycle ( $0 \rightarrow T$ ).

$$P_{av} = V_{rms} I_{rms} \cos \phi$$

where,  $\cos \phi$  = power factor.

**8.** Average power consumption in pure inductive and pure capacitive circuit is equal to zero because

$$\text{Phase difference, } \phi = \frac{\pi}{2}$$

⇒

$$\text{Power factor} = \cos \frac{\pi}{2} = 0$$

∴

$$P_{av} = 0$$

**9. Wattless Current** The current in an AC circuit when average power consumption in AC circuit is zero, is referred as wattless current or idle current.