AC VOLTAGE APPLIED TO AN INDUCTOR

Thus, the circuit is a purely inductive ac c

Let the voltage across the source be

$$v = v_m \sin\omega t.$$

Using the Kirchhoff's loop rule,

$$v - L\frac{di}{dt} = 0$$

where the second term is the self-induced Faraday emf in the inductor; and L is the self-inductance of the inductor

Combining above two equations

$$\frac{di}{dt} = \frac{v}{L} = \frac{v_m}{L}\sin\omega t$$

Integrating on both sides

$$\int \frac{di}{dt}dt = \frac{v_m}{L}\int \sin(\omega t)dt$$

and get,

$$i = -\frac{v_m}{\omega L}\cos(\omega t) + \text{constant}$$

the integration constant is zero

But

$$-\cos(\omega t) = \sin\left(\omega t - \frac{\pi}{2}\right)$$, we have

$$i = i_m \sin\left(\omega t - \frac{\pi}{2}\right)$$

Where $i_m = \frac{v_m}{\omega L}$ is the Amplitude of the Current

The quantity ω L is analogous to the resistance and is called inductive reactance, denoted by X_L:

$$X_L = \omega L$$

The amplitude of the current is, then $i_m = \frac{v_m}{X_L}$

A comparison of equations of current and the voltage shows that the current lags the voltage by π/2 or one-quarter (1/4) cycle

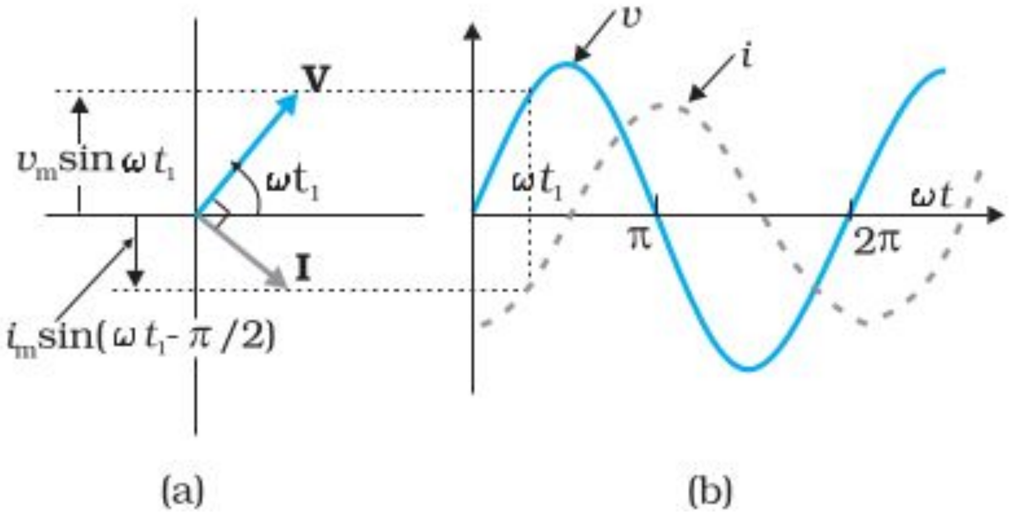
The dimension of inductive reactance is the same as that of resistance and its SI unit is ohm (Ω). The inductive reactance limits the current in a purely inductive circuit in the same way as the resistance limits the current in a purely resistive circuit.

The inductive reactance is directly proportional to the inductance and to the frequency of the current.

Inductance allows a high reactance to AC and allows DC to pass.

The current phasor I is $\pi/2$ behind the voltage phasor V.

When rotated with frequency ω counter-clockwise, they generate the voltage and current



The instantaneous power supplied to the inductor is

$$p_L = i\,v = i_m \sin\left(\omega t - \frac{\pi}{2}\right) \times v_m \sin(\omega t)$$

$$= -i_m v_m \cos(\omega t)\sin(\omega t)$$

$$= -\frac{i_m v_m}{2}\sin(2\omega t)$$

So, the average power over a complete cycle is

$$P_L = \left\langle -\frac{i_m v_m}{2}\sin(2\omega t)\right\rangle$$

$$= -\frac{i_m v_m}{2}\langle \sin(2\omega t)\rangle = 0,$$

since the average of sin (2ωt) over a complete cycle is zero.Thus, the average power supplied to an inductor over one complete cycle is zero (wattless current)