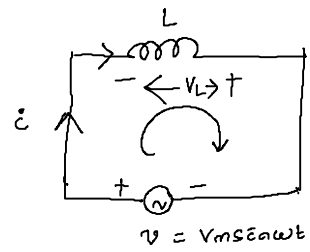
Thursday, December 9, 2021
11:54 AM

Behaviour of AC in Purely Inductive Circuit



$v + v_L = 0$

$v = V_m \sin\omega t$ — (1)

$v = -v_L$

$\Rightarrow L\frac{di}{dt} = V_m \sin\omega t$

$= -\left(-L\frac{di}{dt}\right)$

$\Rightarrow i = \frac{V_m}{L}\int \sin\omega t\, dt = L\frac{di}{dt}$

$= \frac{V_m}{L}\left[\frac{-\cos\omega t}{\omega}\right]$

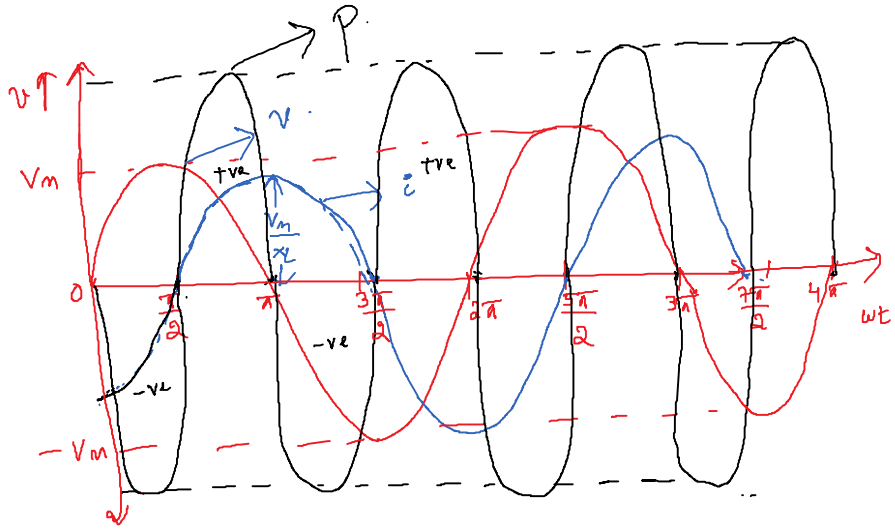
$= -\frac{V_m}{\omega L}[\cos\omega t]$ — (2)

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

$= \sin\left(\frac{\pi}{2} + \omega t\right)$

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

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



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

$I_m = \frac{V_m}{X_L}$

$X_L = \omega L$ (Ω)

(1) $P_{inst} = vi = V_m \sin\omega t\, I_m \sin\left(\omega t - \frac{\pi}{2}\right)$ — (1)

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

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

$\cos\omega t$

$P_{inst} = -\frac{V_m I_m}{2}\sin 2\omega t$ — (2)

V_m I_m

V / I

(2) $P_{avg} = 0$

(3) $P_{active} / P_{real} = VI\cos\theta = VI\cos\frac{\pi}{2}$

(4) Reactive power $= VI\sin\theta = V\bar{I} = V_{rms}\angle 0^\circ \, I_{rms}$

$=$ Apparent power

(5) $pf = \cos\theta = \cos\frac{\pi}{2} = 0$ (lagging)

Q.1. A pure inductive coil allows a current of 10A to flow from a 230V, 50Hz supply. Find (i) X_L (ii) Inductance of the coil (iii) power absorbed (iv) Write down the eqn for voltage and current.

231 min wt

(i) $X_L = \frac{V_{rms}}{I_{rms}} = \frac{230}{10} = 23\Omega$

(ii) $L = \frac{X_L}{2\pi f} = \frac{23}{2\pi \, 50} = 0.073H$

(iii) Avg power $= 0$

(iv) $v = V_m \sin\omega t = 230\sqrt{2}\sin 314.16t$ (325.17)

$i = I_m \sin(\omega t - \pi/2)$

$= 10\sqrt{2}\sin\left(314.2t - \frac{\pi}{2}\right)$ (14.14)