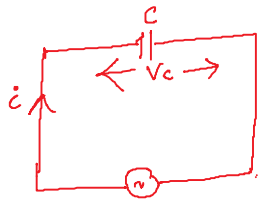
Monday, December 13, 2021
10:08 AM

Behaviour of AC in Purely Capacitive Circuit



(1)

$v = V_m \sin \omega t$

$i = C\frac{dv}{dt} = C\frac{dv_c}{dt}$

$= C\frac{d}{dt}(V_m \sin \omega t)$

$= CV_m \times \omega \cos \omega t$ — (2)

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

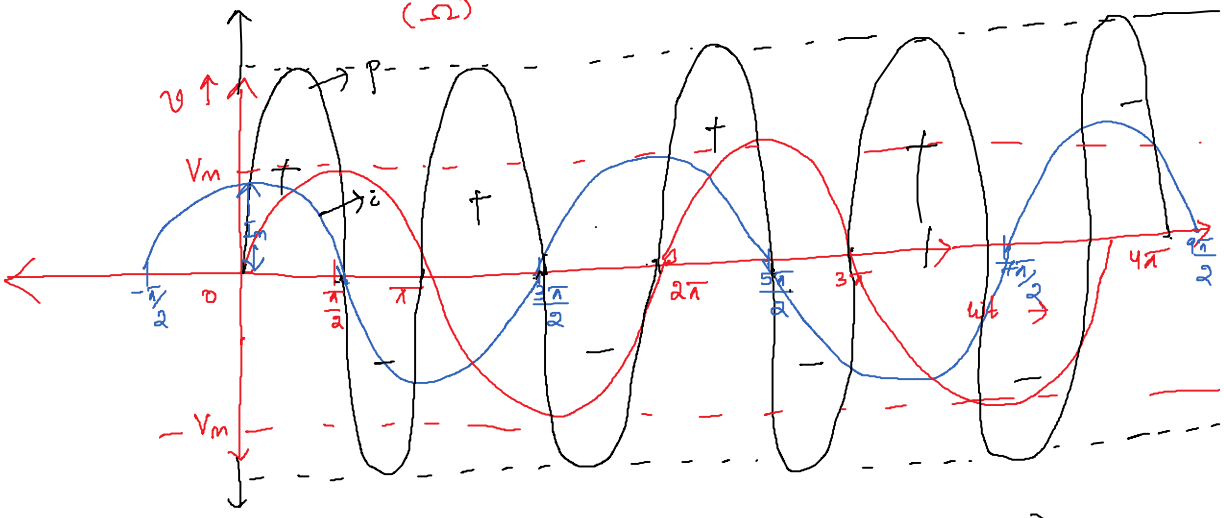
$= \sin\left(\frac{\pi}{2} - \omega t\right)$ ✗

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

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

I_m — (2)

$I_m = \frac{V_m}{X_c} = \frac{V_m}{\left(\frac{1}{\omega C}\right)}$ (Ω)



(1) $P_{instantaneous} = vi = V_m \sin \omega t \; I_m \sin\left(\omega t + \frac{\pi}{2}\right)$

$= 2 \cdot \frac{V_m \sin \omega t \; I_m \cos \omega t}{2}$

$= V_m I_m / 2 \sin 2\omega t$

(2) $P_{avg} = 0$

(3) $P_{active} = V_{rms} I_{rms} \cos \frac{\pi}{2} = 0$

(4) $P_{reactive} = V_{rms} I_{rms} \sin \frac{\pi}{2} = V_{rms} I_{rms}$

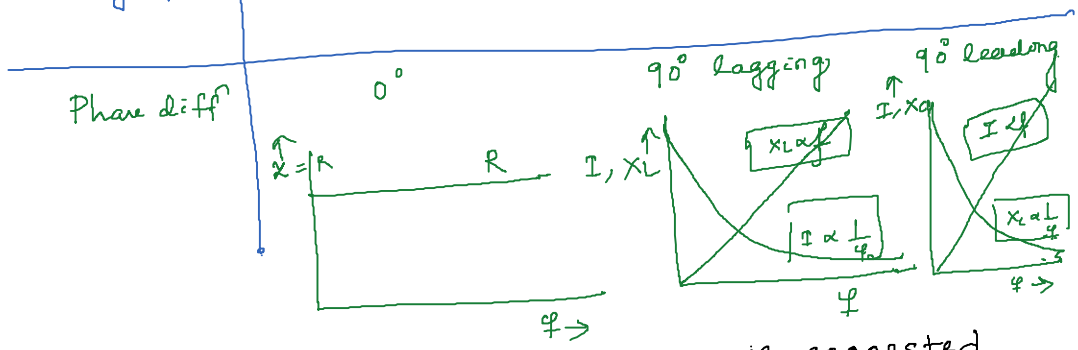
$=$ Apparent

(5) pf = $\cos\frac{\pi}{2}$ = 0 (leading) power

pf = 0 leading
= 0 lagging
= 1. ($\phi = 0°$)

Comparison of R, L, C

	R	L	C
Current	$I = \frac{V}{R}$	$I = \frac{V}{X_L}$ ($I \propto \frac{1}{f}$)	$I = \frac{V}{X_C} = \omega C V$ ($I \propto f$)
frequency dependent	independent	$X_L \propto f$	$X_C \propto \frac{1}{f}$
Avg power	$I_{rms}^2 R$ / $\frac{V_{rms}^2}{R}$	0	0
Phase diff	0°	90° lagging	90° leading



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

Q.1. A pure Capacitor of 318 μF is connected to a 230V, 50 Hz supply. Calculate (i) X_C (ii) I_{rms} (iii) eqn of v, i

(i) $X_C = \frac{1}{\omega C} = \frac{1}{2\pi \times 50 \times 318 \times 10^{-6}} = 10\,\Omega$

(ii) $I_{rms} = \frac{V_{rms}}{X_C} = \frac{230}{10} = 23\,A$

(iii) $v = V_m \sin \omega t = V_{rms}\sqrt{2} \sin 314 \cdot 2t$
$= 23\sqrt{2} \sin 314 \cdot 2t$
$325 \cdot 27$

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

(iv) $i = I_m \sin(\omega t + \frac{\pi}{4})$

$= 23\sqrt{2} \sin(314.2t + \frac{\pi}{2})$

32.5

$180^\circ \rightarrow \pi$

$1^\circ \rightarrow \frac{\pi}{180}$ rad.

$34^\circ \rightarrow 34 \times \frac{\pi}{180}$ rad

π rad $\rightarrow 180^\circ$

1 rad $\rightarrow \frac{180^\circ}{\pi}$

5 rad $\rightarrow 5 \times \frac{180}{\pi}$ degree