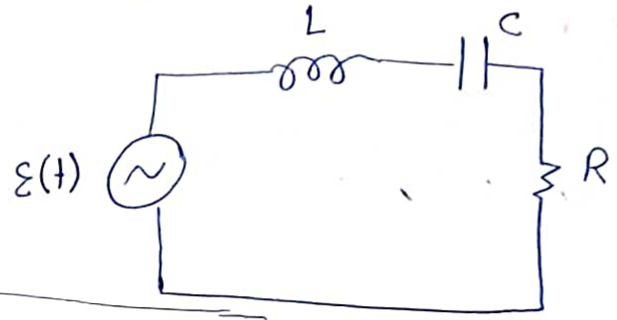
Exp 8 :- Impedance & Reactance



$\varepsilon(t) = \varepsilon_0 \cos \omega t$

$\boxed{\text{Impedance} = \text{Resistance} + j \text{ Reactance}}$ → Complex number

$$Z_R = R$$

$$Z_C = -\frac{j}{\omega C} \Rightarrow \text{Reactance}(X_C) = \frac{-1}{\omega C}$$

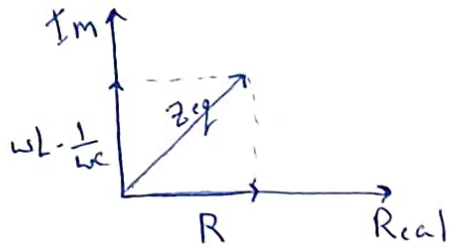
$$Z_L = j\omega L \Rightarrow \text{Reactance}(X_L) = \omega L$$

$$I(t) = \frac{\varepsilon(t)}{Z_{eq}}$$

, Z_{eq} : equivalent Impedance

$$Z_{eq} = Z_R + Z_C + Z_L$$
$$= R + j\left(\omega L - \frac{1}{\omega C}\right)$$

$$I(t) = I_0 \cos(\omega t + \varphi)$$



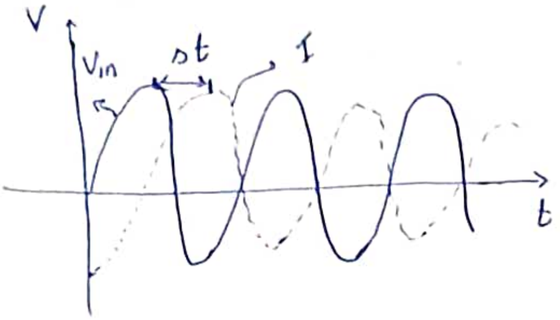
$$I_0 = \frac{\varepsilon_0}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

$$\varphi = \tan^{-1}\left(\frac{-\omega L + \frac{1}{\omega C}}{R}\right)$$

: phase shift bt. $\varepsilon(t)$ & $I(t)$.

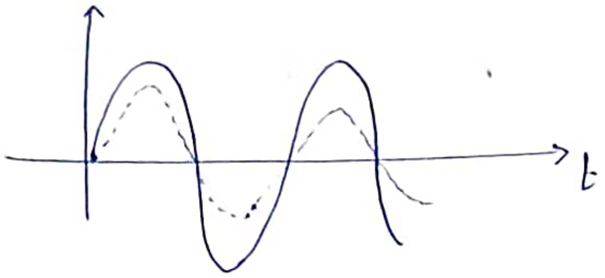
when $\varphi = 0$??

$$\frac{-\omega L + \frac{1}{\omega C}}{R} = 0 \Rightarrow \omega L = \frac{1}{\omega C} \Rightarrow \boxed{\omega = \frac{1}{\sqrt{LC}}}$$



$$\varphi = \omega \Delta t$$

$$\boxed{\varphi = 2\pi f \Delta t}$$



$$\varphi = 0 \quad , \quad \Delta t = 0$$

$$V_L = L \frac{dI}{dt} = L \frac{d}{dt}\left(I_0 \cos(\omega t + \varphi)\right)$$

$$= -\omega L\, I_0 \sin(\omega t + \varphi)$$

$$V_R = R\, I(t) = R\, I_0 \cos(\omega t + \varphi) = R\, I \sin\left(\omega t + \varphi + \frac{\pi}{2}\right)$$

$$V_c = \frac{Q}{C} \quad , \quad Q = \int I \, dt$$

$$= \frac{\int I \, dt}{c} = \int \frac{I_0 \cos(\omega t + \varphi)}{c} dt$$

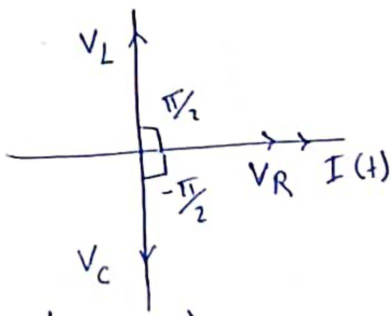
$$V_c = \frac{I_0}{\omega C} \sin(\omega t + \varphi)$$

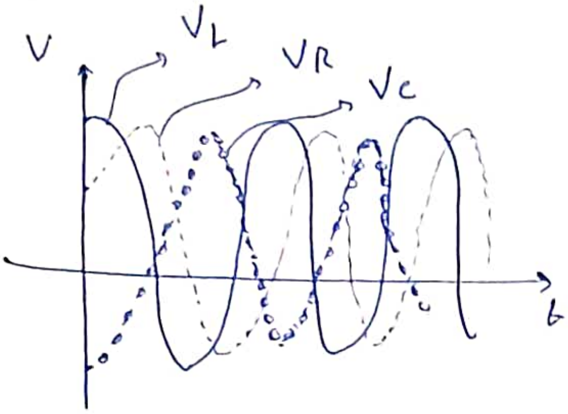
phase shift bt. V_L & V_R $= \frac{\pi}{2}$

" " " V_R & V_c $= -\frac{\pi}{2}$

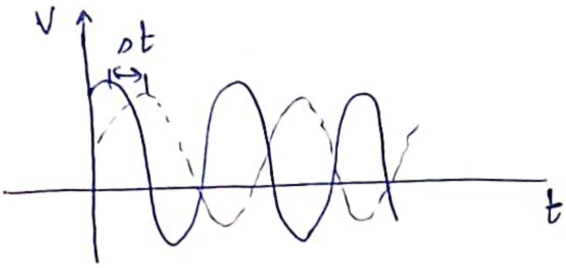
V_R is in phase with $I(t)$

phase shift bt. V_L & V_c $= \pi$ (out of phase)



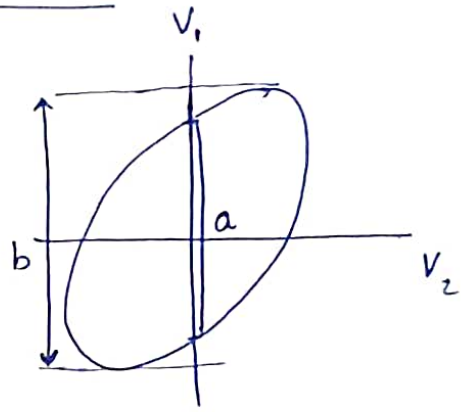


* phase shift by external mod



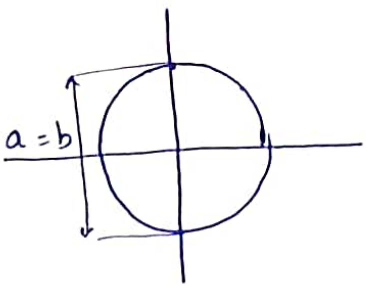
$\phi = \omega \Delta t$

Internal mode



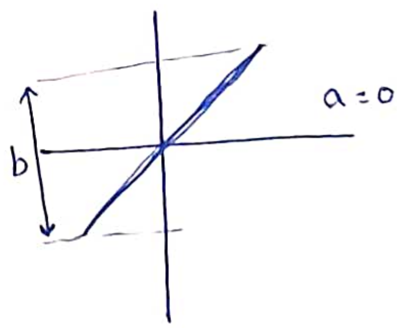
$\phi = \sin^{-1}\left(\frac{a}{b}\right)$

special cases:



$\phi = \sin^{-1}(1)$

$\phi = \frac{\pi}{2}$



$\phi = \sin^{-1}(0)$

$= 0$