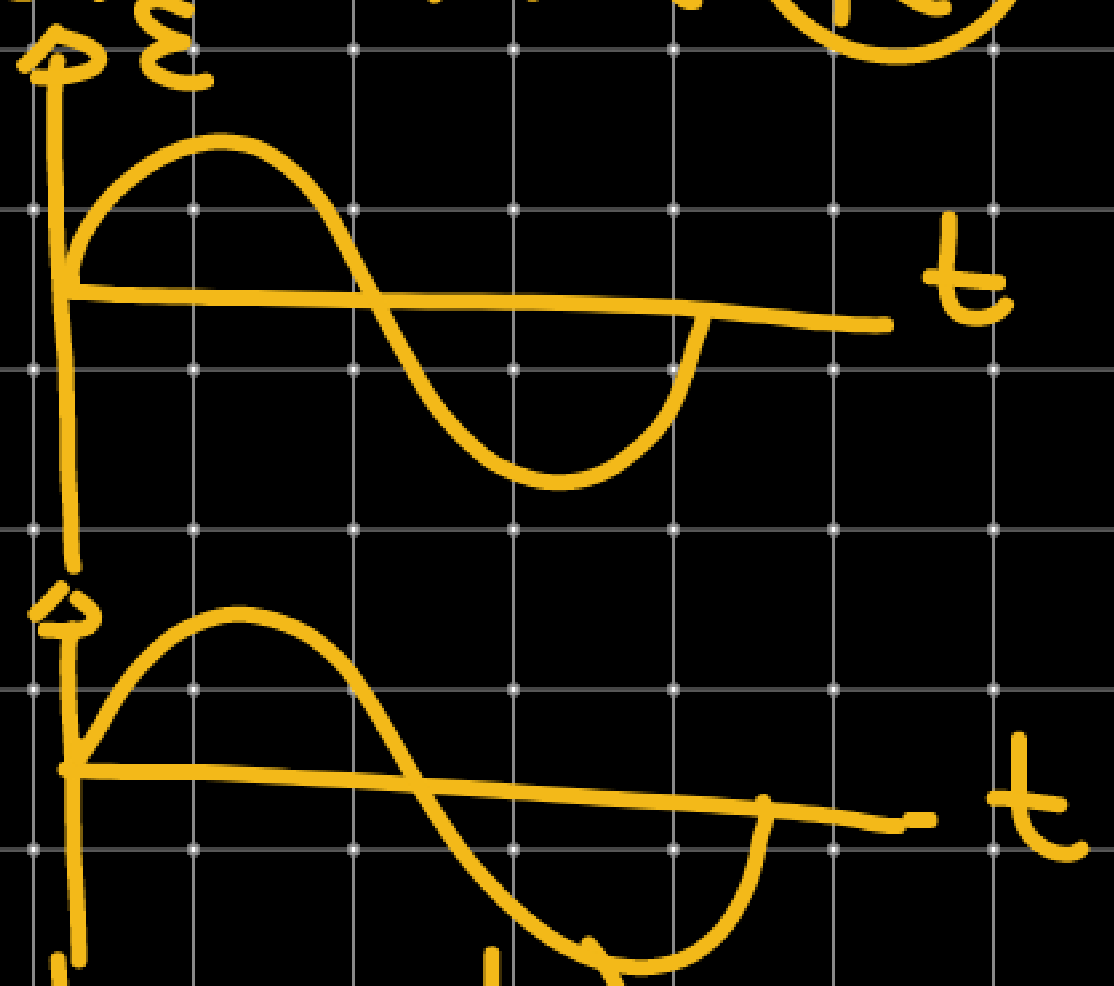
↳ **AC**

⇒ When AC Source Connect with (R)

$\varepsilon = \varepsilon_0 \sin\omega t$

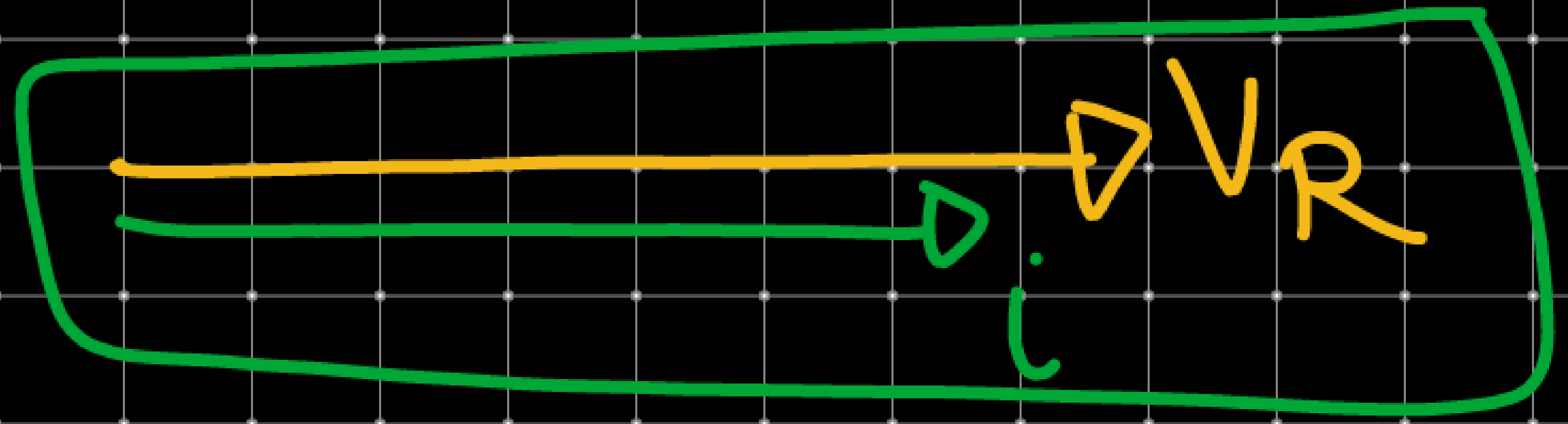
$i = \dfrac{\varepsilon_0 \sin\omega t}{R}$

$i = I_0 \sin\omega t$



Phase diff b/w ε & i $\quad \phi = (\omega t - \omega t) = 0$

$$I_0 = \frac{\varepsilon_0}{R}$$



In (R) E & i in same Phase

When AC Source connect with pure Inductor:-

$\varepsilon = \varepsilon_0 \sin\omega t$

KVL

$\varepsilon_0 \sin\omega t - L\frac{di}{dt} = 0$

$\varepsilon_0 \sin\omega t = L\frac{di}{dt}$

$\frac{di}{dt} = \frac{\varepsilon_0}{L}\sin\omega t$

$\int di = \frac{\varepsilon_0}{L}\int \sin\omega t \, dt$

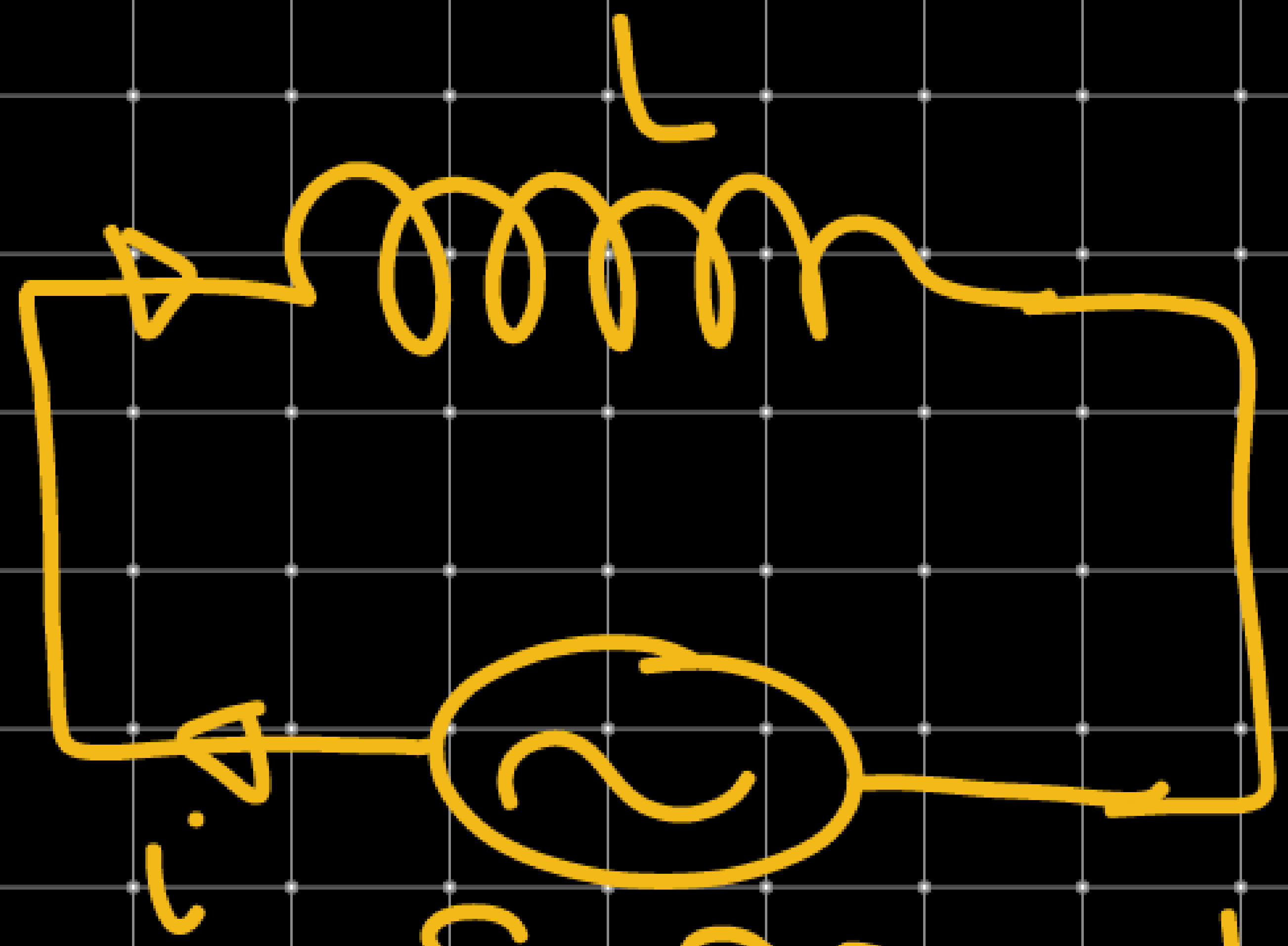
$\sin(90-\theta) = \cos\theta$

$-\sin\theta = \sin(-\theta)$

$i = \frac{\varepsilon_0}{L}\left[\frac{-\cos\omega t}{\omega}\right] = \frac{\varepsilon_0}{\omega L}\left[-\cos\omega t\right] = \frac{\varepsilon_0}{\omega L}\left[-\sin\left(\frac{\pi}{2}-\omega t\right)\right]$

$i = \frac{\varepsilon_0}{\omega L}\left[\sin\left(\omega t - \frac{\pi}{2}\right)\right]$

$i = i_0 \sin(\omega t + \phi)$



$\mathcal{E} = \mathcal{E}_0 \sin \omega t$

$\omega L = X_L$

↳ Inductive reactance

↳ SI unit $= \Omega$.

$\omega = 2\pi f$

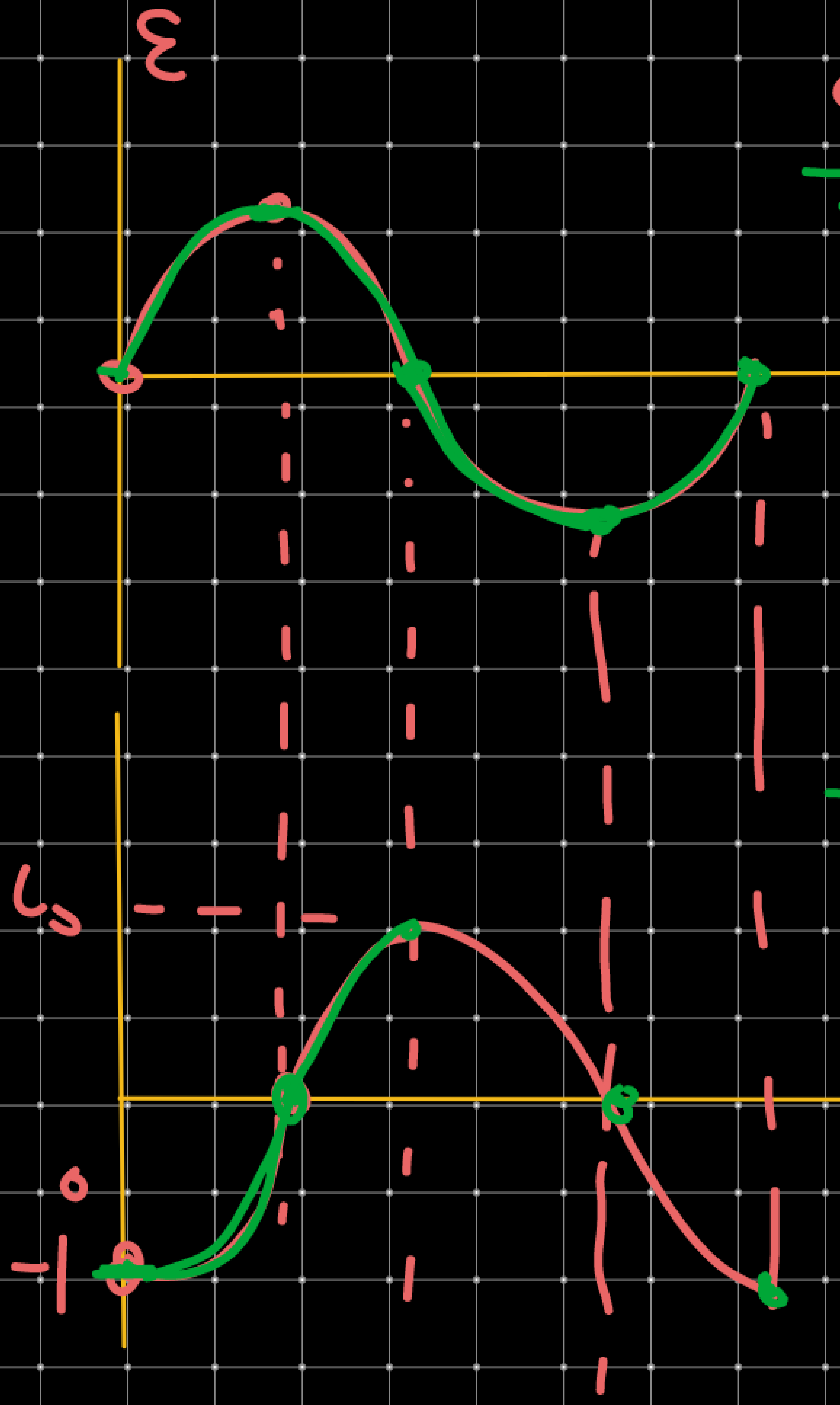
$$X_L = 2\pi f L$$

$$i = \frac{\mathcal{E}_0}{\omega L} \sin\left(\omega t - \frac{\pi}{2}\right)$$

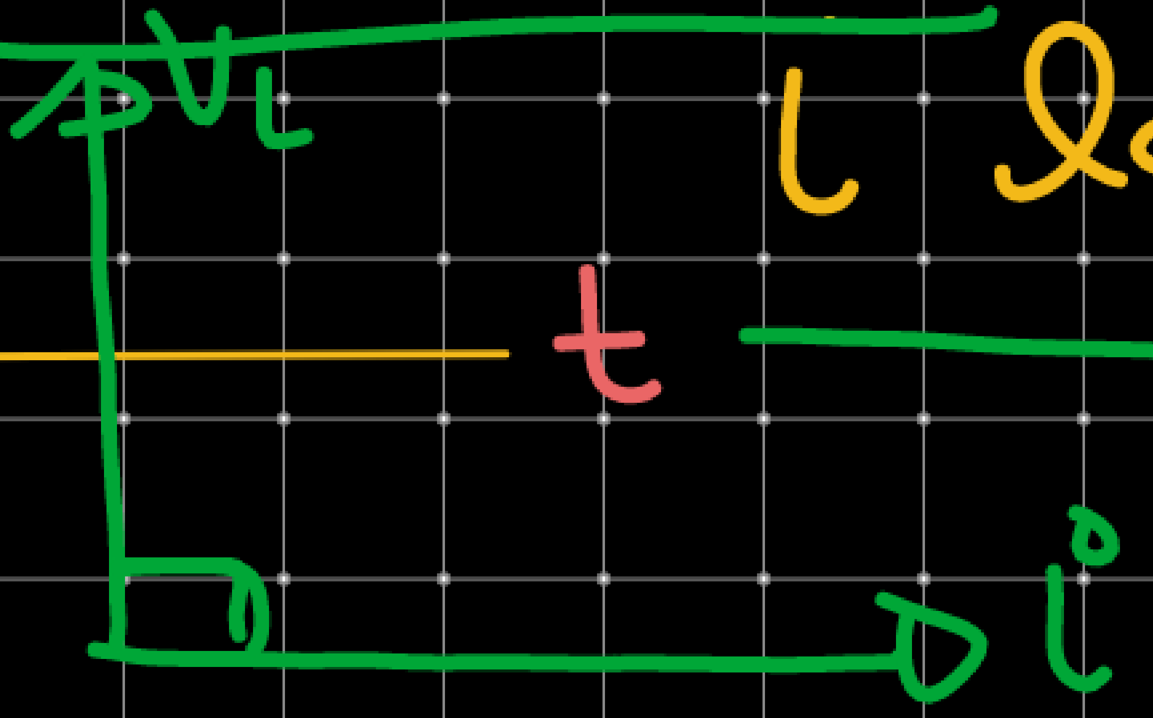
$$i = i_0 \sin(\omega t + \phi)$$

*** Phase diff b/w $\mathcal{E}$ & i is $\left(\frac{\pi}{2}\right)$

$$\left[(\omega t) - \left(\omega t - \frac{\pi}{2}\right)\right] = \frac{\pi}{2}$$



$$\varepsilon = \varepsilon_0 \sin \omega t$$



i lag $\frac{\pi}{2}$ with E.

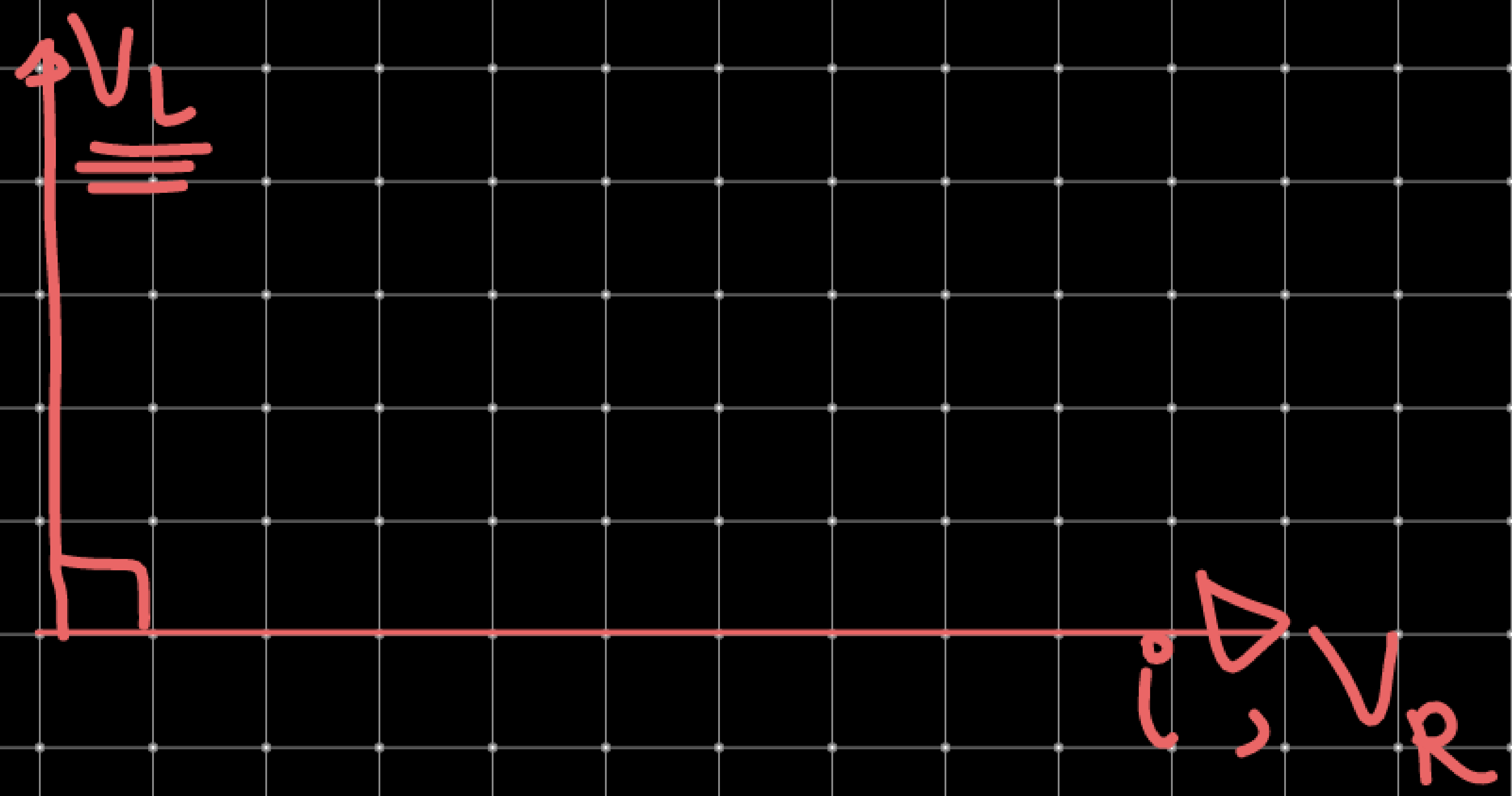
$$i = i_0 \sin\left(\omega t - \frac{\pi}{2}\right)$$

$t = 0$

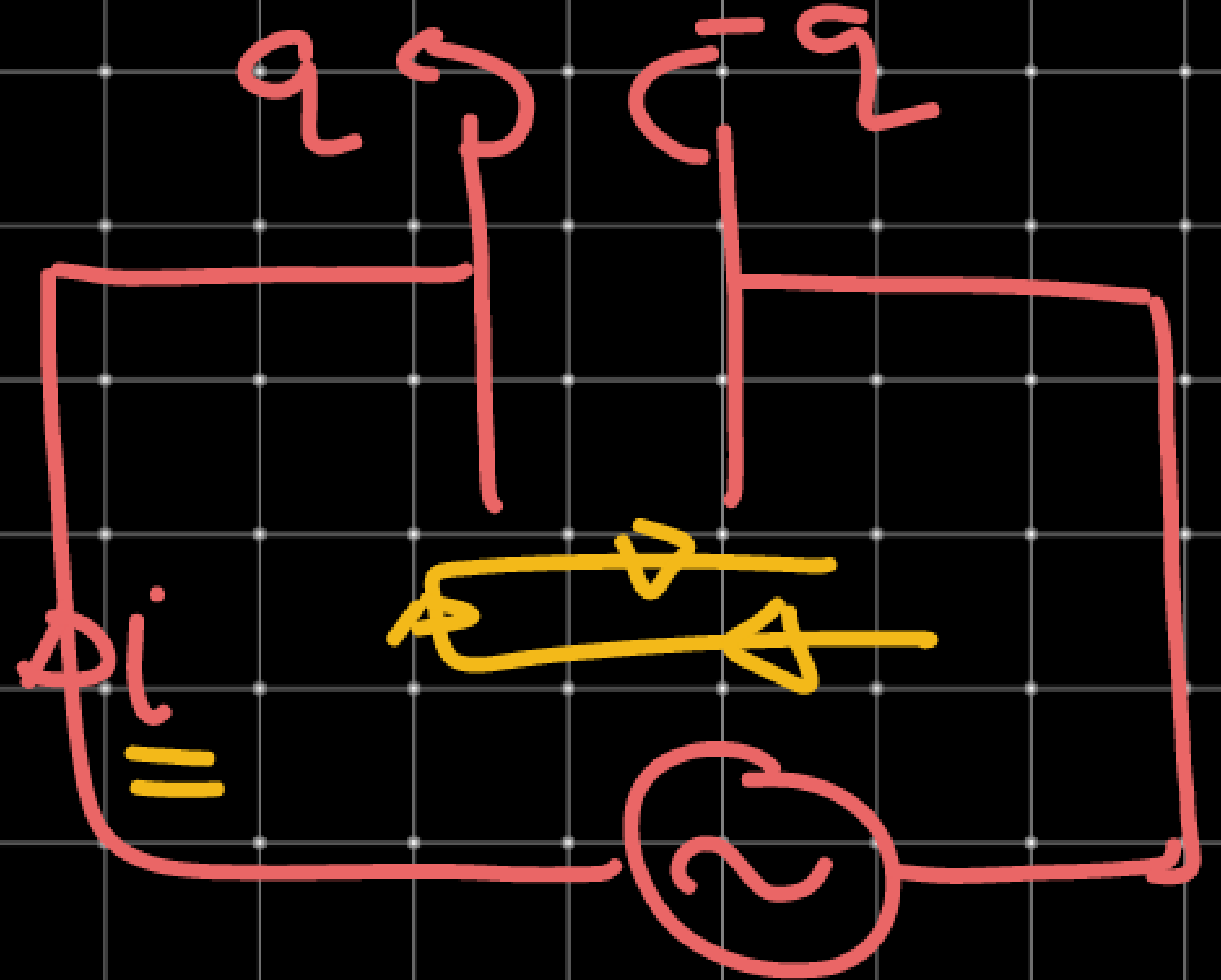
$$i = i_0 \sin\left(-\frac{\pi}{2}\right)$$

$$= -i_0 \sin \frac{\pi}{2}$$

$$= -i_0$$


V_L
i, V_R

⇒ AC Source connect with pure Capacitor



$\mathcal{E} = \mathcal{E}_0 \sin\omega t$

$$\mathcal{E}_0 \sin\omega t - \frac{q}{C} = 0$$

$$\frac{q}{C} = \mathcal{E}_0 \sin\omega t$$

$$q = C\mathcal{E}_0 \sin\omega t$$

$$\frac{dq}{dt} = i = \frac{d}{dt}(C\mathcal{E}_0 \sin\omega t)$$

$$i = C\mathcal{E}_0 \cos\omega t \times \omega$$

$$i = C\omega\mathcal{E}_0 \cos\omega t$$

$$i = \frac{\mathcal{E}_0}{\frac{1}{\omega C}} \sin\left(\frac{\pi}{2} + \omega t\right)$$

$$\frac{1}{\omega C} = X_C$$

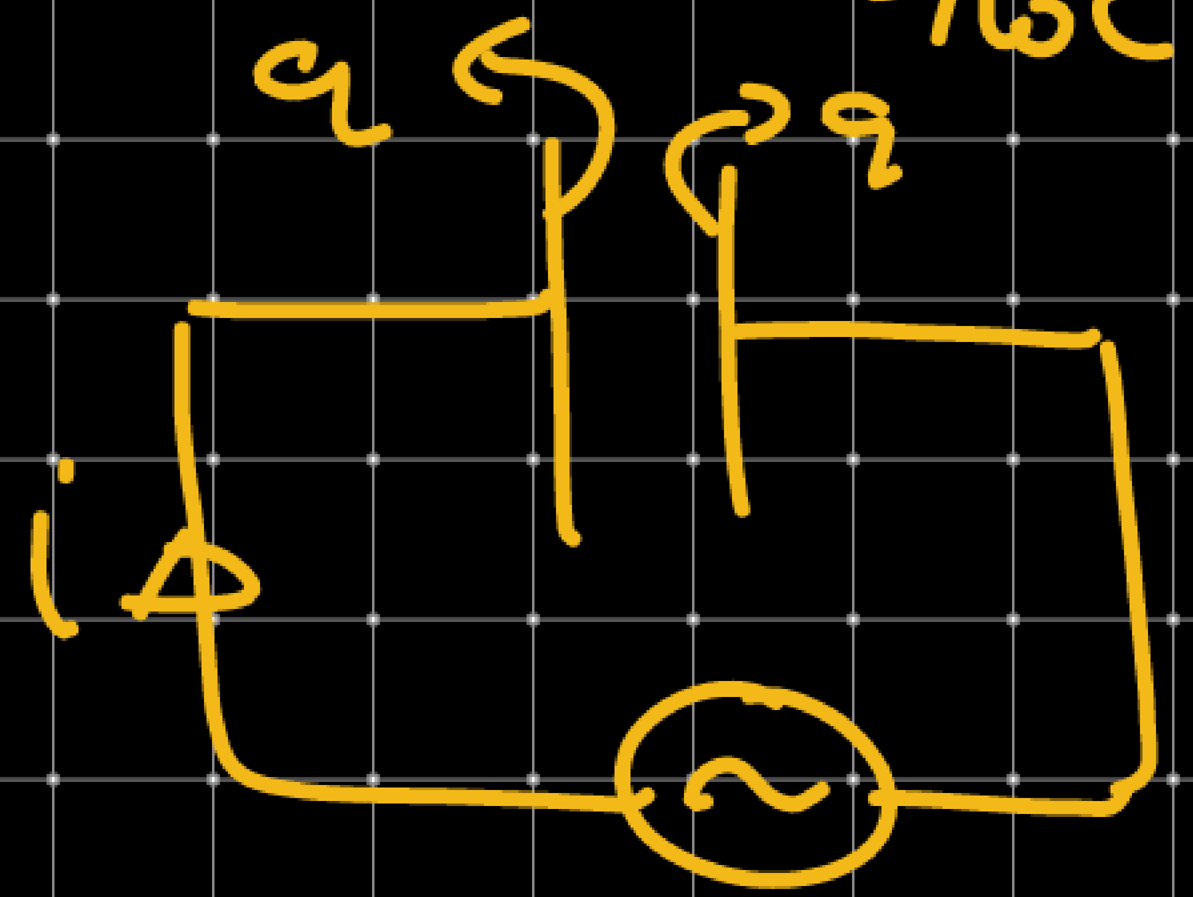
Capacitive reactance

Unit Ω

$$abc = \frac{c}{1/ab}$$

$$\cos\theta = \sin\left(\frac{\pi}{2} + \theta\right)$$

$$i = \frac{\varepsilon_0}{1/\omega C} \sin\left(\omega t + \frac{\pi}{2}\right)$$



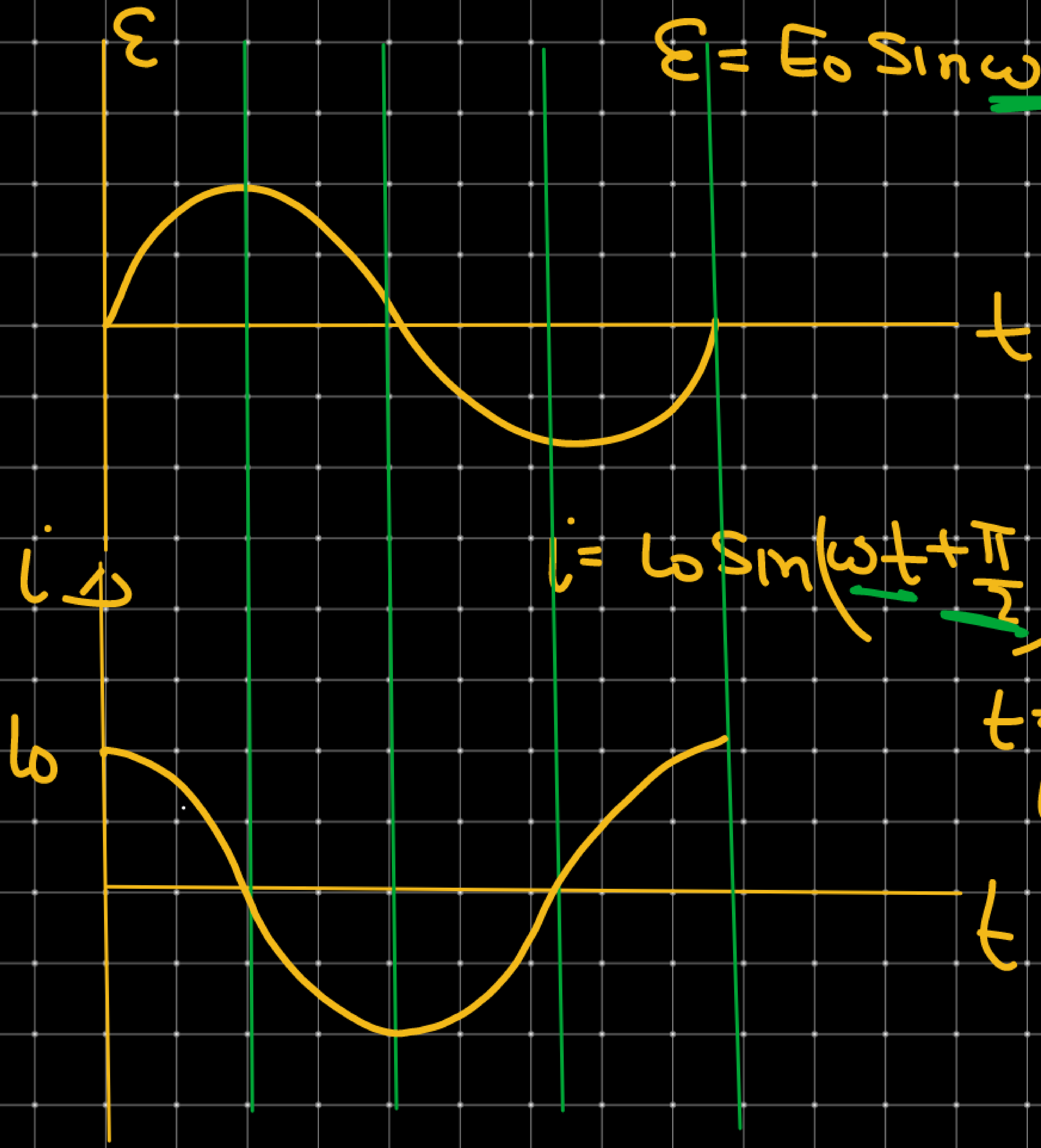
$$i = \frac{\varepsilon_0}{X_C} \sin\left(\omega t + \frac{\pi}{2}\right)$$

$E = E_0 \sin \omega t$

$E = E_0 \sin \omega t$

Phase diff b/w i & $E = \frac{\pi}{2}$

i lead $\frac{\pi}{2}$ with E.



$\varepsilon = E_0 \sin \omega t$

$i = i_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

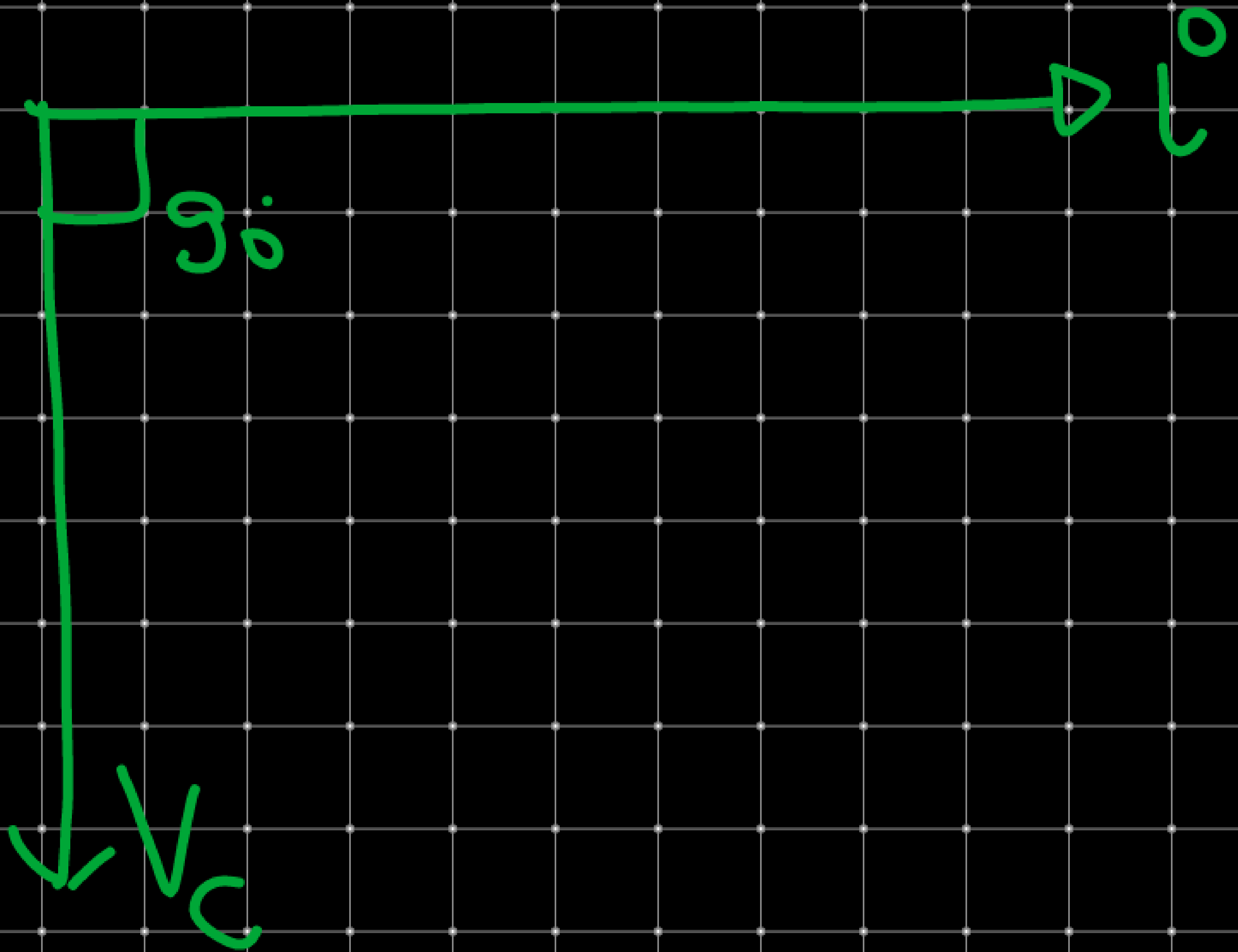
$t = 0$

$i = i_0 \sin \frac{\pi}{2}$

$= i$

$i = \frac{E_0}{1/\omega C} \sin\left(\omega t + \frac{\pi}{2}\right)$

$$i_0 = \frac{E_0}{X_C} = \frac{E_0}{1/\omega C}$$



i – lead $\frac{\pi}{2}$ with $\underline{\underline{V_C}}$

graph

$X_L = \omega L$

L

$X_L \rightarrow$ Inductive reactance.

X_L (V/s) frequency (f)

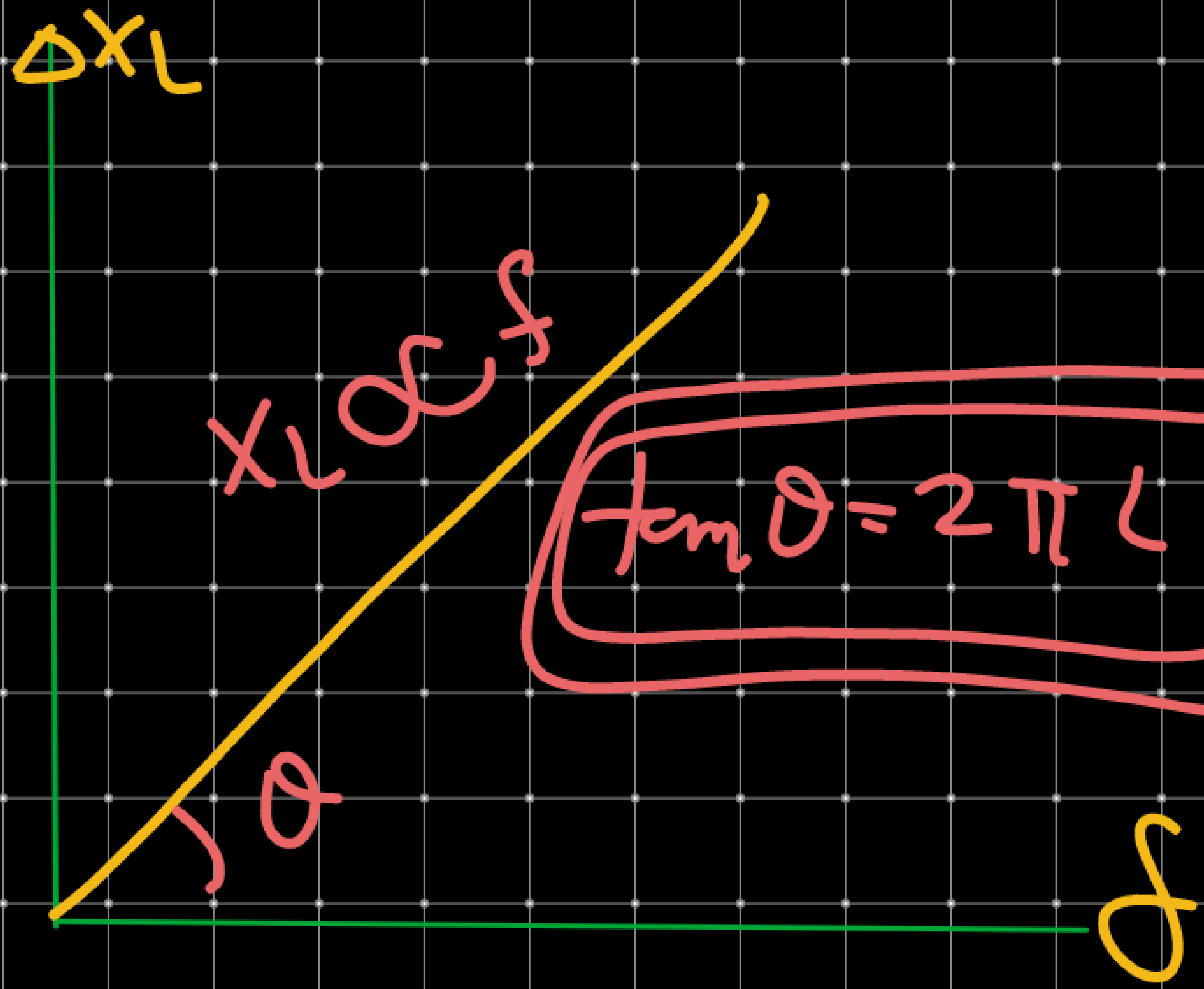
$X_L = \omega L$

$X_L = 2\pi f L$

$(\omega = 2\pi f)$

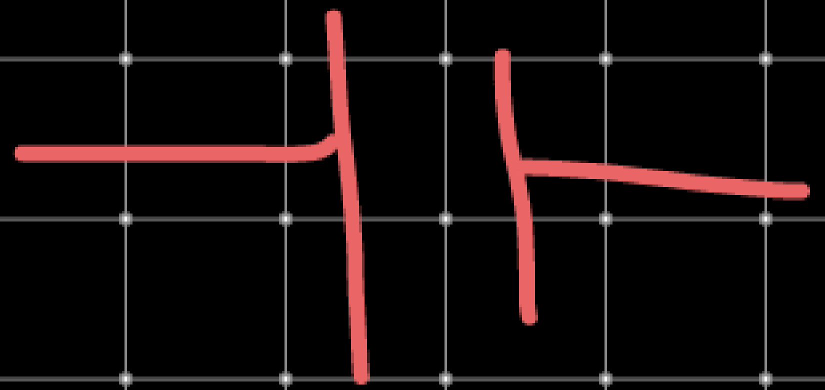
$X_L = (2\pi L) f$

$Y = mx$



$\tan\theta = 2\pi L$

⇒ X_C = Capacitive reactance



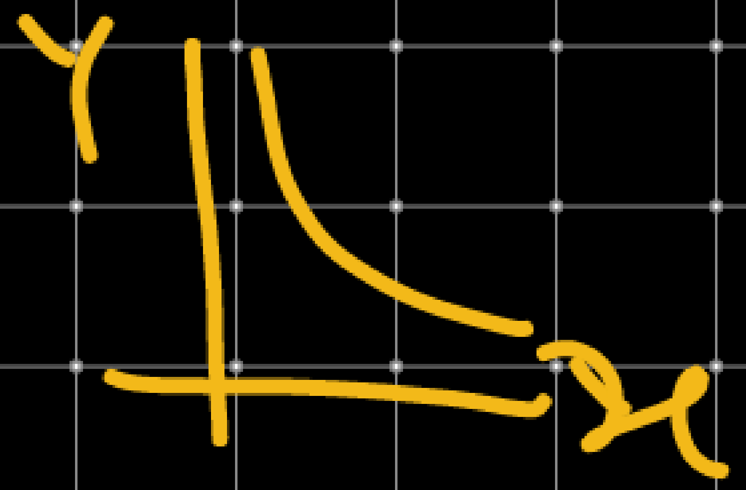
$$X_C = \frac{1}{\omega C} \Rightarrow X_C = \frac{1}{2\pi f C}$$

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

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

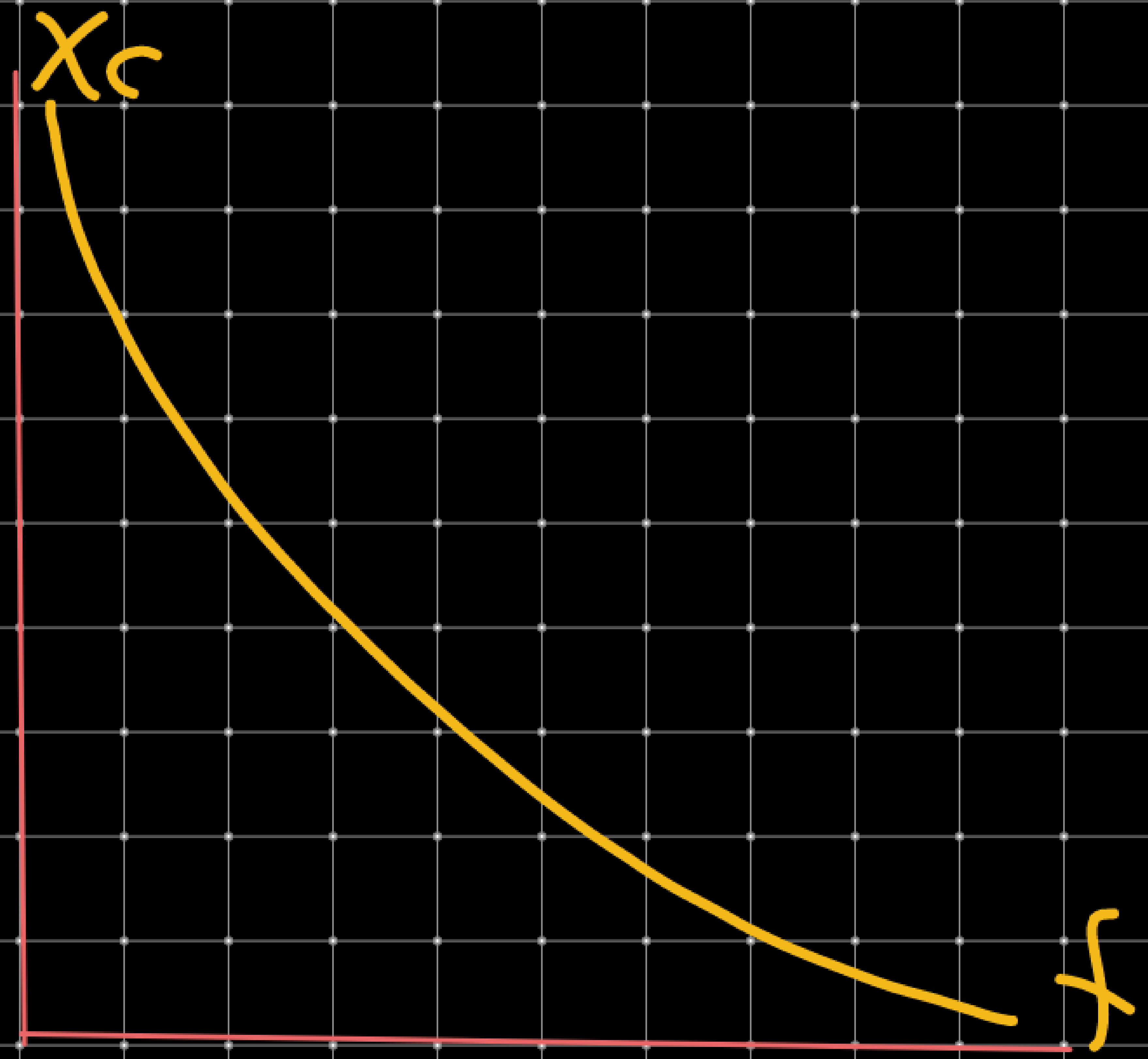
$$X_L\, f = \frac{1}{2\pi C}$$

$\frac{1}{2\pi C}$ ⇒ Cons



$$yx = \text{Constant}$$

$$y = \frac{\text{Constant}}{x}$$



$\Rightarrow$ R → done not depends on frequency of Source.

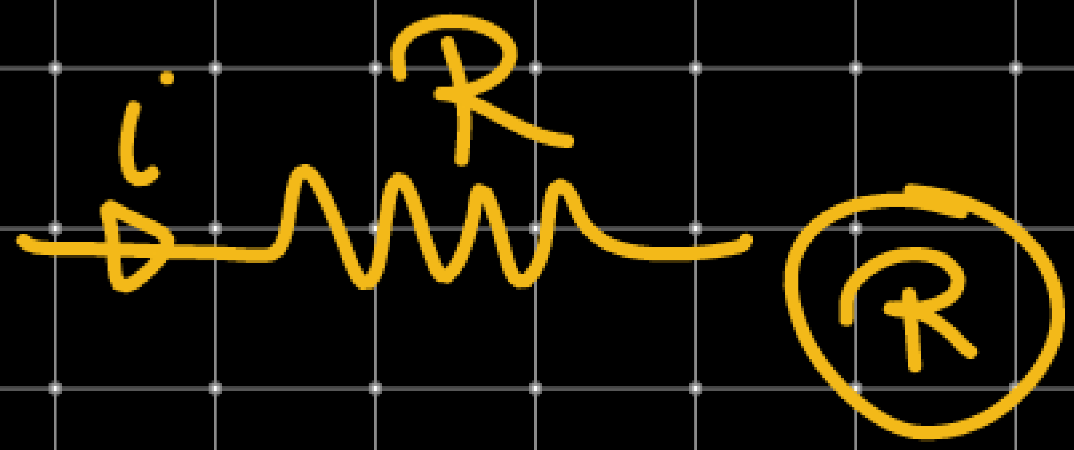
$$R = \frac{\rho A}{l}$$

$$X_L = 2\pi f L$$

$$X_L = \omega L$$

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

$$X_L = \frac{1}{2\pi C f}$$



$\varepsilon = \varepsilon_0 \sin\omega t$ $\quad i = i_0 \sin\omega t$ $\quad \Delta\phi = 0$

$X_L = \omega L$

$\varepsilon = \varepsilon_0 \sin\omega t$ $\quad i = i_0 \sin\left(\omega t - \frac{\pi}{2}\right)$ $\quad \Delta\phi = \frac{\pi}{2}$

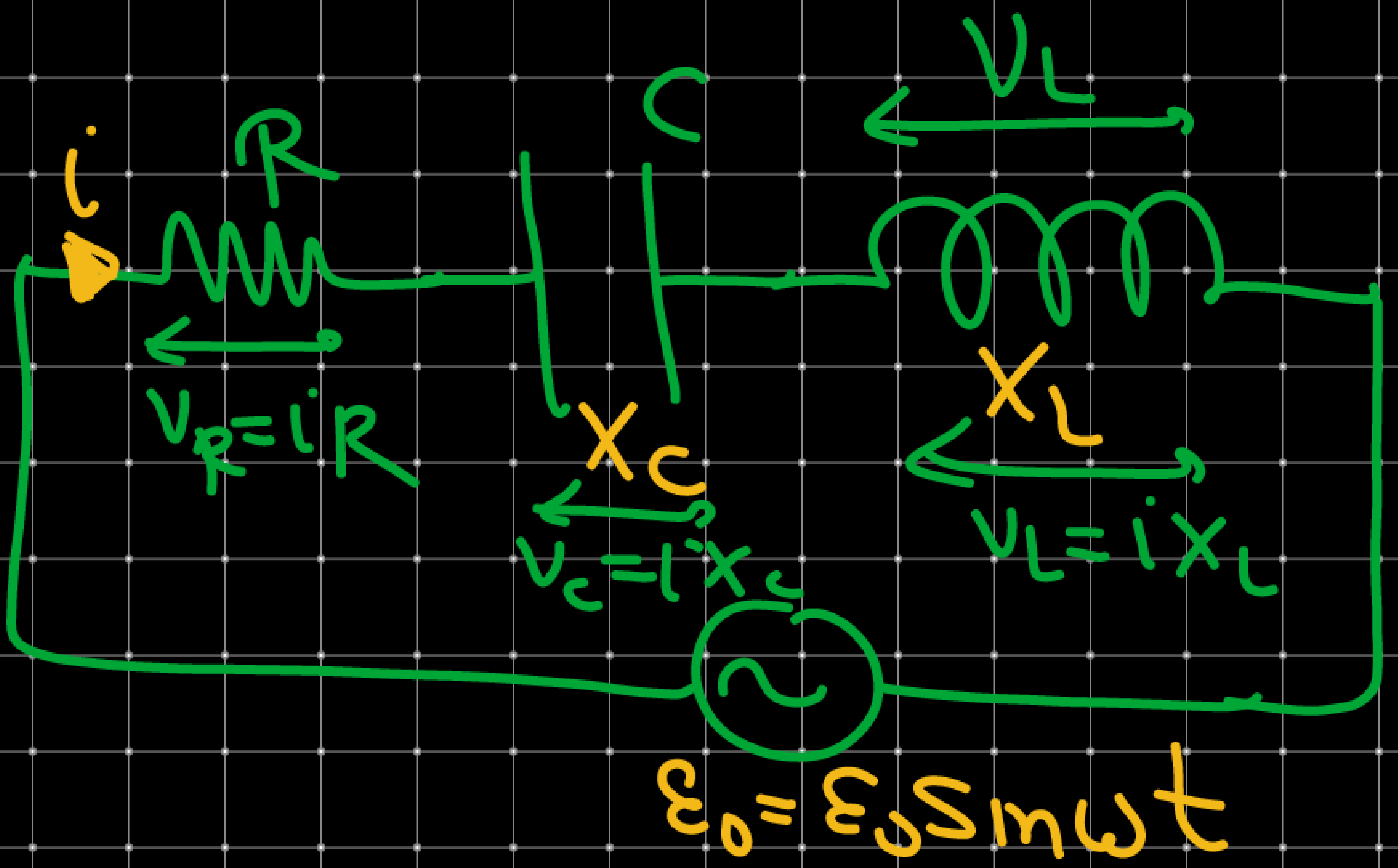
i lag $\frac{\pi}{2}$ with ε

$X_C = \frac{1}{\omega C}$

$\varepsilon = \varepsilon_0 \sin\omega t$ $\quad i = i_0 \sin\left(\omega t + \frac{\pi}{2}\right)$ $\quad \Delta\phi = \frac{\pi}{2}$

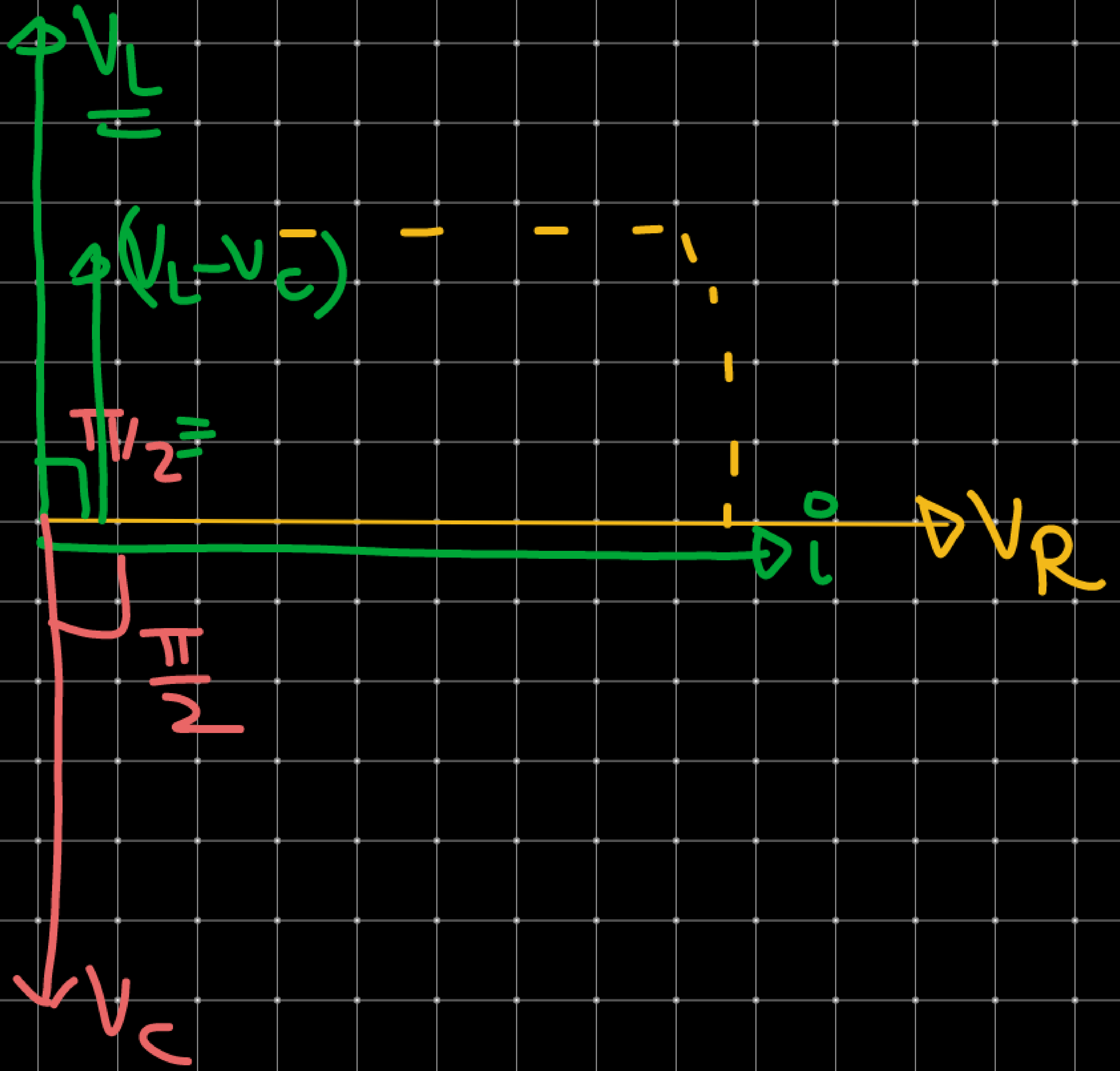
i lead with ε by $\pi/2$

L-C-R with AC Source.



$X_C = \frac{1}{\omega C}$

$X_L = \omega L$

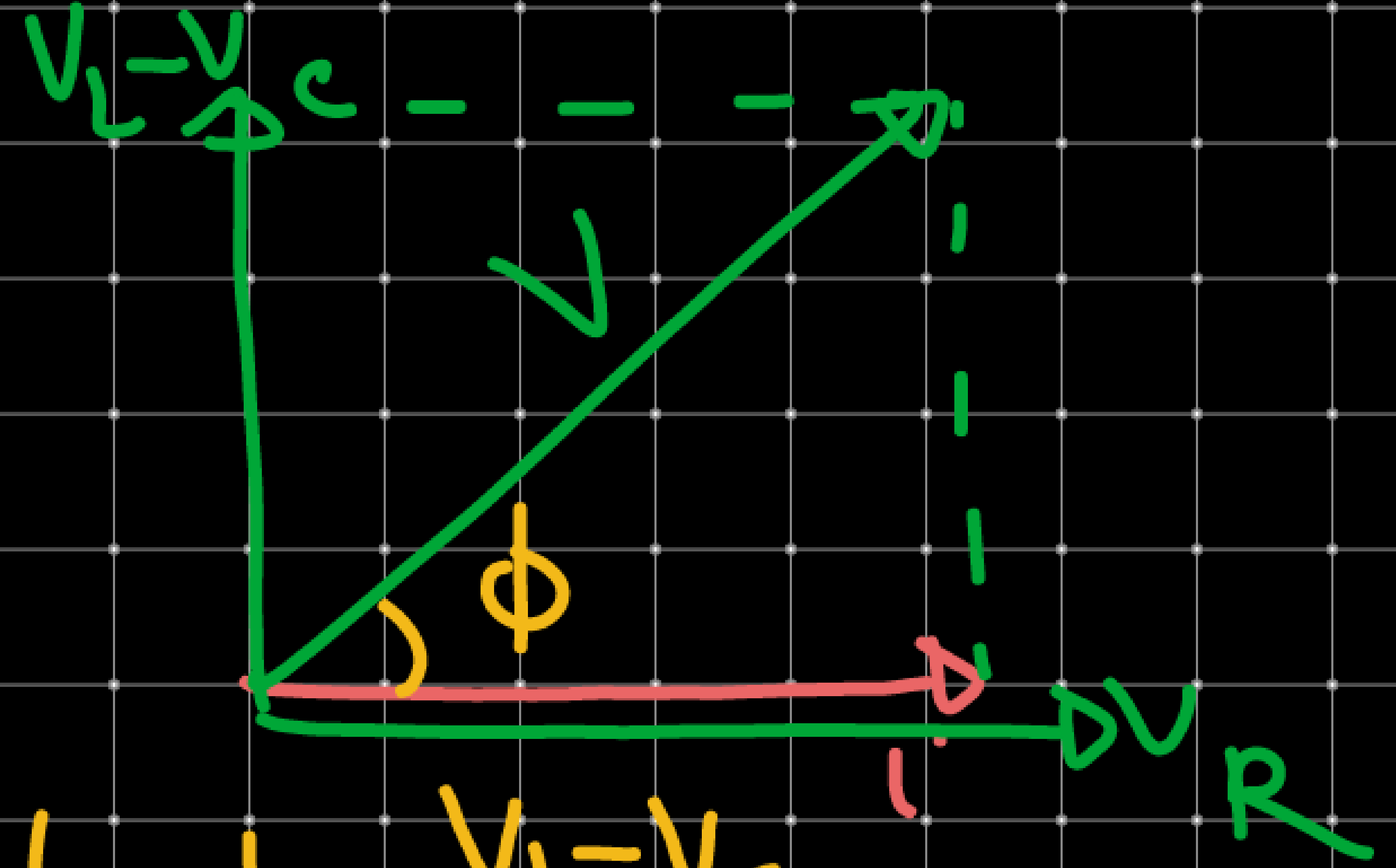


R
$\varepsilon = \varepsilon_0 \sin\omega t$
$i = i_0 \sin\omega t$
$\Delta\phi = 0$

L
$\varepsilon = \varepsilon_0 \sin\omega t$
$i = i_0 \sin(\omega t - \frac{\pi}{2})$
i lags by $\frac{\pi}{2}$

C
$\varepsilon = \varepsilon_0 \sin\omega t$
$i = i_0 \sin(\omega t + \frac{\pi}{2})$
i lead with ε

If $V_L > V_C$



$$\tan\phi = \frac{V_L - V_C}{V_R}$$

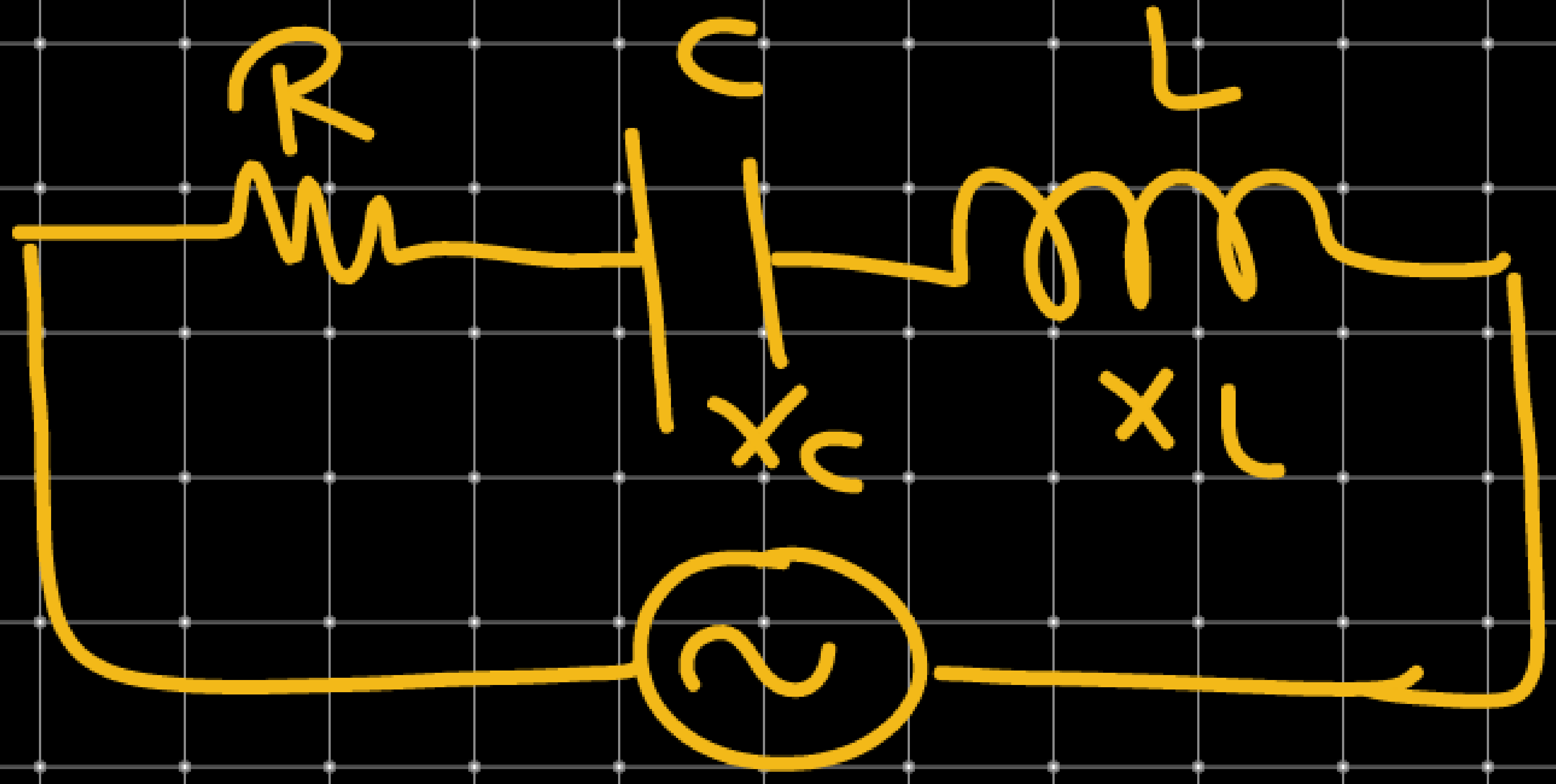
$$V_{net} = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$iZ = \sqrt{(iR)^2 + (iX_L - iX_C)^2}$$

$$iZ = \sqrt{i^2R^2 + i^2(X_L - X_C)^2}$$

$$iZ = i\sqrt{R^2 + (X_L - X_C)^2}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$



$\mathcal{E} = \mathcal{E}_0 \sin \omega t$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Impedence

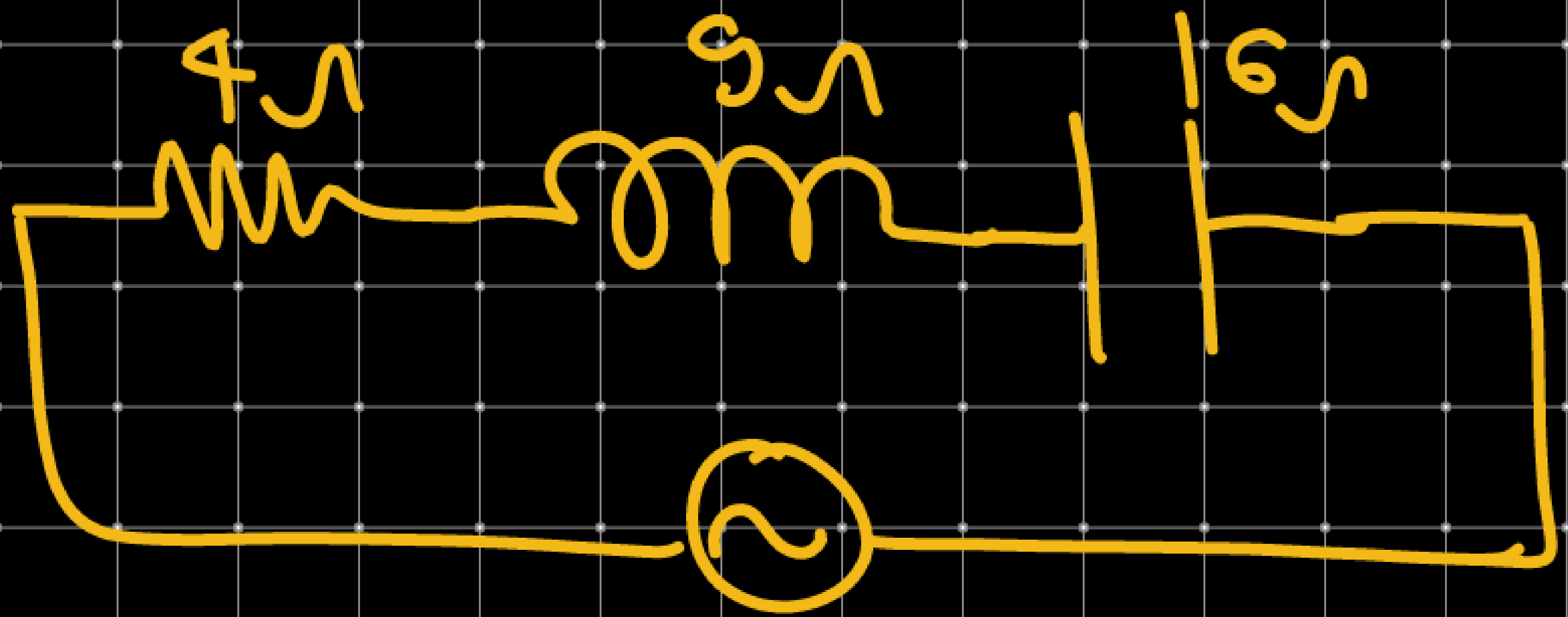
$\Downarrow$

$$\tan\phi = \frac{V_L - V_C}{V_R}$$

$$\tan\phi = \frac{iX_L - iX_C}{iR}$$

$$\boxed{\tan\phi = \frac{X_L - X_C}{R}}$$

find impedance of given L-C-R ckt



$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$= \sqrt{4^2 + (9 - 16)^2}$$

$$= \sqrt{16 + 49} = \sqrt{65}\ \Omega$$

In L-C-R ckt with an ac source

$R = 300\Omega$ $C = 20\mu F$, $L = 1H$, $f = \frac{50}{\pi}$ Hz

find Z & i_{rms} if $\varepsilon_{rms} = 50V$.

Solⁿ L-C-R

$R = 300\Omega$

$X_L = \omega L$

$= 2\pi f L$

$= 2\pi \times \frac{50}{\pi} \times 1$

$= 100\Omega$

$X_L = 100\Omega$

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

$X_C = \frac{1}{2\pi \times \frac{50}{\pi} \times 2 \times 10^{-5}} = \frac{1}{100 \times 2 \times 10^{-5}} = \frac{1000}{2}$

$X_C = 500\Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = \sqrt{(300)^2 + (100 - 500)^2}$

$Z = 500\Omega$

Time taken by Current to its rms value to max value

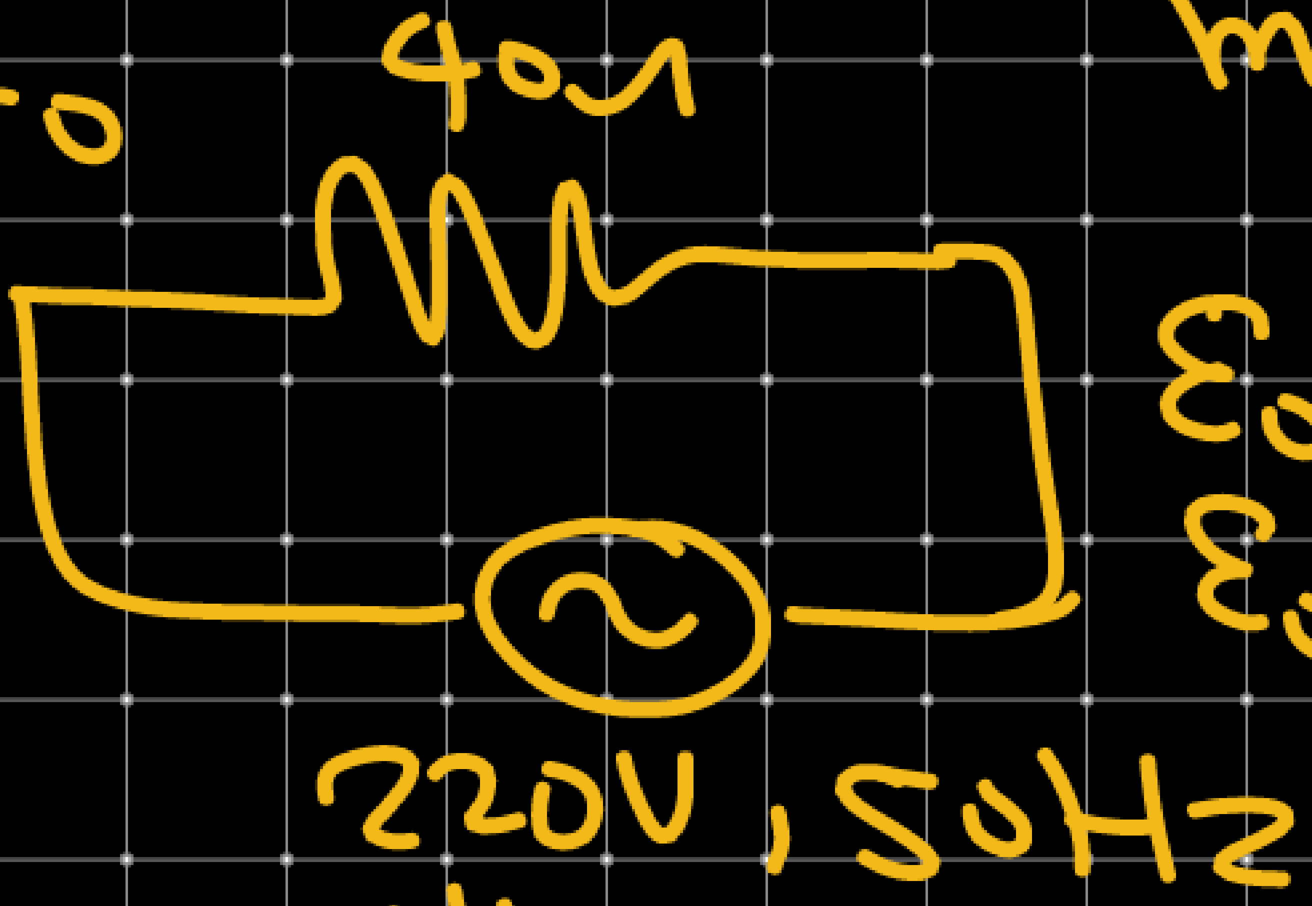
$\omega = 2\pi f$

$= 2\pi \times 50$

$= 100\pi$

$R = 40\Omega$

220V, 50Hz



$\varepsilon = 220\sqrt{2}\sin(\omega t)$

rms value.

$\varepsilon = \varepsilon_0 \sin\omega t$

$\varepsilon_{rms} = \varepsilon_0/\sqrt{2}$

$\varepsilon_0 = \sqrt{2}\,\varepsilon_{rms}$

$\varepsilon_0 = 220\sqrt{2}$

$\varepsilon = \underline{220\sqrt{2}} \sin 100\pi t$

$\Downarrow$

$\cancel{220} = \cancel{220}\sqrt{2} \sin 100\pi t$

$\frac{1}{\sqrt{2}} = \sin 100\pi t$

$\sin\frac{\pi}{4} = \sin 100\pi t$

$\frac{\cancel{\pi}}{4} = 100\cancel{\pi} t$

$t = \frac{1}{400}$ sec

$$\mathcal{E} = \mathcal{E}_0 \sin \omega t$$

$$\mathcal{E} = 220\sqrt{2} \sin \omega t$$

$$\Downarrow$$

$$220 = 220\sqrt{2} \sin \omega t$$

$$i_{rms} = \frac{\varepsilon_{rms}}{Z}$$

$$i_{rms} = \frac{50}{500} = \frac{1}{10} = 0.1 \text{ Amp}$$