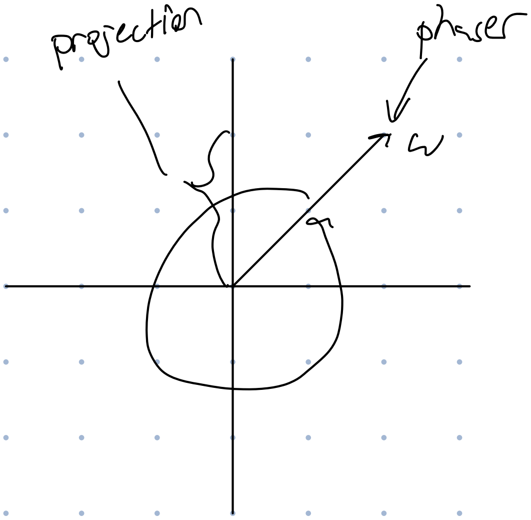
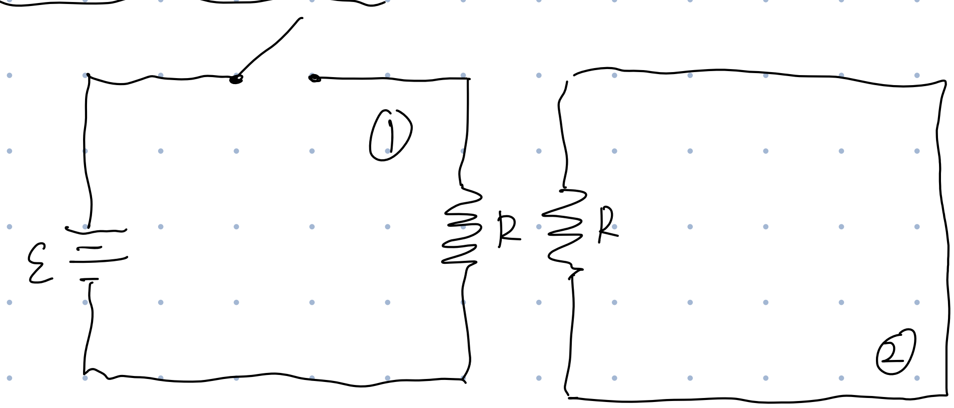
phaser

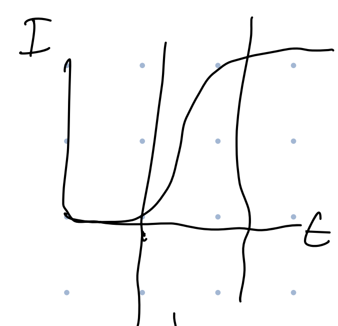


AC voltage is rotating arrow.

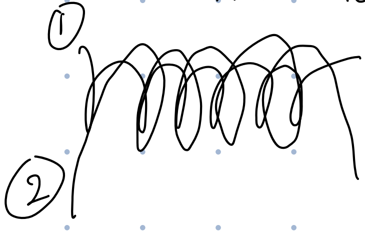
C/L act like a resistor in AC

Mutual inductance





- Close switch → I_1 → $\frac{d\Phi_B}{dt}$ → I_2 short term.



Transformers. Only work with AC because $\frac{d\Phi_B}{dt}$

- Every circuit has an inductance & a capacitance.

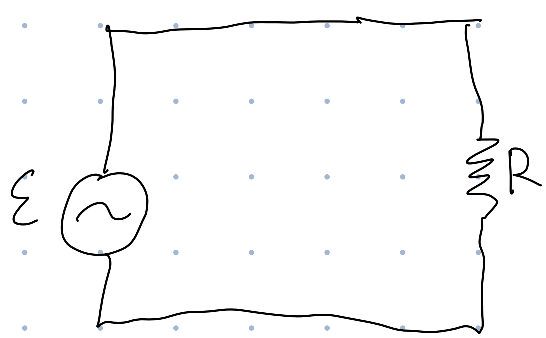
The faster Φ_B changes the more back Emf.

$\uparrow Hz \rightarrow \uparrow$ back Emf

Reactance - Resistance in AC   Impedance -

1) R: Joule resistance ($V = IR$)
   - Doesn't change w/ frequency
2) X_C: Capacitive Reactance
   - Changes w/ frequency
3) X_L: Inductive Reactance
   - Changes w/ frequency

AC Circits



Find I & phase ϕ between I & ε?

Loop:

$$\varepsilon - V_R = 0$$

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

$$\varepsilon_0 \sin \omega t - IR = 0$$

$$I = \frac{\varepsilon_0}{R} \sin \omega t$$

Denominator is always your reactance terms.

I & ε are in phase.

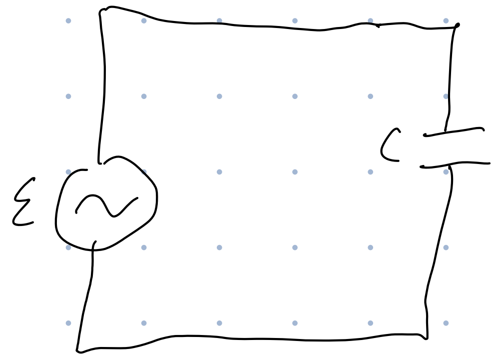
$\phi = 0^\circ$

- Reach their max @ the same time = in phase

Ex 2: Capacitive Reactance

$\uparrow f \uparrow T$ then $\uparrow I$

because I is large when you first start charging capacitor



Loop:

$$\mathcal{E} - V_c = 0 \qquad I = \frac{dQ}{dt}$$

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

I & $\mathcal{E}$ are $\phi = 90^\circ$ out of phase.

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

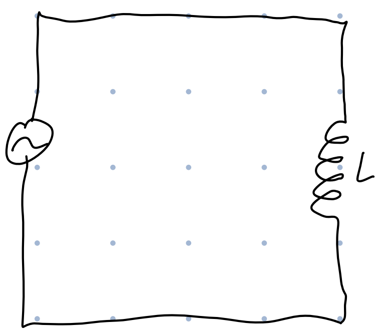
$$\omega C \mathcal{E}_0 \cos \omega t = \frac{dQ}{dt}$$

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{T} = 2\pi f \qquad \frac{\mathcal{E}_0}{\frac{1}{\omega C}} \cos \omega t = I$$

$\frac{1}{\omega C}$ → X_c

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

Ex 3:



Loop:

$$\mathcal{E} - V_L = 0$$

$$\mathcal{E}_0 \sin \omega t - L\frac{dI}{dt} = 0$$

$$\frac{\mathcal{E}_0}{L} \sin \omega t = \frac{dI}{dt}$$

I is -90° out of phase with $\mathcal{E}$

$$\int \frac{\mathcal{E}_0}{L} \sin \omega t \, dt = \int dI$$

$\uparrow Hz$ & $\uparrow \frac{d\Phi_B}{dt} \rightarrow \uparrow X_L$

$$-\frac{\mathcal{E}_0}{L\omega} \cos \omega t = I$$

$L\omega$ → X_L in Ω

L - Opposes any change in I

C - Opposes any change in V

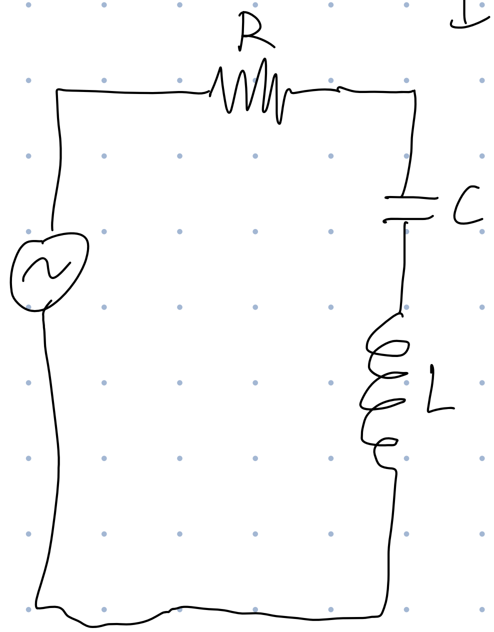
$$X_L = \omega L = 2\pi f L$$

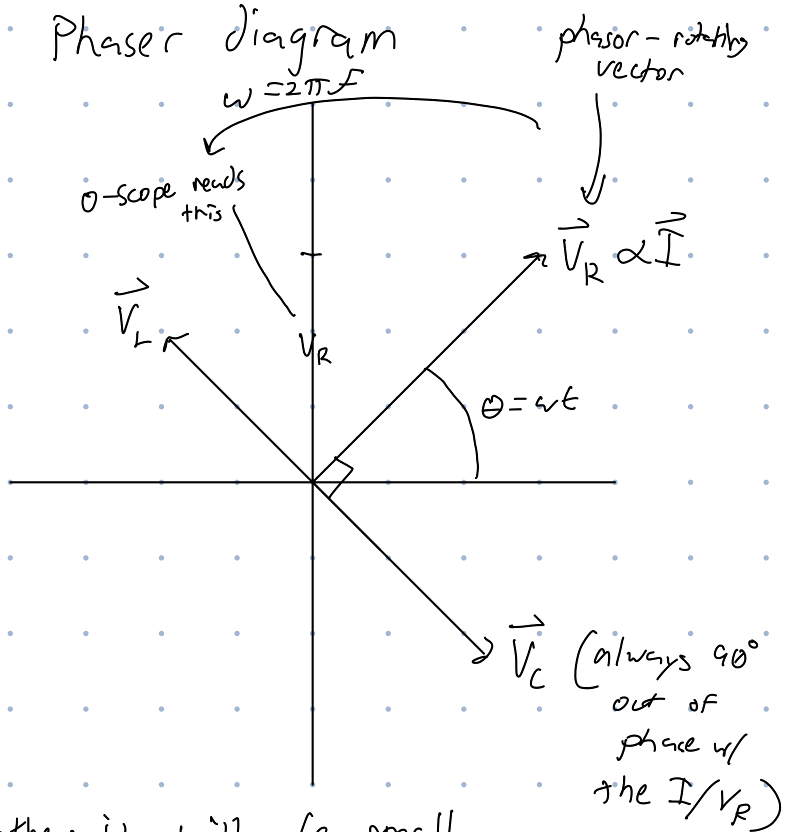
derive inductive reactance.
or capacitive reactance.

LCR series circuit

Phaser diagram

$I = ?$





If where the I will be big, but others it will be small.

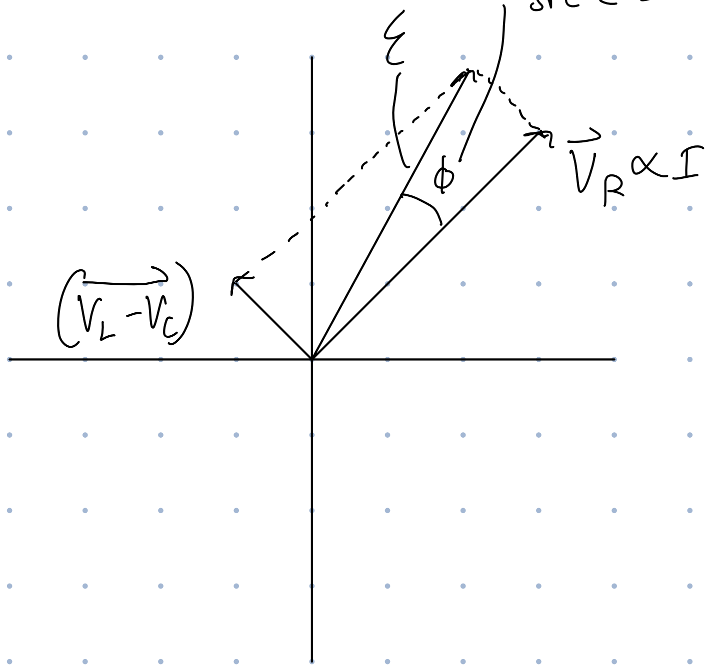
Z - impedance - Joule resistance + Reactances.

ELI the ICEman

L - Inductor
Voltage(ε) leads the current

C - Capacitor
Current leads the voltage(ε)

say $\vec{V}_L > \vec{V}_C$



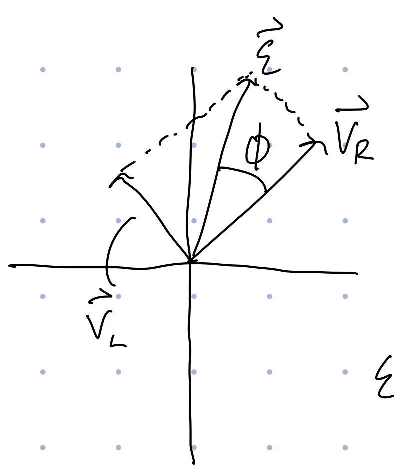
K.L.

$$\vec{\varepsilon} - \vec{V}_L - \vec{V}_R - \vec{V}_C = 0$$

$$\vec{\varepsilon} = \vec{V}_L + \vec{V}_R + \vec{V}_C = 0$$

Find ϕ

L-R circuit series



$$\varepsilon - V_R - V_L = 0$$

$V_L = I X_L$

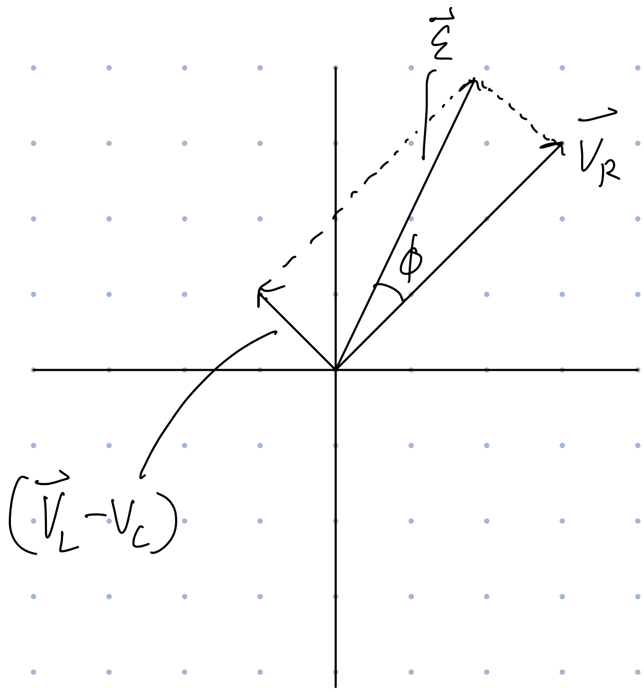
$V_R = I R$

$$\tan\phi = \frac{opp}{adj} = \frac{V_L}{V_R} = \frac{I X_L}{I R}$$

$$\phi = \tan^{-1}\left(\frac{X_L}{R}\right) = \tan^{-1}\left(\frac{\omega L}{R}\right)$$

$$= \tan^{-1}\left(\frac{2\pi f L}{R}\right)$$

L-C-R circuit



Pythagorean.

$$\mathcal{E} = \sqrt{(V_L - V_C)^2 + V_R^2}$$

Ohm's law whole circuit

$$IZ = \sqrt{(IX_L - IX_C)^2 + (IR)^2}$$

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

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

Z is a min when $\omega L - \frac{1}{\omega C} = 0$

So current is a max

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

$$\omega^2 LC = 1$$

$$\omega^2 = \frac{1}{LC}$$

$$f = \frac{1}{2\pi\sqrt{LC}}$$ Reshence frequency