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AC circuit with capacitive load.

Purely Resistive Load: current is in phase with voltage.

Inductive load (L): current lags behind voltage.

Capacitive load (C): current leads the voltage.

* The ratio of voltage maximum to current maximum.

Resistive circuit $I_m = \frac{V_m}{R}$

Inductive load: Inductive reactance

$$X_L = \omega L$$

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

Capacitive load:

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

$$I_m = \frac{V_m}{X_C} = V_m \omega C$$

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$V(t) = V_m \sin \omega t$

$I(t) = I_m \sin(\omega t + \phi)$

Resistive : $\phi = 0$

Inductive : $\phi = -\frac{\pi}{2}$

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

$V(t) = V_m e^{i\omega t}$

$= V_m [\cos \omega t + i \sin \omega t]$

$I(t) = I_m e^{i(\omega t + \phi)}$

Complex impedence

$Z = \frac{V(t)}{I(t)} = \frac{V_m}{I_m} e^{-i\phi}$

For resistive circuit $\phi = 0$, $Z = R$

For inductive circuit $\phi = -\frac{\pi}{2}$

$Z = \omega L e^{i\pi/2} = i\omega L$

For a capacitive circuit

$Z = \frac{1}{\omega C} e^{-i\pi/2} = \frac{-i}{\omega C} = \frac{1}{i\omega C}$