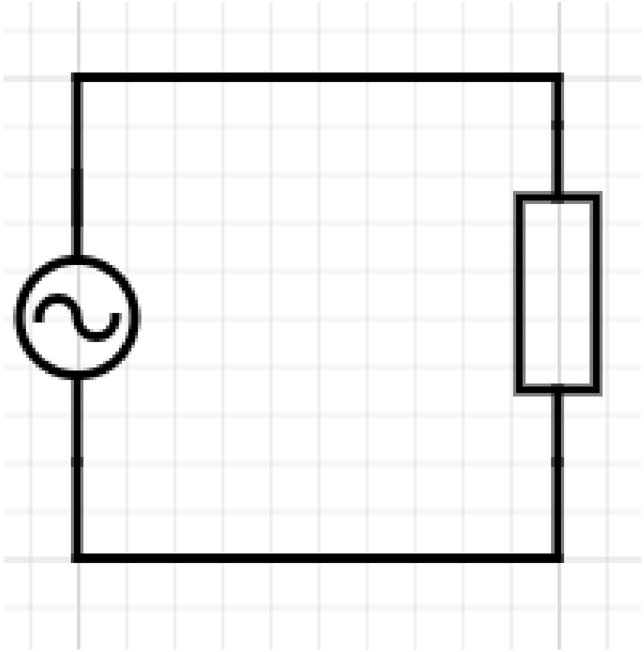
Resistors, Inductors and Capacitors

YORK COLLEGE & UNIVERSITY CENTRE

Resistors

- We can use ohms law to work out the value of voltage, current or resistance using ohms law
- But we can only do that for an instantaneous (a fixed point in the t graph)
- Resistors don't cause phase shift as they are a linear component making it easier than other components



$V = IR$ @ instantaneous t

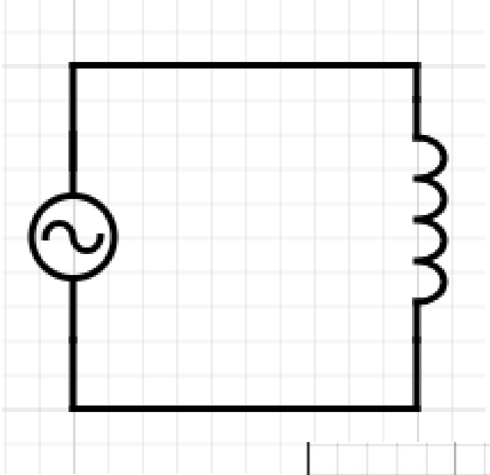
$V_{max} = I_{max} * R$

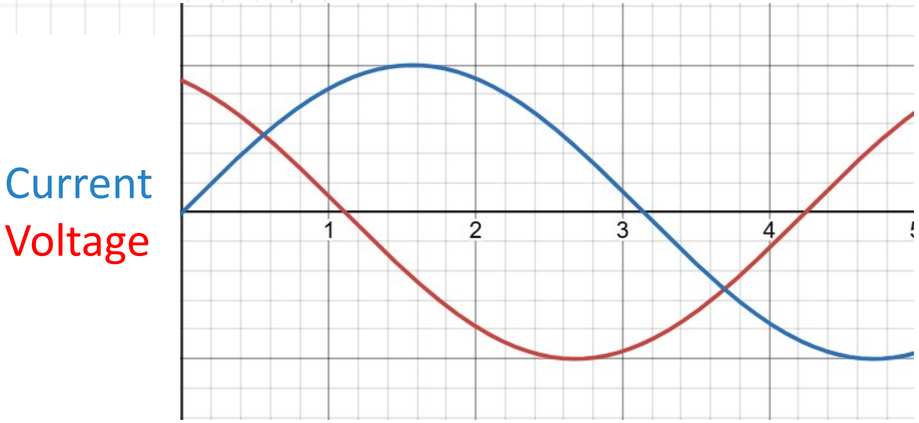
$V_{rms} = I_{rms} * R$

Inductors

- Inductors cause the change in current to slow down (or phase shift)
- In a purely inductive circuit, the voltage will always lead the current by 90°
- In an inductor the relationship between voltage and current can be expressed as:

$$v = L\frac{\Delta i}{\Delta t}$$





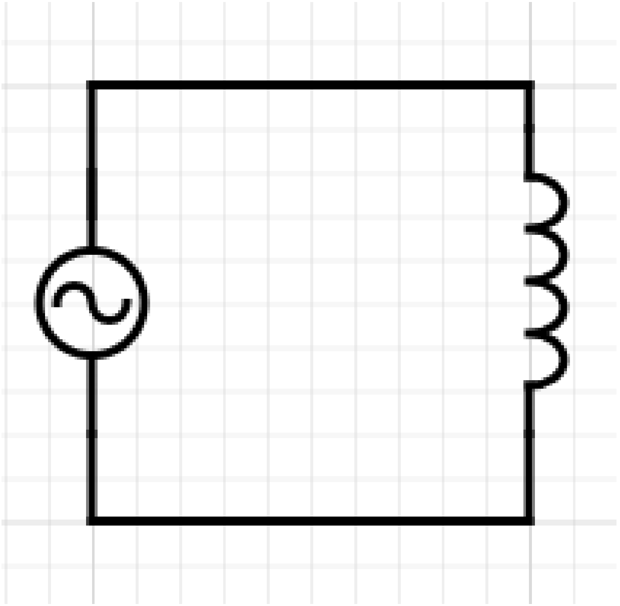
Inductors

- The instantaneous current of a purely inductive circuit is:

$$i = \frac{V_{\max}}{\omega L}\sin\left(\omega t - 90^{o}\right)$$

- We can then write ohm's law for inductors as:

$$I_{max} = \frac{V_{max}}{\omega L} \qquad I_{rms} = \frac{V_{rms}}{\omega L}$$



Inductive Reactance

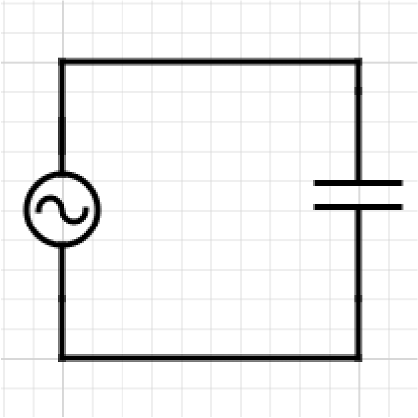
- Inductive reactance can be thought of as AC resistance
- We can write our inductive reactance as $|X_L|$ which is the magnitude of X_L so just half the vector not thinking about direction
- We can write our ohms version of reactance as $\frac{V}{I} = \omega L @ 90^o = j\omega L$ using our imaginary numbers
- $X_L = j\omega L\ \Omega$

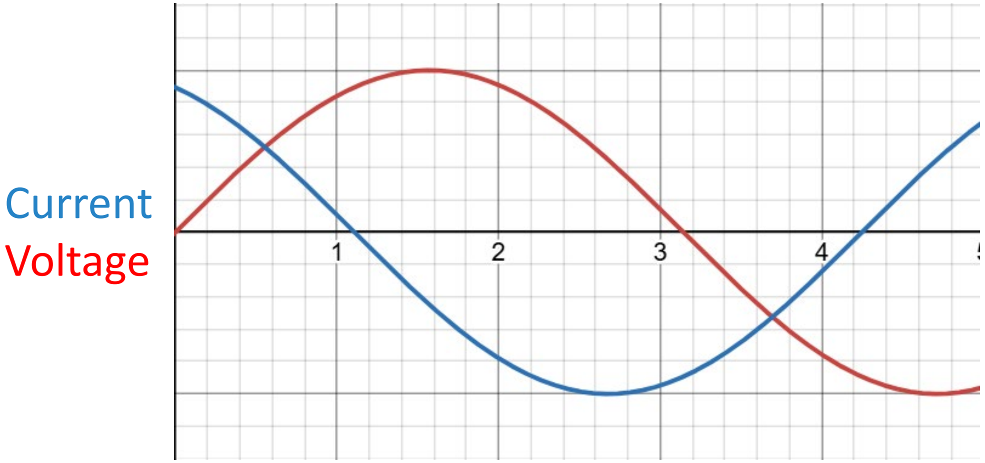
$$\frac{V}{I} = X_L$$

Capacitance

- Capacitors cause the change in voltage to slow down (or phase shift)
- In a purely inductive circuit, the current will always lead the voltage by 90^{o}
- In an inductor the relationship between voltage and current can be expressed as:

$$i = C\frac{\Delta v}{\Delta t}$$





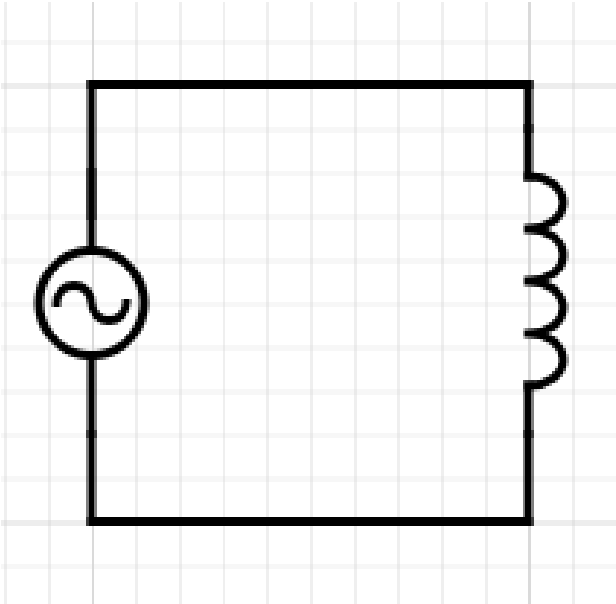
Capacitance

- The instantaneous current of a purely capacitive circuit is:

$$i = \omega C V_{max} \sin(\omega t + 90)$$

- We can then write ohm's law for inductors as:

$$i_{max} = \omega C V_{max} \qquad i_{rms} = \omega C V_{rms}$$



Inductive Reactance

- Inductive reactance can be thought of as AC resistance
- We can write our inductive reactance as $|X_C|$ which is the magnitude of X_C so just half the vector not thinking about direction
- We can write our ohms version of reactance as $\frac{V}{I} = \frac{1}{\omega C@90^o} = \frac{1}{j\omega C}$ using our imaginary numbers
- $X_L = \frac{1}{j\omega C}\ \Omega = -j\frac{1}{\omega C}$

$$\frac{V}{I} = X_C$$