Physics Year 13 (NCEA Level 3)

Alternating Current

Summary

In **AC** the Voltage (and Current) oscillate up and down in SHM.

$V = V_{\max} \sin(\omega t)$ $\quad$ ω is angular frequency of the supply (rad s^{-1})

where $\omega = 2\pi f$ $\quad$ f is the frequency of the supply (Hz)

To convert **AC** to **DC** it must be **rectified**. Diodes are commonly used because they conduct only in one direction.

Single diode: Half wave rectifier

Rectifier bridge (4 diodes): Full wave rectifier.

Ripples can be smoothed by large capacitor across the output.

RMS Voltage is defined as the **DC** voltage which produces the same power as **AC** with a peak voltage $V_{peak} = \sqrt{2} \times V_{RMS}$. Similarly for Current: $I_{peak} = \sqrt{2} \times I_{RMS}$

In an **AC** circuit:

Voltage and Current across a **Resistor** are in phase

Voltage across a **Capacitor** lags Resistor Voltage (and Current) by 90 degrees

Voltage across an **Inductor** leads Resistor Voltage (and Current) by 90 degr.

Reactance of a Capacitor and an Inductor are dependent on frequency:

Capacitor: $X_C = \dfrac{1}{\omega C} = \dfrac{1}{2\pi f C}$ easily conducts **high** frequency (small reactance)

Inductor: $X_L = \omega L = 2\pi f L$ easily conducts **low** frequency (small reactance)

AC filter in audio electronics uses these properties

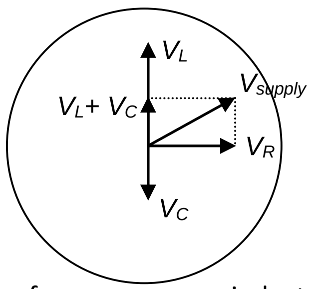
(Tweeter across Inductor; Woofer across Capacitor)

Phasor diagrams to illustrate Voltages and Reactance's:

Supply Voltage is **vector sum** of voltages across components

Circuit Impedance is **vector sum** of Reactance's of components

In RLC-circuit this means addition of three vectors.



Voltages

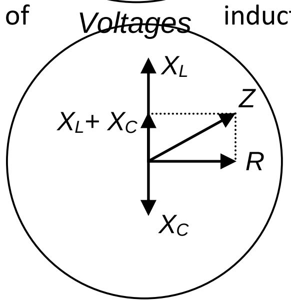
Resonance Frequency when reactance of capacitor is equal the reactance of inductor:

$$X_C = \frac{1}{\omega C} = \omega L = X_L \text{ or } \omega = \frac{1}{\sqrt{LC}}.$$

Then Impedance = resistance of resistor.

Hence current is maximum.

This principle is used in a radio receiver, metal detector, etc.



Reactance's