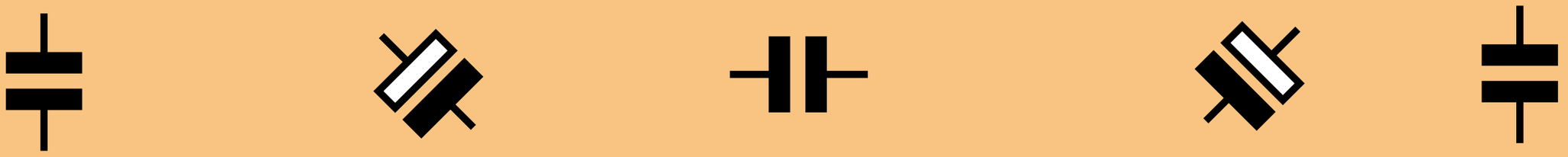
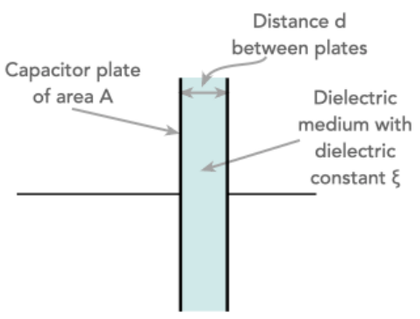
Basics of Capacitance

Capacitance is the ability of a component or circuit to collect and store energy in the form of an electrical charge. It is the amount of electric charge stored on a conductor for a stated difference in electric potential.

The unit of capacitance is the ***Farad.***
A capacitor has a capacitance of one Farad when a potential difference of one volt will charge it with one coulomb of electricity (i.e. one Amp for one second).

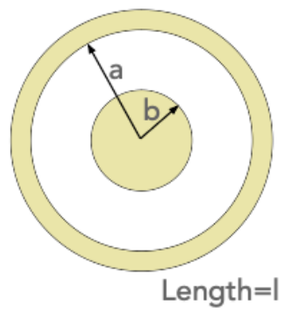


$$C = \varepsilon_r \varepsilon_0 \frac{A}{d}$$



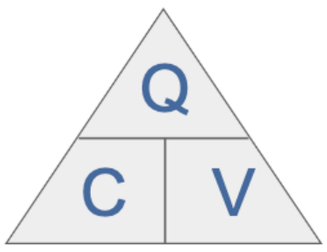
C = capacitance in Farads
ε_r = relative permittivity for that medium
ε_0 = permittivity of space and it is equal to 8.854×10^{-12} F/m
A = the area of one plate in square metres
d = distance between the two plates in metres

$$C = \frac{2 \pi \varepsilon_r \varepsilon_0 l}{\log (a / b)}$$



C = capacitance in Farads
ε_r = relative permittivity for that medium
ε_0 = permittivity of space and it is equal to 8.854×10^{-12} F/m
l = length of cylinder in metres
a = diameter of outer conductor in metres
b = diameter of inner conductor in metres

$$C = \frac{Q}{V}$$



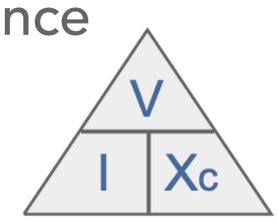
C is the capacitance in Farads
Q is the charge held on the plates in coulomb
V is the potential difference across the plates in volts

$$W = \frac{1}{2} C V^2$$

W is the work done or energy stored in joules, J
C is the capacitance in Farads, F
V is the potential difference across the plates in volts

Ohms law for capacitive reactance

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

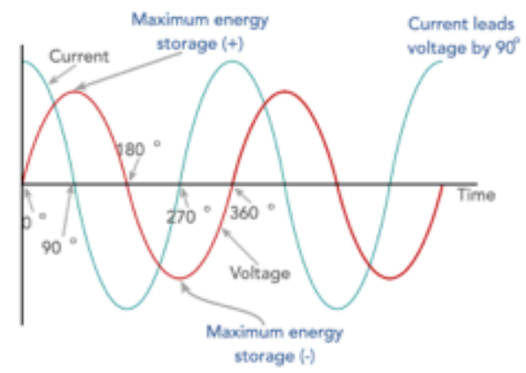


Ohm's law applies to capacitive reactances. If a resistance is also present, then this must be added vectorially as detailed below.

Voltage and current in capacitive only circuit

$$Vt = \sin (\omega t)$$

$$It = \sin (\omega t)$$



$$\text{Capacitive reactance } Xc = \frac{1}{\omega C} = \frac{1}{2 \pi f C}$$

Xc is the capacitive reactance in ohms
C is the capacitance in Farads
f is the frequency in Hertz

Adding capacitive reactance & resistance

When adding resistance to a capacitive impedance, this must be done vectorially because of the phase of the current in the capacitor.

$$\text{Total impedance } Z = \sqrt{R^2 + Xc^2}$$