VESP Vision

To be the centre of excellence in the field of technical education.

Program Code:-AO2I,EE2I

Course Name:-Applied Science(Physics)

Course Code : -22211

Course coordinator: Mrs. Deepa Gupte

Date: 1/4/21

Unit No:1

Unit Name: Electricity and capacitance

Unit Outcomes (UO1a):Explain the working of given capacitor and calculate equivalent capacity and energy stored in the given capacitor.

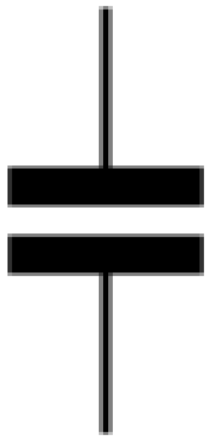
Learning Outcome (LO1) : **Students will be able to explain working of capacitor**

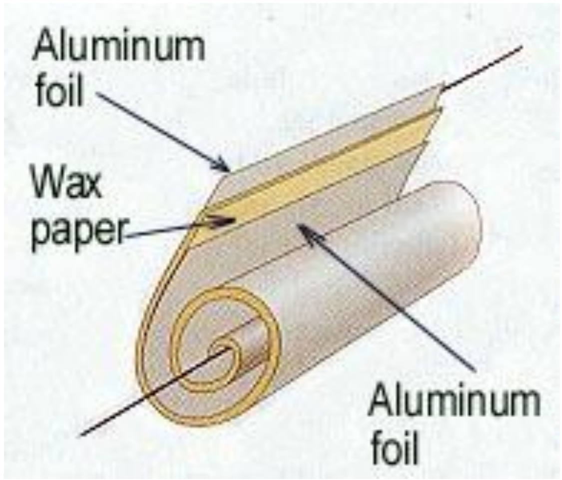
# Learning Objective/ Key learning

- Students will be explain working of capacitor.

- Students will be able to calculate equivalent capacitance in series and parallel combination.
- Students will be able to calculate energy stored in a capacitor.

- A capacitor is a device for storing electric charge.
- It can be any device which can store charges.
- Basically, capacitors consists of two metal plates separated by an insulator. The insulator is called dielectric. (e.g. polystyrene, oil or air)
- symbol:





# Capacity (Capacitance) of a Device

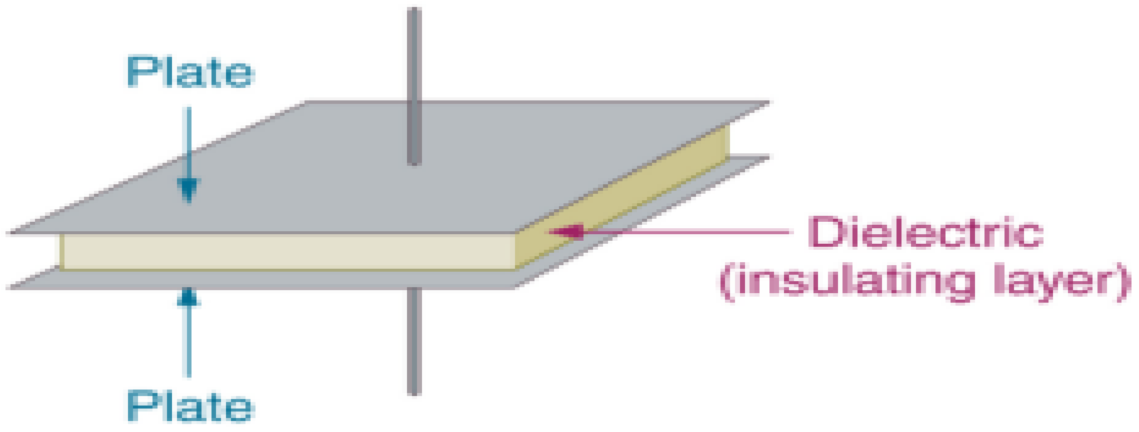
Capacity is the amount of charge that a capacitor can store per unit volt applied.

Capacity is directly proportional to charge and inversely proportional to voltage

$$C = \frac{Q}{V} \quad \text{or} \quad Q = CV$$

# Capacitance of parallel plate capacitor

## Capacitance of a Parallel Plate Capacitor




$$C = \left(8.85 \times 10^{-12}\right)\varepsilon_r \frac{A}{d}$$

# Capacitance of Parallel plate capacitor

$$C = \left(8.85 \times 10^{-12}\right)\varepsilon_r \frac{A}{d}$$

C = the capacity of the component, in farads
$(8.85 \times 10^{-12})$= the permittivity of a vacuum, in farads per meter (F/m)

$\varepsilon_r$ = the relative permittivity of the dielectric

$A$= the area of either plate, in square meters ($m^2$)

$d$ = the distance between the plates, in meters (m)

# Parallel plate capacitor

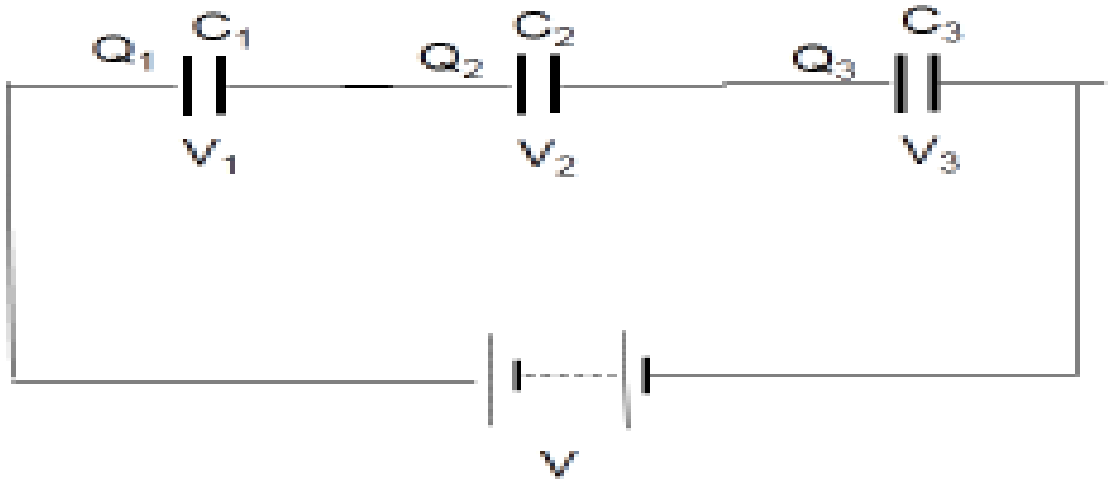
**Plate Area**: capacitance is directly proportional to plate area

**Dielectric Thickness**: capacitance is inversely proportional to dielectric thickness

**Dielectric Permittivity**: the ease with which lines of electrical force are established in the dielectric material

**Relative Permittivity**: the ratio of a material's permittivity to that of a vacuum

# Capacitors in series




$$V_1 = \frac{Q}{C_1} \qquad V_2 = \frac{Q}{C_2} \qquad V_3 = \frac{Q}{C_3}$$

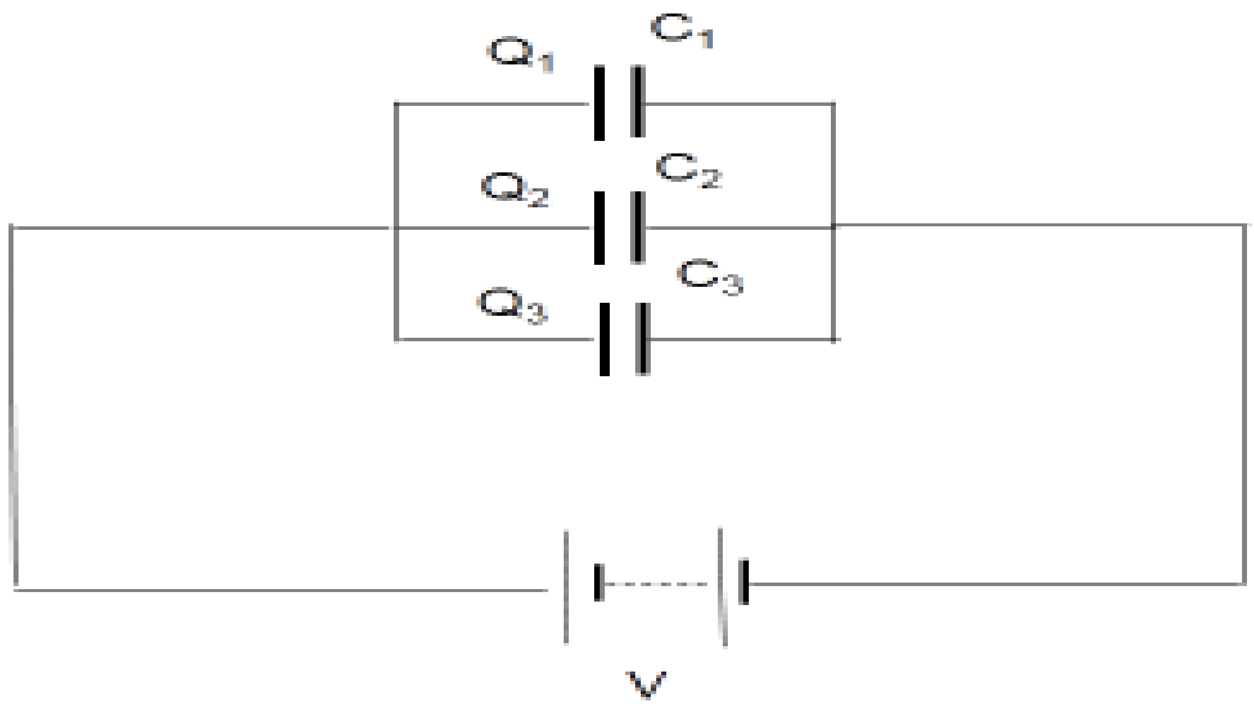
adding $$V_1 + V_2 + V_3 = Q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

i.e. $$V = Q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

A single capacitor which has the same effect is: $V = \dfrac{Q}{C}$

So: $$\frac{1}{C} = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

# Capacitors in parallel




The capacitors are in parallel and therefore there is the same p.d. across each

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

$$Q_1 = C_1V \qquad Q_2 = C_2V \qquad Q_3 = C_3V$$

$$Q_1 + Q_2 + Q_3 = C_1V + C_2V + C_3V$$

$$Q_1 + Q_2 + Q_3 = (C_1 + C_2 + C_3)V$$

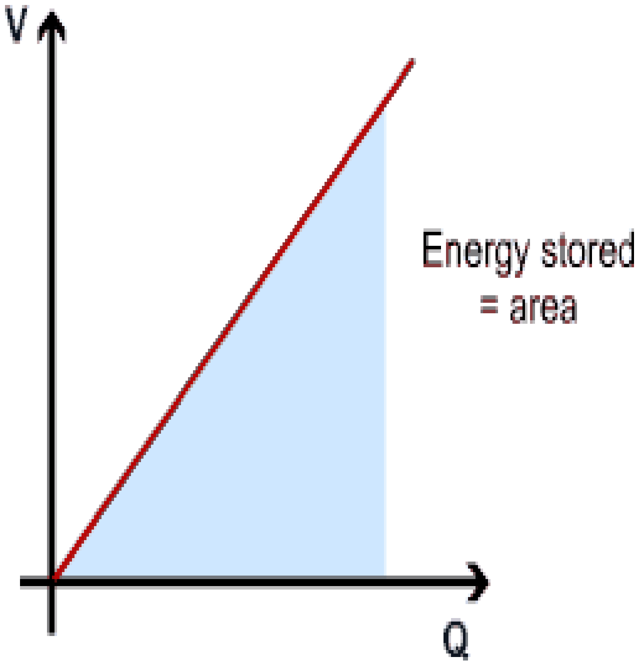
A single capacitor which stores as much charge ($Q = Q_1+Q_2+Q_3$) is represented by:

$$Q = CV$$

So $C = C_1 + C_2 + C_3$

It follows that capacitors in parallel have a total capacitance which is equal to the sum of their individual capacitances.

# Energy stored in capacitor




$$\text{Energy} = \text{Area} = \frac{1}{2} QV$$

As $Q = CV$ we can obtain 2 further equations:

$$\text{Energy} = \frac{1}{2} CV^2$$

And:

$$\text{Energy} = \frac{1}{2} \frac{Q^2}{C}$$