Capacitor | Capacitance Of a Parallel Plate Capacitor

Definition of capacitor

A device used to store electric charge is called a capacitor

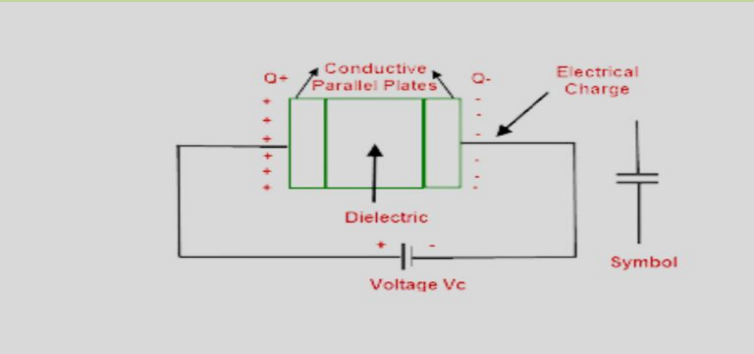
Topic Related Video:

What is capacitor and its capacitance

What does a capacitor do?

A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals

Construction of a capacitor



It consists of two conductors usually in the form of parallel plates placed near each other and separated by vacuum, air, or some dielectric. Such a capacitor is called a parallel plate capacitor.

How Does A Capacitor Work?

When the plates of such a capacitor are connected to a battery of voltage v, the plate connected to the positive terminal acquires +Q charge and the other connected to the negative terminal acquires –Q in an equal amount.

These charges appear on the inner surface of the plates due to attraction.

Expression for the capacitance of a capacitor

Let Q be the magnitude of the charge on either of the plates. It is found that charge Q stored by the capacitor is directly proportional to the potential difference V.

$$Q \propto V$$

$$Q=CV$$

Where C is the constant of proportionality known as Capacitance or capacity of a capacitor, its value depends upon the geometry of the capacitor and the medium between the plates.

The ability or capacitance of a capacitor to store charge is called capacitance.

$$C=\frac{Q}{V}=\frac{coulomb}{volt}=farad$$

So the S.I unit of capacitance is C/V which is called farad after the famous English scientist faraday.

The capacitance of a capacitor is one farad if a charge of one coulomb, given to one of the plates of a parallel plate capacitor produces a potential difference of one volt between them.

Farad is a big unit for practical purposes its sub-multiple units are used.

The capacitance of a parallel plate capacitor

Consider a parallel plate capacitor consisting of two parallel metallic plates each of area A and separated by a distance d. the distance between the plates is small than their size. So the electric field E is uniform and confined in the region between plates.

Let air or vacuum be present as a medium between plates. Then capacitance of the parallel plate's capacitor is given by

$$C_{vac}=Q/V$$

Q is the charge and V is the potential difference between the plates. Since E is uniform so the potential difference is given by

$$V=Ed \qquad (2)$$

But electric intensity between two oppositely charged plates is given by

$$E= \sigma/\epsilon_r$$

By putting value in equation 2

$$V= \sigma d/ \epsilon_r \qquad (4)$$

If Q is the charge on either of the plates of area A, then surface charge density is given as

$$\sigma = \frac{Q}{A}$$

So equation 4 becomes

$$V=\frac{Qd}{A\epsilon o}$$

$$C_{vac}=\frac{Q}{Qd/A\epsilon o}$$

$$C_{vac}=\frac{A\epsilon o}{d}$$

Thus capacitance of a parallel plate capacitor depends upon the nature of the medium, area of plates, and separation between plates.

Capacitance is directly proportional to the area of plates and inversely proportional to the separation of the plates.

Capacitance for Dielectric

If an insulating material called dielectric of relative permittivity ϵ_r is inserted between the plates.

Then the capacitance of the capacitor is increased by the factor ϵ_r called the dielectric constant.

Consider an experimental demonstration in which a charged capacitor is connected to a voltmeter giving the potential difference between plates.

When the dielectric is placed between the plates the reading of the voltmeter decreased so

$$C=Q/V$$

Since Q remains constant so when v decrease the value of C increase. Then

$$C_{med}=\frac{A\epsilon r\epsilon o}{d}$$

Capacitance depends upon which factors?

- Area A of the plates
- The separation d between plates
- The medium between the plates

Dielectric coefficient

The ratio of the capacitance of a parallel plate capacitor with an insulating substance as the medium between plates of its capacitance with vacuum as a medium between them

$$C_{med}/C_{vac}= \epsilon_r$$