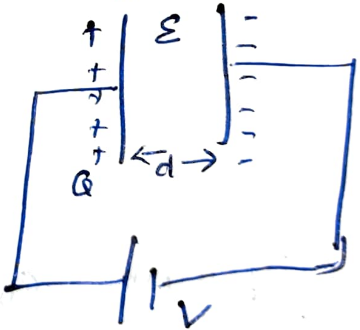
Capacitor and Capacitance:

Capacitor:

→ A capacitor is a passive electronic component with two terminals to store electric energy.

→ It blocks the flow of DC permits the AC.



$C = \frac{Q}{V}$ $C = \frac{A\varepsilon}{d}$.

A → cross sectional area.

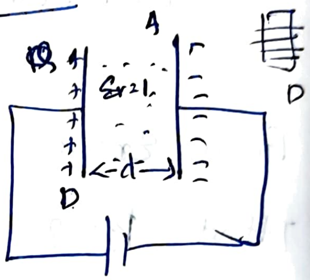
d → dielectric between the plate.

→ property of the capacitor is known as capacitance [C]

→ Unit is farad.

Derive the capacitance of parallel capacitors, spherical capacitor, coaxial and transmission line.

(*) Capacitance of Parallel plate Capacitor :



Consider a capacitor composed of two conducting plates of area 'A'.

$\varepsilon \rightarrow$ dielectric constant.

→ A uniform electric flux density over the plates

D = total charge per Area.

$$D = \frac{Q}{A} \; , C/m^2$$

$[D = \varepsilon E]$ $D \propto E$

Q → Total charge.

$$\varepsilon E = \frac{Q}{A}$$

$$\boxed{Q = \varepsilon E A} \rightarrow (1)$$

we are going to find C in parallel plate $C = \frac{Q \rightarrow}{A \rightarrow ?}$

Relation between E & V :-

$$V = -\int E\,dl \Rightarrow +\int E\,dl \Rightarrow E\int dl = E.d$$

$E = -\nabla V$

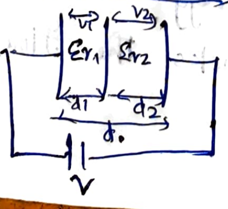
$V = -\int E\,dl$

$$V = E.d \qquad \boxed{E = \frac{V}{d}} \rightarrow \text{Substitute in } (1)$$

$$Q = \frac{\varepsilon A V}{d} = \frac{Q}{V} = \frac{\varepsilon A}{d}$$

$$\boxed{C = \frac{A\varepsilon}{d}} \text{ Farad.}$$

* Capacitance of two dielectric media (Parallel)



→ Consider a parallel plate capacitor with two dielectric media $[\varepsilon_{r1} + \varepsilon_{r2}]$.

→ The applied voltage 'V' is $V = V_1 + V_2$.

$$V = E_1 d_1 + E_2 d_2 \rightarrow (1)$$

The flux density $D_1 = \frac{Q}{A}$ $\quad \varepsilon_1 E_1 = \frac{Q}{A}$ $\quad D = \varepsilon_0 \varepsilon_r E$

$$D_1 \rightarrow E_1 = \frac{Q}{A \varepsilon_0 \varepsilon_{r1}}$$

$$D_2 \rightarrow E_2 = \frac{Q}{A \varepsilon_0 \varepsilon_{r2}}$$

Substitute in (1)

$$V = \frac{Q}{A \varepsilon_0 \varepsilon_{r1}} d_1 + \frac{Q}{A \varepsilon_0 \varepsilon_{r2}} d_2$$

$$V = \frac{Q}{A \varepsilon_0} \left[\frac{d_1}{\varepsilon_{r1}} + \frac{d_2}{\varepsilon_{r2}} \right]$$

$$V = \frac{Q}{A \varepsilon_0} \left[\frac{d_1 \varepsilon_{r2} + d_2 \varepsilon_{r1}}{\varepsilon_{r1} \varepsilon_{r2}} \right]$$

$$V = \frac{Q}{A \varepsilon_0} \left[\frac{d_1 \varepsilon_{r2} + d_2 \varepsilon_{r1}}{\varepsilon_{r1} \varepsilon_{r2}} \right] \Rightarrow \left(\frac{Q}{\frac{Q}{A \varepsilon_0} \left[\frac{d_1 \varepsilon_{r2} + d_2 \varepsilon_{r1}}{\varepsilon_{r1} \varepsilon_{r2}} \right]} \right)$$

$$C = \frac{Q}{V} = \frac{A \varepsilon_0 [\varepsilon_{r1} \varepsilon_{r2}]}{d_1 \varepsilon_{r2} + d_2 \varepsilon_{r1}} \text{ Farad.}$$

$|\varepsilon_{r1}|\varepsilon_{r2}|\varepsilon_{r3}]$