EE468G NOTES (5A)

Capacitance: Defined for one or more conducting structures

Free charge on conductor = Q

Voltage: V

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

Unit: [F]=Faraday

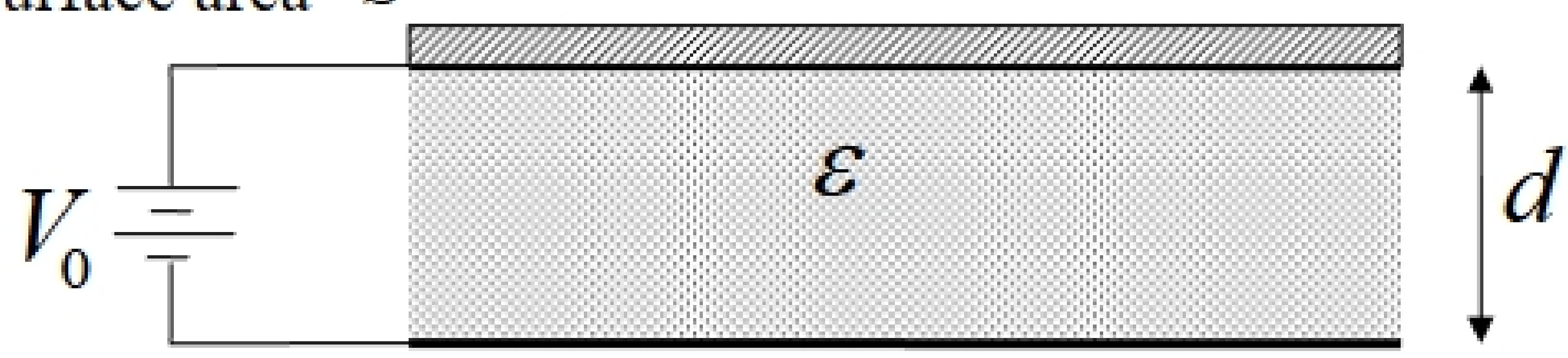
Calculation of capacitance:

Step 1: Apply a voltage source to the conductors V

Step 2: Calculate free-charge amount Q:

Step 3: C=Q/V

Example 1: Parallel plate capacitor (ignore fringe effect): Plate surface area= S



Electric field in the dielectric: the electric field intensity and electric flux are:

$$\vec{E} = -(V_0 / d)\hat{a}_z \qquad \vec{D} = \varepsilon\vec{E} = -\varepsilon(V_0 / d)\hat{a}_z$$

Free charge density and total charge on the upper plate:

$$\rho_S = -\hat{a}_z \cdot \vec{D} = \varepsilon V_0 / d \qquad Q = S\rho_S = \varepsilon S V_0 / d$$

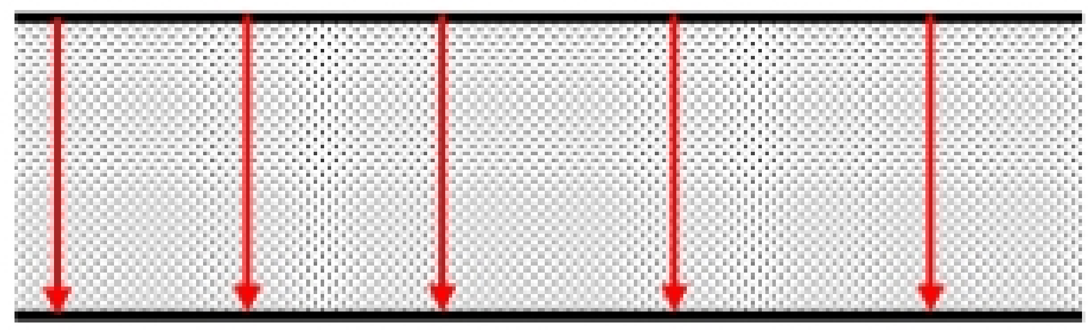
Capacitance

$$C = \frac{Q}{V} = \frac{\varepsilon S V_0 / d}{V_0} = \frac{\varepsilon S}{d} \quad [F]$$

Property:

$$C \propto \varepsilon, \qquad C \propto S, \qquad C \propto 1/d$$

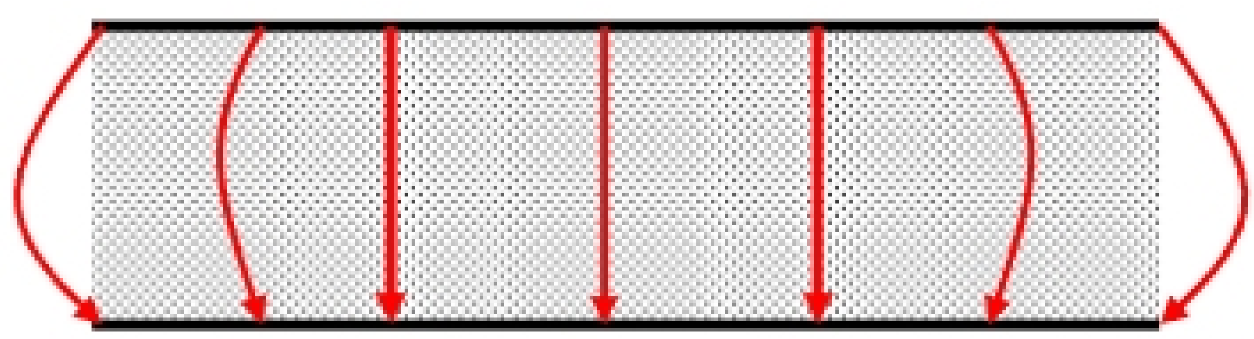
Infinite plate: Electric field intensity vector is uniform between the plates and pointing downward (if the upper plate has higher potential).



Fringe effect (effect of finite plate size):

Electric field intensity is almost uniform between the two plates, especially away from the edges.

The approximation to infinite plate case is good when the dimension in x and y directions are much larger than that of the z-directrion.



By "ignoring the fringe effect" or "ignoring the edge effect", we mean that the fields between the two plates are of the same as that of the infinite plate case.