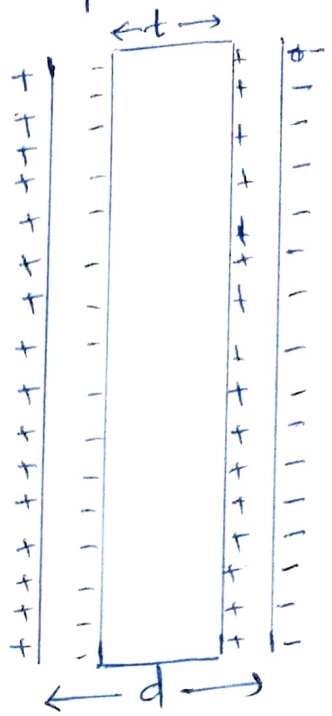
Capacitance of parallel plate capacitor with dielectric slab.



$A \rightarrow$ area of plate

$d \rightarrow$ separation between plates.

$t \rightarrow$ thickness of dielectric slab.

$V_1 \rightarrow$ potential due to dielectric slab.

$V_2 \rightarrow$ potential due to air gap.

$K \rightarrow$ dielectric constant.

$$C = \frac{q}{V} \qquad q = \sigma A \quad (\text{surface charge density})$$

$$V = V_1 + V_2, \quad V_1 = E_m \times t \qquad E_m = \frac{\sigma}{K\varepsilon_0} \qquad K = \frac{\varepsilon_m}{\varepsilon_0}$$

$$= \frac{\sigma}{K\varepsilon_0} \times t.$$

$$V_2 = E(d-t) = \frac{\sigma}{\varepsilon_0}(d-t)$$

$$V = \frac{\sigma}{\varepsilon_0}(d-t) + \frac{\sigma}{K\varepsilon_0} \times t = \frac{\sigma}{\varepsilon_0}\left((d-t) + \frac{t}{K}\right)$$

$$C = \frac{q}{V} = \frac{\sigma A}{\frac{\sigma}{\varepsilon_0}(d - t(1 - \frac{1}{K}))} = \frac{\varepsilon_0 A}{d - t(1 - 1/K)}$$

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