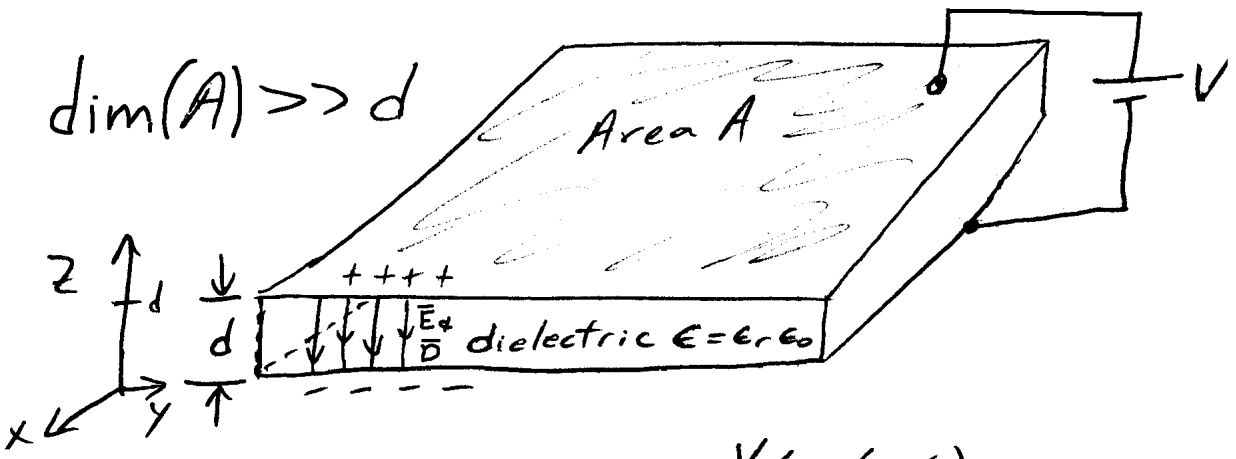
Example- Look at polarization of a dielectric slab inside a parallel-plate capacitor.



$$\bar{E} = -\bar{\nabla} V = -\hat{a}_z \frac{V}{d} \quad (V/m)$$

By defn $\bar{D} = \epsilon \bar{E} = \epsilon_r \epsilon_0 \left(-\hat{a}_z \frac{V}{d}\right) = -\hat{a}_z \frac{\epsilon_r \epsilon_0 V}{d} \quad (C/m^2)$

$$\bar{P} = \bar{D} - \epsilon_0 \bar{E} = -\hat{a}_z \frac{\epsilon_r \epsilon_0 V}{d} + \hat{a}_z \frac{\epsilon_0 V}{d}$$

$$\bar{P} = -\hat{a}_z (\epsilon_r - 1) \frac{\epsilon_0 V}{d} \quad (C/m^2)$$

$$\rho_{ps} = \bar{P} \cdot \hat{a}_n = \begin{cases} 0 & \text{sides} \\ \bar{P} \cdot \hat{a}_z & z = d \quad (\text{Top}) \\ \bar{P} \cdot -\hat{a}_z & z = 0 \quad (\text{Bottom}) \end{cases}$$

$$\rho_{ps} = \begin{cases} 0 & \text{sides} \\ -(\epsilon_r - 1) \frac{\epsilon_0 V}{d} & \text{Top } (z = d) \leftarrow \text{adj. to pos. plate} \\ (\epsilon_r - 1) \frac{\epsilon_0 V}{d} & \text{Bottom } (z = 0) \leftarrow \text{adj. to neg. plate} \end{cases}$$

$$\rho_{pv} = -\bar{\nabla} \cdot \bar{P} = 0 \quad (\bar{P} \text{ is a constant})$$