Lecture 13

niceguy

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1 Summary

Example 1.1. A 3mm gap between two capacitor plates is partially filled with a dielectric of thickness 1mm. The dielectric has a relative permittivity of $\varepsilon_r = 2$, and the charge densities on the two metal pates are $\rho_s = \pm 3\mu\text{C/m}^2$. In terms of magnitude of electric field intensity, $1 = 3 > 2$.
the polarization vector $\vec{P}$ is obviously 0 in free space. In the middle region with the dielectrics, we get

$$\vec{P} = \varepsilon_0 \chi_e \vec{E} = \varepsilon_0 (2-1) \frac{\rho_s}{2\varepsilon_0} = \frac{\rho_s}{2}$$

The relative permittivity ε_r of a material describes how easily it is polarized, relating to the electric susceptibility $\chi_e = \varepsilon_r - 1$.

2 Electric Flux Density

We can write

$$\vec{D} = \varepsilon_r \varepsilon_0 \vec{E} = \varepsilon_0 \vec{E} + \vec{P}$$

Then, $\vec{D}$ does not change with dielectrics, i.e. it is material independent. However, $\vec{E}$ is more associated with the field, or force needed to move charges.