

## QUIZ #4

Q1. The voltage applied to a parallel-plate capacitor is 10 V. If the distance between the two plates is 1 cm, find the **E**-field 0.2 cm away from one of the plates.

$$E = 10 / 0.01 = 1000 \text{ V}$$

Q2. The potential in a region of space is given as  $V = 0.5x^3 + 2yz$ , V. Find the **E**-field vector.

$$\mathbf{E} = -\nabla V = -(1.5x^2 \mathbf{a}_x + 2z \mathbf{a}_y + 2y \mathbf{a}_z)$$

Q3. An external electric field  $\mathbf{E} = \mathbf{a}_x(10 + x) + \mathbf{a}_y z$  V/m is applied to a dielectric material (the region  $x \geq 0$ ), which interfaces with vacuum ( $x < 0$ ). The relative permittivity of the dielectric material is  $\epsilon_r = 5$ . Find the bound surface charge density  $\rho_{sb}$  at the vacuum-dielectric interface.

$$\epsilon_0 = 8.854187 \times 10^{-12} \text{ F/m}$$

$$\mathbf{P} = \epsilon_0 \chi_e \mathbf{E} = \epsilon_0 (\epsilon_r - 1) \mathbf{E}, \quad \rho_{sb} = \mathbf{P} \cdot \mathbf{a}_n$$

$$\mathbf{a}_n = -\mathbf{a}_x \Rightarrow \rho_{sb} = -40\epsilon_0 \approx -354 \times 10^{-12} \text{ C/m}^2$$