# EE 381 Electric and Magnetic Fields Quiz #8 (Fall 2026)

**Name** KEY A

Instructions: **Open** book & notes. Place answers in indicated spaces and show all work for credit.

In free space, the electric potential is $V = -1.6x^2z$ (kV). At point $T$(40 cm, -10 cm, 60 cm), find the electric field and electric flux density vectors as well as the free charge density.

Per (4.76), $\overline{E} = -\overline{\nabla} V$. From the expression for V, use gradient in Cartesian coordinates

$$\overline{E} = -\hat{a}_x \frac{\partial(-1600x^2z)}{\partial x} - \hat{a}_y \frac{\partial(-1600x^2z)}{\partial y} - \hat{a}_z \frac{\partial(-1600x^2z)}{\partial z}.$$

$$= \hat{a}_x 3200xz - 0 + \hat{a}_z 1600x^2 \text{ (V/m)}$$

At point $T$, $\overline{E}_T = \hat{a}_x 3200(0.4)(0.6) + \hat{a}_z 1600(0.4)^2 = \hat{a}_x 768 + \hat{a}_z 256$ (V/m).

Per (4.35), $\overline{D} = \varepsilon_0 \overline{E} = \varepsilon_0 \left( \hat{a}_x 3200xz + \hat{a}_z 1600x^2 \right)$.

At point $T$,

$$\overline{D}_T = \varepsilon_0 \overline{E}_T = 8.8541878 \times 10^{-12} \left( \hat{a}_x 768 + \hat{a}_z 256 \right) = \hat{a}_x 6.8000 \times 10^{-9} + \hat{a}_z 2.2667 \times 10^{-9} \text{ (C/m}^2\text{)}$$

Per Gauss' Law (4.43), $\rho_v = \overline{\nabla} \bullet \overline{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$. Here,

$$\rho_v = \overline{\nabla} \bullet \overline{D} = \frac{\partial(\varepsilon_0 3200xz)}{\partial x} + 0 + \frac{\partial(\varepsilon_0 1600x^2)}{\partial z} = 3200\varepsilon_0 z + 0.$$

At point $T$, $\rho_{v,T} = 3200(8.8541878 \times 10^{-12})0.6 = 1.700004 \times 10^{-8}$ (C/m$^3$).

$\overline{E}_T =$ $\hat{a}_x 768 + \hat{a}_z 256$ (V/m)

$\overline{D}_T =$ $\hat{a}_x 6.8000 + \hat{a}_z 2.2667$ (nC/m$^2$) $\rho_{v,T} =$ **17.00 (nC/m$^3$)**

# EE 381 Electric and Magnetic Fields Quiz #8 (Fall 2026)

**Name** KEY B

Instructions: **Open** book & notes. Place answers in indicated spaces and show all work for credit.

In free space, the electric potential is $V = -1.2\,y^2 z$ (kV). At point $P$ (50 cm, -20 cm, 40 cm), find the electric field and electric flux density vectors as well as the free charge density.

Per (4.76), $\overline{E} = -\overline{\nabla} V$. From the expression for V, use gradient in Cartesian coordinates

$$\overline{E} = -\hat{a}_x \frac{\partial(-1200y^2 z)}{\partial x} - \hat{a}_y \frac{\partial(-1200y^2 z)}{\partial y} - \hat{a}_z \frac{\partial(-1200y^2 z)}{\partial z}.$$

$$= 0 + \hat{a}_y\, 2400yz + \hat{a}_z\, 1200y^2 \ \text{(V/m)}$$

At point $P$, $\overline{E}_P = \hat{a}_y\, 2400(-0.2)(0.4) + \hat{a}_z\, 1200(-0.2)^2 = -\hat{a}_y\, 192 + \hat{a}_z\, 48$ (V/m).

Per (4.35), $\overline{D} = \varepsilon_0 \overline{E} = \varepsilon_0 \left( \hat{a}_y\, 2400yz + \hat{a}_z\, 1200y^2 \right)$.

At point $P$,

$$\overline{D}_P = \varepsilon_0 \overline{E}_P = 8.8541878\times10^{-12}\left(-\hat{a}_y\, 192 + \hat{a}_z\, 48\right) = -\hat{a}_y\, 1.7001\times10^{-9} + \hat{a}_z\, 0.4250\times10^{-9} \ \text{(C/m}^2\text{)}$$

Per Gauss' Law (4.43), $\rho_v = \overline{\nabla}\bullet\overline{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$. Here,

$$\rho_v = \overline{\nabla}\bullet\overline{D} = 0 + \frac{\partial(\varepsilon_0 2400yz)}{\partial y} + \frac{\partial(\varepsilon_0 1200y^2)}{\partial z} = 2400\varepsilon_0 z + 0.$$

At point $P$, $\rho_{v,P} = 2400(8.8541878\times10^{-12})0.4 = 8.50002\times10^{-9}$ (C/m$^3$).

$\overline{E}_P =$ $-\hat{a}_y\, 192 + \hat{a}_z\, 48$ (V/m)

$\overline{D}_P =$ $-\hat{a}_y\, 1.7001 + \hat{a}_z\, 0.4250$ (nC/m$^2$) $\qquad \rho_{v,P} =$ **8.500 (nC/m$^3$)**