Wednesday, November 13, 2024

A

EE 381 Electric and Magnetic Fields Quiz #9 (Fall 2024)

Name Key A

Instructions: Open book & notes. Use units/notation as given in class. Put answers in indicated spaces and **show all** work for credit.

In a volume of oil-contaminated sea water ($\varepsilon = 32\varepsilon_0$, $\sigma = 4$ S/m), the potential is $V = 360x^2 - 90x + 80$ V. Find the electric field, electric flux density, current density, and polarization vectors as well as the free volume charge density when $x = 0.4$ m.

(4.76) $\bar{E} = -\bar{\nabla}V = -\hat{a}_x \frac{\partial V}{\partial x} - \hat{a}_y \frac{\partial V}{\partial y}\to 0 - \hat{a}_z \frac{\partial V}{\partial z}\to 0$

$= -\hat{a}_x (720x - 90)$ V/m

$\bar{E}(x=0.4\text{ m}) = -\hat{a}_x [720(0.4) - 90] = -\hat{a}_x 198$ V/m

(5.34) $\bar{D} = \epsilon \bar{E} = 32(8.8541878 \times 10^{-12})(-\hat{a}_x 198)$

$\bar{D}(x=0.4\text{m}) = -\hat{a}_x 5.610 \times 10^{-8}$ C/m^2

(5.11) $\bar{J} = \sigma \bar{E} = 4(-\hat{a}_x 198) \Rightarrow \bar{J}(0.4\text{m}) = -\hat{a}_x 792$ A/m^2

(5.31) $\bar{P} = \bar{D} - \epsilon_0 \bar{E} = -\hat{a}_x 5.61 \times 10^{-8} - 8.8541878 \times 10^{-12}(-\hat{a}_x 198)$

$\bar{P}(0.4\text{m}) = -\hat{a}_x 5.4347 \times 10^{-8}$ C/m^2

(4.43) & (5.34) $\rho_v = \bar{\nabla} \cdot \bar{D} = \bar{\nabla} \cdot [-\hat{a}_x 32\epsilon_0 (720x - 90)]$

$= -\frac{\partial}{\partial x}[32\epsilon_0(720x - 90)] = -23040\epsilon_0$

$= -23040(8.8541878 \times 10^{-12}) = -2.0400 \times 10^{-7}$ C/m^3 (constant)

electric field vector = $\bar{E} = -\hat{a}_x 198$ (V/m)

electric flux density vector = $\bar{D} = -\hat{a}_x 56.10$ (nC/m^2)

current density vector = $\bar{J} = -\hat{a}_x 792$ (A/m^2)

polarization vector = $\bar{P} = -\hat{a}_x 54.347$ (nC/m^2)

free volume charge density = $\rho_v = -204.00$ (nC/m^3)

Wednesday, November 13, 2024

B

EE 381 Electric and Magnetic Fields Quiz #9 (Fall 2024)

Name Key B

Instructions: Open book & notes. Use units/notation as given in class. Put answers in indicated spaces and **show all** work for credit.

In a volume of oil-contaminated sea water ($\varepsilon = 26\varepsilon_0$, $\sigma = 2$ S/m), the potential is $V = 350y^2 - 70y + 60$ V. Find the electric field, electric flux density, current density, and polarization vectors as well as the free volume charge density when $y = 0.3$ m.

(4.76) $\bar{E} = -\bar{\nabla}V = -\hat{a}_x \frac{\partial V}{\partial x}^{\to 0} - \hat{a}_y \frac{\partial V}{\partial y} - \hat{a}_z \frac{\partial V}{\partial z}^{\to 0}$

$= -\hat{a}_y \frac{\partial}{\partial y}(350y^2 - 70y + 60) = -\hat{a}_y (700y - 70)$ V/m

$\bar{E}(y = 0.3\text{m}) = -\hat{a}_y [700(0.3) - 70] = -\hat{a}_y 140$ V/m

(5.34) $\bar{D} = \epsilon \bar{E} \Rightarrow \bar{D}(0.3\text{m}) = 26(8.8541878 \times 10^{-12})(-\hat{a}_y 140)$

$= -\hat{a}_y 32.29 \times 10^{-9}$ C/m^2

(5.11) $\bar{J} = \sigma \bar{E} \Rightarrow \bar{J}(0.3\text{m}) = 2(-\hat{a}_y 140) = -\hat{a}_y 280$ A/m^2

(5.31) $\bar{P} = \bar{D} - \epsilon_0 \bar{E} \Rightarrow \bar{P}(0.3\text{m}) = -\hat{a}_y 3.229 \times 10^{-8} + \hat{a}_y 8.8542 \times 10^{-12}(140)$

$= -\hat{a}_y 3.0998766 \times 10^{-8}$ C/m^2

(4.43)+(5.34) $\rho_v = \bar{\nabla} \cdot \bar{D} = \bar{\nabla} \cdot [-\hat{a}_y 26\epsilon_0(700y - 70)]$

$= -\frac{\partial}{\partial y}(26\epsilon_0(700y - 70)) = -18200\epsilon_0$

$= -18200(8.8541878 \times 10^{-12}) = -1.61146 \times 10^{-7}$ C/m^3

(constant)

electric field vector = $\bar{E} = -\hat{a}_y 140$ (V/m)

electric flux density vector = $\bar{D} = -\hat{a}_y 32.229$ (nC/m^2)

current density vector = $\bar{J} = -\hat{a}_y 280$ (A/m^2)

polarization vector = $\bar{P} = -\hat{a}_y 30.990$ (nC/m^2)

free volume charge density = $\rho_v = -161.146$ (nC/m^3)