Islamic University in Madinah, Faculty of Engineering, Electrical Engineering Department
EE 282 - Mi[redacted]ter 2017 - 2018
Student ID #: [redacted]

Question 3 (10 + 10 + 10 + 10 = 40 Points): ρ_s

83

40

A uniform **sheet of charge** equal to **27.9 nC/m²** lies in z = 0 plane, and a **uniform line charge density** of **133.5 nC/m** lies along x-axis. Find a) $\vec{D}$ at A(0, 0, 4) and b) $\vec{D}$ at B(1, 2, 4).

ρ_L

$\rho_s = 27.9$ n c/m² in $Z = 0$ / And $\rho_L = 133.5$ n c/m in along X axis

a) A(0,0,4) $\Rightarrow a_{r_s} = \frac{4a_z}{4}$

10

$\Rightarrow \bar{D}_s = \frac{\rho_s}{2} \cdot a_{r_s} = \frac{27.9\times10^{-9}}{2} \cdot \frac{4a_z}{4} = 13.95 a_z$ n c/m²

$a_{r_L} = 4a_z$ And $|a_{r_L}| = \sqrt{4^2} = 4$

10

$\Rightarrow \bar{D}_L = \frac{\rho_L}{2\pi r} \cdot a_r = \frac{133.5\times10^{-9}}{2\times3.14\times4} \frac{(4a_z)}{4} = 5.314 a_z$ n c/m

$\bar{D} = D_L + D_s = 19.264$ n c/m

b) B(1,2,4) $\Rightarrow a_r = a_z$

10

$\bar{D}_s = \frac{\rho_s}{2} \cdot a_r = \frac{27.9\times10^{-9}}{2} \cdot a_z = 13.95 a_z$ n c/m²

$a_{r_L} = 2a_y + 4a_z$ so $|\bar{a}_{r_L}| = \sqrt{2^2+4^2} = \sqrt{20}$ / $a_{r_L} = \frac{2a_y+4a_z}{\sqrt{20}}$

$\bar{D}_L = \frac{\rho_L}{2\pi r} \cdot a_{r_L} = \frac{133.5\times10^{-9}}{2\times3.14\times20} \cdot (2a_y + 4a_z) = 2.125\times10^{-9} a_y + 4.251\times10^{-9} a_z$

$= (2.125 a_y + 4.251 a_z)$ n c/m

10

$\bar{D} = \bar{D}_L + \bar{D}_s = (2.125 a_y + 18.201 a_z)$ n c/m

(v/m)

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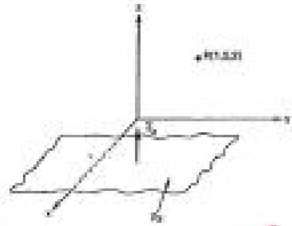
Question 2 (30 Points):

Given a **sheet of charge ρ_S = 25 nC/m²** over the plane z = -1 and the uniform **line charge density ρ_L = 180 nC/m** along x-axis. Find $\vec{E}$ at **P (1, 5, 2)** in free space. In the end, find **total $\vec{E}$** at point P.

Q.2

30

Constant: $\mathcal{E}_0 = \frac{1}{36\pi} \times 10^{-9} = 8.854 \times 10^{-12}$ F/m



$E_s = \frac{\rho_s}{2\epsilon_0} \cdot a_r$

$a_r = a_z$

So $\Rightarrow E_s = \frac{\rho_s}{2\epsilon_0} \cdot a_r = \frac{25\times10^{-9}}{2\times 8.854\times10^{-12}} \cdot (a_z) = 1411.791\, a_z$ V/m (C/m²)

And $E_L = \frac{\rho_L}{2\pi\epsilon_0 r} \cdot a_r$

$r = 5a_y + 2a_z$ so $|\bar{r}| = \sqrt{5^2+2^2} = \sqrt{29}$

so $a_r = \frac{5a_y + 2a_z}{\sqrt{29}}$

$\Rightarrow E_L = \frac{180\times10^{-9}}{2\times3.14\times8.854\times10^{-12}\times29} \cdot (5a_y + 2a_z) = 558.14\, a_y + 223.257\, a_z$ V/m (C/m)

So $\Rightarrow E_{Total} = E_L + E_s = 558.14\, a_y + 223.257\, a_z + 1411.791\, a_z$

$= 558.14\, a_y + 1635.048\, a_z$ V/m

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Q.1 (30)

Question 1 (30 Points):

Consider **Spherical co-ordinate system** and integrate to find the **area of the region** $0 \le \varphi \le \beta$ on the spherical shell of radius a. What will be the area for $\beta = 2\pi$?

$$\text{Area of regino} = \int_0^{\beta}\int_0^{\pi} a^2 \sin\theta \, d\theta \, d\phi$$

$$= \int_0^{\beta} a^2 \left. -\cos\theta \right|_0^{\pi} d\phi = \int_0^{\beta} a^2(-\cos\pi + \cos 0)\, d\phi = \int_0^{\beta} 2a^2 \, d\phi$$

$$= 2a^2 \left. \phi \right|_0^{\beta} = 2a^2\beta$$

when $\beta = 2\pi$

$A = 4a^2\pi$

Area of region $= 4\pi a^2$

Good

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EE 282 – ELECTROMAGNETIC FIELD THEORY

Fall Semester 2017 - 2018

Mid Term # 01

Date: November 02nd, 2017; Duration: 70 minutes

Student's Full Name: [redacted]

Student ID: [redacted] **Section #:1052** **Signature:** [redacted]

Instructions:

- Write your student ID number on the top of each page.
- Write the solution in the space provided under each question.
- Show all the steps of your calculations.
- Bring your own Calculators, use of mobile phone as calculators and sharing of calculators are strictly NOT allowed.

Question No.	Points Assigned	Points Awarded
1. [CO_1, PI_1_62, SO_1]	30	30
2. [CO_2, PI_1_46, SO_1]	30	30
3. [CO_3, PI_5_23, SO_5]	40	40
Total	100	100/100

Instructor's Full Name	Dr. Khawaja Bilal Mahmood
Signature	