

Student ID #: XXXXXXXXXX

Question 1 (100 points):

Apply Biot-Savart law and Calculate the differential magnetic field intensity at point A (2, 3, -2) due to a differential length of conductor. $2\pi(-2a_x + 2a_y - a_z)$ m, carrying a current of $1\mu\text{A}$, if the differential length is placed at point B (1, 3, 2).

At magnetic field intensity

$$dH = \frac{I dl \times a_r}{4\pi R^2}$$

$$I = 1\mu\text{A}$$

$$dl = -4\pi a_x + 4\pi a_y - 2\pi a_z$$

$$I \cdot dl = (-4\pi a_x + 4\pi a_y - 2\pi a_z) \mu\text{A} \cdot \text{m}$$

$$a_n = \left(\frac{-1, 0, 4}{\sqrt{1+16}} \right) = \left(\frac{-1, 0, 4}{\sqrt{17}} \right)$$

$$I dl \times a_r = \begin{vmatrix} a_x & a_y & a_z \\ -4\pi & 4\pi & -2\pi \\ \frac{-1}{\sqrt{17}} & 0 & \frac{4}{\sqrt{17}} \end{vmatrix} = \left[a_x \left(\frac{16\pi}{\sqrt{17}} - 0 \right) - a_y \left(\frac{-16\pi}{\sqrt{17}} - \frac{2\pi}{\sqrt{17}} \right) + a_z \left(0 + \frac{4\pi}{\sqrt{17}} \right) \right] \mu\text{A}$$

$$= \frac{16\pi}{\sqrt{17}} a_x + \frac{18\pi}{\sqrt{17}} a_y + \frac{4\pi}{\sqrt{17}} a_z$$

$$\therefore dH = \frac{1}{4\pi(17)} \left(\frac{16\pi}{\sqrt{17}} a_x + \frac{18\pi}{\sqrt{17}} a_y + \frac{4\pi}{\sqrt{17}} a_z \right) \mu\text{A/m}$$

$$= (-14.267 \times 10^{-3} a_x + 49.934 \times 10^{-3} a_y - 14.267 \times 10^{-3} a_z) \mu\text{A/m}$$

$$= (-14.267 a_x + 49.934 a_y - 14.267 a_z) \text{ nA/m}$$

$$dH = (-57.667 a_x + 64.204 a_y - 14.267 a_z) \text{ nA/m}$$

Some mistake here of sign.



EE 282 – ELECTROMAGNETIC FIELD THEORY

Fall Semester 2017 - 2018

Quiz # 04

Quiz Date: December 17th, 2017; Quiz Duration: 25 minutes

Student's Full Name: _____

Student ID #: _____ Section #: 1052 Signature: _____

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_6, PI_5_25, SO_5]	100	95
Total	100	95

95

100

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* The total outward flux crossing the side

$$d\vec{s} = r dz d\phi \vec{a}_r$$

$$\vec{D} \cdot d\vec{s} = -30r \vec{e}^r dz d\phi$$

$$\oint \vec{D} \cdot d\vec{s} = \int_0^2 \int_0^{2\pi} -30(z) \vec{e}^z dz d\phi$$

$$= -30(z) \vec{e}^z [z]_0^2 [\phi]_0^{2\pi}$$

$$= \underline{-102.04 \text{ C/m}^2}$$

Mistakes!!

The total flux:

$$-314.159 \text{ ~~102.04~~ } -102.04 \text{ ~~102.04~~ }$$

$$= -416.199 \text{ C/m}^2$$

Mistakes!!

Question 1 (30 + 30 + 30 + 10) = 100 points:

The flux density within the cylindrical volume bounded by $r = 5\text{m}$, $z = 0$ and $z = 2\text{m}$ is given by: $\vec{D} = 30e^{-r}\vec{a}_r - 2z\vec{a}_z \text{ C/m}^2$. What is the total outward flux crossing the surface of the cylinder?

75
 * The total outward flux ~~is~~ crossing the TOP:

$$d\vec{s} = r dr d\phi \vec{a}_z$$

$$\vec{D} \cdot d\vec{s} = -2z r dr d\phi \vec{a}_z$$

$$\oint \vec{D} \cdot d\vec{s} = \int_{\phi=0}^{2\pi} \int_{r=0}^5 -2z r dr d\phi =$$

$$z=2$$

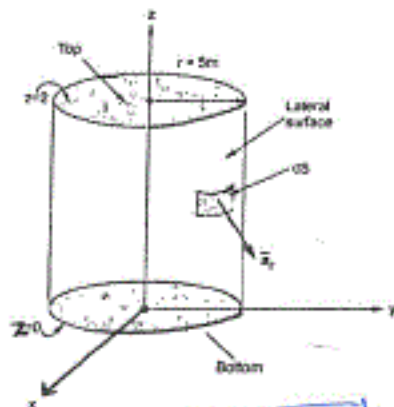
$$= -2(2) \left[\frac{r^2}{2} \right]_0^5 \left[\phi \right]_0^{2\pi} = -314.159 \text{ C/m}^2$$

* The total outward ~~flux~~ flux crossing the BOTTOM:

$$d\vec{s} = r dr d\phi (-\vec{a}_z)$$

$$\vec{D} \cdot d\vec{s} = -2z r dr d\phi (-\vec{a}_z)$$

$$\oint \vec{D} \cdot d\vec{s} = \int_{\phi=0}^{2\pi} \int_{r=0}^5 -2z r dr d\phi = 314.159 \text{ C/m}^2$$





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Quiz # 03

Quiz Date: November 23rd, 2017; Quiz Duration: 25 minutes

Student's Full Name: _____

Student ID #: _____ Section #:1052 Signature: _____

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
I. [CO_3, PI_5_23, SO_5]	100	75+5
Total	100	75+5

$\frac{75+5}{100} \rightarrow \frac{80}{100}$

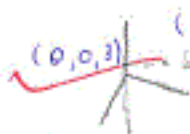
Instructor's Full Name	Dr. Khawaja Bilal Mahmood
Signature	

Student ID #: _____

Question 1 (50 + 50) = 100 points:

- a) A uniform line charge, infinite in extent with $\rho_L = 20 \text{ nC/m}$ lies along the z-axis. Find the \vec{E} at (6, 8, 3)?
 b) A charge of 1C is at (2, 0, 0). What charge must be placed at (-2, 0, 0) which will make y component of the total \vec{E} zero at point (1, 2, 2)?

100



$\rho_L = 20 \text{ nC/m}$ lies along z-axis $E = ?$ at (6, 8, 3)

$E = \frac{\rho_L}{2\pi\epsilon_0 r} \hat{a}_r \Rightarrow \frac{20 \times 10^{-9}}{2\pi \times 8.854 \times 10^{-12} \times 10} \times \left(\frac{6}{10} \hat{a}_x + \frac{8}{10} \hat{a}_y \right) = 21.58 \hat{a}_x + 28.78 \hat{a}_y \text{ C/m}$

$r = \sqrt{6^2 + 8^2} = 10$

b) $Q_1 = 1 \text{ C}$ (2, 0, 0) $Q_2 = ?$ (-2, 0, 0)

make $a_y = 0$ i.e. $E_y = 0$ at (1, 2, 2)

$\vec{r}_{Q_1} = (-1, 2, 2)$ $r_{Q_1} = \sqrt{1+4+4} = 3$ $\vec{r}_{Q_2} = (3, 2, 2)$ $r_{Q_2} = \sqrt{9+4+4} = 4.123$

$E_1 = \frac{1}{4\pi \times 8.854 \times 10^{-12} \times 3^2} \left(\frac{-1}{3} \hat{a}_x + \frac{2}{3} \hat{a}_y + \frac{2}{3} \hat{a}_z \right)$

$E_2 = \frac{Q_2}{4\pi \times 8.854 \times 10^{-12} \times 4.123^2} \left(\frac{3}{4.123} \hat{a}_x + \frac{2}{4.123} \hat{a}_y + \frac{2}{4.123} \hat{a}_z \right)$

$E_{\text{total}} = E_1 + E_2 \Rightarrow \frac{1}{4\pi \times 8.854 \times 10^{-12}} \left[\frac{1}{4} \left(\frac{-1}{3} \hat{a}_x + \frac{2}{3} \hat{a}_y + \frac{2}{3} \hat{a}_z \right) + \frac{Q_2}{17} \left(\frac{3}{4.123} \hat{a}_x + \frac{2}{4.123} \hat{a}_y + \frac{2}{4.123} \hat{a}_z \right) \right]$

$\Rightarrow \frac{1}{4\pi \times 8.854 \times 10^{-12}} \left(\frac{-1}{27} \hat{a}_x + \frac{2}{70.091} \hat{a}_y + \frac{2}{70.091} \hat{a}_z \right) = 0$

make y component zero

$\frac{2}{27} + \frac{2Q_2}{70.091} = 0$

$\frac{2Q_2}{70.091} = -\frac{2}{27}$ $Q_2 = \frac{-2}{27} \times \frac{70.091}{2}$

$Q_2 = -2.596 \text{ C}$



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Quiz # 02

Quiz Date: October 26th, 2017; Quiz Duration: 25 minutes

Student's Full Name: _____

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Instructions:

- Write your student ID number on the top of each page.
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- 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
I. [CO_2, PI_1_46, SO_1]	50 + 50 = 100	100
Total	100	100

100
100

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- b) Consider a Spherical co-ordinate system and Calculate the volume of a sphere of radius R using integration.

b

30

~~$dv = r dr d\theta d\phi$~~

$\int dv = \int_0^\pi \int_0^{2\pi} \int_0^R r^2 dr d\theta d\phi$



Mistakes in limits!

$= \int_0^\pi \int_0^{2\pi} \left[\frac{r^3}{3} \right]_0^R \sin\theta d\theta d\phi$

$= \int_0^\pi \left[\frac{R^3}{3} (-\cos\theta) \right]_0^{2\pi} d\phi$

mistakes in order of limits!

Mistakes here

$= \frac{R^3}{3} \int_0^\pi [-\cos 2\pi - (-\cos 0)] d\phi$

Mistakes in solution

$= \frac{R^3}{3} \int_0^\pi (1+1) d\phi = \frac{2R^3}{3} \phi \Big|_0^\pi$

$= \frac{2\pi R^3}{3}$

should be $\frac{4}{3} \pi R^3$ not $\frac{2}{3} \pi R^3$.

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Question 1 (50 + 50) = 100 points:

- a) Consider a Cartesian co-ordinate system, where three points $A(3, -2, 1)$, $B(-3, -3, 5)$ and $C(2, 6, -4)$ are given.

Find:

- a-1) Unit vector from B to A.
a-2) The distance from B to C.
a-3) The vector from A to the midpoint of the straight line joining B to C.

a) $\vec{BA} = 6a_x + a_y - 4a_z$

$\vec{BA}(6, 1, -4)$

$|\vec{BA}| = \sqrt{36+1+16} = 7.28$

the unit vector $a_{BA} = \frac{\vec{BA}}{|\vec{BA}|} = \frac{6a_x + a_y - 4a_z}{7.28}$

$= 0.82a_x + 0.14a_y - 0.55a_z$

- b) the distance from B to C

$|\vec{BC}| = \sqrt{(2+3)^2 + (6+3)^2 + (-4-5)^2} = 13.67$

- c) $D = \text{midpoint of line } \vec{BC} = (-1, 3, 1)$.

$A = (3, -2, 1)$

$\vec{AD} = -4a_x + 5a_y$

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Fall Semester 2017 - 2018

Quiz # 01

Quiz Date: October 05th, 2017; Quiz Duration: 25 minutes

Student's Full Name: _____
 Student ID #: _____ Section #:1052 Signature: _____

Instructions:

- Write your student ID number on the top of each page.
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- Show all the steps of your calculations.
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Question No.	Points Assigned	Points Awarded
I. [CO_1, PI_1_62, SO_1]	50 + 50 = 100	40 + 30 = 70
Total	100	70

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