

COURSE BINDER

**ROY G. PERRY COLLEGE OF ENGINEERING
ELECTRICAL AND COMPUTER
ENGINEERING DEPARTMENT
PRAIRIE VIEW A&M UNIVERSITY**

ASSESSMENT REPORT COVER PAGE

**ELEG 4305-P01 ELECTROMAGNETIC FIELD
THEORY I**

FALL 2021 SEMESTER

NAME OF INSTRUCTOR: Sarhan M. Musa

**PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
ELEG 4305- Electromagnetic Field Theory I
FALL 2021**

I. COURSE DESCRIPTION IN ABET FORMAT

II. ASSESSMENT RESULTS FOR CURRENT AND PAST THREE PERIODS

Program Outcomes Assessed in Course

Assessment Summary of Class Semester Averages for Outcomes

End of Semester Course Outcomes Assessment Reports

III. EXAMS

Summary of Topics covered by Exam

Original Test Questions & Master Solution/grading scheme used

(Summary of topics can be a separate page or include on the assignment itself)

Above Average (Graded original work)

Average (Graded original work)

Below Average (Graded original work)

III. QUIZZES

Summary of Topics covered by Quiz

Original Quiz Questions & Master Solution/grading scheme used

Above Average (Graded original work)

Average (Graded original work)

Below Average (Graded original work)

IV. ASSIGNMENTS

Summary of Topics covered by Homework

Original Homework Questions & Master Solution/grading scheme used

Above Average (Graded original work)

Average (Graded original work)

Below Average (Graded original work)

VI. PROJECT

Summary of Topics Covered by Project

Project Problem Statement and Grading Scheme

Above Average (Graded original work)

Average (Graded original work)

Below Average (Graded original work)

Course Description in ABET Format
DEPARTMENT OF ELECTRICAL & COMPUTER
ENGINEERING

ELEG 4305- ELECTROMAGNETIC FIELD THEORY I

1.	Course number and name:	ELEG 4305 ELECTROMAGNETIC FIELD THEORY I
2.	Credits and contact hours:	3 credit hours; 3 contact hours
3.	Instructor's or course coordinator's name:	Sarhan M. Musa
4.	Text book: Title:	Elements of Electromagnetics
	Author:	Matthew N.O. Sadiku
	Publisher, Year & Edition:	Oxford University Press, 7 th Edition, 2018
	a. Other Supplemental material	William Hayt and John Buck, "Engineering Electromagnetics," 9 th Edition, McGraw Hill, 2019
5.	Specific course information	
	a. Brief description of the content of the course (catalog description)	ELEG 4305. Network Theory II. (3-0) Credit 3 semester hours. Review of relevant mathematics, electricity, and magnetism. Study of dielectrics, Poisson's and Laplace's equations, magnetic flux, magnetic fields, and magnetic boundary conditions, Ampere's Circuital law, time varying fields and Maxwell's.
	b. Prerequisites or Co-requisites	ELEG 2305 Network Theory I MATH 4317 Advanced Math for Engineers
	c. *Indicate whether a required, elective, or selected elective (as per definition provided) course in the program	Required
6.	Specific goals for the course	Students will be able to:
	a. specific outcomes of instruction (e.g. The student will be able to explain the significance of current research about a particular topic.)	(1) Be able to develop the electromagnetic (EM) vector analysis and three-dimensional coordinate systems concepts. (2) Be able to understand the EM electrostatics and magnetostatics concepts. (3) Be able to Compute the EM boundary-value problems and dielectric. (4) Be able to solve the EM time-varying fields and Maxwell's equations problems. (5) Be able to gain an understanding of EM theory employed to design EM systems.
	b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.	This course addresses: Outcome 7 An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
7	Brief list of topics to be covered	Vector Analysis (6 hours) Electrostatic Fields (6 hours) Electric Fields in Material Space (6 hours) Electrostatic Boundary-Value Problems (6 hours) Magnetostatic Fields (6 hours) Magnetic Forces, Materials, and Devices (5 hours) Maxwell's Equations (5 hours) Electromagnetic Wave Propagation (4 hours)

II ASSESSMENT RESULTS FOR CURRENT AND PAST THREE PERIODS

Program Outcomes Assessed in this course

Outcome 7:

An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Assessment Summary of Class Semester Averages for Outcomes (Should be provided for Fall 2019 through Fall 2021 Assessment Period)

Outcomes	7
Semester	Semester Class Average (%)
Fall 2021	82
Fall 2020	82
Fall 2019	88.7
Comments on Trend of Data (Improving or deteriorating)	Students were able to identify adequate information needed for understanding of the aspects of the project and what needed to be done. However, some students did not follow some of the required format/guideline for their report and did not submit the project due to COVID.

*Expected Semester Class Average = 70% (or as defined by the program)

End of Semester Course Assessment Report

Each summary contains the following Information

1. Performance Statistics

- Total number of students in class
- The class average performance **(stated as %)** in each course outcome assessed in this class and the **two previous times course was assessed.**
- The acceptable class average for the class in each outcome area as set by your Department. **You cannot use any number of your choice**
- Percentage of students who scored below the expected average in each outcome.

2. Implementation Summary

- Brief summary of plans implemented during the semester based on last assessment report

3. Perceived Problems

- Instructor's **critical evaluation** of perceived problems that affected students' performance. **Realistic problems should be identified throughout the semester and summarized in this section of the report.**

4. New Plans for Addressing Problems

- Instructor's plans for addressing the perceived problems the next time the class is taught. **These should be specific enough for another instructor to implement. Most of these should be things that, you, the instructor can implement to help students to improve. Be creative.**

5. Overall Trend over last three assessment periods

- Instructors summary of overall performance trend for each outcome measured over the last three periods.

5. Were Expectations Met?

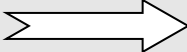
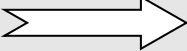
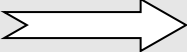
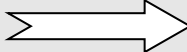
Answer **YES** if the **class average was above the expected average** and the **stated percentage of students** scored at or above the expected average, else

NO.

END OF SEMESTER COURSE OUTCOME ASSESSMENT REPORT
ELEG 4305-P01 ELECTROMAGNETIC FIELD THEORY I
FALL 2021 SEMESTER

Report Prepared by: Musa

Report Date: December 2021

Semester	Analysis Type	Number of Students	Outcome 7 An ability to acquire and apply new knowledge as needed, using appropriate learning strategies		
			Expected Class Average/	Class Average	% Students meeting Expected Average
Fall 2021	Direct	28	70	82	89
Fall 2020	Direct	22	70	82	84
Fall 2019	Direct	31	70	88.7	100
Implementation Summary		Students used resources available in the library and on the Internet to write a short paper on the long- and short-term effects of electromagnetism and how effects can be minimized. Also, the students need to include what is their learning strategy, how do they use the strategy to tackle the problem and describe how electromagnetic radiation can have detrimental impact.			
Perceived Problems		Students were able to identify adequate information needed for understanding of the aspects of the project and what needed to be done. However, some students did not follow some of the required format/guideline for their report and did not submit the project due to COVID.			
Plans for Addressing Problems		Instructor will emphasis on the importance of the guideline and how not following it can affect their grade.			
Overall Trend over Periods		Overall trends continue to be good, emphasize more on individual practice.			
Were Expectations Met?		Yes			

ELECTROMAGNETIC FIELD THEORY I

FALL 2021

Title of Assignment: Exam 1

Exam 1 covered the following topics:

- 1. Point charge in free space and force on charge**
- 2. Coulomb force, electric field intensity, magnitude of electric field intensity, and magnitude of unit vector**
- 3. Volume charge density and total charge in a region**
- 4. Electric flux density and charge density**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE

Ben Nguyen
10/8/21
ELEG 4305

97

Exam 1

1) $Q_1 = 2 \mu\text{C}$ at $(2, 3, 6)$ $Q_2 = 5 \mu\text{C}$ at $(0, 0, 0)$

$$\vec{F}_{Q_1} = \frac{Q_1 \cdot Q_2 (\vec{r}_1 - \vec{r}_2)}{4\pi \cdot \epsilon_0 |\vec{r}_1 - \vec{r}_2|^3}$$

$$= \frac{2 \times 5 \times 10^{-6} \times 10^{-6} [(2, 3, 6) - (0, 0, 0)]}{4\pi \times \frac{10^{-9}}{36\pi} \cdot (\sqrt{2^2 + 3^2 + 6^2})^3}$$

$$= \frac{1 \times 10^{-11}}{3.81 \times 10^{-8}} (2, 3, 6)$$

$$= 2.6239 \times 10^{-4} \cdot (2, 3, 6)$$

$$= 5.2478 \times 10^{-4} \vec{a}_x + 7.8717 \times 10^{-4} \vec{a}_y + 15.7434 \times 10^{-4} \vec{a}_z \quad (\text{N})$$

2) $\vec{F} = 2\vec{a}_x + 3\vec{a}_y + \vec{a}_z$ N $Q = 10 \text{ C}$

(a) electric field

$$\vec{E} = \frac{\vec{F}}{q} = \frac{2\vec{a}_x + 3\vec{a}_y + \vec{a}_z}{10}$$

$$= 0.2 \vec{a}_x + 0.3 \vec{a}_y + 0.1 \vec{a}_z \quad \frac{\text{N}}{\text{C}}$$

(b) Magnitude

$$|\vec{E}| = \sqrt{0.2^2 + 0.3^2 + 0.1^2} = 0.3741 \frac{\text{N}}{\text{C}}$$

(c) Direction

$$\vec{a} = \frac{\vec{E}}{|\vec{E}|} = \frac{(2, 3, 1)}{0.3741} = 5.34 \vec{a}_x + 8.01 \vec{a}_y + 2.67 \vec{a}_z$$

$$3) \rho_v = 5\rho^2 z \text{ mC/m}^3 \quad \begin{matrix} 0 < \rho < 2 \\ 30^\circ < \phi < 90^\circ \\ 0 < z < 1 \end{matrix}$$

total charge

$$\begin{aligned} Q &= \int \rho_v \cdot dV = \int_0^2 \int_{30^\circ}^{90^\circ} \int_0^1 5\rho^2 z \cdot \rho \cdot d\rho \cdot d\phi \cdot dz \\ &= 5 \int_0^2 \rho^3 d\rho \int_{30^\circ}^{90^\circ} d\phi \int_0^1 z \cdot dz \quad \text{mC} \\ &= 5 \cdot \left(\frac{\rho^4}{4} \Big|_0^2 \right) \cdot \left(\phi \Big|_{30^\circ}^{90^\circ} \right) \cdot \left(\frac{z^2}{2} \Big|_0^1 \right) \text{ mC} \\ &= 5 \cdot 4 \cdot \left(\frac{3}{2}\pi - \frac{30}{180}\pi \right) \cdot \frac{1}{2} \text{ mC} \\ &= 41.888 \text{ mC} \end{aligned}$$

$$4) \vec{D} = 2\rho(z+1)\cos\phi \vec{a}_\rho + \cancel{\rho(z+1)\sin\phi} \vec{a}_\phi - \rho(z+1)\sin\phi + \rho^2\cos\phi \vec{a}_z$$

$$\begin{aligned} \rho_v &= \nabla \cdot \vec{D} = \frac{1}{\rho} \frac{\partial}{\partial \rho} (\rho \cdot D_\rho) + \frac{1}{\rho} \frac{\partial}{\partial \phi} D_\phi + \frac{\partial}{\partial z} D_z \quad \mu\text{C} \\ &= \frac{1}{\rho} \cdot \frac{\partial}{\partial \rho} (2\rho^2(z+1)\cos\phi) - \frac{1}{\rho} \frac{\partial}{\partial \phi} (\rho(z+1)\sin\phi) + \frac{\partial}{\partial z} (\rho^2\cos\phi) \quad \mu\text{C} \\ &= \frac{1}{\rho} \cdot \frac{\partial}{\partial \rho} (2\rho^2 z \cos\phi + 2\rho^2 \cos\phi) - \frac{1}{\rho} \frac{\partial}{\partial \phi} (\rho(z+1)\cos\phi) + 0 \quad \mu\text{C} \\ &= \frac{1}{\rho} \cdot (4\rho z \cos\phi + 4\rho \cos\phi) - z \cos\phi - \cos\phi + 0 \quad \mu\text{C} \\ &= 4z \cos\phi + 4 \cos\phi - z \cos\phi - \cos\phi \quad \mu\text{C} \end{aligned}$$

$$= 3 \cos \phi + 3 \cos \phi$$

$\mu C / m^3$

AVERAGE

88

Abel Mendoza 10/8/2021
Dr. MUSA Test 1

(4) $\vec{D} = 2\rho(z+1)(\cos\phi\vec{a}_\rho - \rho(z+1)\sin\phi\vec{a}_\phi + \rho^2\cos\phi\vec{a}_z)$

Find charge density.

$$\rho_v = \nabla \cdot \vec{D} = \frac{1}{\rho} \frac{\partial}{\partial \rho} (\rho D_\rho) + \frac{1}{\rho} \frac{\partial D_\phi}{\partial \phi} + \frac{\partial D_z}{\partial z}$$

$$= \frac{1}{\rho} \frac{\partial}{\partial \rho} (2\rho^2(z+1)\cos\phi) + \frac{1}{\rho} \frac{\partial}{\partial \phi} (-\rho(z+1)\sin\phi) + \frac{\partial}{\partial z} (\rho^2\cos\phi)$$

$$= \frac{1}{\rho} 2(z+1)\cos\phi(2\rho) + \frac{1}{\rho} (-\rho(z+1))\cos\phi + 0$$

$$= 4(z+1)\cos\phi - (z+1)\cos\phi$$

$$= 3(z+1)\cos\phi \text{ } \mu\text{C/m}^3 \quad (-1)$$

③ Total charge Q in

$$\begin{aligned} Q &= \int \rho \, dv = \int_{z=0}^1 \int_{\phi=\frac{\pi}{6}}^{\frac{\pi}{2}} \int_{\rho=0}^2 (5\rho^2 z) \rho \, d\rho \, dz \, d\phi \\ &= \int_{z=0}^1 \int_{\rho=0}^2 \int_{\phi=\frac{\pi}{6}}^{\frac{\pi}{2}} 5(\rho^3 d\rho)(z dz) d\phi \end{aligned}$$

$$= \frac{5}{4} [\rho^4]_0^2 \left[\frac{z^2}{2} \right]_0^1 \left[\frac{\pi}{2} - \frac{\pi}{6} \right]$$

$$Q = \frac{5}{4} \times 16 \times \frac{1}{2} \times \frac{\pi}{3} \, mc = \frac{10\pi}{3} \, mc$$

$$Q = \frac{10\pi}{3} \, mc$$

① Given: $Q_1 = 2 \mu C$ $P_1(2, 3, 6)$
 $Q_2 = 5 \mu C$ $P_2(0, 0, 0)$

Force Q_1 from Q_2

$$F_{12} = \frac{Q_1 Q_2}{4\pi\epsilon_0 R^2} a_{12}$$

$$r_1 = 2ax + 3ay + 6az$$

$$r_2 = 0ax + 0ay + 0az$$

$$r = r_1 - r_2 = (2-0)ax + (3-0)ay + (6-0)az$$

$$= 2ax + 3ay + 6az$$

$$R = |r| = \sqrt{(2)^2 + (3)^2 + (6)^2} = 7$$

$$a_{12} = \frac{r}{|r|} = \frac{2ax + 3ay + 6az}{7}$$

Force on Q_1 due to Q_2

$$F_{12} = \frac{Q_1 Q_2}{4\pi\epsilon_0 R^2} a_{12}$$

$$= \frac{2 \times 10^{-6} \times 5 \times 10^{-6}}{4 \times \pi \times 8.854 \times 10^{-12} \times (7)^2} \cdot \frac{(2ax + 3ay + 6az)}{7}$$

$$F_{12} = 0.262 \times 10^{-3} (2ax + 3ay + 6az)$$

$$F_{12} = (0.524ax + 0.786ay + 1.572az) \times 10^{-3} N$$

$$F_{12} = (0.524ax + 0.786ay + 1.572az) mN$$

$$\textcircled{2} \quad \vec{E} = \frac{\vec{F}}{q} \quad \vec{E} = \frac{2\hat{a}_x + \hat{a}_y + \hat{a}_z}{10}$$

$$\vec{E} = 0.2\hat{a}_x + 0.3\hat{a}_y + 0.1\hat{a}_z \text{ N/C}$$

Unit vector along $\vec{F}$

$$\vec{E} \quad \textcircled{1} \quad |\vec{F}| = \sqrt{2^2 + 3^2 + 1^2} = 3.74 \text{ V/m}$$

$$\vec{a}_E = \frac{\vec{F}}{|\vec{F}|} = \frac{2}{3.74}\hat{a}_x + \frac{3}{3.74}\hat{a}_y + \frac{1}{3.74}\hat{a}_z$$

$$\vec{a}_E = 0.535\hat{a}_x + 0.802\hat{a}_y + 0.267\hat{a}_z$$

$\textcircled{-8}$

BELOW AVERAGE

Hallal Lados

77

1.

$$F_{12} = \frac{q_1 q_2}{4\pi\epsilon_0 R^2} \hat{a}_{12}$$

$$\vec{r}_1 = 2\hat{a}_x + 3\hat{a}_y + 6\hat{a}_z$$

$$\vec{r}_2 = 0\hat{a}_x + 0\hat{a}_y + 0\hat{a}_z$$

$$\vec{r} = \vec{r}_1 - \vec{r}_2 = 2\hat{a}_x + 3\hat{a}_y + 6\hat{a}_z$$

$$R = |\vec{r}| = \sqrt{2^2 + 3^2 + 6^2} = 7$$

$$\hat{a}_{12} = \frac{\vec{r}}{R} = \frac{2\hat{a}_x + 3\hat{a}_y + 6\hat{a}_z}{7}$$

$$F_{12} = \frac{q_1 q_2}{4\pi\epsilon_0 R^2} \hat{a}_{12}$$

$$F_{12} = 0.264 \times 10^{-3} (2\hat{a}_x + 3\hat{a}_y + 6\hat{a}_z)$$

$$F_{12} = (0.524\hat{a}_x + 0.786\hat{a}_y + 1.572\hat{a}_z) \text{ mN}$$

2.

$$\vec{E} = \frac{2\hat{a}_x + 3\hat{a}_y + 4\hat{a}_z}{10}$$

$$\vec{E} = 0.2\hat{a}_x + 0.3\hat{a}_y + 0.4\hat{a}_z$$

$$\vec{E} = \frac{\vec{F}}{q} \quad (-2)$$

N/C

(-1)

(b)

(-10)

(-10)

$$3. \int \rho_v dv = Q = \int_{z=0}^1 \int_{\phi=\pi/2}^{\pi/2} \int_{\rho=0}^2 (5\rho^2 z) \rho d\rho dz d\phi$$

$$\int_{z=0}^1 \int_{\rho=0}^2 \int_{\phi=\pi/2}^{\pi/2} 5(\rho^3 d\rho)(z dz) \times d\phi = \frac{5}{4} [\rho^4]_0^2 \left[\frac{z^2}{2} \right]_0^1 \left[\frac{\phi}{2} - \frac{\pi}{2} \right]$$

$$Q = \frac{10\pi}{3} \text{ mC}$$

$$4. \rho_v = \nabla \cdot \vec{D}$$

$$\rho_v = \frac{1}{r^2} \frac{\partial}{\partial r} [r^2 \rho(r+1) \cos \phi] + \frac{1}{r \sin \phi} \frac{\partial}{\partial \phi} [r(r+1) \sin \phi] + \frac{\partial}{\partial z} [\rho^2 \cos \phi]$$

$$\rho_v = \frac{1}{r} [4\rho(r+1) \cos \phi - \rho(r+1) \cos \phi + 0]$$

$$\rho_v = \frac{1}{r} [3\rho(r+1) \cos \phi]$$

$$\rho_v = 3(r+1) \cos \phi \text{ nC/m}^3$$

ELECTROMAGNETIC FIELD THEORY I FALL 2021

Title of Assignment: Exam 2

Exam 2 covered the following topics:

- 1. Capacitance value and energy stored**
- 2. Relaxation time**
- 3. Electric field intensity**
- 4. Polarization**
- 5. Electric susceptibility of material**
- 6. Magnitude of electric flux density**
- 7. Magnitude of polarization**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE

600 Electromagnetic Field Theory Exam #2 John W. Dewart
11/1/2021

1) $A = 0.06 \text{ m}^2$ $\epsilon_r = 4$ $d = 2 \text{ cm}$

a) $C = \frac{\epsilon_0 \epsilon_r A}{d} = \frac{(8.854 \text{ E-}12)(4)(0.06 \text{ m}^2)}{0.02 \text{ m}} = \boxed{106 \text{ E-}12 \text{ F}}$

b) $Q = CV = (106 \text{ E-}12 \text{ F})(30 \text{ V}) = \boxed{3.187 \text{ E-}9 \text{ C}}$

c) $W_E = \frac{1}{2} CV^2 = \frac{1}{2} (106 \text{ E-}12 \text{ F})(30 \text{ V})^2 = \boxed{47.812 \text{ E-}9 \text{ J}}$

2) $\epsilon_r = 81$ $\sigma = 5 \text{ S/m}$

$T_r = \frac{\epsilon_0 \epsilon_r}{\sigma} = \frac{(81)(8.854 \text{ E-}12) \text{ F/m}}{5 \text{ S/m}} = \boxed{143.438 \text{ E-}12 \text{ sec}}$

3) $\epsilon_r = 2$ $\vec{E} = 5\hat{a}_x + 3\hat{a}_y + 2\hat{a}_z \text{ V/m}$ $\epsilon_0 = 8.854 \text{ E-}12 \text{ F/m}$

a) $\chi_e = \epsilon_r - 1 = 1$

b) $\vec{P} = \chi_e \epsilon_0 \vec{E}$

$\vec{P} = (1)(8.854 \text{ E-}12)(5\hat{a}_x + 3\hat{a}_y + 2\hat{a}_z)$

$\vec{P} = (44.27\hat{a}_x + 26.562\hat{a}_y + 17.708\hat{a}_z) \text{ E-}12 \frac{\text{C}}{\text{m}^2}$

$$4) \vec{E} = 120 \text{ kV/m} \quad \chi_r = 4.35 \quad \epsilon_0 = 8.854 \text{ E-12 } \frac{\text{F}}{\text{m}}$$

$$a) |\vec{D}| = \epsilon_r \epsilon_0 |\vec{E}| \quad (\epsilon_r = \chi_r + 1 = 4.35 + 1 = 5.35)$$

$$|\vec{D}| = (5.35) (8.854 \text{ E-12 } \frac{\text{F}}{\text{m}}) (120 \frac{\text{kV}}{\text{m}})$$

$$|\vec{D}| = 5.684 \text{ E-6 } \frac{\text{C}}{\text{m}^2}$$

$$b) |\vec{P}| = \chi_r \epsilon_0 |\vec{E}|$$

$$|\vec{P}| = (4.35) (8.854 \text{ E-12}) (120 \frac{\text{kV}}{\text{m}})$$

$$|\vec{P}| = 4.617 \text{ E-6 } \frac{\text{C}}{\text{m}^2}$$

AVERAGE

94

Bob Patthammavong
class: ELEG4309

Exam 2

1/.

$$\begin{aligned} \text{Area } A &= 0.06 \text{ m}^2 \\ \epsilon_r &= 4 \\ d &= 2 \times 10^{-2} \text{ m} \end{aligned}$$

a/. Capacitance

$$C = \frac{\epsilon_0 \epsilon_r A}{d} =$$

$$C = \frac{8.85 \times 10^{-12} \times 4 \times 0.06}{2 \times 10^{-2}}$$

$$C = 1.062 \times 10^{-10} \text{ F}$$

b/. Find Charge (Q) when Potential difference = 30V

$$V = 30 \text{ V}$$

$$Q = CV = 1.062 \times 10^{-10} \times 30$$

$$Q = 31.86 \times 10^{-10} \text{ C}$$

c/. W_E

$$W_E = \frac{1}{2} CV^2$$

$$W_E = \frac{1}{2} \times 1.062 \times 10^{-10} \times (30)^2$$

$$W_E = 447.9 \times 10^{-10} \text{ J}$$

2/.

$$\begin{aligned} \epsilon_r &= 81 \\ \sigma &= 5 \text{ S/m} \end{aligned}$$

Find the relaxation time (T_r)

$$\begin{aligned} \text{Relaxation time } T_r &= \frac{\epsilon_r \epsilon_0}{\sigma} \\ T_r &= \frac{81 \times 8.85 \times 10^{-12}}{5} \end{aligned}$$

$$T_r = 143.37 \times 10^{-12} \text{ s}$$

3/

$$\epsilon_r = 2$$

$$\vec{E} = 5\vec{a}_x + 3\vec{a}_y + 2\vec{a}_z \text{ V/m}$$

a/. Find

$$\chi_e = \epsilon_r - 1$$

$$\chi_e = 2 - 1 = 1$$

b/. $\vec{P}$

$$\vec{P} = \chi_e \epsilon_0 \vec{E}$$

$$\vec{P} = 1 \times 8.854 \times 10^{-12} (5\vec{a}_x + 3\vec{a}_y + 2\vec{a}_z)$$

$$\vec{P} = (44.27 \vec{a}_x + 26.56 \vec{a}_y + 17.71 \vec{a}_z) \text{ pC/m}^2$$

4/

$$\vec{E} = 120 \text{ kV/m}$$

$$\chi_e = 4.35$$

$$\epsilon_r = \chi_e + 1$$



a/. Find $|\vec{D}|$

$$|\vec{D}| = \epsilon |\vec{E}| = \epsilon_0 \epsilon_r |\vec{E}|$$

$$|\vec{D}| = 4.35 \times 8.854 \times 10^{-12} \times 120 \times 10^3$$

$$|\vec{D}| = 4.6218 \text{ } \mu\text{C/m}^2$$

b/. $\vec{P}$

$$\vec{P} = \chi_e \epsilon_0 \vec{E}$$

$$\vec{P} = 4.35 \times 8.854 \times 10^{-12} \times 120 \times 10^3$$

$$\vec{P} = 4.6218 \text{ } \mu\text{C/m}^2$$

BELOW AVERAGE

AHMAD YAKUBA

89

Soln

- (1) given area = 0.06 m^2
Distance Between plates (d) = $2 \text{ cm} = 0.02 \text{ m}$

(a) capacitance value

we know $C = \frac{\epsilon_0 \epsilon_r A}{d}$ A

Substitute

$$C = \frac{8.85 \times 10^{-12} \times 1 \times 0.06}{0.02}$$

$$C = 106.2 \text{ pF}$$

(B) finding Charge

we know $Q = CV$

$Q = \text{Charge}$

$C = \text{Capacitance}$

$V = \text{Potential Value}$

given $C = 30 \text{ V}$

$Q = CV$

$$Q = 106.2 \times 10^{-12} \times 30$$

~~$Q = 3.186 \text{ nC}$~~

$$Q = 3.186 \text{ nC}$$

(C) Energy stored

Energy stored in capacitance

$$E = \frac{1}{2} CV^2$$

Putting the value of C & V

$$C = 106.2 \times 10^{-6} \text{ F}$$

$$V = 30 \text{ V}$$

$$E = \frac{1}{2} \times 106.2 \times 10^{-6} \text{ F} \times (30)^2$$

$$E = 47.79 \times 10^{-3} \text{ Joule}$$

(-1)

Q2) Relaxation Time, T_r

$$T_r = \frac{\epsilon}{\sigma} = \frac{\epsilon_0 \epsilon_r}{\sigma}$$

$\epsilon_0 \Rightarrow$ Permittivity of space

$$\epsilon_0 = 8.854 \times 10^{-12}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$$

$$\epsilon_r = 81$$

$$T_r = \frac{8.854 \times 10^{-12} \times 81}{\sigma}$$

$$= 1.43934 \times 10^{-10} \text{ s}$$

$$T_r = 1.43 \times 10^{-10} \text{ s} //$$

ELECTROMAGNETIC FIELD THEORY I

FALL 2021

Title of Assignment: Exam 3

Exam 3 covered the following topics:

- 1. Magnetic field intensity, magnetic flux density and total flux**
- 2. Current density**
- 3. Force on the charge**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE

100

Omer Atman
Test 3

$$1) \vec{H} = 4a\vec{x} + 5a\vec{z} \text{ A/m}$$

$$\vec{B} = \mu_0 \cdot \vec{H}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$$

$$\vec{B} = (4\pi \times 10^{-7}) (4a\vec{x} + 5a\vec{z})$$

$$\vec{B} = (5.02a\vec{x} + 6.28a\vec{z}) \times 10^{-6} \text{ Wb/m}^2$$

$$\vec{B} = (5.02a\vec{x} + 6.28a\vec{z}) \mu\text{Wb/m}^2$$

2)

$$\phi = |\vec{B}| \cdot |\vec{S}|$$

$$\vec{B} = 15 \mu\text{Wb/m}^2$$

$$S = \pi r^2 = \pi (3 \times 10^{-2} \text{ m})^2 = 9\pi \times 10^{-4} \text{ m}^2$$

$$\phi = (15 \mu\text{Wb/m}^2) \cdot (9\pi \times 10^{-4} \text{ m}^2)$$

$$= 42.4 \mu\text{Wb}$$

$$3) \vec{H} = y \cos 2x a\vec{x} + (y + e^x) a\vec{z} \text{ A/m}$$

$$\vec{J} = \vec{H} \times \nabla$$

$$\nabla \times \vec{H} = \begin{bmatrix} a_x & a_y & a_z \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ y \cos 2x & 0 & y + e^x \end{bmatrix}$$

$$= a_x \left[\frac{\partial}{\partial y} (y + e^x) \right] - a_y \left[\frac{\partial}{\partial x} (y + e^x) - \frac{\partial}{\partial z} (y \cos 2x) \right] - a_z \left[\frac{\partial}{\partial y} (y \cos 2x) \right]$$

$$\vec{J} = a_x - e^x a_y - \cos 2x a_z$$

$$|\vec{J}| = (a_x^2 - a_y^2 - a_z^2) \text{ A/m}^2$$

$$4) V = (8a\vec{x} + 2a\vec{y} - 3a\vec{z}) \text{ m/s}, \quad Q = 12 \text{ C}$$

$$a) \vec{E} = 18a\vec{x} + 5a\vec{y} + 10a\vec{z} \text{ V/m}$$

$$\vec{F} = Q \vec{E}$$

$$= (12) [18a\vec{x} + 5a\vec{y} + 10a\vec{z}]$$

$$\vec{F} = [216a\vec{x} + 60a\vec{y} + 120a\vec{z}] \text{ N}$$

$$|F| = \sqrt{216^2 + 60^2 + 120^2}$$

$$|F| = 254.28 \text{ N}$$

$$\begin{aligned}
 b) \quad \vec{B} &= 4a\vec{x} + 4a\vec{y} + 3a\vec{z} \\
 \vec{F} &= q[\vec{V} \times \vec{B}] \\
 &= 12 [(5a\vec{x} + 2a\vec{y} - 3a\vec{z}) \times (4a\vec{x} + 4a\vec{y} + 3a\vec{z})] \\
 &= 12 [(2\cdot 3 - (-3\cdot 4))a\vec{x} + (-3\cdot 4 - (-5\cdot 3))a\vec{y} + (5\cdot 4 - (2\cdot 4))a\vec{z}]
 \end{aligned}$$

$$\begin{aligned}
 &= 12(15a\vec{x} - 27a\vec{y} + 12a\vec{z}) \\
 \vec{F} &= (216a\vec{x} - 324a\vec{y} + 144a\vec{z}) \text{ N} \\
 |\vec{F}| &= \sqrt{216^2 + (-324)^2 + 144^2} \\
 |\vec{F}| &= 418 \text{ N}
 \end{aligned}$$

AVERAGE

Osesiya Ayeri 98

ELEG 4305

Exam 3

① $\vec{H} = 4\vec{a}_x + 5\vec{a}_z$ A/m

$\mu_0 \vec{H} = \vec{B}$

$\vec{H} = 4\vec{a}_x + 5\vec{a}_z$ $\mu_0 = 4\pi \times 10^{-7}$ H/m

$\vec{B} = (4\pi \times 10^{-7})(4\vec{a}_x + 5\vec{a}_z)$

$\vec{B} = (5.026\vec{a}_x + 6.28\vec{a}_z) \mu\text{Wb/m}^2$

② Magnetic flux density = 15 Wb/m^2

Area of the coil = $S = \pi r^2 = \pi (0.03)^2 = 0.9\pi \text{ mm}^2$

Total flux = $(\Phi = \vec{B} \cdot \vec{S} = |\vec{B}| |\vec{S}|)$

$\Phi = (15)(0.9 \times 10^{-3}) = 42.4 \mu\text{Wb}$

③ $\vec{H} = y \cos 2x \vec{a}_z + (y + e^x) \vec{a}_z$
 $(\vec{J}) = ?$

$\nabla \times \vec{H} = \vec{J} = \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ y \cos 2x & 0 & y + e^x \end{vmatrix}$

$= \vec{a}_x (\frac{\partial}{\partial y}(y + e^x) - 0) - \vec{a}_y (\frac{\partial}{\partial x}(y + e^x) - \frac{\partial}{\partial z}(y \cos 2x))$
 $+ \vec{a}_z (0 - \frac{\partial}{\partial y}(y \cos 2x))$

$= \vec{a}_x - e^x \vec{a}_y - \cos 2x \vec{a}_z$

$\oint \vec{H} \cdot d\vec{l} = \int_V (\vec{J} \cdot d\vec{V})$
 $\oint \vec{H} \cdot d\vec{l} = \int_V (\vec{a}_x - e^x \vec{a}_y - \cos 2x \vec{a}_z) \cdot d\vec{V}$

Osesiye Ayeri

④ $Q = 12C \quad \vec{V} = (5\vec{a}_x + 2\vec{a}_y - 3\vec{a}_z) \text{ m/s}$

② $\vec{E} = (18\vec{a}_x + 5\vec{a}_y + 10\vec{a}_z) \text{ V/m}$
 $\vec{F} = QE = 12(18\vec{a}_x + 5\vec{a}_y + 10\vec{a}_z)$
 $\vec{F} = 216\vec{a}_x + 60\vec{a}_y + 120\vec{a}_z \text{ Answe}$
 $|\vec{F}| = \sqrt{(216)^2 + (60)^2 + (120)^2} = 254.28 \text{ V}$

③ $\vec{F} = q(\vec{V} \times \vec{B})$
 $\vec{F} = 12 \{ (5\vec{a}_x + 2\vec{a}_y - 3\vec{a}_z) \times (4\vec{a}_x + 4\vec{a}_y + 3\vec{a}_z) \}$

$$\vec{F} = 12 \begin{bmatrix} a_x & a_y & a_z \\ 5 & 2 & -3 \\ 4 & 4 & 3 \end{bmatrix}$$

$$F = 12 [(2 \times 3 - (4) \times (-3))\vec{a}_x - (5 \times 3 - 4 \times 3)\vec{a}_y + (5 \times 4 - 4 \times 2)\vec{a}_z]$$

$$\vec{F} = 12 [(6 + 12)\vec{a}_x - (15 + 12)\vec{a}_y + (20 - 8)\vec{a}_z]$$

$$\vec{F} = (216\vec{a}_x - 324\vec{a}_y + 144\vec{a}_z) \text{ N}$$

$$|\vec{F}| = \sqrt{(216)^2 + (-324)^2 + (144)^2}$$
$$|\vec{F}| = 415.17 \text{ N}$$

BELOW AVERAGE

Abel Mendoza

Dr. Mvsa

11/17/2021

96

Exam 3

- ① magnetic field intensity, $\vec{H} = 4\vec{a}_x + 5\vec{a}_z$
A/m exists at a point in free space
what is the magnetic flux density.

$$\vec{H} = 4\vec{a}_x + 5\vec{a}_z \quad \mu_0 = 4\pi \times 10^{-7} \text{ H/m}$$

Magnetic flux density

$$(\vec{B}) = \mu_0 \cdot \vec{H} = (4\pi \times 10^{-7})(4\vec{a}_x + 5\vec{a}_z)$$

$$\vec{B} = (5.026\vec{a}_x + 6.28\vec{a}_z) \mu\text{Wb/m}^2$$

- (2) Circular coil of radius of 3cm
Flux density ($\vec{B}$) of 15 wb/m^2
plane of the coil is perpendicular
Find total flux (ϕ) around the coil!

area of the coil $\Rightarrow S = \pi r^2$

$$S = \pi \times (3 \times 10^{-2})^2 = 9\pi \times 10^{-4}$$

Total flux $= \phi = \vec{B} \cdot \vec{S}$ as having
 $\vec{B}$ & $\vec{S}$ in same direction.

$$\vec{B} \cdot \vec{S} = |\vec{B}| |\vec{S}|$$

$$\phi = 15 \times 9\pi \times 10^{-4} = 42.41 \text{ mWb}$$

(3)

If a magnetic field intensity $\vec{H} = y \cos x \vec{a}_x + (y + e^x) \vec{a}_z$ A/m. Find current density ($\vec{J}$) at the origin.

$$\vec{J} = \nabla \times \vec{H}$$

$$\nabla \times \vec{H} = \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ \frac{d}{dx} & \frac{d}{dy} & \frac{d}{dz} \\ y \cos 2x & 0 & (y + e^x) \end{vmatrix}$$

$$\vec{J} \left(\frac{d}{dy} y + e^x - \frac{d}{dz} \cdot 0 \right) \vec{a}_x \left(\frac{d}{dx} y + e^x - \frac{d}{dz} y \cos 2x \right) \vec{a}_y + \left(-\frac{d}{dy} y \cos 2x \right) \vec{a}_z$$

$$= 1 \vec{a}_x - (e^x - 0) \vec{a}_y - \cos 2x \vec{a}_z$$

$$= \vec{a}_x - e^x \vec{a}_y - \cos 2x \vec{a}_z$$

$$= \vec{J} \Big|_{0,0,0} = \vec{a}_x - \vec{a}_y - \vec{a}_z \text{ A/m}^2$$

④ $Q = 12C$ $\vec{V} = 5\vec{a}_x + 2\vec{a}_y - 3\vec{a}_z$.

Find Force ($\vec{F}$)

(a) $\vec{E} = 18\vec{a}_x + 5\vec{a}_y + 10\vec{a}_z$

$$\vec{F} = Q\vec{E} = 12C(+18\vec{a}_x + 5\vec{a}_y + 10\vec{a}_z)$$

$$= 216\vec{a}_x + 60\vec{a}_y + 120\vec{a}_z$$

$$|\vec{F}| = \sqrt{216^2 + 60^2 + 120^2}$$

$$|\vec{F}| = 254.27 N$$

(b) $\vec{B} = 4\vec{a}_x + 4\vec{a}_y + 3\vec{a}_z$

$\vec{F} = Q\vec{E} = 12C(4\vec{a}_x + 4\vec{a}_y + 3\vec{a}_z)$

$$= 48\vec{a}_x + 48\vec{a}_y + 36\vec{a}_z$$

$$|\vec{F}| = \sqrt{48^2 + 48^2 + 36^2}$$

$$|\vec{F}| = 76.8374 N$$

$$F_{net} = 177.432C$$

ELECTROMAGNETIC FIELD THEORY I

FALL 2021

Title of Assignment: Quiz 1

Quiz 1 covered the following topics:

- 1. Cross and dot products, angle between two vectors**
- 2. Convert cylindrical coordinate systems to cartesian coordinate systems**
- 3. Convert cartesian coordinate systems to cylindrical and spherical coordinate systems**
- 4. Laplacian for scalar potential**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE

94

Trevor Johnson

ELEG 4305 - Quiz 1

Trevor Johnson

Quiz 1

$$1. \vec{A} = 10\vec{a}_x + 5\vec{a}_y - 2\vec{a}_z \quad \vec{a}_y = (0, 1, 0)$$

$$a) \vec{A} \times \vec{a}_y = \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ 10 & 5 & -2 \\ 0 & 1 & 0 \end{vmatrix} = \vec{a}_x \begin{vmatrix} 5 & -2 \\ 1 & 0 \end{vmatrix} - \vec{a}_y \begin{vmatrix} 10 & -2 \\ 0 & 0 \end{vmatrix} + \vec{a}_z \begin{vmatrix} 10 & 5 \\ 0 & 1 \end{vmatrix}$$

$$\vec{a}_x(0-2) - \vec{a}_y(0-0) + \vec{a}_z(10-5) = -2\vec{a}_x + 5\vec{a}_z$$

$$b) \vec{A} \cdot \vec{a}_z = (10, 5, -2) \cdot (0, 0, 1) = 0 + 0 - 2 = -2$$

$$c) \theta = ? \quad \vec{A} \cdot \vec{a}_z = |\vec{A}| |\vec{a}_z| \cos \theta$$

$$\cos \theta = \frac{\vec{A} \cdot \vec{a}_z}{|\vec{A}| |\vec{a}_z|} = \frac{-2}{11.357} = -0.176$$

$$\theta = \cos^{-1}(-0.176) = 100.14^\circ$$

$$2. \vec{B} = 2\vec{a}_x + 3\vec{a}_y + 4\vec{a}_z \quad \text{convert to Cartesian at } (2, 3, -1)$$

$$\begin{bmatrix} A_x \\ A_y \\ A_z \end{bmatrix} = \begin{bmatrix} \cos \phi & -\sin \phi & 0 \\ \sin \phi & \cos \phi & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} A_\phi \\ A_\theta \\ A_z \end{bmatrix}$$

$$= \begin{bmatrix} \cos \pi/2 & -\sin \pi/2 & 0 \\ \sin \pi/2 & \cos \pi/2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \\ 4 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \\ 4 \end{bmatrix} = \begin{bmatrix} -3 \\ 2 \\ 4 \end{bmatrix}$$

$$-3\vec{a}_x + 2\vec{a}_y + 4\vec{a}_z$$

3. $P(2, 5, 1)$

$$\rho = \sqrt{x^2 + y^2} = \sqrt{4 + 25} = \sqrt{29}$$

$$\phi = \tan^{-1}(x/y) = \tan^{-1}(2/5) = 63.43^\circ$$

$$z = 1$$

a) $P(\sqrt{29}, 63.43^\circ, 1)$

$$r = \sqrt{x^2 + y^2 + z^2} = \sqrt{4 + 25 + 1} = \sqrt{30}$$

$$\theta = \tan^{-1}\left(\frac{\sqrt{x^2 + y^2}}{z}\right) = \tan^{-1}\left(\frac{\sqrt{29}}{1}\right) = \tan^{-1}(\sqrt{29}) = 79.48^\circ$$

$$\phi = \tan^{-1}(x/z) = \tan^{-1}(2/1) = 68.2^\circ$$

b) $P(\sqrt{30}, 79.48^\circ, 68.2^\circ)$

4. $V = x^2 - y^2 - z^2$, Find Laplacian of $V(\nabla^2 V)$.

$$\nabla^2 V = (\nabla \cdot \nabla V)$$

$$= \left(x \frac{\partial}{\partial x} + y \frac{\partial}{\partial y} + z \frac{\partial}{\partial z}\right) \cdot \left(x \frac{\partial V}{\partial x} + y \frac{\partial V}{\partial y} + z \frac{\partial V}{\partial z}\right)$$

$$= \frac{\partial^2 V}{\partial x^2} + y \frac{\partial^2 V}{\partial y^2} + z \frac{\partial^2 V}{\partial z^2} \quad V = x^2 - y^2 - z^2$$

$$\nabla^2 V = x \frac{\partial}{\partial x}(x^2 - y^2 - z^2) + y \frac{\partial}{\partial y}(x^2 - y^2 - z^2) + z \frac{\partial}{\partial z}(x^2 - y^2 - z^2)$$

$$\nabla^2 V = (2x - 2y - 2z)$$

-3

AVERAGE

michael shepard

Quiz 1

87

1 $\vec{A} = 10\vec{a}_x + 5\vec{a}_y - 2\vec{a}_z$

a) $\vec{A} \times \vec{B} = \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ 10 & 5 & -2 \\ 0 & 1 & 0 \end{vmatrix} = \vec{a}_x(0-2) - \vec{a}_y(0) + \vec{a}_z(10) = -2\vec{a}_x + 10\vec{a}_z$

b) $\vec{A} \cdot \vec{a}_z = (10, 5, -2) \cdot (0, 0, 1) = -2$

c) $\cos \theta = \frac{(10, 5, -2) \cdot (0, 0, 1)}{(\sqrt{109})(1)} = -0.176$
 $\theta = \cos^{-1}(-0.176) = 100.14^\circ$

2 $\vec{B} = 2\vec{a}_x + 7\vec{a}_y + 4\vec{a}_z$

$\begin{pmatrix} 4 \\ 1 \\ 2 \end{pmatrix} = \begin{pmatrix} \cos \pi/6 & \sin \pi/6 & 0 \\ \sin \pi/6 & \cos \pi/6 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 2 \\ 7 \\ 4 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 2 \\ 7 \\ 4 \end{pmatrix} = \begin{pmatrix} -7 \\ 2 \\ 4 \end{pmatrix}$

$\vec{A} = -3\vec{a}_x + 2\vec{a}_y + 4\vec{a}_z$

3 $P(75, 1)$

a) cylindrical $r = \sqrt{x^2 + y^2}$ $\theta = \tan^{-1}(\frac{y}{x})$ $z = z$

$r = \sqrt{2^2 + 5^2} = \sqrt{29}$

$\theta = \tan^{-1}(\frac{5}{2}) = 68.2^\circ$

$z = 1$

$(\sqrt{29}, 68.2^\circ, 1)$

b) spherical $\sqrt{2^2 + 5^2 + 1^2} = \sqrt{30}$

$\tan^{-1}(\frac{5}{2}) = 68.2^\circ$

$\cos^{-1}(\frac{1}{\sqrt{30}}) = 7.45^\circ$

$(\sqrt{30}, 68.2^\circ, 7.45^\circ)$

4 $V = x^2 - y^2 - z^2$

$\nabla V = (V_x, V_y, V_z)$

$\nabla V = \left(\frac{\partial}{\partial x}(x^2 - y^2 - z^2), \frac{\partial}{\partial y}(x^2 - y^2 - z^2), \frac{\partial}{\partial z}(x^2 - y^2 - z^2) \right)$

$\nabla V = (2x, -2y, -2z)$

$\nabla V = \frac{\partial}{\partial x}(x^2 - y^2 - z^2) + y \frac{\partial}{\partial y}(x^2 - y^2 - z^2) + z \frac{\partial}{\partial z}(x^2 - y^2 - z^2)$

$(2x, -2y, -2z)$

BELOW AVERAGE



71

Department of Electrical and Computer Engineering
Electromagnetic Field Theory I / ELEG 4305-P01
Quiz 1- Fall 2021

First Name Taha Last Naras

*Show all your works, including the steps and formulas to get full points

- (30 points) If $\vec{A} = 10\vec{a}_x + 5\vec{a}_y - 2\vec{a}_z$. Find (a) $\vec{A} \times \vec{a}_z$, (b) $\vec{A} \cdot \vec{a}_z$ and (c) the angle between $\vec{A}$ and $\vec{a}_z$, (θ_z)
- (20 points) If $\vec{B} = 2\vec{a}_\rho + 3\vec{a}_\phi + 4\vec{a}_z$, convert $\vec{B}$ into Cartesian (Rectangular) coordinates system at point $(2, \frac{\pi}{2}, -1)$.
- (30 points) Convert the Cartesian point $P(2, 5, 1)$ to (a) cylindrical and (b) spherical.
- (20 points) Given the scalar potential by $V = x^2 - y^2 - z^2$ volts, find the Laplacian of V , ($\nabla^2 V$).

$$1.) \vec{A} \times \vec{a}_z = \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ 10 & 5 & -2 \\ 0 & 0 & 1 \end{vmatrix} = \vec{a}_x \begin{bmatrix} 5 & -2 \\ 0 & 1 \end{bmatrix} - \vec{a}_y \begin{bmatrix} -2 & 10 \\ 0 & 0 \end{bmatrix} + \vec{a}_z \begin{bmatrix} 10 & 5 \\ 0 & 0 \end{bmatrix}$$

$$= \vec{a}_x (5 - 0) - \vec{a}_y (0 - 0) + \vec{a}_z (0 - 0) = 5\vec{a}_x - 0\vec{a}_y + 0\vec{a}_z = 5\vec{a}_x$$

$$\vec{A} \cdot \vec{a}_z = 10\vec{a}_x + 5\vec{a}_y - 2\vec{a}_z \cdot \vec{a}_z = -2$$

$$\cos \theta = \frac{(\vec{A} \cdot \vec{a}_z)}{|\vec{A}| |\vec{a}_z|} = \frac{-2}{\sqrt{10^2 + 5^2 + (-2)^2} \cdot 1} = \frac{-2}{\sqrt{125}} = -0.176$$

$$\theta = \cos^{-1}(-0.176) = 100.14^\circ$$

1. ?
20

3)

a) Cylindrical (R, θ, z)

$$R = \sqrt{x^2 + y^2}$$

$$\theta = \tan^{-1}(y/x)$$

$$z = z$$

$$R = \sqrt{x^2 + y^2} = \sqrt{2^2 + 5^2} = \sqrt{29}$$

$$\theta = \tan^{-1}(y/x) = \tan^{-1}(5/2) = 68.2^\circ$$

$$z = z = 1$$

$$P(\sqrt{29}, 68.2^\circ, 1)$$

b) spherical

$$\rho = \sqrt{x^2 + y^2 + z^2} = \sqrt{2^2 + 5^2 + 1^2} = \sqrt{30}$$

$$\theta = \tan^{-1}(y/x) = \tan^{-1}(5/2) = 68.2^\circ$$

$$\phi = \cos^{-1}\left(\frac{z}{\rho}\right) = \cos^{-1}\left(\frac{1}{\sqrt{30}}\right) = 7.95^\circ$$

$$P(\sqrt{30}, 68.2^\circ, 7.95^\circ)$$

4) $\nabla^2 V = (\nabla \cdot \nabla V)$

$$\Rightarrow \left[\hat{x} \frac{d}{dx} + \hat{y} \frac{d}{dy} + \hat{z} \frac{d}{dz} \right] \cdot \left[\hat{x} \frac{dV}{dx} + \hat{y} \frac{dV}{dy} + \hat{z} \frac{dV}{dz} \right]$$

$$(\nabla^2 V) = \hat{x} \frac{d^2 V}{dx^2} + \hat{y} \frac{d^2 V}{dy^2} + \hat{z} \left(\frac{d^2 V}{dz^2} \right)$$

$$V = (x^2 - y^2 - z^2)$$

$$\frac{d^2 V}{dx^2} = \frac{d^2}{dx^2} (x^2 - y^2 - z^2) = 2\hat{x}$$

$$\frac{d^2 V}{dy^2} = \frac{d^2}{dy^2} (x^2 - y^2 - z^2) = -2\hat{y}$$

$$\frac{d^2 V}{dz^2} = \frac{d^2}{dz^2} (x^2 - y^2 - z^2) = -2\hat{z}$$

ELECTROMAGNETIC FIELD THEORY I FALL 2021

Title of Assignment: Quiz 2

Quiz 2 covered the following topics:

- 1. Magnetic field intensity**
- 2. Scalar magnetic potential**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE

100

Omer Adnan
 Quiz 3
 11/29/2021

$$1) \vec{H} = \frac{1}{\rho} \vec{a}_\phi$$

$$1 \leq \rho \leq 2m$$

$$0 \leq \phi \leq 2\pi$$

$$0 \leq z \leq 2m$$

find scalar mag. potential at (4, 25°, 2)

$$V_m = - \int \vec{H} \cdot d\vec{l}$$

$$\vec{H} = \frac{1}{\rho} \vec{a}_\phi \text{ A/m}$$

$$d\vec{l} = d\rho \vec{a}_\rho + \rho d\phi \vec{a}_\phi + dz \vec{a}_z$$

$$\Rightarrow V_m = - \int \frac{1}{\rho} \vec{a}_\phi \cdot (d\rho \vec{a}_\rho + \rho d\phi \vec{a}_\phi + dz \vec{a}_z)$$

$$= - \int \frac{1}{\rho} \times \rho d\phi = -\phi$$

$$V_m \Big|_{(4, 25^\circ, 2)} = -25^\circ \times \frac{\pi}{180^\circ} = \boxed{-0.436 \text{ A}}$$

AVERAGE

Bob Patthammavong

ELEG 4305

98

Quiz 2

1/. $\vec{H} = \frac{1}{\rho} \vec{a}_\phi$ region $1 < \rho < 2m$
 $0 < \phi < 2\pi$
 $0 < z < 2m$

$$V_m = - \int \vec{H} \cdot d\vec{L}$$

$$\vec{H} = \frac{1}{\rho} \vec{a}_\phi \text{ A/m}$$

$$d\vec{L} = d\rho \vec{a}_\rho + \rho d\phi \vec{a}_\phi + dz \vec{a}_z$$

$$V_m = - \int \frac{1}{\rho} \vec{a}_\phi \cdot (d\rho \vec{a}_\rho + \rho d\phi \vec{a}_\phi + dz \vec{a}_z)$$

$$V_m = - \int \frac{1}{\rho} \times \rho d\phi =$$

$$V_m = -\phi$$

Find the scalar (4, 25, 2)

$$V_m \Big|_{(4, 25, 2)} = -2 \times 25 \times \frac{\pi}{180} =$$

$$V_m = -0.873 \text{ A}$$

-2

BELOW AVERAGE

FRANKY Williams, Ron Fo

$$H = \frac{1}{r} a_\phi$$

$$1 \leq r \leq 2 \text{ m}$$

$$0 \leq \phi \leq 2\pi$$

$$0 \leq z \leq 2 \text{ m}$$

Find the scalar

$$V_0 = - \int H \cdot d\vec{r}$$

$$H = \frac{1}{r} a_\phi \text{ A/m}$$

$$d\vec{r} = dr \vec{a}_r + r d\phi \vec{a}_\phi + dz \vec{a}_z$$

$$V_0 = - \int \frac{1}{r} a_\phi \cdot (dr \vec{a}_r + r d\phi \vec{a}_\phi + dz \vec{a}_z)$$

$$= - \int \frac{1}{r} \times r d\phi = -\phi$$

$$V_0 \Big|_z = -50 \times \frac{\pi}{180}$$

$$V_0 = -0.8726 \text{ V}$$

$$(4, 25^\circ, 2)$$

ELECTROMAGNETIC FIELD THEORY I

FALL 2021

Title of Assignment: Quiz 3

Quiz 3 covered the following topics:

- 1. Magnetic field intensity produced by the current element**
- 2. Vector magnetic potential**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE

Osesingy Ageri

Qwrz 3
ELE 4305

60

Solution:

$$\vec{A} = (y^2 + z^2) \vec{a}_x \text{ Vwb/m}^2$$

$$\frac{\vec{B}}{B} = \nabla \times \vec{A} = 10^{-6} \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ (y^2 + z^2) & 0 & 0 \end{vmatrix}$$

$$\vec{B} = \left[\frac{\partial}{\partial y} (y^2 + z^2) \vec{a}_y - \frac{\partial}{\partial z} (y^2 + z^2) \vec{a}_z \right] \times 10^{-6}$$

$$\vec{B} = [(2z) \vec{a}_y - (2y) \vec{a}_z] \times 10^{-6}$$

$$\vec{B} \Big|_{(2,3,5)} = (10 \vec{a}_y - 6 \vec{a}_z) \times 10^{-6}$$

$$\vec{H} \Big|_{(2,3,5)} = \frac{\vec{B}}{\mu_0} \Rightarrow \vec{H} = \frac{10 \vec{a}_y - 6 \vec{a}_z}{4\pi \times 10^{-7}} \times 10^{-6}$$
$$= (7.96 \vec{a}_y - 4.77 \vec{a}_z) \frac{\text{A}}{\text{m}}$$

AVERAGE

Quiz 3

95

1. Given: $\vec{A} = (y^2 + z^2)\vec{a}_x$ nWb/m²
Find: $(\vec{H})$, mag field intensity produced at (2, 3, 5)

Solution:

$$\vec{A} = (y^2 + z^2)\vec{a}_x \text{ nWb/m}^2$$

$$\vec{\nabla} \vec{A} = 10^{-6} \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ (y^2 + z^2) & 0 & 0 \end{vmatrix}$$

$$= \left[-\left[\frac{\partial}{\partial y} (y^2 + z^2) \right] \vec{a}_y + \left[\frac{\partial}{\partial z} (y^2 + z^2) \right] \vec{a}_z \right] \cdot (10^{-6})$$

$$= (2z)\vec{a}_y + (2y)\vec{a}_z$$

$$\vec{B}_{(2,3,5)} = (6z)\vec{a}_y + (2y)\vec{a}_z$$

$$\vec{H}_{(2,3,5)} \Big|_{\mu_0} = \frac{(6z\vec{a}_y + 2y\vec{a}_z)}{4\pi \times 10^{-7}} \cdot 10^{-6}$$

$$\vec{H} = (4.775 \vec{a}_y + .159 \vec{a}_z) \text{ A/m}$$

BELOW AVERAGE

94

Zhanirua
fall

Quiz 3

- 1) The vector magnetic potential ($\vec{A}$) due to a direct current in a conductor in free space is given by $\vec{A} = (y^2 + z^2) \vec{a}_x \mu\text{wb}/\text{m}^2$. find the magnetic field intensity ($\vec{H}$) produced by the current element at (2, 3, 5)

$$\vec{A} = (y^2 + z^2) \vec{a}_x \mu\text{wb}/\text{m}^2 \quad \vec{B} = \nabla \times \vec{A}$$

$$\vec{B} = 10^{-6} \begin{vmatrix} \vec{a}_y & \vec{a}_z & \vec{a}_x \\ \frac{\partial}{\partial y} & \frac{\partial}{\partial z} & \frac{\partial}{\partial x} \\ 0 & 0 & (y^2 + z^2) \end{vmatrix}$$

$$\vec{B} = \left[\frac{\partial}{\partial z} (y^2 + z^2) \vec{a}_y - \frac{\partial}{\partial y} (y^2 + z^2) \vec{a}_z \right] \times 10^{-6}$$

$$\vec{B} = [(2z) \vec{a}_y - (2y) \vec{a}_z] \times 10^{-6}$$

$$\vec{B} = [6 \vec{a}_y - 4 \vec{a}_z] \times 10^{-6}$$

$$(2, 3, 5) \rightarrow 10(-2) \rightarrow 2$$

$$\vec{H} = \frac{\vec{B}}{\mu_0} \Rightarrow \vec{H} = \frac{(6 \vec{a}_y - 4 \vec{a}_z) \times 10^{-6}}{4\pi \times 10^{-7}}$$

$$\vec{H} = 4.775 \vec{a}_y - 3.183 \vec{a}_z \text{ A/m}$$

ELECTROMAGNETIC FIELD THEORY I

FALL 2021

Title of Assignment: Assignment 1

Assignment 1 covered the following topics:

- 8. Vector magnitude and direction**
- 9. Vector addition and subtractions**
- 10. Dot multiplications of vector**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE

100

Department of Electrical and Computer Engineering
Electromagnetic Field Theory I / ELEG 4305-PO1
Assignment 1- Fall 2021

First Name Brendon Last Beckwitz

- (40 points) If a vector $\vec{A} = \vec{a}_x + 2\vec{a}_y + 3\vec{a}_z$, find its (a) magnitude and (b) direction.
- (30 points) If a vector $\vec{A} = 2\vec{a}_x + 5\vec{a}_y + 6\vec{a}_z$ and $\vec{B} = \vec{a}_x - 3\vec{a}_y + 6\vec{a}_z$, find $\vec{A} + \vec{B}$ and $\vec{A} - \vec{B}$.
- (30 points) If a vector $\vec{A} = \vec{a}_x + \vec{a}_y + 2\vec{a}_z$ and $\vec{B} = 2\vec{a}_x + \vec{a}_y + \vec{a}_z$, find $\vec{A} \cdot \vec{B}$.

1.) $\vec{A} = \vec{a}_x + 2\vec{a}_y + 3\vec{a}_z = (1, 2, 3)$

$|\vec{A}| = \sqrt{(1)^2 + (2)^2 + (3)^2}$

$|\vec{A}| = \sqrt{14}$

Magnitude $|\vec{A}| = \sqrt{14}$

Direction

$\vec{a}_A = \frac{1}{\sqrt{14}}\vec{a}_x + \frac{2}{\sqrt{14}}\vec{a}_y + \frac{3}{\sqrt{14}}\vec{a}_z$

$(0.267, 0.535, 0.802)$

$(\frac{1}{\sqrt{14}}, \frac{2}{\sqrt{14}}, \frac{3}{\sqrt{14}}) = \frac{1}{\sqrt{14}}\vec{a}_x + \frac{2}{\sqrt{14}}\vec{a}_y + \frac{3}{\sqrt{14}}\vec{a}_z$

$\alpha = \cos^{-1}(\frac{1}{\sqrt{14}}) = 74.5^\circ$

$\beta = \cos^{-1}(\frac{2}{\sqrt{14}}) = 57.7^\circ$

$\gamma = \cos^{-1}(\frac{3}{\sqrt{14}}) = 36.7^\circ$

2.) $\vec{A} = (2, 5, 6)$

$\vec{B} = (1, -3, 6)$

$\vec{A} + \vec{B} = (2, 5, 6) + (1, -3, 6) = (3, 2, 12)$

$\vec{A} - \vec{B} = (2, 5, 6) - (1, -3, 6) = (1, 8, 0)$

$\vec{A} + \vec{B} = (3, 2, 12) = 3\vec{a}_x + 2\vec{a}_y + 12\vec{a}_z$

$\vec{A} - \vec{B} = (1, 8, 0) = \vec{a}_x + 8\vec{a}_y$

3.) $\vec{A} = (1, 1, 2)$

$\vec{B} = (2, 1, 1)$

$\vec{A} \cdot \vec{B} = 5$ Scalar

$\vec{A} \cdot \vec{B} = [\vec{A}_x \cdot \vec{B}_x + \vec{A}_y \cdot \vec{B}_y + \vec{A}_z \cdot \vec{B}_z]$

$= 1 \cdot 2 + 1 \cdot 1 + 2 \cdot 1 = 5$

AVERAGE

88

Tuwan Byers
22017151 9/1/21

Musa

mag $\|v\| = \sqrt{v_1^2 + v_2^2 + v_3^2}$

direction: $\cos \alpha = \frac{v_1}{\|v\|}, \cos \beta = \frac{v_2}{\|v\|}, \cos \gamma = \frac{v_3}{\|v\|}$

1. $\vec{A} = \vec{a}_x + 2\vec{a}_y + 3\vec{a}_z$

$\cos \alpha = \frac{1}{\sqrt{14}} = \cos \beta = \frac{\sqrt{4}}{\sqrt{14}}$

$\|\vec{A}\| = \sqrt{1^2 + 2^2 + 3^2}$

$\|\vec{A}\| = \sqrt{14}$

$\cos \alpha = 0.2673 \quad \cos \beta = 0.5345$

$\alpha = \cos^{-1}(0.2673) \quad \beta = \cos^{-1}(0.5345)$

$\alpha = 74.5^\circ \quad \beta = 57.69^\circ$

$\vec{a} = \frac{\vec{A}}{\|\vec{A}\|}$

$\cos \gamma = \frac{3}{\sqrt{14}}$

$\cos \gamma = 0.80178$

$\gamma = \cos^{-1}(0.80178)$

$\gamma = 36.405^\circ$

2. $\vec{A} = 2\vec{a}_x + 5\vec{a}_y + 6\vec{a}_z \quad \vec{B} = \vec{a}_x - 3\vec{a}_y + 6\vec{a}_z$

$\vec{C} = (2+1)\vec{a}_x + (5-3)\vec{a}_y + (6+6)\vec{a}_z$

$\vec{C} = 3\vec{a}_x + 2\vec{a}_y + 12\vec{a}_z$

$\vec{D} = (2-1)\vec{a}_x + (5-(-3))\vec{a}_y + (6-6)\vec{a}_z$

$\vec{D} = \vec{a}_x + 8\vec{a}_y$

3. $\vec{A} = \vec{a}_x + \vec{a}_y + 2\vec{a}_z \quad \vec{B} = 2\vec{a}_x + \vec{a}_y + \vec{a}_z, \quad \vec{A} \cdot \vec{B}$
(1,1,2) (2,1,1)

$\vec{A} \cdot \vec{B} = (1)(2) + (1)(1) + 2(1)$

$1+1+2=4$

$\vec{A} \cdot \vec{B} = 4$

BELOW AVERAGE

83

Oluwadamilola Oboye Dr. MUSA Homework 1

(1) A vector $\vec{A} = \vec{a}_x + 2\vec{a}_y + 3\vec{a}_z$

(a) find its magnitude

(b) find its direction

$$\Rightarrow (1, 2, 3) \Rightarrow \sqrt{(1)^2 + (2)^2 + (3)^2}$$

$$= \sqrt{1 + 4 + 9}$$

$$= \sqrt{14}$$

(-10)

$\boxed{= 3.741}$ magnitude

$$\vec{a} = \frac{\vec{A}}{|\vec{A}|}$$

$$\cos(\theta) = \frac{3.141}{\sqrt{14}}$$

$$\cos(\theta) = \frac{\vec{A}}{|\vec{A}|} \text{ magnitude of } \vec{A}$$

Square root through magnitude

$$\theta = \cos^{-1}\left(\frac{3.141}{\sqrt{14}}\right) \Rightarrow \cos^{-1}(0.839468)$$

$$\boxed{\theta = 32.916}$$

(2) Vector $\vec{A} = 2\vec{a}_x + 5\vec{a}_y + 6\vec{a}_z$ and $\vec{B} = \vec{a}_x - 3\vec{a}_y + 6\vec{a}_z$
find $\vec{A} + \vec{B}$ $\vec{A} - \vec{B}$

no magnitude

$$\vec{A} = (2, 5, 6) \Rightarrow (2, 5, 6) + (1, -3, 6) = (3, 2, 12) = \vec{A} + \vec{B}$$

$$\vec{B} = (1, -3, 6)$$

$$\Rightarrow (2, 5, 6) - (1, -3, 6) = (2, 8, 0) = \vec{A} - \vec{B}$$

(3) A vector

$$\vec{A} = \vec{a}_x + \vec{a}_y + 2\vec{a}_z \quad \vec{B} = 2\vec{a}_x + \vec{a}_y + \vec{a}_z$$

$$\vec{A} = (1, 1, 2)$$

$$\vec{B} = (2, 1, 1)$$

Find $\vec{A} \cdot \vec{B}$

$$\boxed{(2, 1, 2) = \vec{A} \cdot \vec{B}}$$

+++

(-7)

ELECTROMAGNETIC FIELD THEORY I FALL 2021

Title of Assignment: Assignment 2

Assignment 2 covered the following topics:

- 1. Vector multiplications**
- 2. A point in cartesian coordinates to cylindrical coordinates**
- 3. A point in cartesian coordinates to spherical coordinates**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE

60

Department of Electrical and Computer Engineering
Electromagnetic Field Theory I / ELEG 4305-PO1
Assignment 2- Fall 2021

First Name Omer Last Adnan

1. (40 points) If a vector $\vec{A} = 2\vec{a}_x + \vec{a}_y + 2\vec{a}_z$ and $\vec{B} = \vec{a}_x + 2\vec{a}_y + \vec{a}_z$, find $\vec{A} \times \vec{B}$.
2. (30 points) A point in Cartesian coordinates is given by $P(1, 2, 3)$.
Express it in circular cylindrical coordinates.
3. (30 points) A point in Cartesian coordinates is given by $P(1, 2, 3)$.
Express it in spherical coordinates.

1)

$$\vec{A} \times \vec{B} = \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ 2 & 1 & 2 \\ 1 & 2 & 1 \end{vmatrix}$$

$$= \vec{a}_x(1-4) - \vec{a}_y(2-2) + \vec{a}_z(4-1)$$

$$= -3\vec{a}_x + 0\vec{a}_y + 3\vec{a}_z$$

2) $P(1, 2, 3) \rightarrow$ circular cylindrical coords. (ρ, ϕ, z)

$$\left. \begin{aligned} \rho &= \sqrt{x^2 + y^2} = \sqrt{5} \\ \phi &= \tan^{-1}(y/x) = 63.4^\circ \\ z &= 3 \end{aligned} \right\} (\rho, \phi, z) = (\sqrt{5}, 63.4^\circ, 3)$$

3, $P(1, 2, 3) \rightarrow$ spherical (r, θ, ϕ)

$$r = \sqrt{x^2 + y^2 + z^2} = \sqrt{14}$$

$$\theta = \tan^{-1} \left(\frac{\sqrt{x^2 + y^2}}{z} \right) = 36.7^\circ$$

$$\phi = \tan^{-1} \left(\frac{y}{x} \right) = 63.4^\circ$$

$$(r, \theta, \phi) = (\sqrt{14}, 36.7^\circ, 63.4^\circ)$$

AVERAGE

Osesiye Ayeni
ELE G 4305

75
Assignment 2

① $\vec{A} = 2\vec{a}_x + \vec{a}_y + 2\vec{a}_z$ $\vec{B} = \vec{a}_x + 2\vec{a}_y + \vec{a}_z$

$$\vec{A} \times \vec{B} = \begin{vmatrix} \vec{a}_x & \vec{a}_y & \vec{a}_z \\ 2 & 1 & 2 \\ 1 & 2 & 1 \end{vmatrix}$$
$$= 3\vec{a}_x - 0\vec{a}_y + 3\vec{a}_z$$

Ans = $-3\vec{a}_x + 3\vec{a}_z$

② $P(1, 2, 3)$
 $x = 1, y = 2, z = 3$
 $r = \sqrt{1^2 + 2^2} = \sqrt{5}$
 $\theta = \cos^{-1} \left[\frac{1}{\sqrt{1^2 + 2^2}} \right] = 63.43^\circ$

$z = 3$
Cylindrical = $(\sqrt{5}, 63.43^\circ, 3)$

③ $P(1, 2, 3)$
 $x = 1, y = 2, z = 3$
 $r = \sqrt{1^2 + 2^2 + 3^2} = \sqrt{14}$
 $\theta = \cos^{-1} \left[\frac{3}{\sqrt{14}} \right] = 36.69^\circ$
 $\phi = \cos^{-1} \left[\frac{1}{\sqrt{1^2 + 2^2}} \right] = 63.43^\circ$

(r, θ, ϕ)

BELOW AVERAGE

Eley 4305

73

Adeolu Okeanu

Assignment 2

1 Vector $\vec{A} = 2a_x + a_y + 2a_z$ $A(2,1,2)$

Vector $\vec{B} = a_x + 2a_y + 2a_z$ $B(1,2,2)$

Find $\vec{A} \times \vec{B}$

$$\begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ 2 & 1 & 2 \\ 1 & 2 & 2 \end{vmatrix}$$

$a_x \begin{vmatrix} 1 & 2 \\ 2 & 2 \end{vmatrix} = (4-2)a_x = 2a_x$

$a_y \begin{vmatrix} 2 & 2 \\ 1 & 2 \end{vmatrix} = (2-2)a_y = 0a_y$

$a_z \begin{vmatrix} 2 & 1 \\ 1 & 2 \end{vmatrix} = (4-1)a_z = 3a_z$

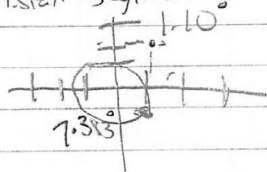
$\vec{A} \times \vec{B} = 2a_x + 0a_y + 3a_z \Rightarrow (2, 0, 3)$

2 $P(1,3,3) \Rightarrow C(2,23,7.383,3)$

$\tan \theta = y/x$

$r^2 = x^2 + y^2$

z stays the same
cylindrical



$\tan \theta = 3/1$

$\theta = \tan^{-1}(3/1)$

$\theta = 1.107 + 2\pi$

$\theta = 7.383$

$r^2 = 1^2 + 3^2$

$1+9$

$\sqrt{r^2} = \sqrt{10}$

$r = 3.16$

3 $P(1, 2, 3)$

$$x=1 \quad y=2 \quad z=3$$

r

$$r = \sqrt{1^2 + 2^2 + 3^2} = \sqrt{14} = 3.74$$

$$\theta = \cos^{-1} \left(\frac{3}{\sqrt{14}} \right) = 36.69^\circ$$

$$\phi = \cos^{-1} \left(\frac{1}{\sqrt{1+2^2}} \right) = 63.43^\circ$$

$$(r, \theta, \phi) = (3.74, 36.69^\circ, 63.43^\circ)$$



ELECTROMAGNETIC FIELD THEORY I FALL 2021

Title of Assignment: Project

Project covered the following topics:

- 1. Learning strategies**
- 2. Electromagnetic radiation impacts**

SAMPLE WORK OF STUDENTS

ABOVE AVERAGE



**Department of Electrical and Computer Engineering Electromagnetic Field Theory I /
ELEG 4305-P01 Project- Fall 2021**

Using resources available in the library and on the Internet, write a short report on the long- and short-term effects of electromagnetism and how the effects can be minimized. Your report should include the following:

- (1) What is your learning strategy?
- (2) How do you use the strategy to tackle the problem?
- (3) Describe how electromagnetic radiation can have detrimental impact.
- (4) The report should not be more than 5 pages long.
- (5) The report should contain at least 10 references (journals, conferences, and web links).

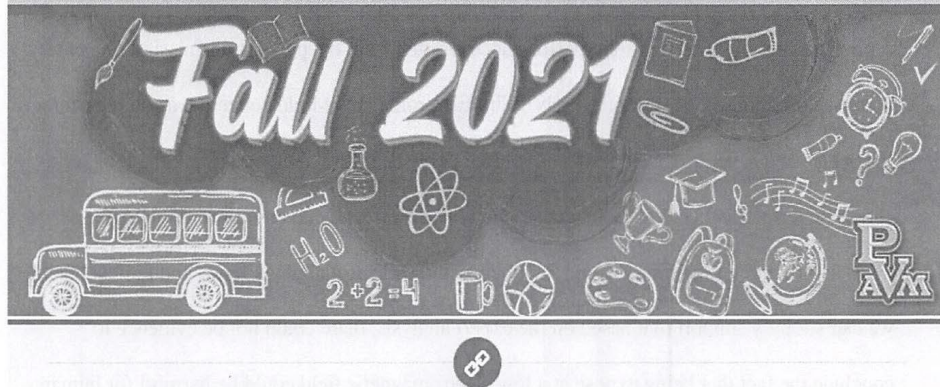
Sample topics could be:

- (a) Effects of mobile-phone electromagnetic fields on human brain.
- (b) Effects of high voltage power transmission lines on human body.
- (c) Effects of cell phone towers on human body.
- (d) Effects of Wi-Fi on human body.
- (e) Effects of smart meters on human body.
- (f) Effects of radiation from air travel on the passengers.
- (g) Electromagnetic interference with aircraft systems.
- (h) Electromagnetic field coupling to buried cables.

Franky Williams Lonfo

ELECTROMAGNETIC FIELD THEORY I: ELEG 4305

Electromagnetic Field Theory I-ELEG 4305



Class Meeting Dates/Times: MWF-12:00 pm - 12:50 pm

Instructor Name: Sarhan Musa

Instructor Email: smmusa@pvamu.edu

Office Phone #: 936-261-9860

Office Hours: MWF: 11:00 am-12:00 pm; 1:00 pm-2:00 pm (virtual office); and by appointment

Office Location: Building 0793 - New Electrical Engr Building, Room 221

Textbook Information (Required and Supplemental):

Semester Fall 2021

1- Introduction

The debate regarding the effects of electromagnetic fields on human body have long time been considered as one important subject on the table and specially for those who are living close the high voltage power line, even the research seems to indicate that those who are living close to the high voltage are not facing a large risk. The probability of a relatively small risk can still be considered and cannot be evacuated. Many studies have proved that people who have been exposure to electromagnetic field (EMF) have seen themselves through various effect such as central nervous system, cognitive performance emitted from the power transmission line close to these specific houses [1,4]. In the early 1970, Electromagnetic field concern was on the center of the debate and several article, news and journal published were about regarding the long term and short-term effects of electromagnetic and how the effect can be minimized. [1] After extensive research regarding an approach between the electromagnetic fields and human health, we can strongly support that based on the expert analysis, there could not be evidence to conclude the fact that being expose at a low electromagnetic field could be harmful for human body. At the same time, the international research is working to find out the possibility between the cancer, electromagnetic. [2,7]

2- Electromagnetic Radiation Impact

Electromagnetic radiation such as infrared radiation which is felt as heat and can cause a serious damage on human skin, and X-rays well known as causing mutation which can be the origin of cancer. For instance, electromagnetic field impact on human body is very dangerous and harmful this can justify the fact that doctor and dentist mostly are standing behind a protective screen whenever they are working or taking lot of X-rays [4]. Also, we all agree the fact that human body temperature can be found raising up or down according to the person body

because different people will probably have different body temperature, this explain the fact that someone could death if that person is exposed to a high dosage of RF radiation and it's not excluded that RF radiation can also be responsible of skin burning and attacking our central nervous. [7]

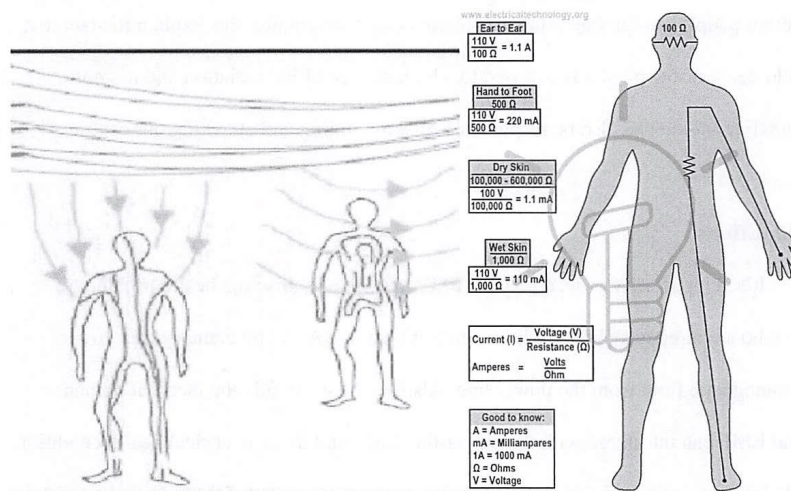
3- Health Effects

It's scientifically proved that the EMF may help to arise the health problem of those who are already sick. In addition, each human DNA can be damaged due to the electromagnetic field from the power line. Also, without exclude the fact that human natural EMF can interfered with the power line EMF and those in critical health condition should be more impacted. Some scientific have demonstrate that if there could be a risk of getting cancer because of power line, it's then necessary to underline that these risks are very small.[5,6]

4- Short-term effect

Being exposure to an electric field which is produced by an alternative current (AC) transmission line can create a serious damage on people and the most common effect of exposure to electric field of AC transmission lines such as: spark discharge, steady-state AC currents.

Respectively and according to the studies, these effects can be explained by the fact that a transient current through a human body might appears at the breaking down of an AC transmission lines and the presence of air gap between the subject and conductivity object or the ground will create that transient current harmful for human body. In addition, we also agree that human body creates a natural electric field which can also exert a force on the hair and being responsible of hair stimulation. [10]

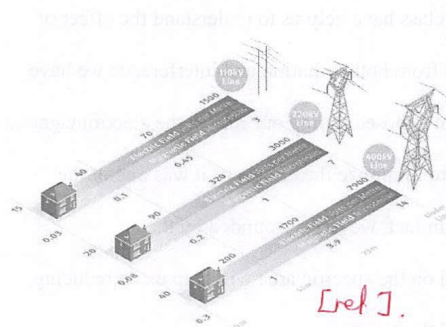


Minimized Effect or Measure preventive [R4]

The advanced of the technologies have been made to provide future significant value but

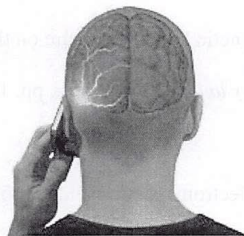
→ make references for figures

People must be careful about their today devices and the ways of using them. The effects of mobile-phone electromagnetic field on human brain can create a cancer so according to international agency of research on cancer (IACR), we should no longer spent too much time on the phone and the using of the speaker mode and headphone will help us to reduce the fact of being expose to the radio frequency (RF). [10] Regarding the minimized effect from the high voltage power line transmission, people should respect the electric filed voltage per meter



whenever the decide to build a house across the transmission line voltage such as 40 meters for 110kv line, 90 meters for 220kv line and 200 for 400kv line. In addition, regarding the internet server system, people should use the wire internet system since the emission of radiation is less compared to

those wireless counterparts.[9] The using of LED in the houses which do contain a mercury instead of incandescence will help to reduce the effect electromagnetic and also good for our skin because the LED do not contain an ultraviolet ray.



[Ref.]

make references at the end of the sentence before the period.

4-1. Learning strategy and how to use it. I always use a microlearning such as breaking down some complex problem into easier way to understand it. Interactive with other students and set up a study group. Mostly, to tackle the problem, I will always go over all the exercises that were done in class by the professor and make sure that I do understand the concept and the application of the material to prepare myself for the coming exam session.

5- Conclusion

The study of electromagnetic field theory in this class have help us to understand the effect of electromagnetic fields through our everyday life, from both radiation and interference we have learned from this project how much we have been exposed during our life on the electromagnetic around of us. For instance, the fact of learn how to minimize the effects of it was one of the important things to underline in this conclusion. In fact, we are surrounded by the electromagnetic fields and following the protocol on the specific area will help us on reducing the impact of it in both healthy environments and the society.

Bold it →

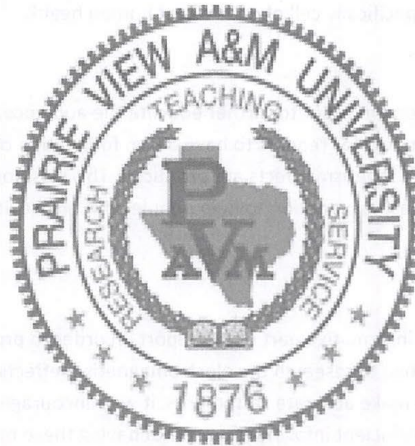
Reference

- 1- Environmental Health Criteria 35: Extremely low frequency (ELF) fields. WHO, Geneva, 1984.
- 2- Public health and safety at work. Non-ionizing radiation. Sources, exposure, and health effects. EC, Brussels, 1996
- 3- E. Kivrak, G. Altun, K. Yurt, "Effects of Electromagnetic Fields Exposure on the Antioxidant Defense System," *Journal of Microscopy and Ultrastructure*, pp. 167-168, October 2017.
- 4- A. Goldsworthy, "The Biological Effects of Weak Electromagnetic Fields Problems and Solutions," pp. 4-10, March 2012.

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AVERAGE

**ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT
PRAIRIE VIEW A&M UNIVERSITY**



**Electromagnetic Field Theory I / ELEG 4305-P01
Fall 2021**

**Final Project:
Short Report**

Submitted By: Abel Mendoza

**Submitted on:
November 15, 2021**

**To:
Dr. Sarhan Musa**

Learning Strategy Method

Idea:

I began by determining an issue that is related to the overall goal of this report. In this case, it was to address the effects of electromagnetism for society. The idea was chosen to be how mobile devices and more specifically cell phones effect human health.

Background:

Initial research had to be done in order to further educate the audience about what electromagnetism is. It is import for readers to have a firm foundation of the concept in order to understand why electromagnetism affects are produced. This was done by reading plenty of articles and providing the best explanation to help people with no previous background to understand.

Research:

This will be the critical and informative part of the report. In order to provide accurate information, it was imperative to research the electromagnetism effects of cell phones and mobile devices. In order to make accurate statements, it was encouraged to research and find 10 sources in order to get sufficient info. The purpose of having these many resources was to compare and contrast data in order to validate the data that is repeated by many articles. With this info and analytical data that was collected, readers can then make accurate assumptions and have certainty of the detrimental effects of electromagnetism on the human body.

Analysis:

Using the data collected it is necessary to analyze and determine the accurate conclusion. This is done by reader whenever they get presented with sufficient evidence that will shift its thought to a designated outcome. Whenever a set analysis is made it safe to use this as a building block to develop a way to mitigate the problem.

Solution:

The final part of the learning methodology is to develop a solution for initial problem. By putting together the previous for sections it was easier to suggest and pinpoint a potential solution to a problem. By having the previous background information and data to support our solutions it is certain that we will more accurately steer toward a positive outcome.

In the 21st century, the advancements in technology have progressed a significant way. Such advancements have made it possible for many people to enjoy the convenience of handheld electronics such as a phone, headphones, smart watches, etc. in their every day lives. These devices are being purchased by the thousands every day around the world by consumers. People with these devices may believe that the only purpose of these devices is to make lives easier. However, in this report I will explain how electromagnetism produced by these devices is also affecting their lives. It is true that these electronics are convenient, but it is also important to inform the public of what electromagnetism is. This phenomenon has a short- and long-term effect on the body of a human being.

To begin, I will describe what electromagnetism is and how various electronics project this concept. Electromagnetism is a branch of Physics, that deals with the electromagnetic force that occurs between electrically charged particles. The electromagnetic force is one of the four fundamental forces and exhibits electromagnetic fields such as magnetic fields, electric fields, and light. It is the basic reason electrons bound to the nucleus and responsible for the complete structure of the nucleus. This is relevant because every handheld portable electronic device as well as stationary devices produce Electromagnetic radiation (EMR). This constant exposure has been more abundant because it is certain that we as a society have become dependent on electricity. As technology has become readily available and required at mostly every job or learning environment, it is impossible to not interact with Electromagnetic waves every day. EMR exposure takes place in the car, home, work, and classroom. This will create a never-ending cycle of repeated exposure. At this rate, exposure to electromagnetic radiation is almost impossible to avoid if we also take into consideration that the general public relies on these devices for entertainment. In recent times and upcoming generations, it will not be uncommon to see infants with a phone or tablet.

At this point, even if people were to know about this effect it is likely that they choose to ignore the consequences. However, once we realize what these effects can have on your overall health, we will start to seriously consider what our everyday habits should be. The troublesome evidence discovered recently from the American Academy of Environmental Medicine (AAEM) begins with the fact that children absorb up to 60 percent more energy per pound of body weight than adults do. This can only mean that children exposed to electromagnetic frequency are more at risk to this harmful radiation. For example, when it comes to an adult body it is known that the signal strength of cell phones can penetrate the adults head up to one inch. This same phone signal when exposed to a child, will completely pass through a child's head. This is extremely worrisome and has never been experienced by previous generations.

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Short-Term Electromagnetic Radiation Effects

- Headaches
- Tingling or burning sensation
- Aches and pains
- Decreased sperm mobility
- Hands are hurting
- Trouble sleeping

It is almost certain that at some point in your life you have experienced some of the effects from the list above. You may have thought that whenever you had these symptoms, that the reasoning behind it was unknown or assumed an inaccurate assessment. However, now you can also take in consideration that it is (EMF) what may produce these problems. These short-term effects are influenced by the fact that usually a mobile device such as a phone is very close to your face most of the day. When holding a phone in a certain position for prolonged periods of time it is common for people to feel the sensation of hurting hands which is what is developed when there is a long hand orientation for prolonged time.

Tingling or burning sensations are felt when your eyes are fixed on a screen. There can also be headaches that are prevalent simultaneously. The reason behind this is because caused by a lack of blinking. "When you look at a screen, you're so involved that you forget to blink. The blink rate goes from 15 times a minute to five or seven times per minute," explains Dr. Gardiner. Dr. Gardiner is an ophthalmologist with Harvard-affiliated Massachusetts Eye and Ear Infirmary. In order to have safe eyes, it is imperative to blink to re-establish the tear film on the eyes — a thin layer of liquid that protects the surface of the eye. If you don't blink enough, your eyes dry out, causing blurry vision and discomfort.

Long-Term Electromagnetic Radiation Effects

- Brain tumors
- Mental illness
- Cognitive and Behavioral disorders
- Immune disorders
- Cancers – blood, breast and more
- Mutated cells
- Fragmented DNA
- Toasted Skin Syndrome

↓ space

When talking about long term effects of electromagnetic radiation it is certain that this scenario is specified to people who have a device usage addiction or born in the new generations of kids that use technology a few months after being born. As the new generations grows more data can be collected to further prove that long term effects will be a topic of discussion. This effect will be very drastic since the exposure to electromagnetic frequency is only going to increase time passes. When we are exposed to EMR repeatedly over an extended period of time, tissue damage can occur as electrons are released into cells. This process is called ionization. The investigation into the long-term effects of exposure to EMR has been going on for many years but is still fairly new in comparison to other diseases. Time and time again, researchers have found that EMR has a negative impact on health. Especially when it comes to cell phones, they are considered to be more dangerous as a result of microwave range waves regularly placed next to body. This damage can be multiplied considerably when realizing that there are millions of individuals who sleep with the phone next to the bed who have deprived sleep. After a prolonged time, it affects the memory and impairs learning.

Solution to (EMF) radiation from mobile devices:

- Sit about two feet away from a computer or phone screen to whenever doing extensive work or research.
- Use your speakerphone or a wired headset when on a call
- Keep your phone away from your body
- Take regular time outs from your phone (turn it off, etc.)
- Spend more time outdoors, less time in secluded environments
- Place your phone in a separate stand that is not withing the vicinity of your bed.

All of these mentioned solutions are behavioral changes that we as individuals must act upon in order to not experience the full effect of electromagnetic frequency because not having (EMF) is also not a realistic solution.



Number your references

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Abel Mendoza

Final Project

Dr. Musa

Cell Phones and Cancer Risk Fact Sheet - National Cancer Institute

BELOW AVERAGE

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING



Department of Electrical and Computer Engineering
Electromagnetic Field Theory I

Project- Fall 2021

ELEG 4305-P01

Submitted by:

Johnn Owens

Date of Submission: 11/15/2021

Whenever I am introduced to new material, I first must understand if it is a concept or a fact that I am learning. In a different situation, I tend to be an active/reflective learner. Active students are more likely to remember and understand the information when they're doing something active with it, discuss or explain it to others. Reflective learners prefer to walk through the problem first and then try it out themselves. For instance, while attempting to work through a math problem, I must first learn the material during a lecture to understand the concept and facts needed to complete the problem. Once I retain the information, I tend to work through the problem myself and actively engage in trying to solve the problem. This is the process of experiential learning, in which individuals learn through participation and experience.

Electromagnetic (EM) radiation is a form of energy around us and takes many forms, such as radio waves, microwaves, X-rays, and gamma rays. Sunlight is also a form of EM energy, but visible light is only a small portion of the EM spectrum, containing a broad range of electromagnetic wavelengths. EM radiation is created when an atomic particle, such as an electron, is accelerated by an electric field, causing it to move. The movement produces oscillating electric and magnetic fields, which travel at right angles to each other in a bundle of light energy called a photon. In terms of modern quantum theory, electromagnetic radiation is the flow of photons (also called light quanta) through space. Photons are packets of energy ($h\nu$) that constantly move with the universal speed of light. The waves have specific characteristics, given as frequency, wavelength, or energy. A wavelength is a distance between two consecutive peaks of a wave. This distance is given in meters (m). Frequency is the number of waves that form in each length of time. It is usually measured as the number of wave cycles per second or hertz (Hz). A short wavelength means that the frequency will be higher because one cycle can pass in

a shorter amount of time. A longer wavelength has a lower frequency because each cycle takes longer to complete.

Electromagnetic radiation can have a detrimental impact; Radio frequency radiation is found to have more thermal-related effects. A person's body temperature can be raised, which could result in death if exposed to a high dosage of RF radiation. Focused RF radiation can also cause burns on the skin or cataracts to form in the eyes. Electromagnetic interference (EMI) can cause avionic equipment performance to degrade or even malfunction. EMI can affect cockpit radios and radar signals, interfering with communication between the pilot and control tower. Airborne devices that can cause interference include laptop computers, electronic games, cell phones, and all have been suspected of causing events such as autopilot disconnects, erratic flight deck indications, and airplanes turning off course. EMI effects from lightning, solar flares, electrostatic discharge, high intensity radiated fields (HIRF) from radar, and various kinds of transmitters or communications equipment have resulted in numerous aviation incidents throughout the years. As a result, EMI effects are now considered in all aspects of avionics design and certification.

One major way to combat EMI is to shield various line replaceable units (LRUs) and harnesses. Shielding a device or system not only reduces EMI emissions, but it also improves susceptibility performance. With advances in wireless technology and increased device signal sensitivity, shielding becomes even more important to maintain the functionality and safety of avionic equipment. For effective shielding, the LRU should be surrounded by an electrically conductive material. Shielding effectiveness is dependent on the conductivity and thickness of the material and the frequency and amplitude of the electromagnetic field. However, shields have shortcomings such as weight, susceptibility to corrosion, wear, apertures and seams, and physical

Use references in text [7]

rigidity. Apertures and seams are especially critical as they allow leakage of electromagnetic energy and lower the shielding capability of the enclosure design. The bigger the size of the aperture or seam, the less shielding.

There are two basic approaches to reduce or shield electromagnetic emissions from a device or system and improve its susceptibility performance. One is shielding at the printed circuit board level using proper design. The second is to place the device or system in a shielded enclosure where gaskets can improve the shielding of the enclosure. Shielding solutions are applicable for avionics packaging, enclosure shielding, radio packaging, canopy/window perimeters, structure gaps, and access cover plates.

In conclusion, this report helps me understand my concept of learning and has given me insight into Electromagnetic interference (EMI). Back when I intern at Bell Helicopter for the past two summers on the wiring integration team, I was able to understand and get a real-life experience on how EMI can interfere with a different type of aircraft equipment. I reviewed schematics that let me visualize and observe that they cover the LRUs with a metal material that prevents EMI from escaping. The project that I was working on the previous summer was to research the viability of using Fiber Optics as a means of connectivity between DPIU's and Switches of Digital Backbone instead of the military standard copper wires. Design the Digital Backbone schematics that distribute data across the MS and Air Vehicle System. Part of the process was to assign specific Ref Des for the LRUs for Flights Controls and Air Data Systems based on MIL-STD-1808. Next, we analyze various diagrams to gather the distance and weights of the wiring harness that runs between LRUs. Finally, I communicated across different teams to research if fiber optic would integrate with our MIL-STD interconnect components. The entire system will be interfaced with the digital backbone of the aircraft; fiber optic connectors and

components manufacturers are innovating to enhance cockpit management and revolutionize aircraft cabin design. Fiber optics offer many benefits compared with traditional copper wiring, including supporting higher bandwidth, lighter weight, better signal integrity, and immunity from EMI. This information gave me more knowledge about aircraft EMI, which will help me at my full-time offer at Lockheed Martin as a Flight Control Hardware Engineer.

Show the long and short term impacts

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Number your references

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