



FINAL
Examination Paper
(COVER PAGE)

Session : April 2017

Programme : Diploma In Electrical And Electronic Engineering (DEEI)

Course : EEE2104: Electromagnetic Field Theory

Date of Examination : 1 August 2017 (Tuesday)

Time : 11:00am – 1:00pm

Duration : 2 Hours Reading Time : Nil

Special Instructions :

This paper consists of SIX (6) questions. Answer any FOUR (4) questions in the answer booklet provided. All questions carry equal marks.

IMPORTANT NOTE : THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION HALL

Materials Permitted : Non Programmable Scientific Calculator

Materials Provided : Appendix

Examiner(s) : Ms. Ch'ng Siew Peng

Moderator : Dr. Ooi Beng Lee

This paper consists of 5 printed pages, including the cover page.

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DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
 EEE2104: ELECTROMAGNETIC FIELD THEORY
 FINAL EXAMINATION: APRIL 2017 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks. The marks allocated to each sub-question are shown in the brackets at the right-hand margin.

Question 1

- a. Find the potential at point (0,0,5) with respect to point (0,0,15) due to a point charge 500pC at the origin. (7 marks)
- b. One uniform line charge of density $\rho_l = 4\mu\text{C/m}$ along the z-axis. Find the \vec{E} at (4,0,10). (5 marks)
- c. The capacitance of a variable parallel plate capacitor can be varied between 1×10^{-10} F and 5×10^{-10} F. The capacitance is first fixed at 5×10^{-10} F and the capacitor is charged using a voltage source of 200V.
 - i. Find the magnitude of charge on each plate of the capacitor. (3 marks)
 - ii. The battery is disconnected and the capacitance is changed to 1×10^{-10} F. Find the final potential difference across the capacitor and the mechanical work done to change the capacitance. (10 marks)

Question 2

- a. Two point charges of $-2\mu\text{C}(Q_1)$ and $5\mu\text{C}(Q_2)$ are located at (4,8,-10) and (2,-8,20) respectively. Calculate the total electric force acts on a point charge $40\mu\text{C}(Q_3)$ at (1,5,-25). Hence, find electric field strength at (1,5,-25). (13 marks)
- b. With Coulomb's Law, shows that the electric field, \vec{E} at point (0,0,h) due to infinite surface charge (ρ_s C/m²) located at xy plane is:

$$\vec{E} = -\frac{\rho_s}{2\epsilon_0} \vec{a}_z$$
 where h is any negative value. (10 marks)
- c. Defined electric potential between two points. (2 marks)

Question 3

- a. If an infinite current line with current, I_0 is placed along z-axis. With Ampere's Law, proves that \vec{H} at any point (ρ, ϕ, z) is

$$\vec{H} = \frac{I_0}{2\pi\rho} \vec{a}_\phi \quad (5 \text{ marks})$$

- b. A filamentary current of 3A from $x = 0$ to $x = \infty$. With Biot-Savart Law, find \vec{H} at $(-3, 4, 0)$. (16 marks)
- c. Find the force on a particle of mass 1.7×10^{-27} kg and charge 1.6×10^{-19} C of it enters a field $\vec{B} = 5\text{mT } \vec{a}_z$ with speed of 83.5km/s \vec{a}_y . (4 marks)

Question 4

- a. Let $V = xy^2z$, calculate the energy expended in transferring a $2\mu\text{C}$ point charge from $(1, -1, 2)$ to $(2, 1, -3)$. (6 marks)
- b. Region $y < 0$ consists of a perfect conductor while region $y \geq 0$ is a dielectric medium ($\epsilon_{r1} = 2$). If there is a surface charge of 2 C/m^2 on the conductor, determine \vec{E} at
- $A(3, -2, 2)$ (2 marks)
 - $B(-4, 1, 5)$ (4 marks)
- c. The xy -plane serves as the interface between two different medium. Medium 1 ($z < 0$) is filled with a material whose $\mu_r = 6$ and the medium 2 ($z > 0$) is filled with a material whose $\mu_r = 4$. If the interface carries current $(1/\mu_0) \text{ A/m}$ and $\vec{B}_2 = 5\vec{a}_x + 8\vec{a}_z \text{ Wb/m}^2$, find \vec{H}_1 . (13 marks)

Question 5

- a. A conducting rod of length $l = 35.0 \text{ cm}$ is free to slide on two parallel conducting bars as shown in Figure Q5(a). Two resistors $R_1 = 2\Omega$ and $R_2 = 5\Omega$ (are connected across the ends of the bars to form a loop. A constant magnetic field $B = 2.50 \text{ T}$ is directed perpendicularly into the page. An external agent pulls the rod to the left with a constant speed of $v = 8.00 \text{ m/s}$. Find
- the currents in both resistors (magnitude and direction) (8 marks)
 - the total power delivered to the both resistances of the circuit. (3 marks)

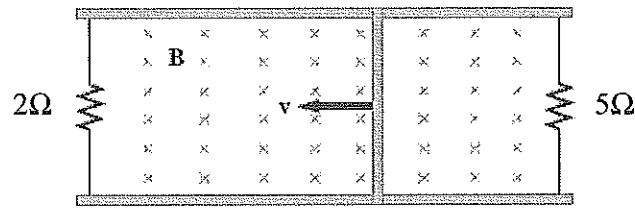


Figure Q5(a)

- b. Classify magnetic material according to the magnetic susceptibility and characteristic. (9 marks)
- c. Given that $\vec{E} = E_m \sin(\omega t - \beta z)\vec{a}_y$, in free space, find \vec{B} . (5 marks)

Question 6

- a. A 2m conductor which carrying 3A is placed parallel to the z-axis at distance $\rho_0 = 10\text{cm}$ as shown in Figure Q6(a). Given that field in the region is $\cos(\phi/3)\vec{a}_\phi$ Wb/m², calculate works require to rotate the conductor for one complete revolution about the z-axis? (11 marks)

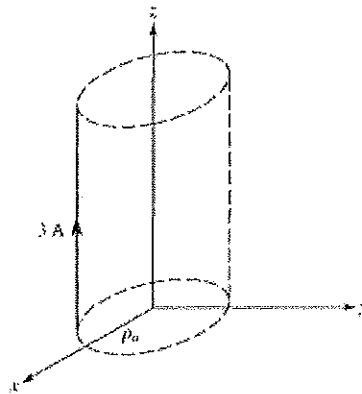


Figure Q6(a)

- b. The steel core magnetic circuit in Figure Q6(b) below has 500 coil turns and a uniform cross section of 1.5cm^2 throughout. The mean length are $l_1 = l_3 = 10\text{cm}$ and $l_2 = 4\text{cm}$. Determine the coil current required to create 0.25T in l_3 . Given the permeability of steel is $500\mu_0$. (12 marks)

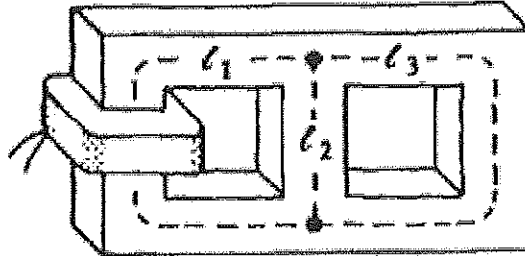


Figure Q6(b)

- c. Defined Ampere's Law

(2 marks)

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