



FINAL
Examination Paper

(COVER PAGE)

Session : August 2018

Programme : Diploma in Electrical and Electronic Engineering (DEEI)

Course : EEE2104: Electromagnetic Field Theory

Date of Examination : 12 December 2018 (Wednesday)

Time : 11:00am – 1:00pm Reading Time : Nil

Duration : 2 Hours

Special Instructions :

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

Materials permitted :

Non-Programmable Scientific Calculator

Materials provided :

Mathematical Formulas and Physical Constant Sheet

Examiner(s) : Dr. Solahuddin Yusuf Bin Fadhlullah

Moderator : Dr. Ooi Beng Lee

This paper consists of 8 printed pages, including the cover page

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
 EEE2104: ELECTROMAGNETIC FIELD THEORY
 FINAL EXAMINATION: AUGUST 2018 SESSION

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

Question 1

- a) Define Electric Field Intensity and Electric Flux Density.

(3 marks)

- b) Figure Q1b shows the charge distributions that are present in free space. Point charge 12 nC is located at $(2,0,6)$. A uniform line charge density 3 nC/m is located at $x=-2, y=3$ and an infinite uniform surface charge density 0.2 nC/m^2 at $x=2$.

- Find the electrical field at origin.
- Determine the force acting on a point charge $10 \mu\text{C}$ placed at the origin.
- Calculate the total electric flux leaving the surface of a sphere of 2 m radius centred at $(2,0,6)$.

(15 marks)

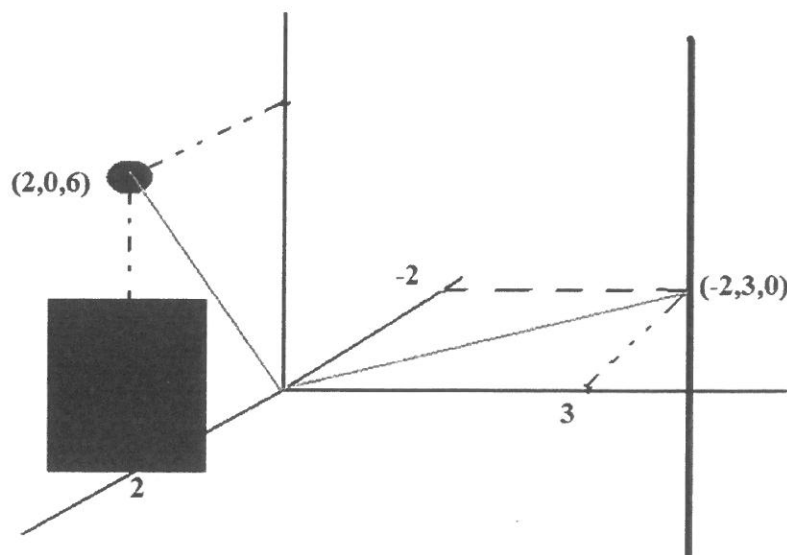


Figure Q1b

- c) A point charge, $Q=30$ nC is located at $(0,0,0)$. Find the electric flux density at $(1,3,-4)$ m.
(5 marks)
- d) State one of the conditions for a valid Gaussian surface.
(2 marks)

Question 2

- a) What does it mean if the electric potential is negative in value?
(2 marks)
- b) Given $\vec{D}=z\rho \cos^2\phi \mathbf{a}_z$ C/m². Calculate:
i. the charge density at $(1,\pi/4,3)$.
ii. the total charge enclosed by the cylinder of radius 1 m with $-2 \leq z \leq 2$ m by using Gauss's Law.
(9 marks)
- c) If $V=x - y + xy + 2z$ V, find \vec{E} at $(1, 2, 3)$.
(5 marks)
- d) Find the potential at point $(0,0,5)$ with respect to point $(0,0,15)$ due to the point charge 500 pC at the origin.
(5 marks)
- e) Region $y < 0$ consists of a perfect conductor while region $y \geq 0$ is a dielectric medium ($\epsilon r_1=2$). If there is a surface charge of 2 nC/m² on the conductor, determine \vec{E} and \vec{D} at:
i. A $(3, -2, 2)$
ii. B $(-4, 1, 5)$
(4 marks)

Question 3

- a) Explain the term capacitance and also write its related formula. (2 marks)
- b) With the aid of a diagram, explain about the Fringing Effect in parallel plate capacitors. (3 marks)
- c) A parallel-plate capacitor with area 0.30 m^2 and separation 5.5 mm contains three dielectrics with interfaces normal to \vec{E} and \vec{D} as follows:
 $\epsilon_{r1} = 3.0$, $d_1 = 1.0 \text{ mm}$, $\epsilon_{r2} = 4.0$, $d_2 = 2.0 \text{ mm}$, $\epsilon_{r3} = 6.0$, $d_3 = 2.5 \text{ mm}$
Determine the total capacitance. (9 marks)
- d) Two conducting parallel plates are separated by a dielectric material with $\epsilon = 5.6\epsilon_0$ and thickness 0.64 mm . Assume that each plate has an area of 80 cm^2 . If the potential field distribution between the plates is $V=3x+4y-12z+6 \text{ kV}$, determine:
- The capacitance of the capacitor (3 marks)
 - The potential difference between the plates (8 marks)

Question 4

- a) Define Ampere's Law and explain its importance in understanding electromagnetic field theory.

(3 marks)

- b) Find \vec{H} at (-3,4,5) when there are filamentary currents 10 A along \vec{a}_y and 20 A along $-\vec{a}_z$.

(12 marks)

- c) Given the magnetic vector potential $\vec{A} = -\frac{\rho^2}{4}\vec{a}_z$ Wb/m, calculate the total magnetic flux crossing the surface $\phi = \frac{\pi}{2}$, $1 \leq \rho \leq 2$ m, $0 \leq z \leq 5$.

(4 marks)

- d) A current distribution gives rise to the vector magnetic potential:

$$\vec{A} = x^2y\vec{a}_x + y^2x\vec{a}_y - 4xyz\vec{a}_z \text{ Wb/m}$$

Calculate the magnetic flux ϕ through the surface defined by $z=1$, $0 \leq x \leq 1$ and $-1 \leq y \leq 4$.

(6 marks)

Question 5

- a) Explain the classification of magnetic materials according to the magnetic susceptibility. For each type of magnetic materials, state two of its attributes. (9 marks)
- b) A solenoid in Figure Q5b with $N_1 = 2000$, $r_1 = 2$ cm and $L_1 = 100$ cm is concentric within a second coil of $N_2 = 2000$, $r_2 = 4$ cm and $L_2 = 200$ cm. Calculate:
- the Magnetic Flux Density, \vec{B}
 - the mutual inductance between two coils in a free space condition.

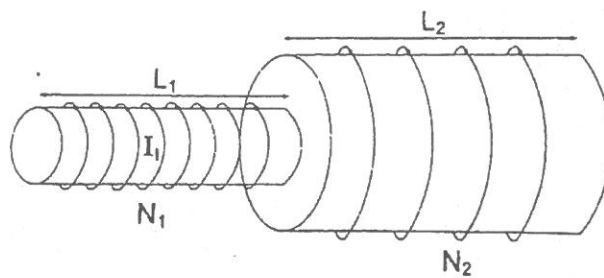


Figure Q5b

(8 marks)

- c) The magnetic circuit in Figure Q5c has a current of 10 A in the coil of 2000 turns. Assume that all the branches have the same cross section of 2 cm² and that the material of the core is iron with $\mu_r = 1500$. Calculate R, F and ϕ for
- the core
 - the air gap

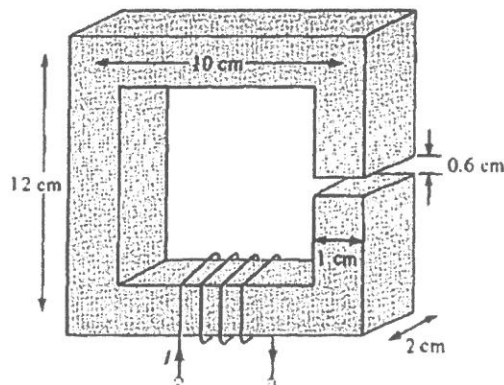


Figure Q5c

(8 marks)

Question 6

- a) Define Lenz's Law and also write down its related equation. (3 marks)
- b) In a Cartesian coordinate system, a conducting bar slides freely over two conducting rails as shown in Figure Q6b. Using Faraday's Law, solve the generated electromagnetic force (emf) if:
- the bar is stationary at $x = 4 \text{ cm}$ and $\vec{B} = 4 \cos 10^6 t \vec{u}_z \text{ mWb/m}^2$ (6 marks)
 - the bar is sliding at a velocity of $\vec{v} = 10\vec{u}_x \text{ m/s}$ and $\vec{B} = 4\vec{u}_z \text{ mWb/m}^2$ (6 marks)

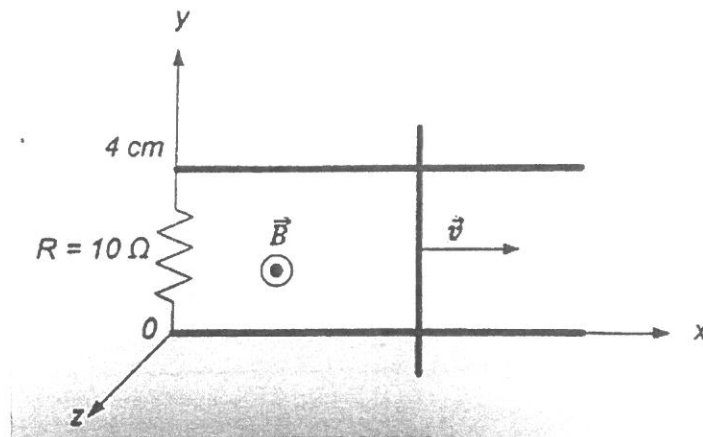


Figure Q6b

- c) A 50-V voltage generator at 20 MHz is connected to the plates of an air dielectric parallel plate capacitor with plate area 2.8 cm^2 and separation distance 0.2 mm. Find:
- the displacement current.
 - the maximum value of displacement current density.
- (6 marks)

- d) Fill in the empty spaces with the correct terminologies which defines the Maxwell's Equations

Differential Form	Law
$\nabla \cdot \mathbf{D} = \rho$	i.
$\nabla \cdot \mathbf{B} = 0$	ii.
$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$	iii.
$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$	iv.

(4 marks)