INTI
International College Penang

FINAL
Examination Paper

(COVER PAGE)

Session	:	**August 2019**
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EEE2104: Electromagnetic Field Theory**
Date of Examination	:	16 December 2019 (Monday)
Time	:	8:00am – 10:00am 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	:	Prof. Ir. Dr. Mandeep Singh

*This paper consists of **10** printed pages, including the cover page*

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
EEE2104: ELECTROMAGNETIC FIELD THEORY
FINAL EXAMINATIONS: AUGUST 2019 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) Figure Q1a shows charge 1, 2 and 3 with different distances between one another.

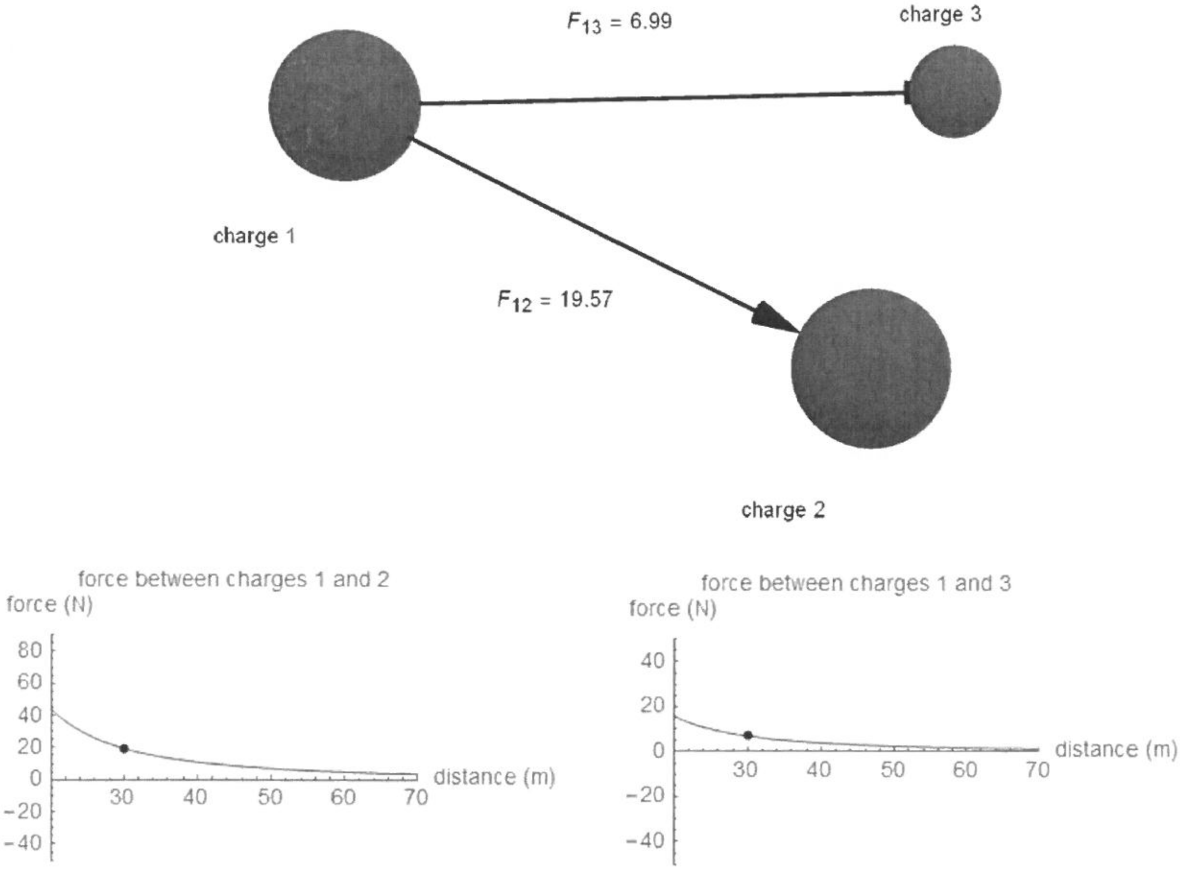

Figure Q1a: The force, F_{12} and F_{13} are 19.57 N and 6.99 N, respectively

i. Identify a suitable law that would explain the relationship between the forces experienced between charge 1, 2 and 3 as in Figure Q1a.

(1 mark)

ii. Discuss the pattern of the graphs by relating to the law that you have identified in Q1a)i.

(4 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.

i. Calculate the electrical field at origin.

(10 marks)

ii. Determine the force acting on a point charge 10 μC placed at the origin.

(2 marks)

iii. Calculate the total electric flux leaving the surface of a sphere of 2 m radius centred at (2,0,6).

(3 marks)

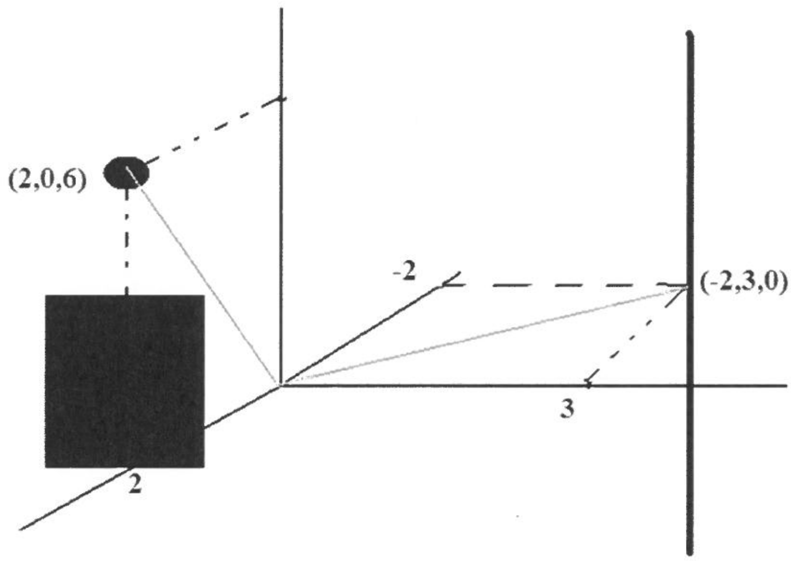

Figure Q1b

c) A point charge, Q = 30 nC is located at (0,0,0). Calculate the electric flux density at (1,3,−4) m.

(5 marks)

Question 2

a) Explain your understanding on the following statement: "Electric Potential, V_{AB} is independent of the path taken." Assume that A and B are the initial and final positions of a charge Q, respectively.

(2 marks)

b) Given $\vec{D}=z\rho\cos^2\varphi\, a_z$ C/m^2. Calculate the:

i. Charge density at $(1,\pi/4,3)$.

(2 marks)

ii. Total charge enclosed by the cylinder of radius 1 m with $-2 \le z \le 2$ m by using Gauss's Law.

(7 marks)

c) If $V=x-y+xy+2z$ V, calculate $\bar{E}$ at (1, 2, 3).

(5 marks)

d) Calculate 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 $y \ge 0$ is a dielectric medium (εr_1=2). If there is a surface charge of 2 nC/m^2 on the conductor, determine $\bar{E}$ and $\bar{D}$ at:

i. A (3, -2, 2)

(1 mark)

ii. B (-4, 1, 5)

(3 marks)

Question 3

a) Explain the correlation between capacitor and electric field. Provide a relevant formula to justify your answer.

(2 marks)

b) With the aid of a diagram, explain 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:

$\varepsilon_{r1} = 3.0$, $d_1 = 1.0$ mm, $\varepsilon_{r2} = 4.0$, $d_2 = 2.0$ mm, $\varepsilon_{r3} = 6.0$, $d_3 = 2.5$ mm

Determine the total capacitance.

(9 marks)

d) Two conducting parallel plates are separated by a dielectric material with $\varepsilon = 5.6\varepsilon_0$ 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 $V = 3x + 4y - 12z + 6\ kV$, determine the:

i. Capacitance of the capacitor.

(3 marks)

ii. Potential difference between the plates.

(8 marks)

Question 4

a) μ_0 is the permeability of free space. Elaborate your understanding on μ_0 and its correlation to magnetic flux density.

(3 marks)

b) Calculate $\bar{H}$ at (-3,4,5) when there are filamentary currents 10 A along $\bar{a_y}$ and 20 A along $-\bar{a_z}$.

(12 marks)

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

(4 marks)

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

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

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) Identify the classification of the magnetic materials provided in Table Q5a. List two attributes for each of the material.

Table Q5a

Material	μ_r
Silver	0.9999736
Platinum	1.003
Cobalt	250

(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:

i. Magnetic Flux Density, $\vec{B}$

(6 marks)

ii. Mutual inductance between two coils in a free space condition.

(2 marks)

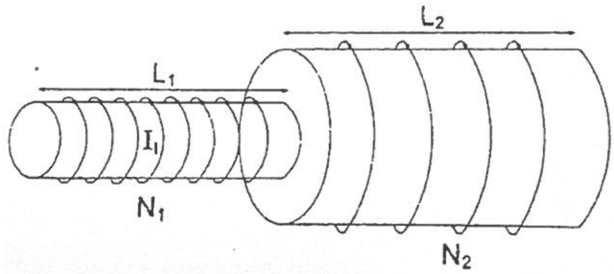

Figure Q5b

c) The toroid in Figure Q5c has a coil of 1000 turns wound on its core. If ρ_0=10 cm and a=1 cm, calculate the current required to establish a magnetic flux of 0.5 mWb,

i. If the core is non-magnetic

(3 marks)

ii. If the core has μ_r=500

(3 marks)

iii. Assuming that the values of ρ_0 and the magnetic flux are to be retained (not changing), how should the setup of the toroid be modified to reduce the current value?

(2 marks)

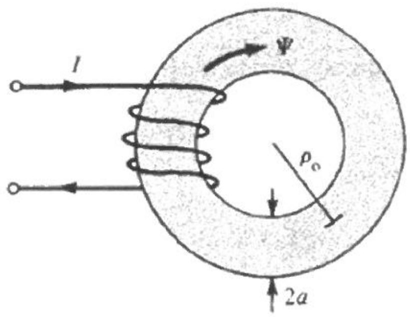

Figure Q5c

Question 6

a) Explain the activity shown in Figure Q6a and relate it to the relevant theory.

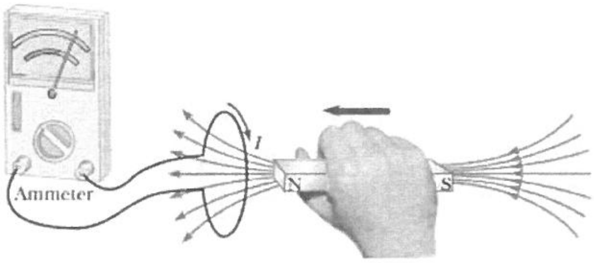

Figure Q6a

(4 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:

i. Stationary at $x = 4\ cm$ and $\bar{B} = 4\cos 10^6 t\ \bar{u}_z\ mWb/m^2$

(6 marks)

ii. Sliding at a velocity of $\bar{v} = 10\bar{u}_x$ m/s and $\bar{B} = 4\bar{u}_z$ mWb/m^2

(6 marks)

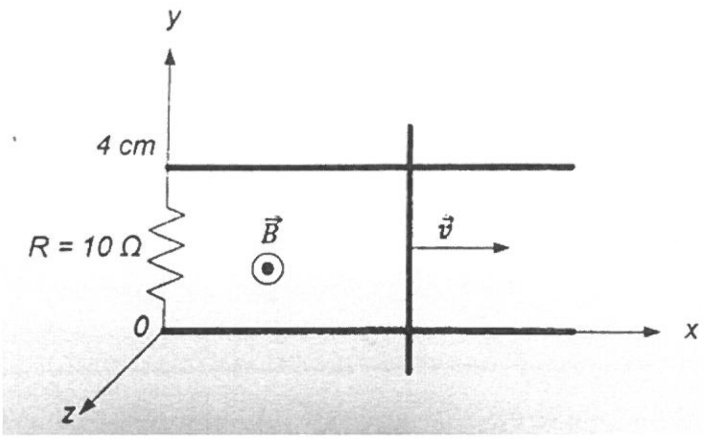

Figure Q6b

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. Calculate the:

i. Displacement current.

(4 marks)

ii. Maximum value of displacement current density.

(2 marks)

d) Describe the impact of the four Maxwell's equations on telecommunication system.

(3 marks)

– THE END –