INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**August 2021**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EEE2104/EGE2114: Electromagnetic Field Theory**
Date of Examination	:	7 December 2021 (Tuesday)
Time	:	8.00am – 11.00am Reading Time : Nil
Duration	:	3 Hours

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer **ALL** questions and all questions carry equal marks. The marks allocated to each sub-questions are shown in the brackets at the right-hand margin.

Material permitted : Non-Programmable Scientific Calculator

Materials provided : Mathematical Formulas and Physical Constant Sheet

Examiner(s)	:	**Dr. Solahuddin**
Chief Moderator	:	Alan Wong Kam Mun

*This paper consists of **9** printed pages, including the cover page*

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2104 / EGE2114: ELECTROMAGNETIC FIELD THEORY
FINAL ALTERNATIVE ASSESSMENT: AUGUST 2021 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer **ALL** questions and 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) Point charges 1 mC and -2 mC are located at (3, 2, -1) and (-1, -1, 4), respectively. Calculate the electric force on a 10 nC charge located at (0, 3, 1).

(5 marks)

b) Based on the illustration given in Figure Q1b, determine whether it is a valid Gaussian surface. Justify your answer by relating to the definition of Gauss's Law.

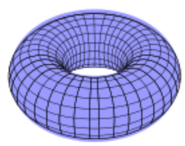

Figure Q1b

(3 marks)

c) Two infinite sheets of charge with uniform surface charge densities in free space are shown in Figure Q1c. The first sheet with a charge density, $\rho_{s1} = 10^{-5}$ C/m^2 is located at z = 0 (x-y plane). The second sheet with a charge density, $\rho_{s2} = -10^{-5}$ C/m^2 is located at z = 4 m. Using Gauss's Law, compute the electric field intensity, $\vec{E}$ along z-axis.

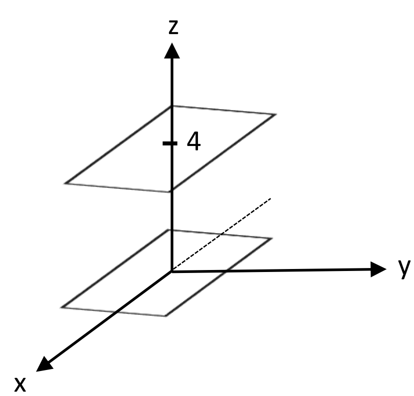

Figure Q1c

(9 marks)

d) Given the potential $V = (10/r^2) \sin\theta \cos\phi$. Calculate the work done in moving a 10 C charge from A (1, 30°, 120°) to B (4, 90°, 60°) using integration method.

(6 marks)

e) Explain your understanding on the following statement: "Electric Potential, V_{AB} is independent of the path taken" whereby $_A$ and $_B$ are the initial and final positions of a charge Q, respectively.

(2 marks)

Question 2

a) A fully charged capacitor is shown in Figure Q2a. The separation distance, *d*, between the two plates of the capacitor is then slightly increased. By doing this, explain why:

i. the capacitance would decrease.

(2 marks)

ii. the voltage of the capacitor would remain the same at 3 V.

(2 marks)

iii. the total charge on the plates would decrease.

(2 marks)

iv. the electric field would decrease.

(2 marks)

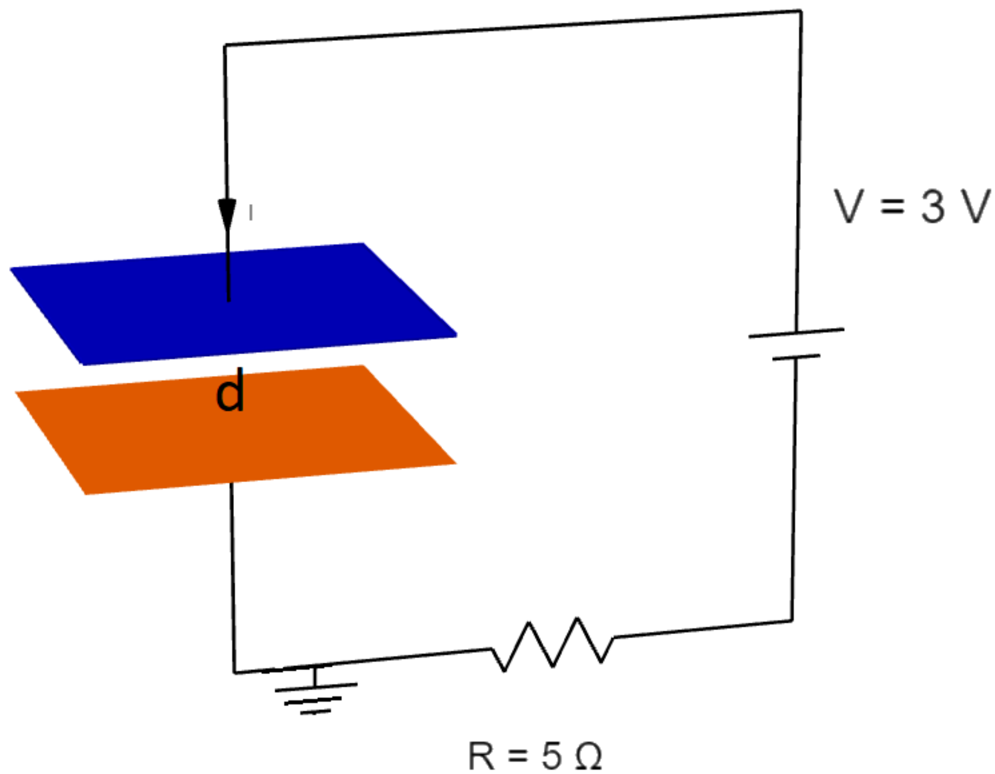

Figure Q2a

b) Figure Q2b shows four capacitors having the same capacitance and a battery providing 120 V. Assume this is the initial setup for each cases numbered below (i,ii,iii) and initially all of the capacitors are uncharged. Assume the capacitors to be fully charged when powered.

Case:

i. Determine the electric potential difference across each capacitor when Switch B is closed while Switch A remains opened.

(1 mark)

ii. Determine the electric potential across each capacitor when switch A is closed but switch B is opened. You may explain the logic behind your answer.

(2 marks)

iii. Switch A and B are now closed. Determine the electric potential across each capacitor. You may explain the logic behind your answer.

(2 marks)

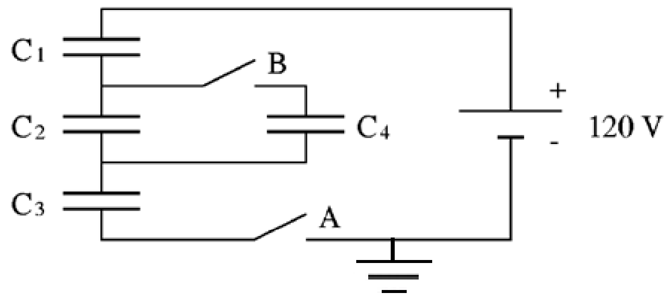

Figure Q2b

c) Two conducting parallel plates are separated by a dielectric material with ε = 5.6ε_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.

(2 marks)

ii. Potential difference between the plates.

(7 marks)

d) Calculate the capacitance per unit length of a coaxial cable with outer radius of 4 mm and inner radius of 0.5 mm. The relative permittivity of the cable is given as, ε_r = 5.2.

(3 marks)

Question 3

a) Figure Q3a shows an infinite line charge along the z-axis. The line has a radius of a =1 mm and I= 20 A. The magnetic field formula for the line charge is given as:

$$H_{\phi} = \frac{\rho^2}{a^2}\frac{I}{2\pi\rho}$$

Calculate the:

i. H_ϕ at ρ = 0.5 mm

(2 marks)

ii. magnetic flux density, B_ϕ at ρ = 0.8 mm

(3 marks)

iii. magnetic flux per unit length inside the line charge

(3 marks)

iv. flux for ρ > 1.0 mm

(3 marks)

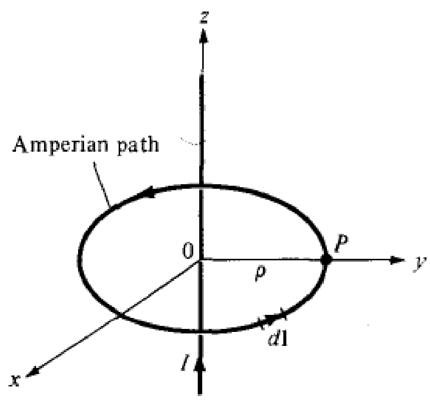

Figure Q3a

b) Charge Q is travelling at a velocity of $\bar{v} = 5 \times 10^{-6}(0.6\bar{a}_x + 0.75\bar{a}_y + 0.3\bar{a}_z)$ m/s in the presence of a magnetic flux density $\bar{B} = -3.0\bar{a}_x + 4.0\bar{a}_y + 6.0\bar{a}_z$ mT. Calculate the force $|\bar{F}|$ exerted on the charge.

(4 marks)

c) Figure Q3c shows an infinite wire carrying 15 A in the y-axis which has a magnetic flux density, $\bar{B} = \frac{3}{x}\bar{a}_z$ μT.

i. Calculate the force exerted on the square-shaped loop conductor which carries 2 mA. (8 marks)

ii. Draw the direction of the force vector calculated in part i. in Figure Q3c. (2 marks)

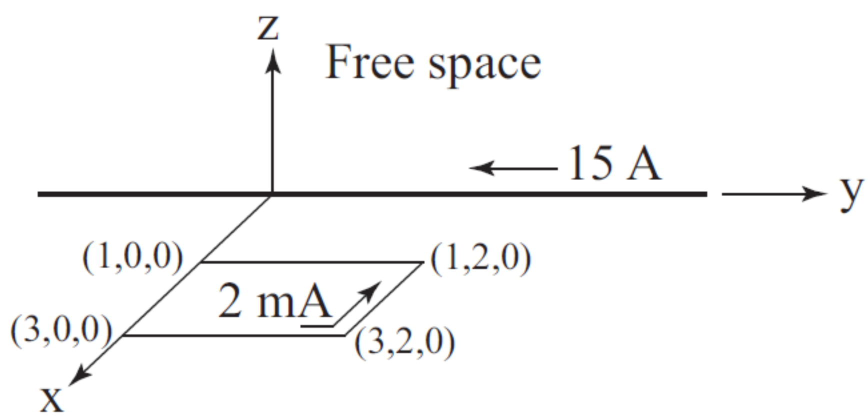

Figure Q3c

Question 4

a) In a certain material for which $\mu = 6.5\mu_0$, H=$10\vec{a}_x + 25\vec{a}_y - 40\vec{a}_z\ A/m$, calculate the:

i. magnetic susceptibility of the material

(1 mark)

ii. magnetic flux density, $\vec{B}$

(2 marks)

iii. magnetization, $\vec{M}$

(2 marks)

b) The magnetic circuit in Figure Q4b has a current of 10 A in the coil of 2000 turns. Assume that all the branches have the same cross section of 2 cm^2 and that the material of the core is iron with μ_r = 1500. Calculate reluctance (*R*), magnetic force (*F*) and magnetic flux (*φ*) for:

i. the core
ii. the air gap

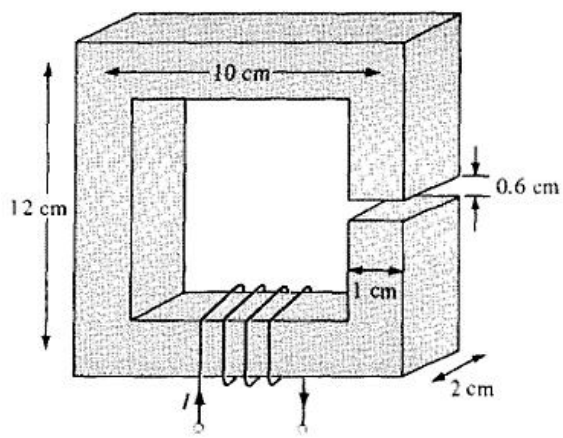

Figure Q4b

(7 marks)

c) In a Cartesian coordinate system, a conducting bar slides freely over two conducting rails as shown in Figure Q4c. Using Faraday's Law, calculate the generated electromagnetic force (emf) if the bar is:

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

(5 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

(4 marks)

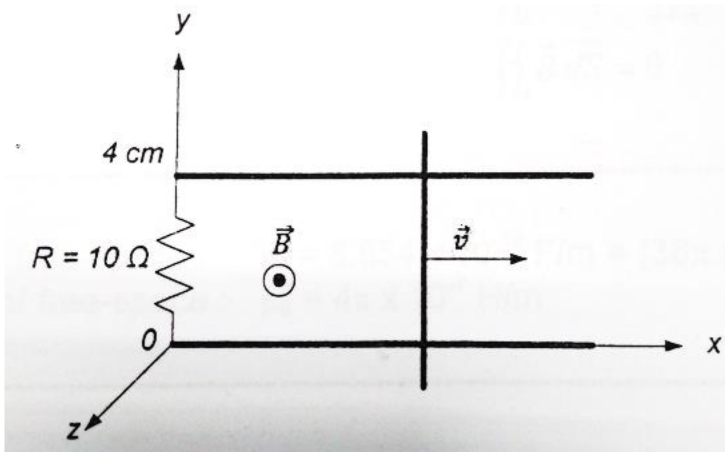

Figure Q4c

d) Explain, in your own words, the difference between Faraday's Law and Lenz's Law.
(4 marks)

~THE END~