INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**January 2022**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EGE2114: Electromagnetic Field Theory**
Date of Examination	:	5 March 2022 (Saturday)
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	:	Steven Khoo Boo Tap

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

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EGE2114: ELECTROMAGNETIC FIELD THEORY
FINAL ALTERNATIVE ASSESSMENT: JANUARY 2022 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) Two point charges of 2.2×10^{-9} C and 5.4×10^{-9} C are located on the x-axis at $x_1 = -1.5$ m and $x_2 = 2.0$ m respectively. Find the net force exerted on a 3.5×10^{-9} C charge located at the origin.

(5 marks)

b) Explain the two Gaussian surface conditions (requirements) for using Gauss's Law.

(4 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 m (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, $\vec{E}$ in all regions.

(10 marks)

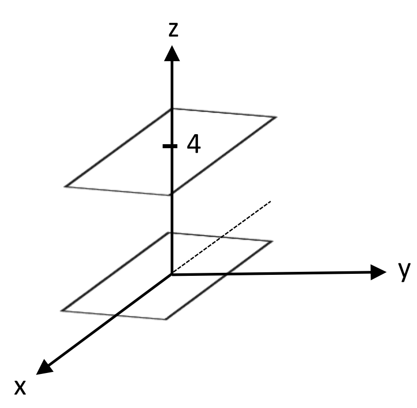

Figure Q1c

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.

(4 marks)

e) Sketch the equipotential lines for a system of two point charges on the y-axis shown in Figure Q1e.

(2 marks)

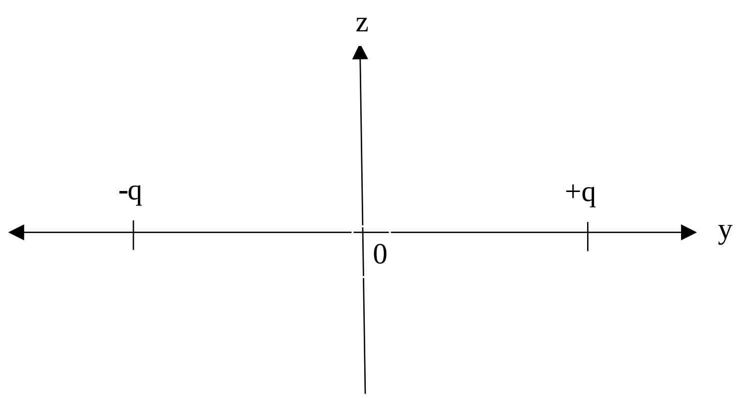

Figure Q1e

Question 2

a) The initial state of a circuit with a parallel plate capacitor is shown in Figure Q2a. Explain with justification, what would happen to the parameter of interest for each of the cases below. Use formula to aid the explanation and assume all components in the circuit are ideal.

i. Parameter of interest: capacitance of the capacitor.
Condition: switch SW1 remains open but the separation distance, *d* between plates P1 and P2 is increased.

(2 marks)

ii. Parameter of interest: capacitance of the capacitor.
Condition: switch SW1 remains open but the area of plates P1 and P2 is increased.

(2 marks)

iii. Parameter of interest: electrical field between plates P1 and P2.
Condition: switch SW1 is closed and the separation distance, *d* between plates P1 and P2 is decreased.

(2 marks)

iv. Parameter of interest: voltage of the capacitor.
Condition: switch SW1 is closed for several seconds and then opened. After that, the separation distance, *d* between plates P1 and P2 is increased.

(2 marks)

v. Parameter of interest: energy stored in the capacitor.
Condition: switch SW1 is closed for several seconds and then opened. After that, the area of plates P1 and P2 is increased.

(2 marks)

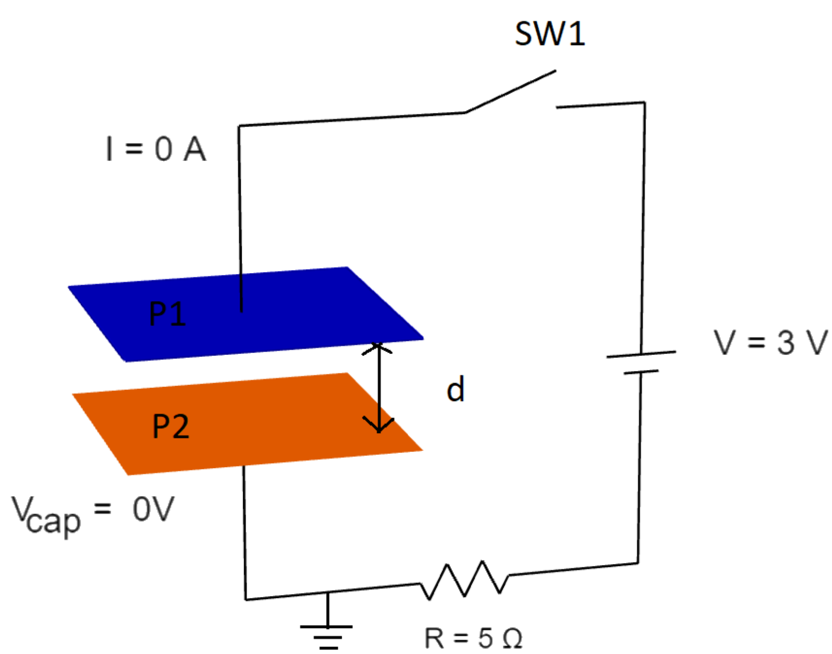

Figure Q2a

b) A parallel-plate capacitor with an area, S of 0.30 m^2 and separation distance, d of 5.5 mm contains three dielectrics with interfaces normal to the electric field intensity, $\vec{E}$ and electric flux density, $\vec{D}$ as follows:

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

Calculate the total capacitance of the capacitor.

(5 marks)

c) 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.

(2 marks)

ii. Potential difference between the plates.

(6 marks)

d) Explain why using materials with a higher value of dielectric constant, K produces higher capacitance in a capacitor.

(2 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 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. 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

(2 marks)

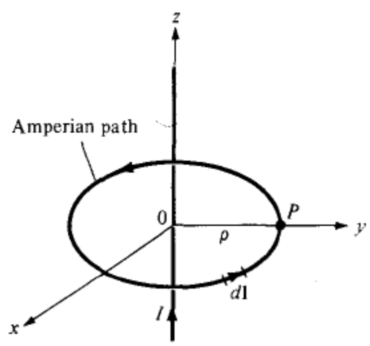

Figure Q3a

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 exerted on the charge, $|\bar{F}|$.

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

(8 marks)

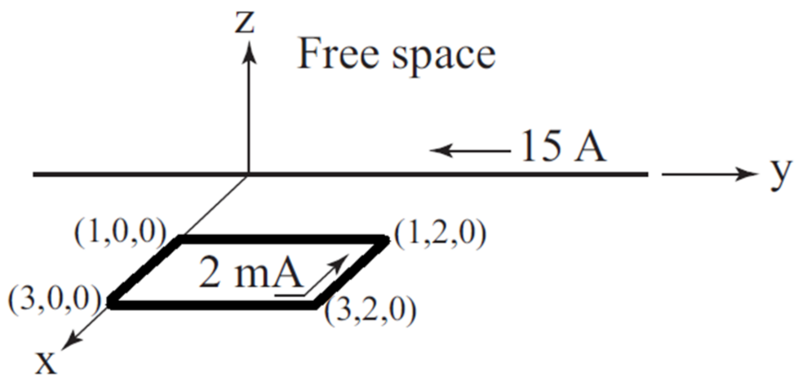

Figure Q3c

d) Explain the meaning and importance of the following formula:

$$\oint \bar{B} \cdot d\bar{S} = 0$$

(3 marks)

Question 4

a) Based on Figure Q4a, answer the following questions:

i. Calculate the inductance when the number of turns=100, length=30 cm, radius=10 cm and μ_r=3.1.

(2 marks)

ii. In your own words, explain why μ_r is needed for calculating the inductance.

(2 marks)

iii. Explain what would happen to the inductance in part (a)i. if a solid rod made out of platinum is inserted into the coil. Justify your answer by calculation or reasoning.

(2 marks)

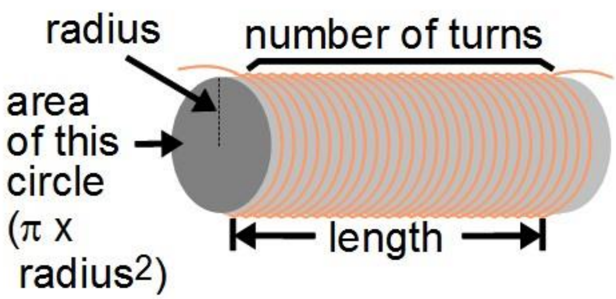

Figure Q4a

b) 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)

c) The magnetic circuit in Figure Q4c 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

(7 marks)

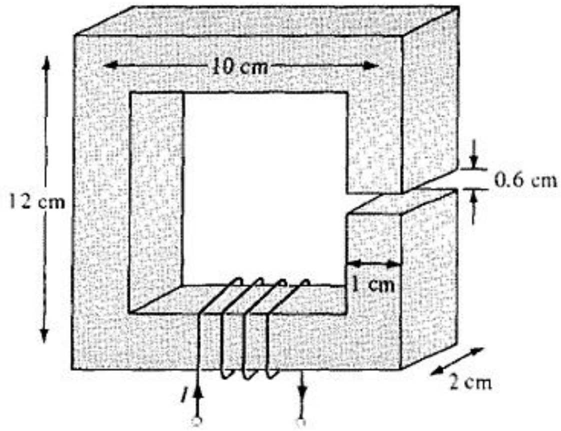

Figure Q4c

d) A conductive circular loop of radius 5 cm lies in the z = 0 plane in a magnetic field B = ($20 \cos 210t$ $a_x + 2 \sin 210t$ a_z) mWb/m^2. Calculate the induced voltage in the loop.

(5 marks)

e) Explain the effect of Eddy current on wireless transmission.

(2 marks)

~THE END~