INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**August 2020**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EEE2104: Electromagnetic Field Theory**
Date of Examination	:	15 December 2020 (Tuesday)
Time	:	2.00pm – 5.00pm Reading Time : Nil
Duration	:	3 Hours

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer **ALL** 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.

Material permitted :
Non-Programmable Scientific Calculator

Materials provided :
Mathematical Formulas and Physical Constant Sheet

Examiner(s)	:	**Dr. Solahuddin**
Chief Moderator	:	Chong Kok Ming

*This paper consists of **7** printed pages, including the cover page*

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2104: ELECTROMAGNETIC FIELD THEORY
FINAL ALTERNATIVE ASSESSMENT: AUGUST 2020 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) 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) Figure Q1b shows the charge distributions that are present in free space. Point charge 12 *n*C is located at (2,0,6). A uniform line charge density 3 *n*C/m is located at x = -2, y = 3 and an infinite uniform surface charge density 0.2 *n*C/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 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)

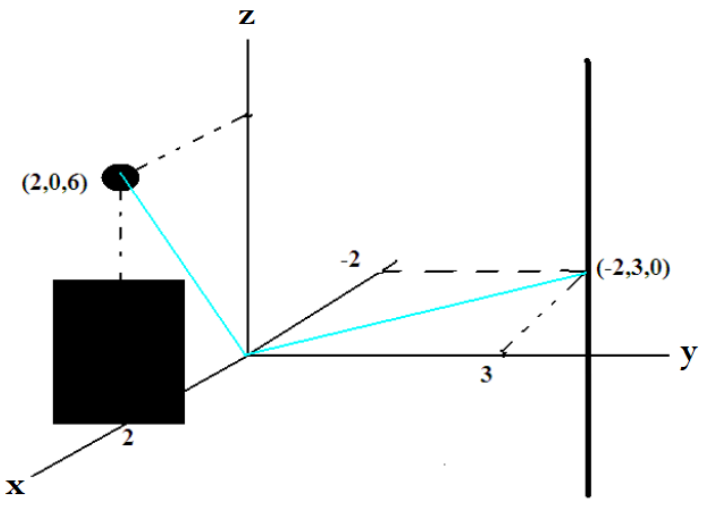

Figure Q1b

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

(3 marks)

d) Region y < 0 consists of a perfect conductor while region y ≥ 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)

iii. Explain your understanding of the result in Q1d)i. relating to electromagnetic wave.

(1 mark)

Question 2

a) Explain how the inverse square law affects electric flux density.

(2 marks)

b) A free space parallel plate capacitor is charged by a momentary connection to a voltage source *V*, which is then removed. Explain and justify how the parameters listed below change as the plates are moved apart twice the original distance.

i. The total charge, *Q* (2 marks)
ii. The capacitance, *C* (2 marks)
iii. The electric field intensity, *E* (2 marks)
iv. The electric flux density, *D* (2 marks)
v. The electric potential, *V* (2 marks)
vi. The energy stored, *W* (2 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) Calculate the capacitance per unit length of a coaxial cable with outer conductor shield at radius of 4 mm, inner conductor with radius of 0.5 mm and the dielectric of the isolator in between has $\varepsilon_r = 5.2$.

(3 marks)

Question 3

a) Consider a semi-infinite filament conductor carrying a current of 5 A in the positive-y direction. Assume that the conductor is part of a large circuit. Apply Biot-Savart's law to calculate the magnetic flux density, $\vec{B}$ at point P (4,6,0).

(9 marks)

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

(10 marks)

c) Given that $\bar{B}=10e^{-y}\,\bar{a_z}\ mWb/m^2$ and $\mu=4.6\mu_0$, calculate the:

i. Magnetic susceptibility, X_m

(1 mark)

ii. Magnetic field intensity, $\bar{H}$

(2 marks)

d) Explain, in the context of electromagnetic field theory, how Maxwell solved a problem stemming from the limitation of the Ampere's Law.

(3 marks)

Question 4

a) Explain the mechanism (concept) of ferromagnetism.

(3 marks)

b) The toroid in Figure Q4b 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

(2 marks)

ii. If the core has μ_r=500

(2 marks)

iii. If the value of ρ_0 cannot be changed, which parameter of the toroid setup should be modified to excite the toroid to the same magnetic flux, Ψ but with reduced current?

(2 marks)

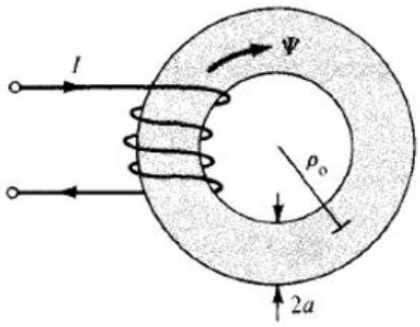

Figure Q4b

c) Explain, in your own words, the difference between Faraday's Law and Lenz's Law.

(2 marks)

d) In a Cartesian coordinate system, a conducting bar slides freely over two conducting rails as shown in Figure Q4d. Using Faraday's Law, solve the generated electromagnetic force (emf) if the bar is:

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

(4 marks)

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

(4 marks)

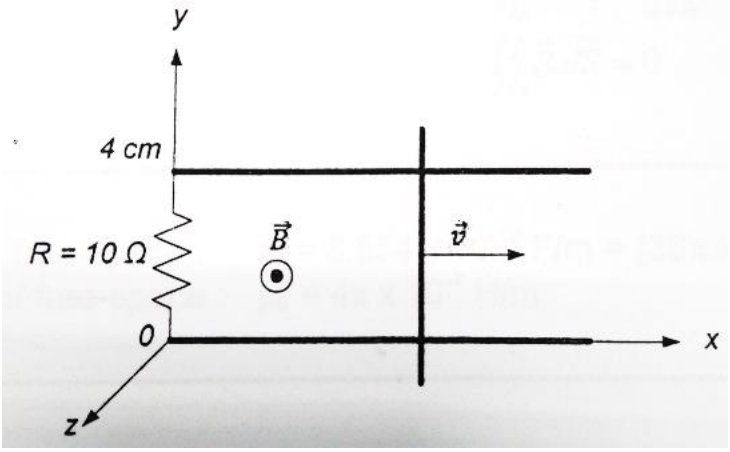

Figure Q4d

e) Explain how Maxwell's Equations assist us in understanding electromagnetic wave propagation.

(3 marks)

f) The magnetic field intensity of uniform plane wave in free space is 35 A/m along $\bar{u}_y$ direction and the wave is propagating at frequency of 4 x 10^9 rad/sec. Compute:

i. the wavelength (λ)
ii. the frequency (f)
iii. the period (T)

(3 marks)

~THE END~