INTI
International College Penang
LAUREATE INTERNATIONAL UNIVERSITIES*

FINAL
Examination Paper

(COVER PAGE)

Session	:	**August 2017**
Programme	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EEE2104: Electromagnetic Field Theory**
Date of Examination	:	8 December 2017 (Friday)
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 on the answer booklet provided. All questions carry equal marks.

Materials permitted :

Non-Programmable Scientific Calculator

Materials provided :

Mathematical Formulas and Physical Constant

Examiner(s)	:	**Dr. Solahuddin Yusuf Bin Fadhlullah**
Moderator	:	Dr. Ooi Beng Lee

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

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING (DEEI)
EEE2104: ELECTROMAGNETIC FIELD THEORY
FINAL EXAMINATION: AUGUST 2017 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) State Coulomb's law equation. From the equation, describe the characteristic of electric field intensity produced by one point charge.

(3 marks)

b) Two point charges, $Q_1 = 50\ \mu C$ and $Q_2 = 10\ \mu C$ are located at (-1,1,-3) m and (3,1,0) m respectively. Compute the magnitude and direction of force exerted on point charge Q_1.

(7 marks)

c) Point charges 5 nC and -2 nC are located at (2, 0, 4) and (-3, 0, 5) respectively. Determine the electric field intensity on a 1×10^{-9} C point charge located at (1, -3, 7).

(9 marks)

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

(6 marks)

Question 2

a) Based on the surface given in Figure Q2a, determine whether it is a valid Gaussian surface. Justify your answer by giving the definition of Gauss's Law.

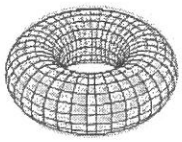

Figure Q2a

(2 marks)

b) An infinite sheet of charge in Figure Q2b with uniform surface charge density $\rho_{s1} = 10^{-5}$ C/m^2 is located at z = 0 (x-y plane) and another infinite sheet $\rho_{s2} = -10^{-5}$ C/m^2 is located at z = 4 m, both in free space. Using Gauss's Law, compute the electric field intensity, $\vec{E}$ in all regions.

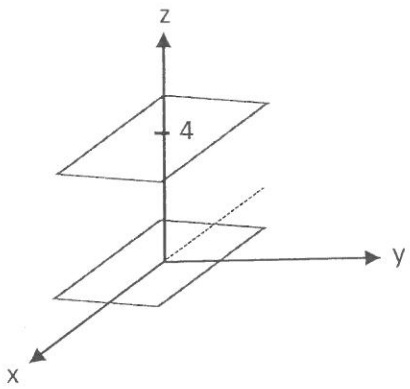

Figure Q2b

(12 marks)

c) Determine the total charge
   i. at the line of $0 < x < 5$ m if $\rho = 12x^2$ mC/m
   ii. on the cylinder where $\rho = 3$ and $0 < z < 4$ m if $\rho_s = \rho z^2$ nC/m^2

(6 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)

Question 3

a) 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, $\varepsilon_{r2} = 6.0$, $d_3 = 2.5$ mm

Determine the total capacitance.

(9 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 to a separation distance 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) Find the capacitance per unit length of a coaxial cable with outer radius of 4 mm and inner radius of 0.5 mm if the dielectric has $\varepsilon_r = 5.2$.

(4 marks)

Question 4

a) State the mathematical expression of the magnetic field intensity, $\vec{H}$ for all types of current distribution as stated in the Biot-Savart's Law.

(3 marks)

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

(10 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 $\emptyset = \frac{\pi}{2}, 1 \leq \rho \leq 2m, 0 \leq z \leq 5$.

(4 marks)

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

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

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

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

i. The magnetic susceptibility of the material

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

iii. The magnetization of $\vec{M}$

(6 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 cm^2 and that the material of the core is iron with $\mu_r = 1500$. Calculate R, F and φ for

i. the core

ii. the air gap

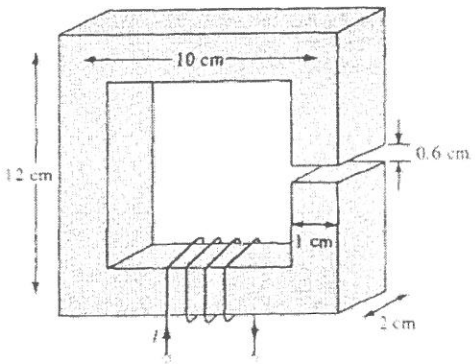

Figure Q5c

(10 marks)

Question 6

a) Define Faraday's Law and its related equations.

(3 marks)

b) A conducting bar can slide freely over two conducting rails as shown in Figure Q6b. Calculate the induced voltage in the bar:

i. If the bar is stationed at $y = 8\ cm$ and $B = 4\sin 10^6 t\ \bar{a}_z\ \mathrm{mWb/m^2}$ (2 marks)

ii. If the bar slides at a velocity $\bar{u} = 20\bar{a}_y\ \mathrm{m/s}$ and $\bar{B} = 4\bar{a}_z\ \mathrm{mWb/m^2}$ (2 marks)

iii. If the bar slides at a velocity $\bar{u} = 20\bar{a}_y\ \mathrm{m/s}$ and $\bar{B} = 4\sin(10^6 t\text{-}y)\ \bar{a}_z\ \mathrm{mWb/m^2}$ (4 marks)

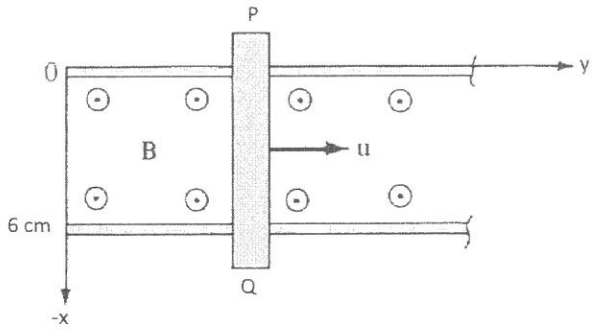

Figure Q6b

c) A parallel plate capacitor with an area of 5 $\mathrm{cm^2}$ and plate separation of 3 mm has a voltage of 50 $\sin 10^3 t$ V applied to its plate. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$.

(6 marks)

d) In a material for which $\sigma = 5.0$ S/m and $\varepsilon_r = 1$, the electric field intensity is given as $E = 250 \sin 10^{10} t$ V/m. Find:

i. The conduction current density (2 marks)

ii. The displacement current density (3 marks)

iii. The frequency at which they have equal magnitudes (3 marks)

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