



**FINAL
ALTERNATIVE ASSESSMENT**

(COVER PAGE)

Session : April 2020

Programme : Diploma in Electrical & Electronic Engineering (DEEI)

Course : EEE2104: Electromagnetic Field Theory

Date of Examination : 5 August 2020 (Wednesday)

Time : 8.00am – 11.00am 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 : Mr Chong Kok Ming

This paper consists of 6 printed pages, including the cover page

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DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2104: ELECTROMAGNETIC FIELD THEORY
FINAL ALTERNATIVE ASSESSMENT: APRIL 2020 SESSION

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Question 1

- a)
- i. Explain why divergence is needed in studying electromagnetic field theory. (2 marks)
 - ii. Draw an illustration that shows the concept of divergence. (2 marks)
- b) 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)
- c) Sketch the equipotential lines for a system of two point charges on the y-axis shown in Figure Q1c.

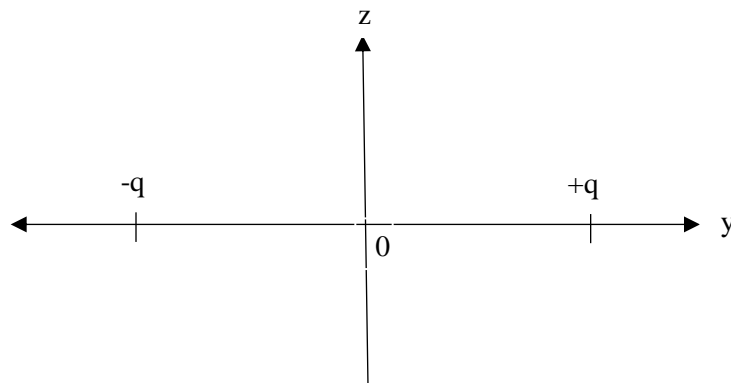


Figure Q1c

(2 marks)

- d) Given $\vec{D} = z\rho \cos^2\phi \mathbf{a}_z \text{ C/m}^2$. Calculate the:
- Charge density at $(1, \pi/4, 3)$.
(2 marks)
 - Total charge enclosed by the cylinder of radius 1 m with $-2 \leq z \leq 2$ m by using Gauss's Law.
(7 marks)
- e) 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)

Question 2

- a) With the aid of a diagram, explain how geometry affects capacitance. You may choose any one example in your answer.

(3 marks)

- b) Explain the effect of dielectric on capacitance.

(2 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:

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

Determine the total capacitance.

(9 marks)

- d) Two conducting parallel plates are separated by a dielectric material with $\epsilon = 5.6\epsilon_0$ 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 $V=3x+4y-12z+6 \text{ kV}$, determine the:

- i. Capacitance of the capacitor.

(3 marks)

- ii. Potential difference between the plates.

(8 marks)

Question 3

- 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 \vec{H} at (-3,4,5) when there are filamentary currents 10 A along \vec{a}_y and 20 A along $-\vec{a}_z$.

(12 marks)

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

(4 marks)

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

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

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 4

- a) Identify the classification of the magnetic materials provided in Table Q4a. List two attributes for each of the material.

Table Q4a

Material	μ_r
Silver	0.9999736
Platinum	1.003
Cobalt	250

(9 marks)

- b) A solenoid in Figure Q4b 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)

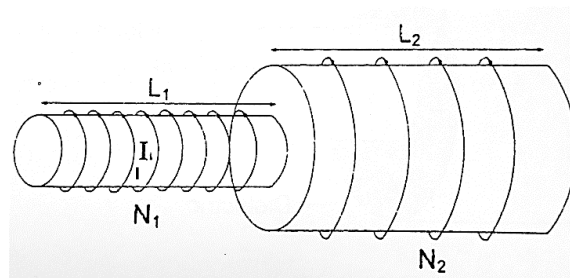


Figure Q4b

- c) A conductive circular loop of radius 5 cm lies in the $z = 0$ plane in a magnetic field $\mathbf{B} = (20 \cos 210t \mathbf{a}_x + 2 \sin 210t \mathbf{a}_z)$ mWb/m². Calculate the induced voltage in the loop. (5 marks)
- d) Calculate the inductance of a solenoid of 200 turns wound lightly on a cylindrical tube of 6 cm diameter. The length of the tube is 60 cm and the solenoid is in air. (3 marks)