



**FINAL
ALTERNATIVE ASSESSMENT**

(COVER PAGE)

Session : January 2021

Programme : Diploma in Electrical & Electronic Engineering (DEEI)

Course : EEE2104/EGE2114: Electromagnetic Field Theory

Date of Examination : 9 March 2021 (Tuesday)

Time : 2.00pm – 5.00pm 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 7 printed pages, including the cover page

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DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
 EEE2104 / EGE2114: ELECTROMAGNETIC FIELD THEORY
 FINAL ALTERNATIVE ASSESSMENT: JANUARY 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) Figure Q1a shows charge 1, 2 and 3 with different distances between one another.

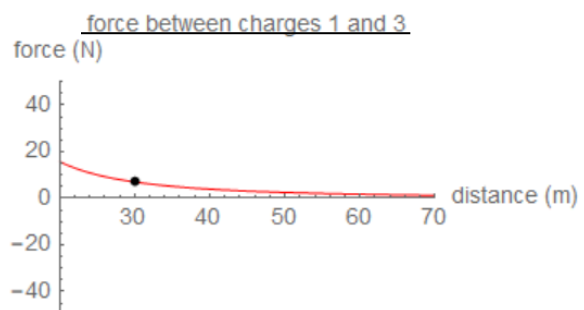
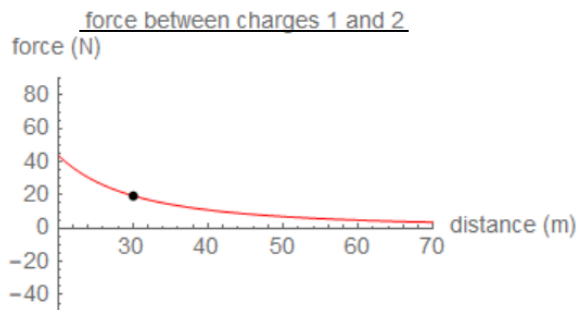
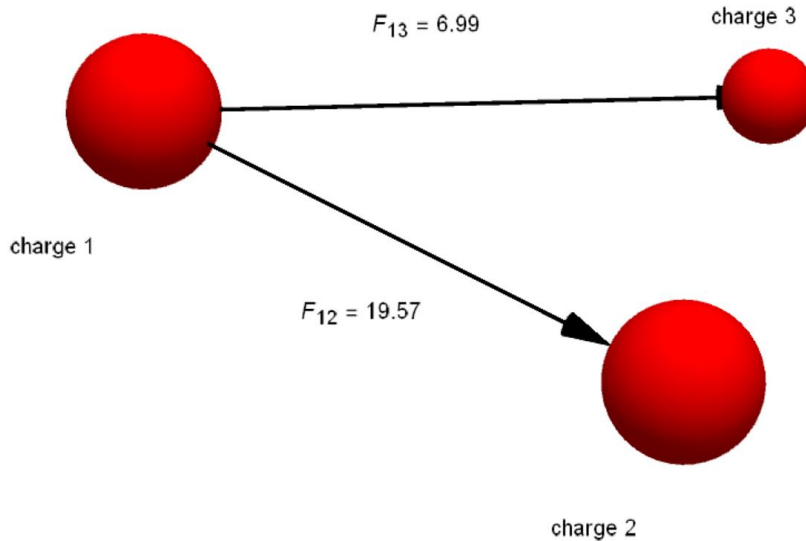


Figure Q1a: The force, F_{12} and F_{13} are 19.57 N and 6.99 N, respectively

- i. Identify a suitable law that would explain the relationship between the forces experienced between charge 1, 2 and 3 as in Figure Q1a.

(1 mark)

- ii. Discuss the pattern of the graphs by relating to the law and its formulae that have been identified in Q1a)i. (3 marks)
- b) 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)
- c) Given $V = x - y + xy + 2z$ V, calculate \vec{E} at $(1, 2, 3)$. (3 marks)
- 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. (3 marks)
- e) Region $y < 0$ consists of a conductor while region $y \geq 0$ is a dielectric medium ($\epsilon_{r1}=3$). If there is a surface charge of 7 nC/m^2 on the conductor, determine \vec{E} and \vec{D} at:
- A $(3, 4, 5)$ (3 marks)
 - B $(7, -8, 9)$ (1 mark)
 - Explain your understanding about electricity (electrical energy) at the conductor based on the results from part i) and ii). (2 marks)

Question 2

- a) Explain the correlation between capacitor and electric field. Provide a relevant formula to justify your answer.

(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)

- c) 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. (2 marks)

- ii. Potential difference between the plates. (6 marks)

- d) 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 \vec{E} and \vec{D} as follows:

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

Calculate the total capacitance of the capacitor.

(5 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) 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)

- c) Calculate \vec{H} at (-3, 4, 5), when there is an infinite filamentary current 10A passing along y-axis in the direction of \vec{a}_y , and another filamentary current 20A passing along z-axis in the direction of $-\vec{a}_z$.

(9 marks)

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

(4 marks)

Question 4

a) Explain the activity shown in Figure Q4a) and relate it to the relevant theory.

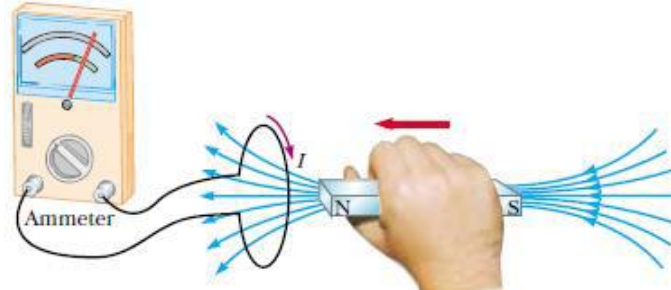


Figure Q4a)

(3 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 $\mu_r = 1500$. Calculate reluctance (R), magnetic force (F) and magnetic flux (ϕ) for

- i. the core
- ii. the air gap

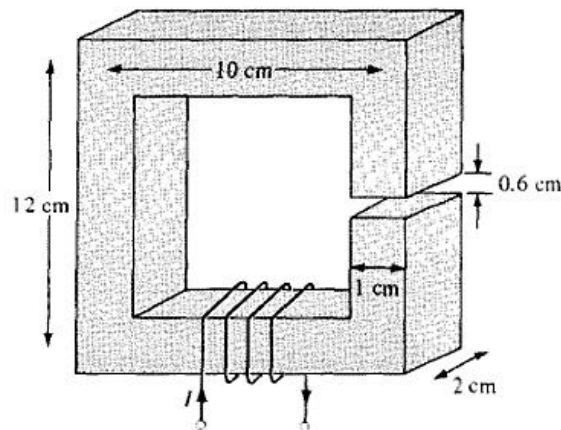


Figure Q4b)

(8 marks)

- c) A 50-V voltage generator at 20 MHz is connected to the plates of an air dielectric parallel plate capacitor with plate area 2.8 cm^2 and separation distance 0.2 mm. Calculate the:
- Displacement current. (4 marks)
 - Maximum value of displacement current density. (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, calculate the generated electromagnetic force (emf) if the bar is:
- Stationary at $x = 4 \text{ cm}$ and $\vec{B} = 4 \cos 10^6 t \vec{u}_z \text{ mWb/m}^2$ (4 marks)
 - Sliding at a velocity of $\vec{v} = 10\vec{u}_x \text{ m/s}$ and $\vec{B} = 4\vec{u}_z \text{ mWb/m}^2$ (4 marks)

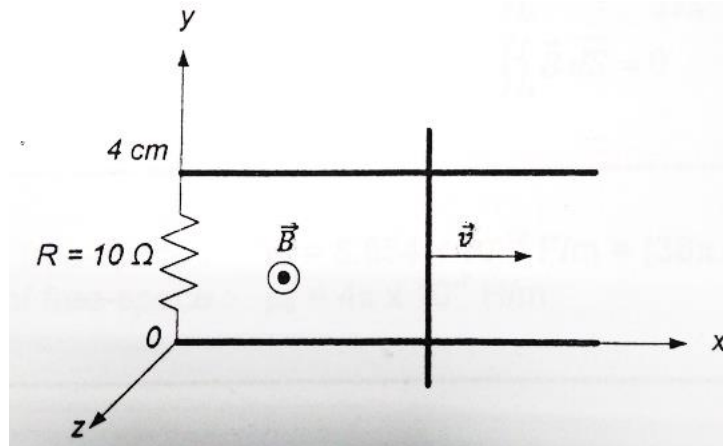


Figure Q4d)

~THE END~