FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENT OF MINING ENGINEERING

ELECTRICITY AND MAGNETISM

EGS 1210

Final Examination Paper

MAY 2023

This examination paper consists of 4 printed pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Mr. P. Sigwegwe

INSTRUCTIONS

ANSWER ALL PARTS OF QUESTION 1 IN SECTION A AND ANY THREE QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

MARK ALLOCATION

QUESTION	MARKS
1.	**40**
2.	**20**
3.	**20**
4.	**20**
5.	**20**
6.	**20**
Maximum possible mark	**100**

Additional Requirements

Calculator

Constants

Permeability of free space $\mu_o = 4\pi \times 10^{-7}\ Hm^{-1}$

Permittivity of free space $\epsilon_o = 8.85 \times 10^{-12}\ F\ m^{-1}$

Charge of an electron $e = 1.6 \times 10^{-19}\ C$

Mass of an electron $m_e = 9.11 \times 10^{-31}\ kg$

Mass of an proton $m_p = 1.67 \times 10^{-27}\ kg$

SECTION A

QUESTION 1

1. (a) State the properties of a point charge. [2]

   b) Giving equations outline the following laws:

      (i) Kirchhoff's voltage law. [3]

      (ii) Kirchhoff's current law. [3]

      (iii) Coulomb's law. [3]

   c) Using Gauss's law derive the equation for electric field **E** around an infinitely long charged conductor. [5]

   d) Draw a phasor diagram to show how voltage and current vary in a capacitor. [3]

   e) Describe the property(s) of an ideal transformer. [3]

   f) Three (3) point charges are placed at the vertices of an equilateral triangle of side 2cm. If the charges are 2μC, 1μC and 3μC. Calculate the resultant force on the 1μC charge. [8]

   g) Describe the Hall effect. [4]

   h) Using Ampere's law derive the equation for the Magnetic field **B** around a long current carrying conductor. [6]

SECTION B

QUESTION 2

2 Give the following Maxwell's equations and state their scientific meaning.

a) Gauss's law. [5]

b) Gauss's law in Magnetism. [5]

c) Faraday's law of Induction. [5]

d) Ampere – Maxwell law. [5]

QUESTION 3

3. (a) Define surface charge density. [2]

(b) An electric field of 1.5kV and a magnetic field of 0.4T act on a moving electron to produce no force. Calculate the minimum electron speed. [5]

(c) Calculate the force between two parallel conductors each of length 0.5m placed 30cm apart carrying 2A and 3A currents. [6]

(d) A ring of radius ***a*** carries a uniformly distributed positive total charge **Q**. Calculate the electric field due to the ring at a point P lying a distance ***x*** from its center along the central axis perpendicular to the plane of the ring. [7]

QUESTION 4

4. (a) Derive the equation for resistors in: (i)parallel, (ii) series. [6]

b) Calculate the resonance frequency in an RCL circuit with a capacitor of 1μF, an Inductor of 9H and a resistor of 5Ω. [5]

c) If a 0.1T magnetic field is being cut by a 5cm long wire carrying a current of 2A, calculate the force on the wire due to the field. [4]

d) Calculate the magnetic field 2cm around a current carrying conductor. [5]

QUESTION 5

5. (a) Define rectification. [2]

(b) Describe how the Cyclotron and the Mass Spectrometer work. [10]

(c) (i) Calculate the V_{rms} and the I_{rms} values for a system with a maximum Voltage and current of 100V and 5A respectively. [6]

(ii) Distinguish between electric potential and potential difference. [2]

QUESTION 6

6. (a) Calculate the force on charge q_3 (figure 1) given that $q_1 = +3\mu C$, $q_2 = -2\mu C$ and $q_3 = 2\mu C$. [7]

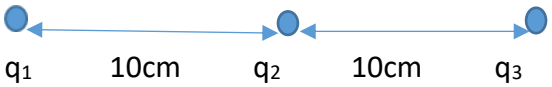

Figure 1: Diagram showing 3 charges along the x axis.

(b) State Faraday's Law of Electromagnetic induction. [3]

(c) An electric dipole consists of two charges of equal magnitude and opposite sign separated by a distance 2a as shown in Figure 2. The dipole is along the x axis and is centered at the origin.

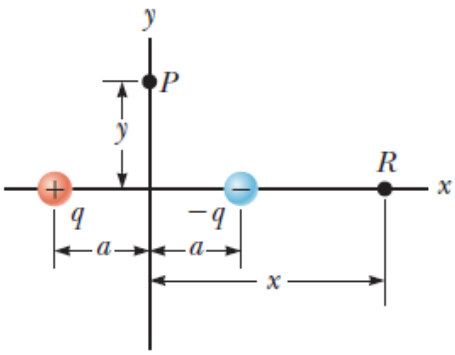

Figure 2: An electric dipole located at the *x* axis.

(i)Calculate the electric potential at a point P on the y axis. [5]

(ii)Calculate the electric potential at point R on the positive axis. [5]