



MACHAKOS UNIVERSITY

University Examinations 2020/2021

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)

SPH 108: ELECTRICITY AND MAGNETISM

DATE: 17/6/2021

TIME: 8.30 – 10.30 A.M.

INSTRUCTIONS:

Answer **QUESTION ONE** and **ANY OTHER TWO** questions.

Question 1 carries **30** marks and the others carry **20** marks each.

YOU MAY USE:

You may need to use the following constants

$\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$; $K = 1/(4\pi\epsilon_0) = 9 \times 10^9$, Electron charge, $q_e = -1.6 \times 10^{-19} \text{ C}$, Proton charge, $q_p = +1.6 \times 10^{-19} \text{ C}$, Mass of an electron, $m_e = 9.11 \times 10^{-31} \text{ Kg}$, $\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$, $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$

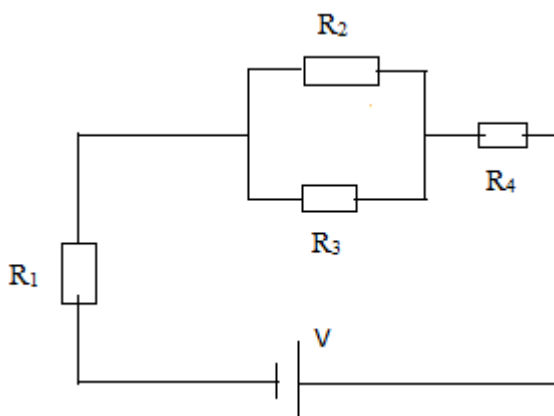
QUESTION ONE (30 MARKS)

- a) Identify the four fundamental forces (4 marks)
- b) State the fundamental law of electrostatics (2 marks)
- c) While writing its mathematical expression, state Ampere's law (3 marks)
- d) Two charges $Q_1(4\mu\text{C})$ and $Q_2(-7\mu\text{C})$ are located at coordinates (0,0) and (40,0) respectively. Assuming distance in centimetres, calculate the electric field associated with these charges at (40,30). (4 marks)
- e) Sketch the electric field and equipotential lines associated with interacting positive and negative point charges. (3 marks)

- f) Sketch a graph of the magnitude of electric charge on either plate of a capacitor versus the magnitude of the potential difference between the plates. What does its slope indicate? And based on this curve, provide the two SI units representing this relationship. (4 marks)
- g) The magnetic field density of a bar magnet is 0.05T. Calculate its magnetic intensity. (3 marks)
- h) A 20 turns coil with a radius of 17cm carries a current of 4.5A. Determine the magnitude of its magnetic dipole moment? (2 marks)
- i) A coil of radius 2.1 cm carries a current of magnitude 3.8A. Calculate the magnetic field in the coil if it is wound 30 turns (3 marks)
- j) State Gauss' law (2 marks)

QUESTION TWO (20 MARKS)

- a) With aid of diagrams, state Kirchoff's laws of electricity (4 marks)
- b) Consider the circuit below. Given that $V=48V$, $R_1 = 6\mu\Omega$, $R_2 = 1\mu\Omega$, $R_3 = 3\mu\Omega$ and $R_4 = 12\mu\Omega$, Calculate;



- i) The equivalent resistance (4 marks)
- ii) The current flowing through each resistor (4 marks)
- c) An electron with K.E. of 10^3eV moves perpendicular to the lines of uniform field $\mathbf{B}=10^{-3}\text{T}$. Calculate;
- (i) the period (4 marks)
- (ii) the radius of the orbit (4 marks)

QUESTION THREE (20 MARKS)

- a) An infinite straight solid wire of radius R carries a current I . Determine the magnetic field $\vec{B}$ at a distance r from the centre of the wire for;
- i) $r > R$ (3 marks)
 - ii) $r < R$ (3 marks)
 - iii) $r = R$ (2 marks)
 - iv) Plot a graph $\vec{B}$ vs r (2 marks)
- a) Sketch the field lines associated with an isolated pole of a magnet (2 marks)
- b) Write the integral forms of Maxwell's equations while indicating which physical laws they represent. (8 marks)

QUESTION FOUR (20 MARKS)

- a) Distinguish between Faraday's and Lenz's laws. (4 marks)
- b) Derive the expression of resistivity in terms of length (L), resistance (R) and area of cross-section (A) of a conductor. (6 marks)
- c) Two charges Q_1 ($3\mu C$) and Q_2 ($7\mu C$) are placed 1 m apart. Determine the net electric field at the neutral point. (4 marks)
- d) The radius of a copper wire is 1.3mm. A potential difference (p.d) of 22 V is applied across a 3m length of this wire. Resistivity of copper = $1.1 \times 10^{-8} \Omega m$. Find,
- i) Its resistance (2 marks)
 - ii) The current (2 marks)
 - iii) The electric field (2 marks)

QUESTION FIVE (20 MARKS)

- a) State the two laws of magnetic induction (3 marks)
- b) For a parallel-plate capacitor with plate area A , separation distance d , show that its capacitance is given by
- $$C = \frac{\epsilon_0 A}{d} \quad (6 \text{ marks})$$
- c) An electron has a velocity of $V = 10^5 \hat{k} m/s$ in a field of $E = 10^4 N/C$ and $B = 2 \times 10^{-3} \hat{i} T$. Determine the magnitude and direction of the force. (5 marks)
- d) (i) State Biot-Savart law (2 marks)
- (ii) Determine the magnetic field density for a circular coil of N turns and carries a current I in each turn. Assume the radius of the coil is r . (4 marks)