MACHAKOS UNIVERSITY

University Examinations 2018/2019

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: 3/5/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS TO CANDIDATES

*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

$\varepsilon_o = 8.85\times10^{-12}$F/m; $K=1/(4\pi\varepsilon_o) = 9\times10^9$, Electron charge, $q_e=-1.6\times10^{-19}$C, $q_p=+1.6\times10^{-19}$C, Mass of an electron, $M_e=9.11\times10^{-31}$Kg, $\mu_o=4\pi\times10^{-7}$Tm/A, 1eV= 1.6×10^{-19}J

QUESTION ONE (30 MARKS)

a) Define a capacitor and list any four (4) uses of a capacitor (5 marks)

b) Identify the two types of charges (2 marks)

c) While writing its expression, state Ampere's law (2 marks)

d) Two charges $Q_1(4\mu C)$ and $Q_2(-7\mu C)$ are located at coordinates (0,0) and (40,0) respectively. Assuming distance in metres, calculate the electric field associated with these charges at (40,30). (4 marks)

e) i Sketch the electric field and equipotential lines associated with interacting positive and negative point charges. (3 marks)

ii Two charges Q1 $(5\mu C)$ and Q_2 $(8\mu C)$ are placed 1m apart. Determine the electric field at the neutral point. (4 marks)

f) The magnetic field density of a bar magnet is 0.05T. Calculate its magnetic intensity. (3 marks)

g) A battery has an emf of 12 V and an internal resistance of 0.5 Ω. Its terminals are connected to a load resistor of 3 Ω.

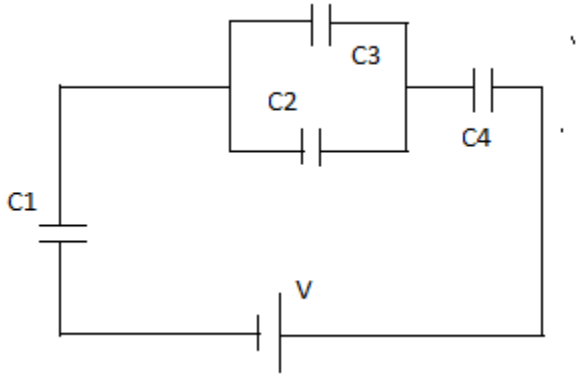
i. Find the current in the circuit and the terminal voltage of the battery. (3 marks)

ii. Calculate the power delivered to the load resistor and the power delivered to the internal resistor of the battery. (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, $C1 = 6\mu F, C2 = 1\mu F, C3 = 3\mu F$ and $C4 = 12\mu F$, Calculate;



i. The equivalent capacitance (3 marks)

ii. The charge and the p.d. of each capacitor (4 marks)

c) Three-point charges $Q_1(5\mu C)$, $Q_2(-2\mu C)$ and Q_3 $(3\mu C)$ are located at coordinates (0,0), (2,0) and (6, 0) respectively. Determine;

i. The force that Q_1 and Q_3 exert on each other (4 marks)

ii. The net force exerted on Q_2 (5 marks)

QUESTION THREE (20 MARKS)

a) An infinite straight solid wire of radius R carries a current I. Find 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)

b) Sketch the field lines associated with an isolated pole of a magnet (2 marks)

c) Write the differential 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) The radius of a copper wire is 1.47mm. A potential difference (p.d.) of 44 V is applied across a 3m length of this wire. Resistivity of copper=$1.1\times10^{-8}\Omega$m. Find,

i. Its resistance (2 marks)

ii. The current (2 marks)

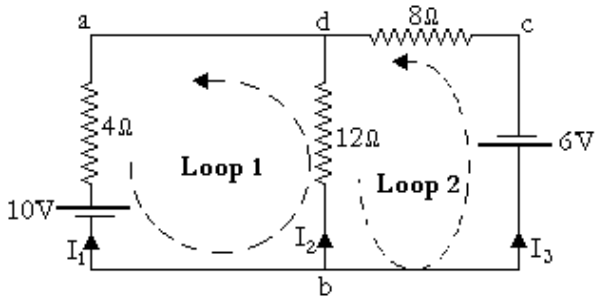
iii. The electric field (2 marks)

d) 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)

QUESTION FIVE (20 MARKS)

a) Consider the following circuit. Calculate the current I_1, I_2 and I_3 in the above circuit.

(8 marks)



b) An electron has a velocity of $V = 10^5 \hat{\boldsymbol{k}}\, m/s$ in a magnetic field of $B = 2 \times 10^{-3} \hat{\boldsymbol{\imath}} T$. Determine the magnitude and direction of the force. (5 marks)

c) State the two laws of magnetic induction (3 marks)

d) Using Biot-Savart law, 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)