MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SPECIAL/SUPPLMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)

SPH 108: ELECTRICITY AND MAGNETISM

DATE: 12/8/2021 **TIME: 8:30 – 10:30 AM**

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

$\varepsilon_O = 8.85\times10^{-12}$F/m; $K=1/(4\pi\varepsilon_O) = 9\times10^9$, Alpha particle=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

a) State the fundamental law of electrostatics (2 marks)

b) Calculate the force between two alpha particles kept at a distance of 0.02mm in air. (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. (4 marks)

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

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

g) Two charges $+2\mu F$ and $-5\mu F$ are separated by 1m. Calculate the electric field at the neutral point (4 marks)

h) 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.

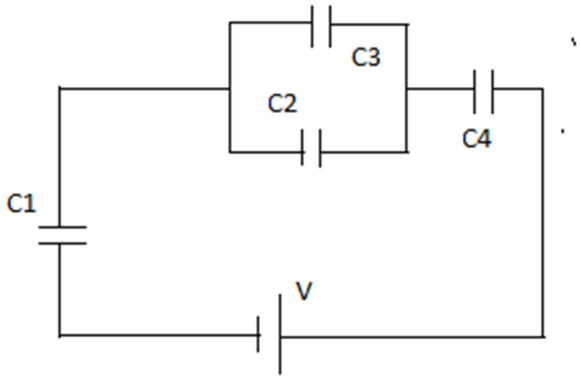
i) Find the current in the circuit and the terminal voltage of the battery. (3 marks)

ii) Calculate the power delivered to the load resistor and the power delivered to the internal resistor of the battery. (4 marks)

QUESTION TWO

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 (4 marks)

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

c) State three factors that affect resistance of conductor. (3 marks)

d) Derive the expression for a magnetic field B at a distance r from a long straight wire carrying a current I. (5 marks)

QUESTION THREE

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) $r < R$ (2 marks)

iii) $r = R$ (2 marks)

b) An electron in a television picture tube moves toward the front of the tube with a speed of $2.3\text{x}10^7$ m/s along the y axis. Surrounding the neck of the tube are coils of wire that create a magnetic field of magnitude 0.35 T, directed at an angle of 50° to the x-axis and lying in the x-*y* plane. Calculate the magnetic force on the electron and its direction. (3 marks)

c) Write the differential and integral forms of Maxwell's equations while indicating which physical laws they represent. (10 marks)

QUESTION FOUR

a) Distinguish between Faraday's and Lenz's laws. (2 marks)

b) A non-conducting ring of radius r has charge q distribute over it. What will be the equivalent current if it rotates with an angular velocity ω? (3 marks)

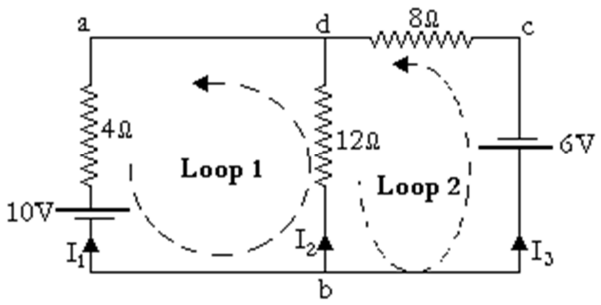
c) Derive the expression of resistivity in terms of length (L), resistance (R) and area of cross-section (A) of a conductor. (6 marks)

d) Sketch a graph of the magnitude of capacitance versus the magnitude of the potential difference between the plates. What is the physical meaning of the curve? (3 marks)

e) A long solenoid has n turns per unit length and carries a current I. Using a figure, determine its magnetic field. (6 marks)

QUESTION FIVE

a) Consider the following circuit. Calculate the current I_1, I_2 and I_3 in the above circuit. (6 marks)



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

c) An electron with K.E of 10^4eV moves perpendicular to the lines of uniform field **B**=10^{-4}T. Determine:

i) The period of the orbit (2 marks)

ii) The radius of orbit (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)