JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCE)

2ND YEAR 2ND SEMESTER 2016/2017 ACADEMIC YEAR

MAIN

REGULAR

COURSE CODE: SPH 202

COURSE TITLE: ELECTRICITY AND MAGNETISM II

EXAM VENUE: **STREAM: EDUCATION**

DATE: **EXAM SESSION:**

TIME: 2:00 HRS

Instructions:

1. **Answer question 1 (Compulsory) and ANY other 2 questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

SECTION A

QUESTION 1(30 MARKS)

(a) State Gauss' law **(2 marks)**

(b) State two applications of Gauss **(2 marks)**

(c) (i) Define capacitance **(1 mark)**

(ii) A change of 20 μC is stored by a capacitor connected to a 60V emf source. Calculate the capacitance of the capacitor. **(3 marks)**

(d) Define the following terms

(i) Dielectric **(1 mark)**

(ii) Polarization **(1 mark)**

(iii) Electric dipole moment. **(1 mark)**

(e) State two importances of dielectrics in capacitors. **(2 marks)**

(f) An electron in a television picture tube moves toward the front of the tube with a speed of $8\times10^{6}\,ms^{-1}$ along the x-axis. Surrounding the neck are coils of wire that create a magnetic field of magnitude 0.025T, directed at an angle of 60^{0} to the x-axis and lying in the xy plane. Calculate the magnetic force on the electron. **(3 marks)**

(g) A proton is moving in a circular orbit of radius 14cm in a uniform 0.35T magnetic field perpendicular to the velocity of the proton. Find the speed of the proton. **(3 marks)**

(h)Derive the expression for the Lorentz force. **(3 marks)**

(i) State the two devices that work on the principle of torque on a current carrying coil.

(2 marks)

(j) Show that the electric dipole has its lowest energy when the dipole moment and electric field are in the same direction and greatest energy when the dipole moment and electric field are in opposite directions. **(2 marks)**

(k) State Faraday's law of electromagnetic induction. **(1 mark)**

(l) Explain the following magnetic properties of matter.

(i) Diamagnetic substances **(1 mark)**

(ii) Paramagnetic substances. **(1 mark)**

(iii) Ferromagnetic substances. **(1 mark)**

SECTION B

Answer any TWO questions in this section

QUESTION 2 (20 MARKS)

(a) Present a derivation of Gauss' law. **(5 marks)**

(b) An insulating solid sphere of radius, a , has uniform volume charge density ρ and carries a total positive charge Q.

(i) Calculate the magnitude of the electric field at a point outside the sphere. **(5 marks)**

(ii) Find the magnitude of electric field inside the sphere. **(10 marks)**

QUESTION 3 (20 MARKS

(a) (i) Show that the capacitance of a parallel-plate capacitor is given by

$C = \frac{\varepsilon_0 A}{d}$ where the symbols have the usual meanings. **(4 marks)**

(ii) A parallel – plate capacitor has plates with dimensions 3cm× 4cm, separated by 2mm. The plates are connected across a 60V battery. Find the magnitude of charge on each plate **(6 marks)**

(b) A charge q in the presence of a uniform magnetic field $\vec{B}$ circulates at velocity $\vec{v}$ perpendicular to the direction of the magnetic field. Determine

(i) the radius of its path. **(3 marks)**

(ii) its period. **(3 marks)**

(iii) its angular frequency. **(4 marks)**

QUESTION 4 (20 MARKS)

(a) A rectangular coil of dimensions 3cm by 5cm carrying a current of 2A is immersed in a uniform magnetic field. If the angle between the direction of current and magnetic field is 60^o, calculate the torque on this current carrying coil. **(4 marks)**

(b) A $3.5\mu F$ capacitor is charged to a potential difference V_o=250V and connected across an inductor having inductance L=2.5mH. Find :

(i) the magnitude q_o of the initial electric charge on the capacitor. **(3 marks)**

(ii) the total energy E stored in the system. **(3 marks)**

(iii) the angular frequency of oscillation ω_o. **(3 marks)**

(iv) the corresponding frequency υ_o. **(3 marks)**

(v) the maximum current which flows through the system **(4 marks)**

QUESTION 5 (20 MARKS)

(a) Show that the inductor – capacitor (LC) circuit is analogous to the mass spring simple harmonic oscillation. **(10 marks)**

(b) A patient having an MRT needs removal of a copper bracelet. The bracelet is 6cm in diameter and has a resistance of $0.010\,\Omega$. The magnetic field in the MRT solenoid is directed along the person's body from head to foot, bracelet is perpendicular to $\vec{B}$. As the scan is taken, the magnetic field in the solenoid decreases from 1.00T to 0.40T in 1.25. What are the magnitude and direction of the current induced in the bracelet? **(10 marks)**