JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF EDUCATION (SCIENCE)

MAIN

REGULAR RESIT

COURSE CODE: SPH 202

COURSE TITLE: ELECTRICITY AND MAGNETISM II

EXAM VENUE: LAB 1 **STREAM: (BED SCI)**

DATE: 6/5/2016 **EXAM SESSION: 11:30AM-1:30 PM**

TIME: 2 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.**

You may use the following constants:
ε_o = 8.85 x 10^{-12} F/m; $\mu_o = 4\pi x10^{-7}$Tm/A; c = 3.0 x 10^8 m/s; $Z_o = 377\Omega$, Electron charge, e = 1.6 x 10^{-19}C; Rest mass of an electron, M_e = 9.1 x 10^{-31}kg, Rest mass of a proton Mp = 1.672 x 10^{-27}kg; Resistivity of copper ρ = 1.7 x 10^{-8}, $\mu_0 = 4\pi \times 10^{-7} TmA^{-1}$,

SECTION A

a) Define the term 'capacitance of a capacitor' **1mk**

b) State Lenz's law. **2mks**

c) If a current of 5A flows for 2 minutes, find the quantity of electricity transferred. **2mks**

d) State the fundamental law of electrostatics **1mk**

e) A parallel-plate capacitor with air between the plates has an area $A = 2.00 \times 10^{-4} m^2$ and a plate separation $d = 1.00\ mm$. Find its capacitance **3mks**

f) Distinguish between hard and soft magnetic materials **1mk**

g) State the Lorentz force law for a charged particle moving in a magnetic field only **1mk**

h) Differentiate between hard and soft ferromagnetic materials **4mks**

i) Show that the reciprocal of equivalent capacitances in series is given by $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ **3mks**

j) How many electrons per second pass through a section of wire carrying a current of 0.7 A? **2mks**

k) One early form of X-ray set, obtained energy by charging capacitors to a high voltage and then discharging them. What factors should be considered when designing these capacitors, assuming they are parallel-plate type? **3mks**

l) Draw the field line patterns due to the following cylindrical magnet **2mks**

Figure 1

m) State Coulomb's law of electrostatics **1mk**

n) An electron is observed to move along an arc at a cyclotron angular velocity of 20 rad/sec. If a magnetic field $(\vec{B})$propels the electron to move with a linear velocity of 2×10^{-3}m/s. find

i). The cyclotron radius **2mks**

ii). The cyclotron frequency **2mks**

SECTION B

QUESTION TWO (20 MARKS)

a) Define the term 'resonance frequency' **1mks**

b) A sinusoidal a.c. voltage of peak value 180V is applied to a resistor and produces a current of peak value 12A. What is the

i) r.m.s. value of the voltage

ii) r.m.s. value of the current

iii) Power dissipated in the resistor **3mks**

c) A 240V, 700Hz a.c. generator is in series with a 15Ω resistor, a 10μF capacitor and a 0.01H inductor (of negligible internal resistance).

i) Sketch the phase diagram for the circuit **1mk**

ii) What is the Impedance, Z of the circuit **5mks**

iii) The potential difference across each component **5mks**

iv) The phase angle, ϕ **3mks**

v) The resonant frequency of the circuit **2mks**

QUESTION THREE (20 MARKS)

a) Define the following terms: term 'self-induction' and 'inductance' **4mks**

b) Find the direction of the current in the resistor in the Figure below

i. At the instant the switch is closed **1mk**

ii. After the switch has been closed for several minutes, **1mk**

iii. At the instant the switch is opened **1mk**

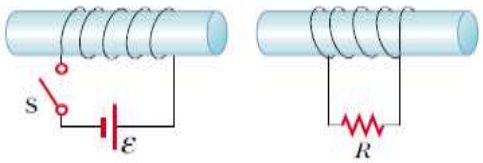

Figure 2

c) Find the inductance of a uniformly wound solenoid having *N* turns and length *l*. Assume that *l* is much longer than the radius of the windings and that the core of the solenoid is air. **6mks**

d) Calculate the inductance of an air-core solenoid containing 300 turns if the length of the solenoid is 25.0 cm and its cross-sectional area is 4.00 cm^2 **3mks**

e) Calculate the self-induced e.m.f in the solenoid of (d) above if the current it carries is decreasing at the rate of 50.0 A/s **4mks**

QUESTION FOUR (20 MARKS)

a) Find the electric force that a proton exerts on an electron in a hydrogen atom at a radius of 0.052nm. Compare the result with the gravitational force between the two. **6mks**

b) Starting with Gauss's Law derive Coulomb's Rule. **6mks**

c) The Earth has an electric field of about 150N/C pointed downward. A 1.00μm radius water droplet is suspended in calm air. Find (a) the mass of the water droplet, (b) the charge on the water droplet and (c) the number of excess electrons on the droplet. **8mks**

QUESTION FIVE (20 MARKS)

(a) A conducting rod of length l moves with a constant velocity v, perpendicular to an infinitely long, straight wire carrying a current I, as shown in the Figure 3 below. What is the e.m.f generated between the ends of the rod? **3mks**

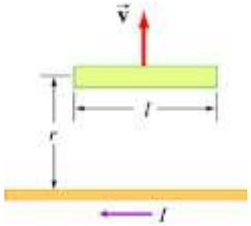

Figure 3

(b) A total charge, Q, is uniformly distributed throughout a non-conducting sphere of radius, R. Find the electric field inside and out. Sketch E vs. r. **8mks**

(c) A circular loop of wire of radius a is placed in a uniform magnetic field, with the plane of the loop perpendicular to the direction of the field, as shown in Figure below.

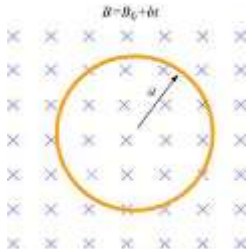

Figure 4

The magnetic field varies with time according to $B = B_o + bt$ where B_o and b are positive constants.

i. Calculate the magnetic flux through the loop at t = 0 3**mks**

ii. Calculate the induced e.m.f in the loop. **2mks**

iii. What is the induced current and its direction of flow if the overall resistance of the loop is R? **2mks**

iv. Find the power dissipated due to the resistance of the loop **2mks**