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

UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF EDUCATION(SCIENCE)

2ND YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR

MAIN

COURSE CODE: SPH 202

COURSE TITLE: ELECTRICITY & MAGNETISM I

EXAM VENUE: LAB 6 **STREAM: (SBPS)**

DATE: 17/04/14 **EXAM SESSION: 9.00 – 11.00 AM**

TIME: 2.00 HOURS

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.**

IMPORTANT COSTANTS:
$m_e = 9.1x10^{-31}$ kg, $\mu_0 = 4\pi x10^{-7}$ kg, $m_p = 1.67x10^{-27}$ kg, $g = 9.8$ m/s^2, $c = 3x10^8$ m/s, $e = 1.6x10^{-19}$C, $1/4\pi\varepsilon_0 = 9x10^9$ Nm^2/C

SECTION A

1. a) (i) State Gauss's law. **(2 marks)**
(ii) Using Gauss's law, show that the electric field intensity **E** at a point r from a positive charge q is given by $E = q/(4\pi\varepsilon_0)r^2$. **(4 marks)**

b) Explain why excess quantity of charge on a conductor in static equilibrium resides on the surface of the conductor. **(4 marks)**

c) A spherical capacitor has an inner radius a = 2.5 mm and outer radius b = 3.5 mm. The capacitor is connected to a battery with emf V = 1.5 v. Calculate the charge on the plates of the capacitor. **(5 marks)**

d) What are the forces acting on a circulating charge q in a magnetic field **B**? **(3 marks)**

e) (i) State Faraday's law of electromagnetic induction. **(2 marks)**
(ii) A long solenoid of length 0.5 m and a x-sectional area of 10 m^2 is closely wound with 100 turns of (N_1) of wire and a small coil of 10 turns (N_2) surrounds it at its centre . Find the *mutual inductance M* of the system. **(4 marks)**

f) A flat rectangular coil consisting of 50 turns measures 25 cm by 30 cm. It is in a uniform magnetic field B = 1.2T, with the plane of the coil parallel to the field. In 0.222 seconds, it is rotated so that the plane of the coil is perpendicular to the field.
(i) What is the change in the magnetic fux through the coil due to this rotation?
. **(3 marks)**
(ii) Find the magnitude of the average emf induced in the coil due to the rotation.
. **(3 marks)**

SECTION B: Attempt **ONLY TWO** questions from this section.

2. a) Figure 1 shows four capacitors connected to 48V battery. If the capacitances are $C_1 = 6\mu F$, $C_2 = 1\mu F$, $C_3 = 3\mu F$ and $C_4 = 12\mu F$.

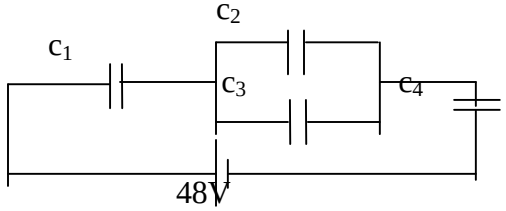


Fig.1

Calculate:
(i) the equivalent capacitance, C_T, of the arrangement. **(4 marks)**

(ii) the charge and potential difference across each capacitor. **(8 marks)**

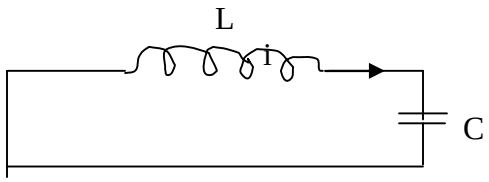
b) A capacitor is designed to store energy for running a 100-watt light for 5 minutes.
(i) How much energy is needed for the lighting. **(2 marks)**
(ii) If a potential difference of 50V is needed to charge the capacitor, what is the capacitance? **(3 marks)**
(iii) If the capacitor above is a parallel plate model with area A = 6 m^2, determine the separation distance of the plates if it is filled with air. **(3 marks)**

3. a) A proton moves in a circle of radius 20 cm perpendicular to a magnetic field B = 0.05 T. Find
(i) the momentum of the proton. **(4 marks**)
(ii) the kinetic energy of the proton in electron volts **(6 marks)**

b) A current of 17 mA is flowing through a single circular loop of circumference 2 m. A magnetic field B = 0.8 T is directed parallel to the plane of the loop. Calculate:
(i) the magnetic moment μ of the loop**.** **(6 marks)**
(ii) the torque τ acting on the coil due to the magnetic field. **(4 marks)**

4. a) State three factors that affect the self inductance of a circuit. **(3 marks)**

b) The circuit in figure 2 shows an inductor l connected to a capacitor of capacitance C.



(i) Write an expression for the total energy U of the system in terms of L and C .
. **(1 mark)**
(ii) Show that the angular frequency ω of the circuit above is ω = $1/(LC)^{½}$ **(6 marks)**

c) (i) Explain what causes magnetism in solids. **(2 marks)**
(ii) Differentiate clearly between the following magnetic properties; *diamagnetism, paramagnetism* and *ferromagnetism.* **(6 marks)**

d) State two types of magnetic dipole moments**.** **(2 marks)**

5. a) A particle with charge q is moving in a magnetic field of magnitude *B* with a velocity *v*. The magnetic field is directed into the plane of the paper and the particle's velocity is on the plane of the paper.
(i) Sketch the trajectory of the particle showing the direction of *B* and *v.*
. **(3 marks)**

(ii) Derive the expression for the cyclotron frequency. **(7 marks)**

b) A circular coil of radius 0.05 m, with 30 turns of wire, lies in a horizontal plane. It carries a current of 5 A in a counterclockwise sense when viewed from above. The coil is in a uniform magnetic field directed to the right, with a magnitude of 1.2 T. Find:

(i) the magnitude of the magnetic moment μ_T on the coil. **(5 marks)**

(ii) the torque τ on the coil. **(5 marks)**