ALUPE UNIVERSITY COLLEGE
...Bastion of Knowledge...
P. O.Box 845-50400 Busia(K)
principal@auc.ac.ke
Tel: +254 741 217 185
+254 736 044 469
off Busia-Malaba road

OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2020 /2021 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER REGULAR EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE & COMPUTER SCIENCE

COURSE CODE: PHY 210

COURSE TITLE: ELECTRICITY AND MAGNETISM

DATE: 11/03/2021 TIME: 1400 – 1700 HRS

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 6 PRINTED PAGES PLEASE TURN OVER

REGULAR – MAIN EXAM

PHY 210: ELECTRICITY AND MAGNETISM

STREAM: BED (Science) **DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

i. *Answer **TWO** questions in section **A** and any other **THREE** questions in section **B**.*

You may need to use the following constants

- *Permittivity of free space, $\varepsilon_O = 8.85 \times 10^{-12}$ F/m (k = 8.99 x 10^9 Nm^2C^{-2})*
- *Mass of an electron, $M_e = 9.11 \times 10^{-31}$ Kg*
- *Mass of a proton, $M_p = 1.67 \times 10^{-27}$ Kg*
- *Electronic charge, $e = 1.6 \times 10^{-19}$ C*
- *Permeability of free space, $\mu_O = 4\pi \times 10^{-7}$ Tm/A*
- *$1eV = 1.6 \times 10^{-19}$ J*

SECTION A (28 MARKS)

Question One (14 Marks)

a) Distinguish between electric potential and electric potential energy. (2 Marks)

b) The electron and proton of a hydrogen atom are separated (on the average) by a distance of approximately 5.3 x 10^{-11} m. Find the magnitudes of the electric force between the two particles. (3 Marks)

c) (i) State the Gauss's law (1 Mark)

(ii) A State any three properties of electric field lines (3 Marks)

d) A conductor 300mm long moves at a uniform speed of 4m/s at right-angles to a uniform magnetic field of flux density 1.25T. Determine the current flowing in the conductor when its ends are connected to a load of 20 Ω resistance. (3 Marks)

e) A capacitor has 3.5 μC of charge on it and an electric field of 2.0 kV/mm is desired. What must each plate's area be if they are separated by 5.0 mm of air. (2 Marks)

Question Two (14 Marks)

a) Define the term electric polarization as used with dielectric materials (1 Mark)

b) Give two differences between electric force and magnetic force (2 Marks)

c) A current of 500mA is passed through a 600 turn/m coil wound on a toroid of mean diameter 10cm and has a magnetic permeability of $\mu_w = 5\ 000\mu_o$ under the given conditions. Calculate the magnetic field strength *H* and magnetic field intensity *B* inside the toroid. (4 Marks)

d) (i) State the ohm's law (1 Mark)

(ii) A battery has an emf of 12.0 V and an internal resistance of 0.05 Ω. Its terminals are connected to a load resistance of 3.00 Ω. Find the terminal voltage of the battery and the power delivered by the battery (3 Marks)

e) A resistance thermometer, which measures temperature by measuring the change in resistance of a conductor, is made from copper and has a resistance of 30.0 Ω at 20.0°C. Calculate the resistance of copper at 60°C if the temperature coefficient of resistance for copper is $4.0 \times 10^{-3}C^{-1}$. (3 Marks)

SECTION B (42 MARKS)

Question Three (14 Marks)

a) State Ampere's law (1 Mark)

b) An electron in a television picture tube moves toward the front of the tube with a speed of 8.0 $\times 10^6$ m/s along the *x* axis. Surrounding the neck of the tube are coils of wire that create a magnetic field of magnitude 0.025 T, directed at an angle of 60° to the *x* axis and lying in the *xy* plane. Calculate the magnetic force on the electron (3 Marks)

c) Show that for a positively charged particle moving in a uniform magnetic field with the initial velocity vector of the particle perpendicular to the field, its period of revolution is given by

$$T = \frac{2\pi m}{qB}$$ (5 Marks)

d) A flux density of 1.2 T is produced in a piece of cast steel by a magnetizing force of 1250 A/m. Find the relative permeability of the steel under these conditions. (2 Marks)

e) A 20-turn coil with circular cross-section of radius 0.5m and resistance 25Ω is placed in a uniform magnetic field perpendicular to the plane of the coil. The field changes from 0.1T to 0.3T in a time interval of 5s, find the averaged induced emf and average current in the coil during this interval. (3 Marks)

Question Four (14 Marks)

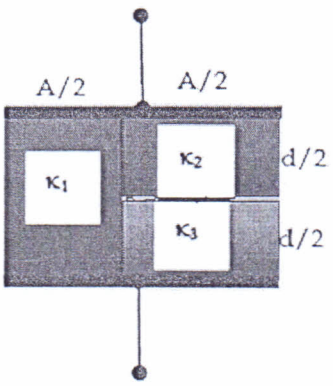
a) A parallel plate capacitor is fully charged at a potential V. A dielectric with constant k =4 is inserted between the plates while the potential remains constant. What happens to the amount of charge stored? (3 Marks)

b) Suppose a parallel plate capacitor has plates that are 2.0 cm by 3.0 cm which are separated by 1.0 mm. The maximum dielectric strength of air, is 3.00×10^6V/m.

(i) What is the maximum charge that can be placed on this capacitor? (4 Marks)

(ii) Suppose paper with a dielectric constant of $k = 3.7$ and a dielectric strength of 16×10^6 V/m is placed between the plates. How much charge can it hold now? (3 Marks)

c) Find the capacitance of the capacitor shown in figure below. (4 Marks)



Question Five (14 Marks)

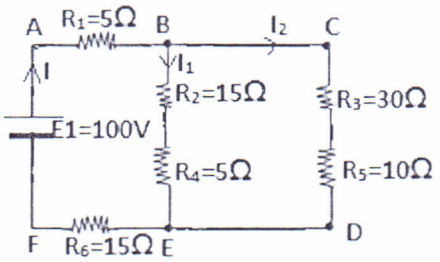
a) The radius of a copper wire is 1.47mm. A potential difference of 44V is applied across a 30m length of this wire. Given that the resistivity of copper is 1.7×10^{-8} Ωm, find:

(i) Its resistance (2 Mark)

(ii) The electric field (2 Mark)

b) Show that the current density, J, for a current carrying wire of cross-sectional area A is given by, $J=neV$ where the symbols have their usual meanings (4 Marks)

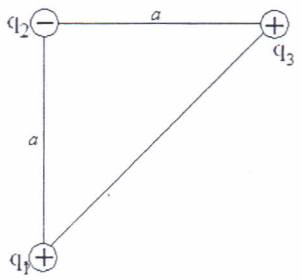
c) Find the currents I_1, I_2 and I_3 in the circuit shown below (6 Marks)



Question Six (14 Marks)

a) State Coulomb's law of electrostatics (1 Mark)

b) Consider three point charges located at the corners of a right angled triangle as shown in the figure below.



i. Given that $q_1 = q_3 = 5.0\ \mu C$, $q_2 = -2.0\ \mu C$, and $a = 0.10$ m, find the resultant force exerted on q_3. (6 Marks)

ii. Determine the potential energy (3 Marks)

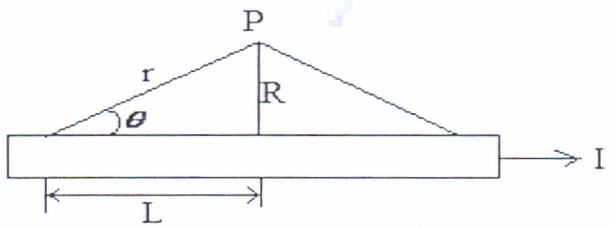
c) Point charges Q_1 (4μC), Q_2 (-7μC) and Q_3 (2μC) are located at coordinates (0,0), (0,30) and (40, 0) respectively. Determine the electric potential at point (40,30) due to all these charges. (4 Marks)

Question Seven (12 Marks)

a) An electron is forced to move into a uniform magnetic field B given by $B = (0.2\mathbf{i} + 0.5\mathbf{j})$ Wb/m^2. Find an expression for the magnetic force acting on the electron if $v = 5x10^6\mathbf{j}$ m/s. (4 Marks)

b) State the Bio-Savart law for a current element (1 Mark)

c) i) Consider a straight infinitely long wire carrying a steady current I. Show that the magnetic field at a point P at a distance R from the wire as shown in the figure below. $B = \frac{\mu_0 I}{2\pi a}$ Where the symbols have their usual meanings. (7 Marks)



ii) Determine the magnetic field intensity at the centre of the circular conductor, with 2m radius and 8A current flowing through it. (2 Marks)

****