TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCE

MATHEMATICS &PHYSICS DEPARTMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL &ELECTRONICS ENGINEERING,BUILDING &CIVIL ENGINEERING,MECHANICAL &AUTOMOTIVE ENGINEERING,MATHEMATICS &COMPUTER SCIENCE,STATISTICS & COMPUTER SCIENCE, FOOD &QUALITY ASSURANCE AND BACHELOR OF TECHNOLOGY IN INFORMATION TECHNOLOGY

(BSEE,BSCE,BSME,BSSC,BMCS,BSFQ,BTIT)

APS 4102/SPH 2171/SPH 2174: PHYSICS II/PHYSICS FOR ENGINEERS II

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

TIME: HOURS

DATE: MAY 2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of 5 questions.

Do not write on the question paper. Answer question ONE (compulsory) and any other two questions.

Question ONE

a) (i) State Coulomb's law **(2 marks)**

(ii) An electron and a proton are separated by a distance of 5.5×10^{-11}m. Find the magnitude of the electrostatic force between them. **(3 marks)**

b) Use the superposition principle for forces between multiple charges to show that given charges $q_1, q_2 \ldots\ldots\ldots\ldots q_n$ the force experienced by qi due to the other charges is given by:

$$F = \sum_{a=2} \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_i}{r_{a_i}^{\ 2}}$$ **(3 marks)**

where r_i is the displacement between charge q_1 and qi

c) In the classical model of the hydrogen atom the electron revolves around the proton with a radius of r = 0.53 x lo°m. The magnitude of the charge of the electron and proton is e 1.6 x 10^{-19} C.

(i) What is the magnitude of the electron force between the proton and the electron? (2 **marks)**

(ii) What is the magnitude of the electric field due to the proton at r? (2 **marks)**

(iii) What is ratio of magnitudes of the electric (electrostatic) and gravitational force between electron and proton? Does the result depend on the distance between the proton and electron? **(4 marks)**

d) (i) What is an electric dipole? **(1 mark)**

(ii) Show that electric field strength due to a dipole is given by: $\overrightarrow{E} = \frac{1}{4\pi\varepsilon_0}\frac{2\vec{p}}{r^3}$ **(4 marks)**

e) Two capacitors C_1 and C_2 are connected in series with voltage V across the combination. Show that the voltages across the individual capacitor are:

$V_1 = \frac{C_2 V}{C_1 + C_2}$ and $V_2 = \frac{C_1 V}{C_1 + C_2}$ **(4 marks)**

f) (i) Differentiate between self and mutual inductance. (2 **marks)**

(ii) Give three difference between electric and magnetic forces. **(3** marks)

(iii) State Ampere's law (2 **marks)**

Question TWO

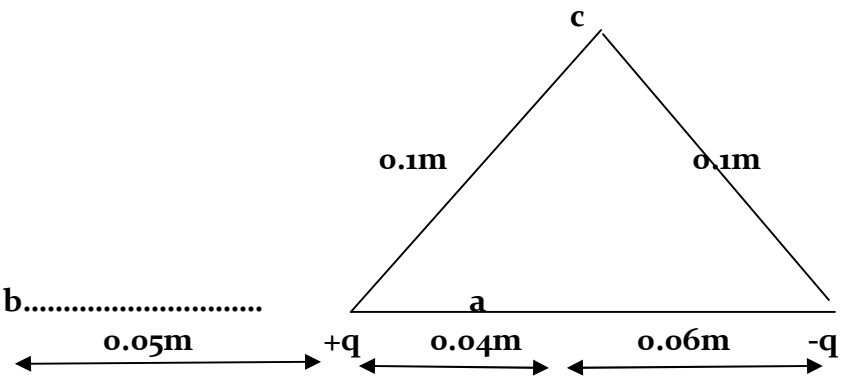
a) An electron $q = -e$ placed near a charged body experiences a force in the +y direction of magnitude 3.6 x 10^8N:

(i) What is the electric field at that location? **(3 marks)**

(ii) What would be the force exerted by the same charged body on an alpha particle (q = *+2e)* placed at the location formerly occupied by the electron? Take *e* = +1.602 x 10^{-19}C **(3 marks)**

b) Two points charges q_1 and q_2 of 8 x 10^{-9}C and 8 x 10^{-9}C respectively are placed o.lm apart as shown.

Find the electric fields at point a, b and c. (8 **marks)**



c) Electric dipole consists of two charges q separated by 0.04m. Find the electric field at a point 1.5m away from the centre of the dipole.

(i) On the side of the charge q_1 **(3 marks)**

(ii) On the line perpendicular to the axis. **(3** marks)

Question THREE

a) A potential difference of 300V is applied to a 2 «*F* capacitor and a 8 «*F* connected in series.

(i) Calculate the potential difference across each capacitor **(3** marks)

(ii) The charged capacitors are reconnected with their positive plates together and then negative plates together with no external voltage being applied. Calculate the charge and the potential difference across capacitor **(4 marks)**

(iii) The charged capacitor in (a) are connected together with plates of opposite sign. Calculate the charge and the potential difference across each capacitor. **(2 marks)**

b) A camera flash gets its energy from *150* «*F* capacitor and requires 170V to fire. If the capacitor is charged by a 200V source through an 18 kΩ resistor, how long must the photographer wait between flashes? **(4 marks)**

c) Show that for a spherical capacitor consisting of conducting a sheet of radius b and charge Q concentric with a smaller conducting sphere of radius a and charge Q is given by:

$$C = \frac{ab}{k(b-c)}$$ *(5* **marks)**

Question FOUR

a) (i) A certain meter has a resistance of 5 Ω and deflect full scale for a voltage of 20 mV across its terminal. How can it be converted into a 3A ammeter? **(3 marks)**

(ii) Calculate the magnetic field of a long straight wire carrying a current of 10A at a distance 8cm from the wire. (3 **marks)**

(iii) A wire loop of radius 10cm has a resistance of 2 Ω . The plane of the loop is perpendicular to a uniform magnetic field that is increasing at 0.1 OT/s. Find the magnitude of the induced current in the loop. **(5 marks)**

b) (i) State factors that affect capacitance. (2 **marks)**

(ii) A parallel place capacitor with air between the plates has an area of $2cm^3$ and plate separation of 1mm. Find its capacitance. **(4 marks)**

Question FIVE

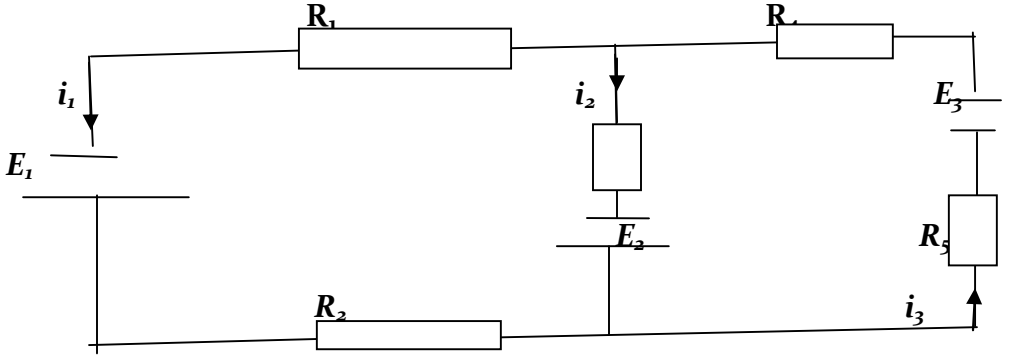
a) State Kirchhoff's Laws. **(2 marks)**

b) A steady uniform current of 5m **A** flows axially along **a** metal cylinder of cross-section area 0.2mm2, length 5m and resistivity $3 \times 10^{-5}\ \Omega$ m. Find:

(i) The potential difference between the ends of the cylinder. (3 **marks)**

(ii) The rate of heat production. (3 **marks)**

c) Consider the circuit below:



If $E_1 = E2 = E_3 = 2.1V$; $R_1 = R_2 = R_4 = R5 = 1.7\ \Omega$ and $R3 = 3.5\ \Omega$. Find current i_1, i_2. i_3. (**7 marks)**

d) Consider the formation of the Helium nucleus whose atomic number is 2 and mass number is 4. Using 2 protons and 2 neutrons. Determine nuclear mass defect and the binding energy of helium nucleus. Take Mp 1.007277 a.m.u, Mn = 1,008666a.m.u and mass of helium 4.001509 a.m.u where 1.am.u= 1.66×10^{-27}kg