



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.

magnitude of

(3 marks)

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

$$F = \sum_{\lambda=2}^n \frac{1}{4\pi\epsilon_0} \frac{q_1 q_\lambda}{r_{\lambda i}^2}$$

(3 marks)

where r_i is the displacement between charge q_i and q_i

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

(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: $\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{2\vec{p}}{r^3}$ (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:

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

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

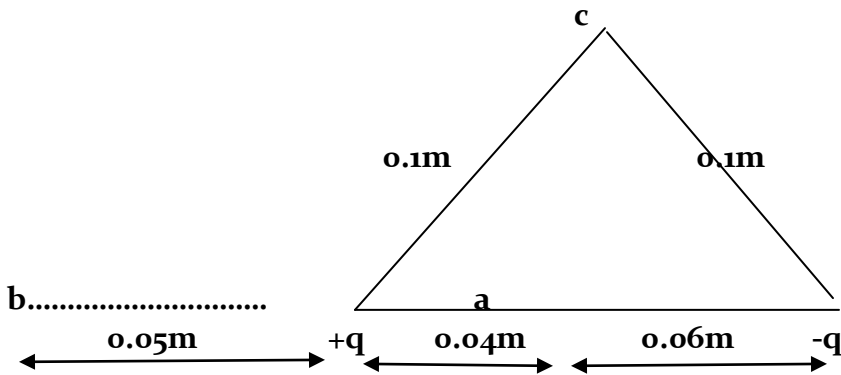
a) An electron $q = -e$ placed near a charged body experiences a force in the +y direction of magnitude $3.6 \times 10^{-8} \text{N}$:

(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 $e = 1.602 \times 10^{-19} \text{C}$ (3 marks)

b) Two points charges q_1 and q_2 of $8 \times 10^{-9} \text{C}$ and $8 \times 10^{-9} \text{C}$ respectively are placed 0.1m 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 $2\ \mu\text{F}$ capacitor and a $8\ \mu\text{F}$ 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 $150\ \mu\text{F}$ capacitor and requires 170V to fire. If the capacitor is charged by a 200V source through an $18\ \text{k}\Omega$ 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:

$$C = \frac{ab}{k(b - a)} \quad (5 \text{ marks})$$

Question FOUR

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

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

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

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

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

Question FIVE

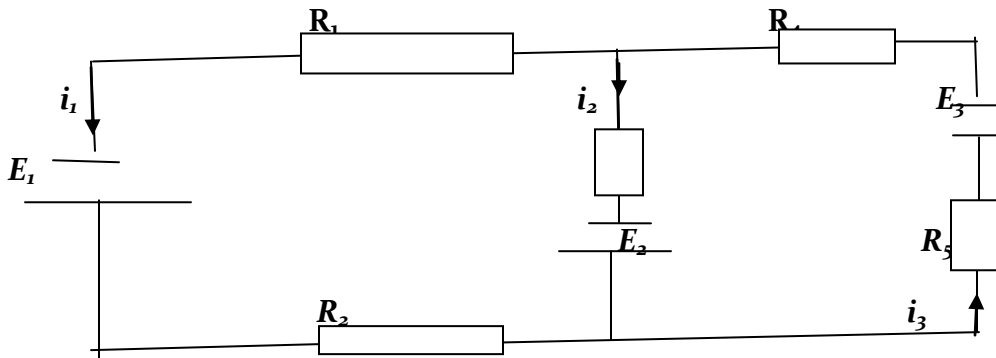
a) State Kirchhoff's Laws. **(2 marks)**

b) A steady uniform current of $5\ \text{A}$ flows axially along a metal cylinder of cross-section area $0.2\ \text{mm}^2$, length $5\ \text{m}$ and resistivity $3 \times 10^{-5}\ \Omega\ \text{m}$. 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 $E_1 = E_2 = E_3 = 2.1\ \text{V}$; $R_1 = R_2 = R_4 = R_5 = 1.7\ \Omega$ and $R_3 = 3.5\ \Omega$. 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 $M_p = 1.007277\ \text{a.m.u}$, $M_n = 1.008666\ \text{a.m.u}$ and mass of helium $4.001509\ \text{a.m.u}$ where $1\ \text{a.m.u} = 1.66 \times 10^{-27}\ \text{kg}$