TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

BACHELOR OF SCIENCE IN STATISTICS & COMPUTER SCIENCE

BACHELOR OF TECHNOLOGY IN INFORMATION TECHNOLOGY

BACHELOR OF SCIENCE IN FOOD & QUALITY ASSUARANCE

(BSEE/BSCE/BSSC/BTIT/BSFQ)

SPH 2171/APS 4102: PHYSICS II

END OF SEMESTER EXAMINATION

SERIES: APRIL 2014

TIME ALLOWED: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** questions

Answer question **ONE (COMPULSORY)** and any other **TWO** questions

Maximum marks for each part of a question are as shown

This paper consists of **FOUR** printed pages

Take

- $\varepsilon_0 = 8.85\times10^{-12}\,Fm^{-1}$
- $\frac{1}{4\pi\varepsilon_o} = 9\times10^{9}\,NC^{-2}$
- K =

$1.602\times10^{-19}C$

- e^- =
- G = 6.63 x 10^{-11} Nm^2 kg^2
- Mass of proton = 1.67 x 10^{-27}kg

$\mu_o = 4\pi\times10^{-7} Tm/A$

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Question One (Compulsory)

a) (i) State Coulomb's law for the electrostatic force between two point charges. **(2 marks)**

(ii) An electron and a proton are separated by a distance of 5.5 x 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….q_n the force experienced by q1 due to the other charges is given by:

$$F_1 = \sum_{i=2}^{n} \frac{1}{4\pi\varepsilon_o} \frac{q_1\, qi}{r_i^2} \hat{r}\, i_1$$

Where $\vec{r}_{i1}$ is the displacement between q_1 and q_i. **(4 marks)**

c) In the classical model of the hydrogen atom the electron revolves around the proton with a radius of r $r = 0.53\times10^{-10}\,m$ $e^- = 1.6\times10^{-19}C$

The magnitude of the charge of the electron and proton is

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

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

(iii) What is the ratio of magnitudes of the 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?

(ii) Show that the electric field strength along due to a dipole is given by:

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

(4 marks)

e) Two capacitors C1 and C2 are connected in series with voltage V across the combination. Show that the voltage across the individual capacitor are:

$$V_1 = \frac{C_2 V}{C_1 + C_2} \qquad V_2 = \frac{C_1 V}{C_1 + C_2}$$

and **(4 marks)**

(3 marks)

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

(ii) Give THREE differences between electric and magnetic forces. **(3 marks)**

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

Question Two (20 marks)

a) An electron $(q = e^-)$ placed near a charged body experiences a force in the +y direction of magnitude 3.6 x 10^{-8}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 alpha particle $(q = 2e)$ placed at the location formerly occupied by the electron. Take: $e = 1.602 \times 10^{-19} C$ **(3 marks)**

b) Two points q_1 and q_2 of 8 x 10^{-9}C and -8 x 10^{-9}C respectively are placed 0.1m apart as shown. Find the electric fields at points a, b and c **(8 marks)**

+q

c) Electric dipole consists of two charges $q_1 = -6mC$ and $q_2 = 6mC$ 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 q1 **(3 marks)**

(ii) On the time perpendicular to the axis **(3 marks)**

Question Three (20 marks)

a) A potential difference of 300V is applied to a $2\mu F$ capacitor and an $8\mu F$:

(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 the 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 μF capacitor and requires 170V to fire. If the capacitor is charged by a 200V source through an 18 $K\Omega$ resistor, how long must the photographer wait between the flashes. **(4 marks)**

c) (i) Show that for a spherical capacitor consisting of conducting sheet of radius b and charge Q is given by:

$$C = \frac{ab}{Ic(b-a)}$$

(ii) Derive expression of energy density of a capacitor. **(3 marks)**

Question Four (20 marks)

a) (i) A certain meter has a resistance of 5 Ω and deflects full scale for a voltage of 200mV across its terminal. How can it be converted into a 3A ammeter? **(4 marks)**

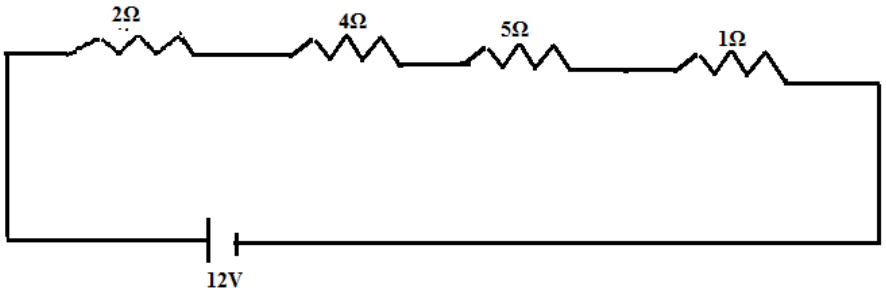
(ii) Calculate the magnetic field a long a straight wire carrying a current of 10A at a distance 8cm from the wire. **(3 marks)**

(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 0.10T/s. Find the magnitude of the induced current in the loop. **(5 marks)**

b) (i) State factors that affect the capacitance of a capacitor. **(2 marks)**

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

(iii) Four resistors are arranged as shown below: Find the current if the e.m.f of the battery is 12.V **(2 marks)**



Question Five (20 marks)

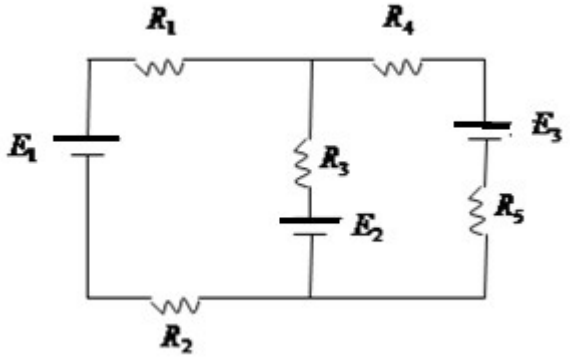
a) State Kirchoff's Laws **(2 marks)**

b) A steady uniform current of 5mA flows axially along a metal cylinder of cross-section area 0.2mm^2, length 5m and resistivity 3 x 10^{-5} Ω m. Find:

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

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

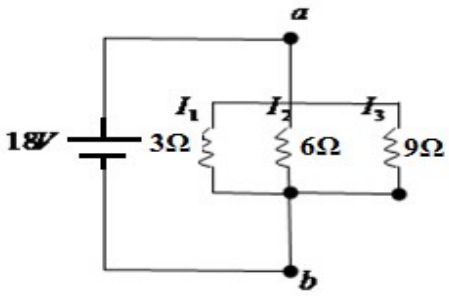
c) Consider the circuit below:



$R_1 = R_2 = R_4 = R_5 = 1.7\Omega,\ R_3 = 3.5\Omega$ and $E_1 = 2.1V,\ E_2 = 6.3V$ *and* $E_3 = 6.3V$

If , find currents i_1, i_2, and i_3 **(5 marks)**

d) (i) Three resistors are connected in parallel as shown below. A potential difference of 18V is maintained between points a and b. Find the current in each resistor. **(3 marks)**



(ii) Calculate the power dissipated by each resistor and the total power by the three resistors.

(4 marks)