Machakos University College

(A Constituent College of Kenyatta University)

UNIVERSITY EXAMINATIONS 2013/2014

SCHOOL OF COMPUTING AND APPLIED SCIENCES

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCE)

SPH 101: ELECTRICITY AND MAGNETISM 1

DATE: Tuesday, 1st April, 2014 TIME: 8.30 a.m. – 10.30 a.m.

INSTRUCTIONS:

Answer question **ONE** which is compulsory and any other **TWO**

Take *Permittivity due free space,* $\varepsilon_o = 8.854 \times 10^{-12} CN^{-1}m^{-1}$

Charge on electron, $e = 1.6 \times 10^{-19} C$

Permeability of free space $\mu_0 = 4\pi \times 10^{-7} NA^{-2}$

SECTION A

Question One (Compulsory)

Q. 1 (a) State four properties of magnetic forces (4 marks)

(b) Distinguish free space in electrostatics and in magnetism (2 marks)

(c) (i) State the Lenz's law (2 marks)

(ii) Protons are flowing out of a wall within a region, where the magnetic field is upwards the plane of the wall. On a sketch illustrate the direction of the lines of force. (3 marks)

(d) An hollow box has a uniform surface charge q. What is the electric field along its centre. Explain (2 marks)

(e) Using the work law, derive the Ampere law (3 marks)

(f) Three resistors R_1, R_2 and R_3 are connected in parallel. Derive an expression for the net resistance (3 marks)

(g) The potential at a certain region is given by $V = xz^2 - 2yx^2 + z^3$ volts. Find the components of the electric field intensity, E at the point (1, -1, 2) metres. (6 marks)

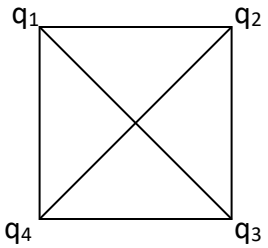
(h) Using the Gauss law, derive the Coulomb law for an isolated point charge (5 marks)

SECTION B

*Answer any **TWO** questions in this section*

Question 2

The configuration below shows four charges placed at the vertices of a square of sides 1 cm.



Given that $q_1 = 0.1\mu C$, $q_2 = -0.1\mu C$ $q_3 = -0.2\mu C$ and $q_3 = +0.4\mu C$, Find:-

(a) The resultant force on q_3 and its direction due to this charge distribution (6 marks)
(b) The electric field at X, the centre of the square (9 marks)
(c) The electric potential at X (2 marks)
(d) The total electric potential energy due to the configuration (3 marks)

Question 3

(a) Show that the electric field strength E at a point P due to an infinite line of charge density λ, is inversely proportional to the perpendicular distance from the line (7 marks)

(b) Determine the potential at point P, r metres on the axis of a uniformly changed disk of radius a, whose surface density is ρ. Hence show that it behaves as a point charge when $r \gg a$

(13marks)

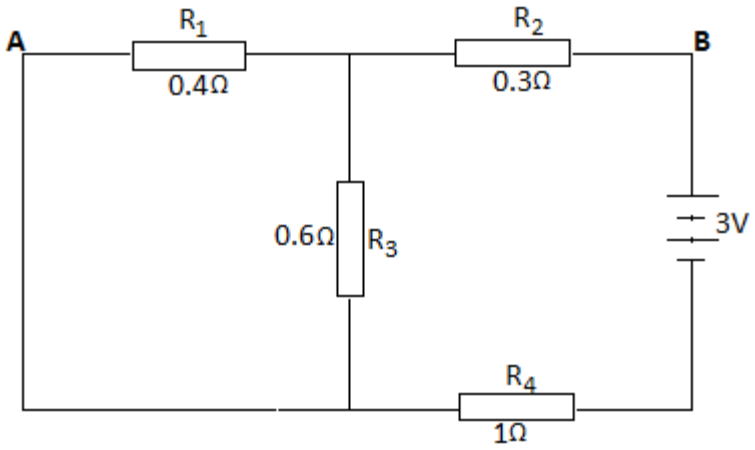
Question 4

(a) (i) State the Ohm's law. (2 marks)

(ii) Calculate the work done by an ideal battery of terminal potential 12 V on a unit charge passing from the positive to the negative terminal of the battery
(3 marks)

(b) Show that the induntance L of a solenoid of N turns is proportional to the square of the number of turns, N^2. (5 marks)

(c) The figure below shows a circuit in which the emf, $\in = 3V$, Resistance $R_1 = 0.4\Omega$, $R_2 = 0.3\Omega$, $R_3 = 0.6\Omega$ *and* $R_4 = 1\Omega$



Calculate:-

(i) The equivalent resistance between A and B (4 marks)

(ii) The electric potential across R_1 (3 marks)

(iii) The current through R_3 (3 marks)

Question 5

(a) (i) Determine the flux density at a point P, r metres from an isolated unit N-pole(4 marks)

(ii) A rectangular loop of width *a* and length *b* is located a distance *c* from a long wire carrying a current I. Using the Amperes law, find the expression of magnetic flux through the loop. (6 marks)

(b) A Singly charged carbon ion is moving at a speed of 300 km/s at right angles to a magnetic field of 0.75 T

(i) What is the force on the ion? (3 marks)

(ii) What is the centripetal acceleration of the ion? (4 marks)

(iii) Find the radius of the circle in which the ion moves (3 marks)

$$Mass\ of\ carbon\ 12\ amu,\ \ 1\ amu = 1.66X10^{-27}kg,$$

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UNIVERSITY EXAMINATIONS 2013/2014

SCHOOL OF COMPUTING AND APPLIED SCIENCES

FIRST YEAR EXAMINATION FOR THE DEGRE OF BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

ECU 103: PHYSICS FOR ENGINEERS II

DATE: Tuesday, 1st April, 2014 TIME: 8.30 a.m. – 10.30 a.m.

INSTRUCTIONS:

Answer question **ONE** which is compulsory and any other **TWO**

Take *Permittivity due free space,* $\varepsilon_o = 8.854 \times 10^{-12} CN^{-1}m^{-2}$

Charge on electron, $e = 1.6 \times 10^{-19} C$

Permeability of free space $\mu_0 = 4\pi \times 10^{-7} NA^{-2}$

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Q. 1 (a) State four properties of magnetic forces (4 marks)

(b) Distinguish free space in electrostatics and in magnetism (2 marks)

(c) (i) State the Lenz's law (2 marks)

(ii) Protons are flowing out of a wall within a region, where the magnetic field is upwards the plane of the wall. On a sketch, illustrate the direction of the lines of force. (3 marks)

(d) An hollow box has a uniform surface charge q. What is the electric field along its centre. Explain
(2 marks)

(e) Using the work law, derive the Ampere law (3 marks)

(f) Three resistors R_1, R_2 and R_3 are connected in parallel. Derive an expression for the net resistance (3 marks)

(g) The potential at a certain region is given by $V = xz^2 - 2yx^2 + z^3$ volts. Find the components of the electric field intensity, E at the point (1, -1, 2) metres. (6 marks)

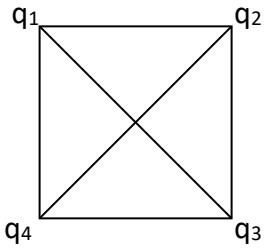
(h) Using the Gauss law, derive the Coulomb law for an isolated point charge (5 marks)

SECTION B

*Answer any **TWO** questions in this section*

Question 2

The configuration below shows four charges placed at the vertices of a square of sides 1 cm.



Given that $q_1 = 0.1\mu C$, $q_2 = -0.1\mu C$ $q_3 = -0.2\mu C$ and $q_4 = +0.4\mu C$, Find:-

(a) The resultant force on q_3 and its direction due to this charge distribution (6 marks)
(b) The electric field at X, the centre of the square (9 marks)
(c) The electric potential at X (2 marks)
(d) The total electric potential energy due to the configuration (3 marks)

Question 3

(a) Show that the electric field strength E at a point P due to an infinite line of charge density λ, is inversely proportional to the perpendicular distance from the line (7 marks)

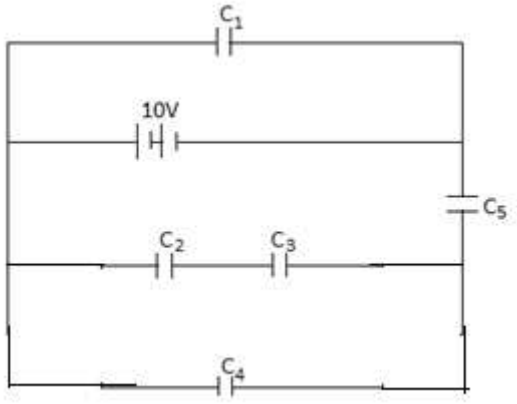
(c) Determine the potential at point P, r metres on the axis of a uniformly changed disk of radius a, whose surface density is ρ. Hence show that it behaves as a point charge when $r \gg a$

(13marks)

Question 4

(a) Describe the charging and discharging process of a capacitor. (5 marks)

(b) A circuit is connected as shown below. Each of the capacitors has a capacitance of 5μF



(i) Find the total capacitance of the circuit (4 marks)

(ii) Determine the charge on C_1 and C_5 (5 marks)

(iii) Determine the total energy stored in the network when fully charged. (3 marks)

(c) Explain the effect of a dielectric on the capacitance of a capacitor (4 marks)

Question 5

(a) A Singly charged carbon ion is moving at a speed of 300 km/s at right angles to a magnetic field of 0.75 T

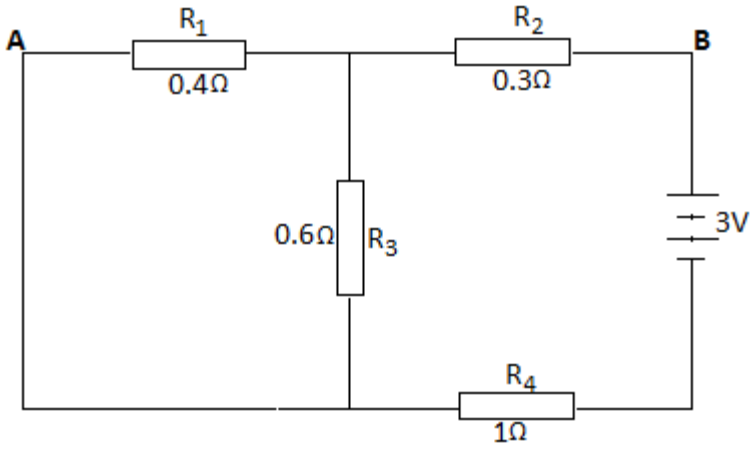
(i) What is the force on the ion? (3 marks)

(ii) What is the centripetal acceleration of the ion? (4 marks)

(iii) Find the radius of the circle in which the ion moves (3 marks)

$$Mass\ of\ carbon\ 12\ amu,\ \ 1\ amu = 1.66X10^{-27}kg,$$

(b) The figure below shows a circuit in which the emf, $\in = 3V$, Resistance $R_1 = 0.4\Omega$, $R_2 = 0.3$, $R_3 = 0.6\Omega$ *and* $R_4 = 1\Omega$



Calculate:-

(i) The equivalent resistance between A and B (4 marks)

(ii) The electric potential across R_1 (3 marks)

(iii) The current through R_3 (3 marks)