MACHAKOS UNIVERSITY

University Examinations 2020/2021

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

BACHELOR OF EDUCATION (SPECIAL NEEDS)

BACHELOR OF SCIENCE (MATHEMATICS)

BACHELOR OF EDUCATION (SCIENCE)

SPH 101: ELECTRICITY AND MAGNETISM 1

DATE: 17/6/2021 **TIME: 8.30 – 10.30 A.M.**

INSTRUCTIONS:

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

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

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

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

a) State four properties of electrostatic forces (4 marks)

b) A capacitor does not conduct direct current but seems to conduct alternating current. Explain (3 marks)

c) State the Ampere's law (1 mark)

d) A piece of plastic pipe of radius r has a uniform surface charge q. What is the electric field along its axis? Explain (2 marks)

e) Three capacitors C_1, C_2 and C_3 are connected in series. Derive an expression for the net capacitance (4 marks)

f) The potential at a certain region is given by $V = 4x^2 - 3xy^2 + 2z^2$ volts. Determine the components of the electric field intensity, E at the point (4, -3, 2) metres. (6 marks)

g) (i) State the Lorentz's law (1 mark)

(ii) Charges are flowing into a plane (say this page) within a region where the magnetic field is vertically upwards. On a sketch, illustrate the direction of the lines of force due to this field. (3 marks)

h) Two isolated conductors of radii r_1 and r_2 are electrically connected together. Determine the ratio of their final charge densities ρ_1 and ρ_2 (4 marks)

i) Explain why semiconductors are said to be non-ohmic? (2 marks)

SECTION B: ANSWER ANY TWO QUESTIONS IN THIS SECTION
QUESTION TWO (20 MARKS)

Three charges are placed at the vertices of an equilateral triangle of sides 10 cm, such that the line joining q_1 to q_2 is parallel to the x-axis. Given that $q_1 = 1.0\mu C$, $q_2 = +3\mu C$ and $q_3 = -2\mu C$, calculate the following: -

a) resultant force on q_1 and its direction due to this charge distribution (6 marks)
b) electric field at the point X, the centre of the configuration (9 marks)
c) electric potential at X (2 marks)
d) total electric potential energy due to the configuration (3 marks)

QUESTION THREE (20 MARKS)

a) Show that the electric field strength E due to a dipole of magnitude q placed a distance $2a$ apart at a point x, a distance r from the line joining them is inversely proportional to r^3, where $r \gg a$ (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 $r \gg a$ (13 marks)

QUESTION FOUR (20 MARKS)

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

b) A circuit is connected as shown in Figure 1, where each of the capacitors has a capacitance of 5μF, determine the following: -

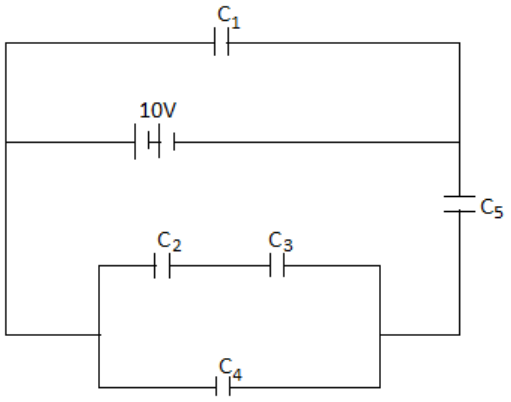


Figure 1 capacitor circuit

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

(ii) charge on C_1 and C_4 (5 marks)

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

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

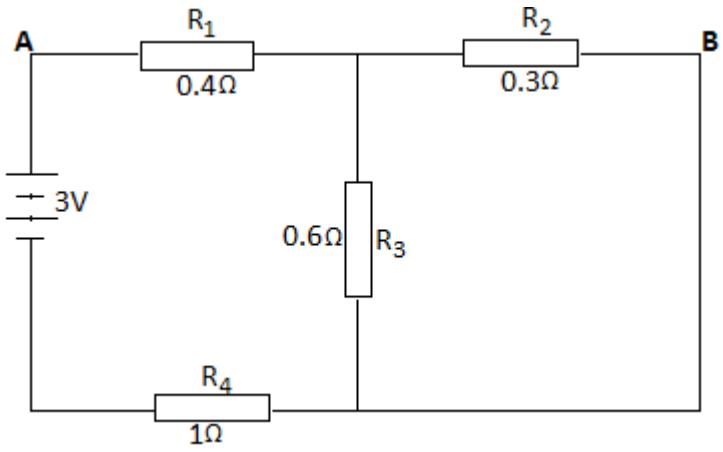
QUESTION FIVE (20 MARKS)

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. Given that mass of carbon is 12 amu, where $1\ amu = 1.66X10^{-27}$ kg, determine the following:

(i) force on the ion? (3 marks)
(ii) centripetal acceleration of the ion? (4 marks)
(iii) radius of the circle in which the ion moves (3 marks)

b) Figure 2 shows a circuit in which the emf, $\in = 3V$, while the resistances are

$$R_1 = 0.4\ \Omega, \qquad R_2 = 0.3\ \Omega, \qquad R_3 = 0.6\ \Omega \text{ and } R_4 = 1\ \Omega$$



Calculate the following: -

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

(ii) electric potential across R_1 (3 marks)

(iii) current through R_3 (3 marks)