



UNIVERSITY OF EMBU

2018/2019 ACADEMIC YEAR

SECOND SEMESTER EXAMINATIONS

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

SPH 102: ELECTRICITY AND MAGNETISM I

DATE: APRIL 8, 2019

TIME: 8:30 AM – 10:30 AM

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

QUESTION ONE (30 MARKS)

Constants

Electron charge: $1.6 \times 10^{-19} \text{ C}$

Mass of an electron $m_e = 9.1 \times 10^{-31} \text{ kg}$

Coulomb's constant $k = 8.99 \times 10^9 \text{ NM}^2\text{C}^{-2}$

Mass of a proton $m_p = 1.6 \times 10^{-27} \text{ kg}$

Permittivity of vacuum $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$

QUESTION ONE (30 MARKS)

- a) A 5nC test charge is placed at a point such that it experiences a force of $2 \times 10^{-4} \text{ N}$ in the x direction. What is the electric field at that point (2 marks)
- b) A single phase transformer has 480 turns on the primary winding and 90 turns on the secondary winding. The maximum value of the magnetic flux density is 1.1T when 2200 volts, 50Hz is applied to the transformer primary winding. Calculate the maximum flux in the core and the cross sectional area of the core. (5 marks)



ISO 27001:2013 Certified *Knowledge Transforms*



ISO 9001:2015 Certified

- c) What is the resistance of a transistor that has a voltage drop of 9.35V and a current of 0.55 mA? (2 marks)
- d) Calculate the capacitance of the capacitor having dimensions, 30 cm x 40 cm and separated with a distance $d=8\text{mm}$ air gap. (4 marks)
- e) Two balloons are charged with an identical quantity and type of charge: -6.25 nC . They are held apart at a separation distance of 61.7 cm. Determine the magnitude of the electrical force of repulsion between them. (3 marks)
- f) Figure 1.1 below shows a map of a non-uniform magnetic field measured near a sheet of magnetic material. If the bold line at the centre represents a loop of wire, what is the magnetic flux through the loop? (4 marks)

6	6	6	6	6	5	5	6	6	6
6	6	6	6	6	5	5	6	6	6
5	5	6	5	6	6	5	5	5	5
5	6	5	5	5	4	4	5	5	6
5	5	4	4	5	3	5	5	5	5
5	5	4	4	3	4	4	3	5	5
4	4	4	4	3	3	3	3	3	4
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3

All numbers represent mT out of the page.
Grid lines drawn with 1 cm spacing.

Fig 1.1

- g) A long, rigid wire lying along the y -axis carries a 5.0-A current flowing in the positive y -direction. If a constant magnetic field of magnitude 0.30 T is directed along the positive x -axis, what is the magnetic force per unit length on the wire? (3 marks)
- h) An air filled parallel plate capacitor has capacitance 1.3pF. The separation of the plates is then doubled and a piece of wax is inserted between the plates. The new capacitance is now 2.6 pF. Find the dielectric constant of the wax . (3 marks)
- i) Two resistors of resistance $4\ \Omega$ and $6\ \Omega$ are connected in parallel and connected to a 12V dc source. Calculate the current passing through each resistor. (4 marks)

QUESTION TWO (20 MARKS)

In the circuit below in fig 2.1 which consists of 7 resistors $R_1 = 4\ \Omega$, $R_2 = 4\ \Omega$, $R_3 = 8\ \Omega$, $R_4 = 10\ \Omega$, $R_5 = 4\ \Omega$, $R_6 = 2\ \Omega$ and $R_7 = 2\ \Omega$. The supply voltage is 5 V. Calculate the *effective resistance*

and find the voltage across each of the resistors

(20

marks)

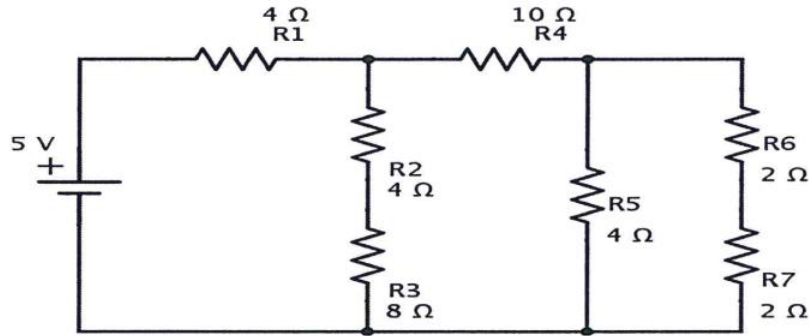


Fig 2.1

QUESTION THREE (20 MARKS)

- a) The Figure 3.1 shows three point charges q_1 , q_2 and q_3 that lie in the x, y plane in a vacuum. The distance between q_1 and q_2 is 0.15m, while the distance between q_2 and q_3 is 0.10m. The angle between the line joining q_1 and q_2 and the horizontal is 73°

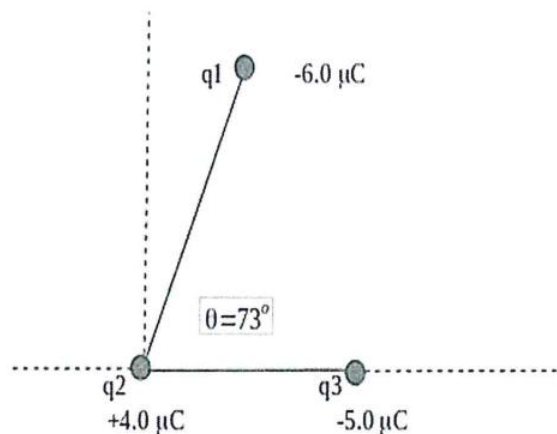


Fig 3.1

What is the magnitude and direction of the net electrostatic force and direction on q_2 ?

(12 marks)

- b) A moving coil galvanometer gives a full scale deflection with a current 0.5mA and has a resistance of 20Ω . Design the following:

(8 marks)

- i) An ammeter which will read full scale when the current is 5A
- ii) A voltmeter to measure a maximum of 10V at full scale deflection

QUESTION FOUR (20 MARKS)

- a) A uniform magnetic field \vec{B} with magnitude 1.2 mT points vertically upwards throughout the volume of the room in which you are sitting. A 5.3MeV proton moves horizontally from south to north through a certain point in the room. Calculate the deflecting magnetic force that acts on the proton as it passes through this point and the acceleration of the proton. (7 marks)
- b) In the Bohr model of the hydrogen atom, the electron is in orbit about the nuclear proton at a radius $5.29 \times 10^{-11}\text{m}$. Find the electrostatic attractive force between the two and the velocity of the electron, assuming the orbit to be circular. (8 marks)
- c) A wire of cross sectional area A , diameter d and length 1m has a resistance of 0.3Ω . It is uniformly stretched to a length of 2m. What is its new resistance? (5 marks)

QUESTION FIVE (20 MARKS)

- a) Calculate the effective capacitance, the total charge and work done in charging the capacitors in the capacitor network shown in fig 5.1 below, given that $V = 20\text{V}$ (10 marks)

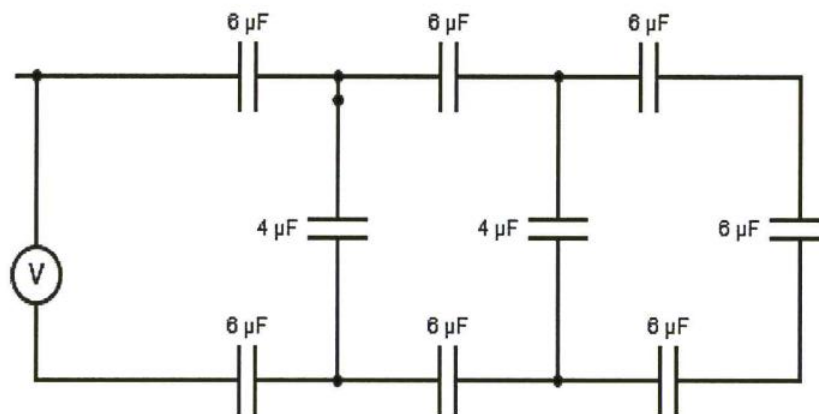


Fig 5.1

- b) With the aid of a diagram, discuss the *principal features* of a Cathode Ray Tube and *their functions* and explain how a CRO is used to measure *voltage* and *frequencies* of signals (10 marks)

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