



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.

Tel: +254(0) 799 529 958, +254(0) 799 529 959, +254 (0)712 524 293

Website: [www.must.ac.ke](http://www.must.ac.ke) Email: [info@mucst.ac.ke](mailto:info@mucst.ac.ke)

---

## UNIVERSITY EXAMINATIONS 2023/2024

FIRST YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING AND BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

### SPS 3151: PHYSICS II

DATE: APRIL 2024

TIME: 2 HOURS

---

**INSTRUCTIONS: Answer Question ONE and any other TWO questions.**

---

#### Constants

charge of an electron  $= 1.6 \times 10^{-19} C$

Coulomb's constant  $k_e = 8.988 \times 10^9 Nm^2/C^2$

$\mu_0$  =magnetic permeability  $= 1.26 \times 10^{-6} T.M/A$

permittivity of free space  $\epsilon_0 = 8.85 \times 10^{-12} C^2/NM^2$

charge of proton  $= 1.6 \times 10^{-19} C$

Mass of electron  $M_e = 9.11 \times 10^{-31} kg$

Mass of proton  $M_p = 1.67 \times 10^{-27} kg$

#### QUESTION ONE (30 MARKS)

- a) i. Define an Electric Force? (1 Mark)



MUST is ISO 9001:2015 and



ISO/IEC 27001:2013 CERTIFIED

- ii. Two point charges  $Q_1 = 400\mu C$  and  $Q_2 = 100\mu C$ , are kept fixed, 60cm apart in vacuum. Find intensity of the electric field at midpoint of the line joining  $Q_1$  and  $Q_2$  (4 Marks)
- b) Define the following terms
- Electric potential (1 Mark)
  - Electric potential energy (1 Mark)
- c) Two point charges,  $q_1 = 10 \times 10^{-8}C$  and  $q_2 = -2 \times 10^{-8}C$  separated by a distance of 60cm in air,
- Find at what distance from the 1<sup>st</sup> charge  $q_1$ , would the electric potential be zero. (4 Marks)
  - Calculate electrostatic potential energy of the system. (3 Marks)
- d) State the following electromagnetic laws
- Faraday's Law of electromagnetic induction (2 Marks)
  - Lenz's law of electromagnetic induction (2 Marks)
- e) A conducting circular loop of radius 0.250m is placed in the  $xy$ -plane in a uniform magnetic field of 0.360T that points in the positive  $z$ -direction, the same direction as the normal plane.
- Calculate the magnetic flux through the loop (3 Marks)
  - Suppose the loop is rotated clockwise around the  $x$ -axis, so the normal direction now points  $45^\circ$  angle with respect to  $z$ -axis. Recalculate the magnetic flux through the loop (3 Marks)
  - What is the change in flux due to the rotation of the loop (2 Marks)
- f) Explain what an electric field is, how is it created? (4 Marks)

## QUESTION TWO (20 MARKS)

- a) Figure 1 shows two long parallel wires carrying currents and  $i_1$  and  $i_2$  in opposite directions. What are the magnitude and direction of the net magnetic field at point P? Assume the following values:  $i_1 = 15A$ ,  $i_2 = 32 A$ , and  $d = 5.3$  cm. (14 Marks)



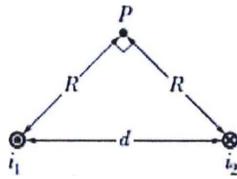


Figure 1

- b) Give three uses of Radioactivity (3 Marks)
- c) A nuclear reaction of significant note occurred in 1932 when Chadwick, in England, bombarded a beryllium target with alpha particles. Analysis of the experiment indicated that the following reaction occurred:  ${}^4_2\text{He} + {}^{14}_7\text{N} \rightarrow {}^{17}_8\text{O} + {}^A_Z\text{X}$   
 What is the value of A, Z and x. (3 Marks)

### QUESTION THREE (20 MARKS)

- a) Figure 2 shows three charged particles held in fixed positions by forces that are not shown. What is the electric potential energy U of this system of charges? Assume that  $d = 12 \text{ cm}$  and that  $q_1 = +q$ ,  $q_2 = -4q$  and  $q_3 = +2q$  in which  $q = 150 \text{ nC}$ . (6 Marks)

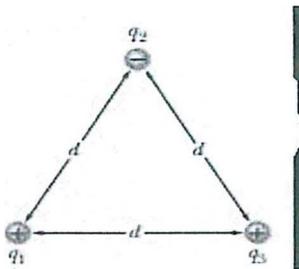


Figure 2

- b) A series RLC AC circuit has resistance  $R = 2.50 \times 10^2 \ \Omega$ , inductance  $L = 0.600 \text{ H}$ , capacitance  $C = 3.50 \text{ F}$ , frequency  $f = 60.0 \text{ Hz}$ , and maximum voltage  $V_{\text{max}} = 1.50 \times 10^2 \text{ V}$ .  
 Find
- the impedance in the circuit. (4 Marks)
  - the maximum current in the circuit. (2 Marks)
  - the phase angle. (2 Marks)
  - the maximum voltages across the elements. (6 Marks)

**QUESTION FOUR (20 MARKS)**

- a) What is electric dipole (1 Mark)
- b) Three charges lie along the x-axis as in Figure 3. The positive charge  $q_1 = 15\mu\text{C}$  is at  $x = 2.0\text{ m}$ , and the positive charge  $q_2 = 6.0\mu\text{C}$  is at the origin. Where must a negative charge  $q_3$  be placed on the x-axis so that the resultant electric force on it is zero? (10 Marks)

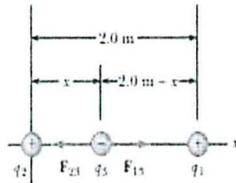


Figure 3

- c) A coil with 25 turns of wire is wrapped on a frame with a square cross-section 1.80 cm on a side. Each turn has the same area, equal to that of the frame, and the total resistance of the coil is 0.350  $\Omega$ . An applied uniform magnetic field is perpendicular to the plane of the coil, as in Figure 4. If the field changes uniformly from 0.00 T to 0.500 T in 0.800 s,

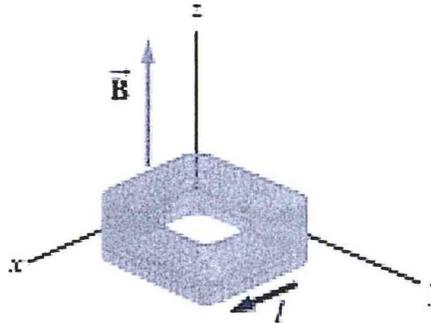


Figure 4

- i. Find the induced emf in the coil while the field is changing. (4 Marks)
- ii. Find the magnitude (2 Marks)
- iii. Find the direction of the induced current in the coil while the field is changing. (2 Marks)