



KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

**SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS**

FOR THE DEGREE OF B.ED (SCIENCE) AND BSC (PHYSICS)

COURSE CODE: SPC 211

COURSE TITLE: ELECTRICITY AND MAGNETISM

DURATION: 2 HOURS

DATE: 03/02/2022

TIME: 8-10AM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover of the answer booklet.
- Yours answers to each of the three questions starts on a new page and make sure your work is correctly numbered.

This paper consists of 3 printed pages. Please Turn Over



KIBU observes ZERO tolerance to examination cheating

Question One

- a) State the law of charges and the law of currents. (2 marks)
- b) Differentiate between transient current and steady current. (2 marks)
- c) State the Coulomb's law. (2 marks)
- d) Estimate the force due an electron at a distance of 50pm from the proton (electron charge is $-1.6 \times 10^{-19} \text{C}$, proton charge is $+1.6 \times 10^{-19} \text{C}$ while the permittivity of free space is 1.257×10^{-7}). (3 marks)
- e) Define an Ohm. (1 mark)
- f) A metal rod of length l , cross-sectional area A , and electrical conductivity σ is clamped between two points that have a potential difference of V between them. Derive the Ohm's law. (4 marks)
- g) Define capacitance. (2 marks)
- h) We have a capacitor whose plates are each of area A , separation d , and the medium between the plates has permittivity ϵ . It is connected to a battery of EMF V , so the potential difference across the plates is V . Show that $C = \epsilon \frac{A}{d}$. (3 marks)
- f) State the Kirchhoff's rules. (2 mark)
- g) The circuit in Figure 1 shows a network of resistors connected to a 24 V battery with negligible internal resistance.

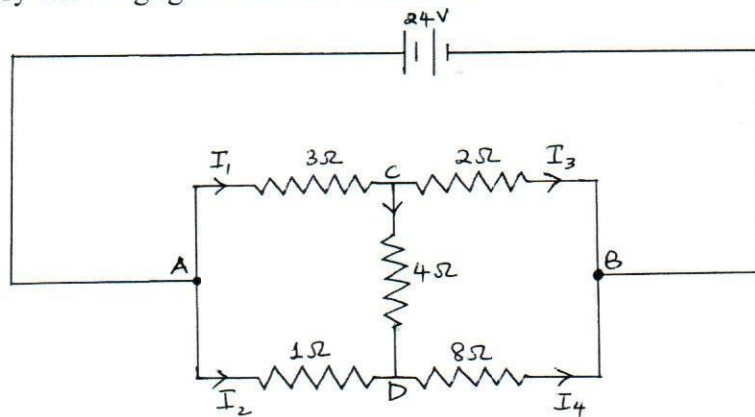


Figure 1

- Form all the equations that are required to evaluate the currents I_1 , I_2 , I_3 , I_4 and I_5 . (4 marks)
- h) Define an electric dipole. State the assumption made for an ideal electric dipole. (2 marks)
- i) Three equal charges each of magnitude Q are placed at the corners of a square of side x . Find the resultant electric field at the fourth corner where there is no charge. (2 marks)
- j) Define the intensity B of a magnetic field. (1 mark)

Question Two

- a) A plane circular sheet of radius b has a charge distributed uniformly over its surface with a density of σ per unit area. A charge Q is situated perpendicularly at a distance, a , from the centre of the sheet;

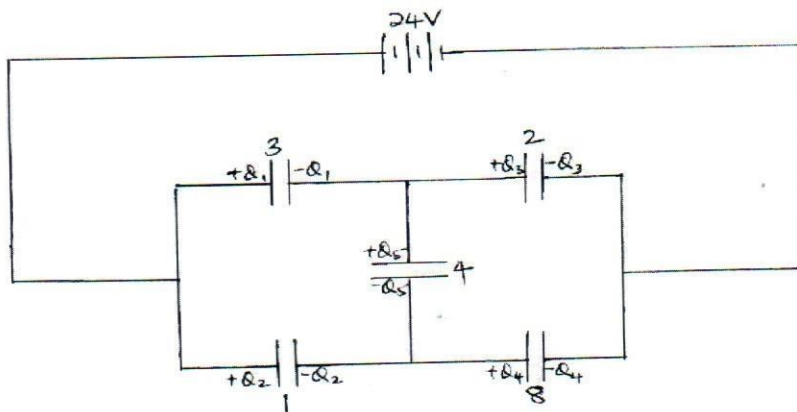
- i) Find the force on the charge. (10 marks)
 ii) What would the force become as $b \rightarrow 0$ and $b \rightarrow \infty$? (4 marks)
- b) Four equal charges each of magnitude 2 Coulombs are placed at the four corners of a square of side 1cm. Find the resultant force on any of the charges. (6 marks)

Question Three

- a) Find the components of \vec{E} given that $\vec{E} = 2xy$ and $\vec{E} = r^2 \cos \theta$ (8 marks)
- b) A plane circular sheet has a circular hole of radius b at its centre and has a charge distributed uniformly over its surface with a density of σ per unit area. A charge Q is situated perpendicularly at a distance, a , from the centre of the sheet. Find the electric field on the charge. (12 marks)

Question Four

- a) Starting with two spheres are of inner and outer radii a and b , with a potential difference V between them, with charges $+Q$ and $-Q$ on the inner and outer spheres respectively, show that the capacitance of an isolated sphere of radius a is given by $C = 4\pi\epsilon a$. (10 marks)
- b) Calculate the charge held in each capacitor. (10 marks)



Question Five

- a) State the Biot Savart law. (2 marks)
- b) Derive the equations of magnetic field
- i) near a long, straight, current-carrying conductor (4 marks)
- ii) on the axis and in the plane of a plane circular current-carrying coil. (8 marks)
- iii) on the axis of a long solenoid. (6 marks)