



**Strathmore**  
UNIVERSITY

SCHOOL OF COMPUTING AND ENGINEERING SCIENCES (SCES)  
BACHELORS OF ELECTRICAL AND ELECTRONICS ENGINEERING  
END OF SEMESTER EXAMINATION  
BEE 2204: ELECTROMAGNETISM

DATE: 31<sup>st</sup> July, 2024

Time: 15.30 – 17.30 Hours

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**Instructions**

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

- Q1. (a) (i) Define Electromagnetics. (2mks)  
(ii) State any two electromagnetic devices (1mks)
- (b) If  $\mathbf{A} = 10\mathbf{a}_x - 4\mathbf{a}_y + 6\mathbf{a}_z$  and  $\mathbf{B} = 2\mathbf{a}_x + \mathbf{a}_y$   
Find:  
(i) The component of  $\mathbf{A}$  along  $\mathbf{a}_y$  (1mks)  
(ii) A unit vector along  $\mathbf{A} + 2\mathbf{B}$  (1mks)
- (c) Point charges 1 mC and - 2 mC are located at (3, 2, - 1) and (-1, -1, 4), respectively.  
Calculate the electric force on a 10-nC charge located at (0, 3, 1) and the electric field intensity at that point (5mks)
- (d) For the current density  $\mathbf{J} = 10Z \sin \phi^2 \mathbf{a}_\phi$  A/m<sup>2</sup>, find the current through the cylindrical surface  $\rho = 2, 1 \leq Z \leq 5$  m. (5mks)
- (e) For a linear homogeneous material medium,  
(i) Derive Poisson's and Laplace's equation. (2mks)  
(ii) Describe the general procedure for solving Poisson's or Laplace's equation. (3mks)
- (f) Planes  $Z=0$  and  $Z=4$  carry current  $\mathbf{K} = -10\mathbf{a}_x$  A/m and  $\mathbf{K} = 10\mathbf{a}_x$  A/m, respectively.  
Determine  $\mathbf{H}$  at (1, 1, 1) (5mks)
- (g) (i) State the three ways that forces due to magnetic fields can be experienced.

- (3mks)
- (ii) Derive the Lorentz force equation. (2mks)
- Q2. (a) (i) Define distance vector. (1mks)
- (ii) An airplane has a ground speed of 350 km/hr in the direction due west. If there is a wind blowing northwest at 40 km/hr, calculate the true air speed and heading of the airplane. (4mks)
- (b) If  $J = \frac{1}{r^3} (2\cos\theta a_r + \sin\theta a_\theta) A/m^2$ , Calculate the current passing through:
- (i) A hemisphere shell of radius 20 cm. (5mks)
- (ii) A spherical shell of radius 10 cm. (5mks)
- Q3. (a) (i) If  $\mathbf{A} = a_x + 3a_z$  and  $\mathbf{B} = 5a_x + 2a_y - 6a_z$  find  $\theta_{AB}$  (5mks).
- (iii) Describe nonpolar and polar dielectrics and provide examples for each. (4mks)
- (iii) Show that for a parallel-plate capacitor, the capacitance is given by
- $$C = \frac{Q}{V} = \frac{\epsilon S}{d} \text{ Farads.} \quad (3\text{mks})$$
- Where C- Capacitance,  $\epsilon$  – permittivity of the dielectric, S-plate area and d- separation distance between the plates.
- (iv) Describe convection and conduction currents (3mks)
- Q4. (a) Three point charges -1 nC, 4 nC, and 3 nC are located at (0,0,0), (0,0,1), and (1,0,0), respectively. Find the energy in the system. (6mks)
- (b) Determine the magnetic moment of an electric circuit formed by the triangular loop of Figure 4.1. (9mks)

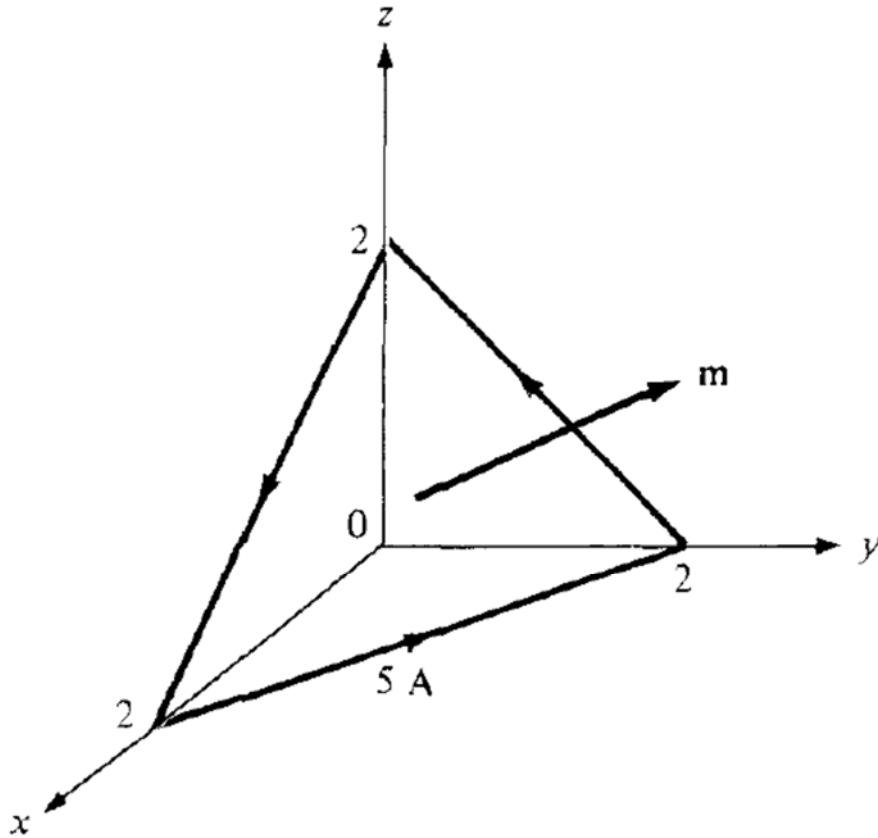


Fig 4.1. Triangular loop.

Q5. (a) State and explain the three types of magnetic materials. (5mks)

(b) If  $\mathbf{D} = (2y^2 + Z)\mathbf{a}_x + 4xy\mathbf{a}_y + x\mathbf{a}_z$  C/m<sup>2</sup>, find

(i) The volume charge density at (-1, 0, 3) (3mks)

(ii) The flux through the cube defined by  $0 \leq x \leq 1, 0 \leq y \leq 1, 0 \leq z \leq 1$ .

(4mks)

(iii) The total charge enclosed by the cube.

(1mks)

(c) A charged particle of mass 2 kg and charge 3C starts at point (1,-2,0) with velocity

$4\mathbf{a}_x + 3\mathbf{a}_z$  m/s in an electric field  $12\mathbf{a}_x + 10\mathbf{a}_y$  v/m. At time  $t=1$ s, determine the

acceleration of the particle.

(2mks)