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(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN ELECTRICAL
AND
COMMUNICATION ENGINEERING

COURSE CODE: ECE 312

COURSE TITLE: ELECTROMAGNETICS I

DATE: 14TH DECEMBER, 2022 **TIME:** 12: 00 PM – 2:00 PM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

QUESTION 1

1a) Define the term electromagnetics (EM) (1mk)

b) Explain the following terms as they are applied in electromagnetics. (3mks)

i. Electric field intensity

ii. Electric susceptibility

iii. Electric dipole

c) Point charges 1mC and 2mC are located at (3, 2,-1) and (-1,-1, 4), respectively. Calculate the electric force on a 10nc charge located at (0, 3, 1) and the electric field intensity at that point. (5mks)

d) Explain the three types of charge distribution (4½mks)

e) Explain the image theory (5½mks)

f) A 50cm length of coaxial cable has an inner radius of 1mm and an outer radius of 4mm. the space between conductors is assumed to be filled with air. The total charge on inner conductor is 30nC. Find

i. The charge density on each conductor (5mks)

ii. The E and D fields (6mks)

QUESTION 2

2a) State Stokes Theorem and express it mathematically. (4mks)

b) Given Gauss' equation for a linear material medium, derive the Laplace and Poisson's equations. (5mks)

c) A dielectric sphere ($\varepsilon_r = 5.7$) of radius 10cm has a point charge 2pC placed at its centre. Calculate the force exerted by the charge on -4pC point charge placed on the sphere. (5mks)

d) Derive the continuity current equation. (6mks)

QUESTION 3

3a) Explain Gauss's law and express it in integral form. (3mks)

b) State Ampere's current law (2mks)

c) Determine the magnetic field at the centre of the semi-circular place of wire with a radius of 0.20m. The current carried by the semicircular piece of wire is 150A. (5mks)

d) Use Gauss' law to derive the equation of electric field inside a uniformly charged sphere (charge density p) of radius R. (4mks)

e) Draw an illustration of the divergence of a vector field at a point P that shows (3mks)

i. positive divergence

ii. negative divergence

iii. zero divergence

f) State the divergence theorem and express it mathematically. (3mks)

QUESTION 4

4a) Two point charge -4μC and 5μC are located at (2,-1,3) and (0,4,-2),respectively. Find the potential at (1,0,1) assuming zero potential at infinity. (5mks)

Bi) state the amperes circuital law (2mks)

ii) Apply Stokes theorem to transform the integral form of amperes circuital law to its differential form. (2mks)

c) A Z-directed wire of radius carries a total z-directed current I.

i. Determine the magnetic field distribution,both inside and outside the wire,if the current is evenly distributed throughout the wire. (2mks)

ii) Determine the magnetic field distribution if the current is concentrated in a thin layer at the surface of the wire. (2mks)

di) State Biot-Savart's law. (2mks)

ii. Express Biot-Savart's law in terms of distributed current sources (5mks)

QUESTION 5

5a) State Faraday's law. (2mks)

b) A 10 turn circular wire loop of radius a=0.4m lies centred in the X-Y plane with its axis along the Z-axis. The loop is located in a time varying vector field defined by $H = H_0 \cos wtz'$ where H=200μA/m and F=1mHz. Determine the emf in the loop terminals. (6mks)

ci. Define the term toroid as it is used in electromagnetics. (2mks)

ii. Derive the formula for magnetic field of a toroid giving all the relevant explanations. (5mks)

d) Calculate the electrostatic force of a repulsion between two alpha particles when at a distance 10^{-13}m from each other,charge of an alpha particle is 3.2×10^{-12}C. If the mass of each particle is 6.68×10^{-27}kg,compare this force with the gravitational force between them. Take the gravitational constant as equal to 6.67×10^{-11}N-m^2/Kg^2. (5mks)