



MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (TELECOMMUNICATION & INFORMATION
TECHNOLOGY)

SPH 315 ELECTRODYNAMICS

DATE: 10/11/2020

TIME: 8.30-10.30 AM

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS)

- a) State the principle of superposition (2 marks)
- b) Define (6 marks)
 - i) Dielectric
 - ii) Polar molecule
 - iii) Wave
- c) Find the electric field a distance z above the midpoint between two equal charges (q), a distance d apart (Fig. 1) (5 marks)

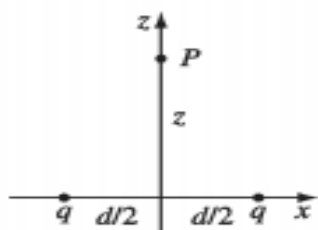


Fig.1

- d) Find the magnetic field a distance s from a long straight wire (Fig 2.), carrying a steady current I (4 marks)

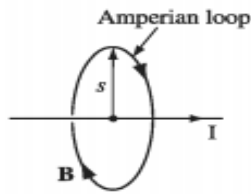


Fig. 2

- e) A long straight wire, carrying uniform line charge λ , is surrounded by rubber insulation out to a radius a (Fig. 3). Find the electric displacement. (5 marks)

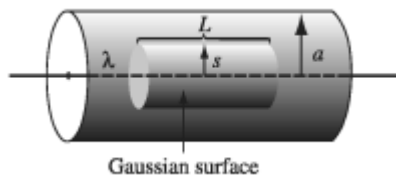


Fig. 3

- f) State Faraday's law and give the equation in differential form (4 marks)
- g) From the differential form of Ampere's law, derive its integral equivalent. (4 marks)

QUESTION TWO (20 MARKS)

- a) From Gauss's integral equation, show that

$$\nabla \cdot \mathbf{E} = \frac{1}{\epsilon_0} \rho. \quad (6 \text{ marks})$$

- b) Find the field outside a uniformly charged solid sphere of radius R and total charge q . (5 marks)
- c) A point charge q is situated a distance a from the center of a grounded conducting sphere of radius R (Fig. 4). Find the potential outside the sphere and the force between the charge and the sphere. (9 marks)

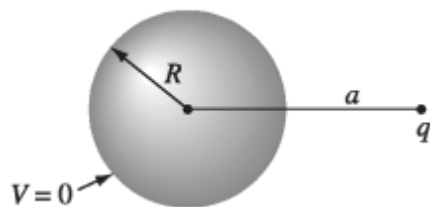


Fig. 4

QUESTION THREE (20 MARKS)

- a) An infinite plane carries a uniform surface charge σ . Find its electric field. (6 marks)
- b) Derive the Poisson's equation (4 marks)

- c) Show that the potential is *constant* inside an enclosure completely surrounded by conducting material, provided there is no charge within the enclosure. (6 marks)
- d) Outline Maxwell's equations (4 marks)

QUESTION FOUR (20 MARKS)

- a) Find the vector potential of an infinite solenoid with n turns per unit length, radius R , and current I . (8 marks)
- b) Find the electric field a distance z above the midpoint of a straight line segment of length $2L$ that carries a uniform line charge. (Fig. 5). (8 marks)

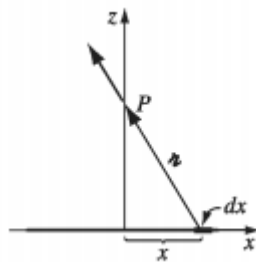


Fig. 5

- c) How different are insulators from conductors? (4 marks)

QUESTION FIVE (20 MARKS)

- a) A long cylindrical magnet of length L and radius a carries a uniform magnetization M parallel to its axis. It passes at constant velocity v through a circular wire ring of slightly larger diameter (Fig. 6). Graph the emf induced in the ring, as a function of time. (7 marks)

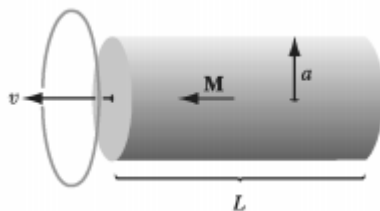


Fig. 6

- b) A charge Q is located at the center of a sphere of radius R . Calculate the flux going out through the surface of the sphere (6 marks)
- c) A long cylinder (Fig. 7) carries a charge density that is proportional to the distance from the axis: $\rho = ks$, for some constant k . Find the electric field inside this cylinder. (7 marks)

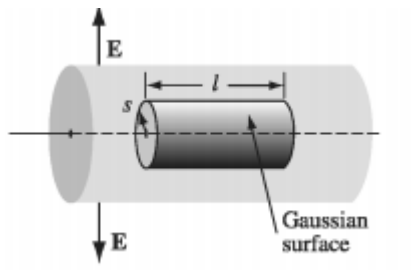


Fig. 7