MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

SPH 315 ELECTRODYNAMICS

DATE: 10/12/2021 **TIME: 11:00 – 1:00 PM**

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY)(30 MARKS)

a) Define electric potential and give its expression in terms of electric field. (4 marks)

b) A sphere of radius R has a cavity of radius a inside it. The sphere has uniform charge density ρ spread over its volume. Show that the field inside the cavity is constant. (6 marks)

c) For regions with no charge, show that $\nabla^2 V = 0$. (5 marks)

d) Give 3 kinds of symmetry. (3 marks)

e) Define (8 marks)

i) polarization
ii) Polar molecule
iii) Wave
iv) Curl of a vector

f) A long straight wire, carrying uniform line charge λ, is surrounded by rubber insulation out to a radius a (Fig. 1). Find the electric displacement. (4 marks)

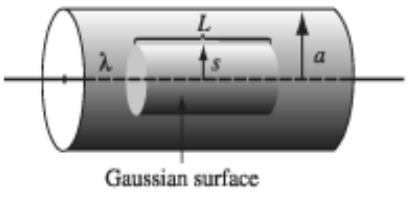

Fig. 1

QUESTION TWO (20 MARKS)

a) An infinite plane carries a uniform surface charge σ Find its electric field. (6 marks)

b) Derive Gauss's differential equation. (10 marks)

c) Find the field outside a uniformly charged solid sphere of radius *R* and total charge *q.* (4 marks)

QUESTION THREE (20 MARKS)

a) Show that the potential is *constant* inside an enclosure completely surrounded by conducting material, provided there is no charge within the enclosure. (6 marks)

b) A long cylinder (Fig. 2) carries a charge density that is proportional to the distance from the axis: $p = ks$, for some constant *k.* Find the electric field inside this cylinder. (7 marks)

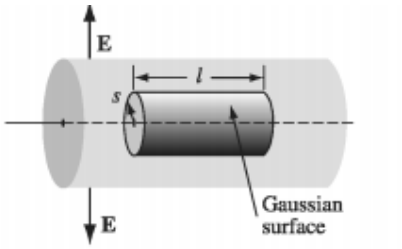

Fig. 2

c) A point charge *q* is situated a distance *a* from the centre of a grounded conducting sphere of radius *R* (Fig. 3). Find the potential outside the sphere. (7 marks)

QUESTION FOUR (20 MARKS)

a) State Faraday's law and show that $\nabla \times E = -\frac{\partial B}{\partial t}$. (7 marks)

b) Find the vector potential of an infinite solenoid with n turns per unit length, radius R, and current I. (7 marks)

c) 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. 3). Graph the emf induced in the ring, as a function of time. (6 marks)

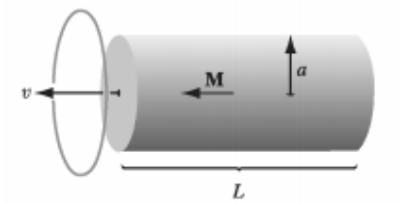

Fig. 3

QUESTION FIVE (20 MARKS)

a) Give Maxwell's equations in a linear and homogeneous medium. (4 marks)

b) Briefly describe 5 ways of polarization (10 marks)

c) A charge Q is located at the centre of a sphere of radius R. Calculate the flux going out through the surface of the sphere (6 marks)