



THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

JANUARY - APRIL 2015 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCES (PHYSICS)

PHY 302: ELECTROMAGNETISM

Date: April 2015	Duration: 2 Hours
Instructions: Answer Question ONE and any other TWO Questions.	

- Q1. a) i) Define equipotential surface. **(1 mark)**
ii) Give the expressions of Gauss' Law in integral and differential forms. **(2 marks)**
iii) Explain the superposition principles as it applies to electric potentials. **(1 mark)**
- b) A spherical shell of radius R carries a uniform surface charge. By setting the reference point at infinity, find the potential outside and inside the spherical shell. **(6 marks)**
- c) i) Under what conditions does poisson's equation reduce to Laplace's equation? **(1 mark)**
ii) Distinguish between Biot Sarvat Law and ampere's Law in terms of calculating the magnetic field due to current in a wire. **(2 marks)**
- d) i) Show that the divergence of the magnetic vector potential given as $\vec{B} = \nabla \times \vec{A}$ Yields ampere's law. **(3 marks)**
ii) For continuous charge distribution give the electric fields for surface charge and volume charge. **(2 marks)**
- e) The distance between a neutral atom of polarizability α and a point charge of q is r. What is the force of attraction between them? **(4 marks)**

- f) The electric flux through a surface S is given by $\phi_E = \int_S \vec{E} \cdot d\vec{a}$
 Define ϕ_E , $\vec{E} \cdot d\vec{a}$ and $d\vec{a}$ in the expression.
 (3 marks)
- g) i) State Lenz's Law and Faraday's Law
 (2 marks)
 ii) A long straight wire carries a steady Current I. Find the magnetic field a distance S from the wire.
 (3 marks)
- Q2. a) Find the potential of a uniformly charged spherical shell of radius R for points inside and outside the sphere.
 (17 marks)
- b) The electric field can be written as the gradient of a scalar potential $\vec{E} = -\Delta V$. By using Gauss' Law in differential form derive poisson's equation and Laplace's equation.
 (3 marks)
- Q3. a) Briefly explain:
 i) Electric multipoles (1 mark)
 ii) Electric dipole (1 mark)
 iii) Polar molecules (1 mark)
- b) A primitive model of an atom consists of a point nucleus (+q) surrounded by a uniformly charged spherical cloud (-q) of radius a. Calculate the atomic polarizability of such an atom.
 (7 marks)
- c) Find the magnetic field a distance s from a long straight wire carrying a steady current I.
 (10 marks)
- Q4. a) Find the vector potential produced at point r by a spinning spherical shell of radius R, and carrying a uniform surface charge σ . The spinning angular velocity of the shell is ω .
 (15 marks)
- b) Consider two equal charges q, separated by a distance d. Find the electric field a distance Z above the mid-point between the charges.
 (5 marks)
- Q5. a) Use Gauss' Law to find the field outside a uniformly charged solid sphere of radius R and total charge q. Comment on your result.
 (10 marks)
- b) Find the electric field a distance z above the center of a circular disk of radius R, which carries a uniform surface charge σ . What does your formula give in the limit $R \rightarrow \infty$
 (10 marks)

END