KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDCATION (SCIENCE)

SPH 401: ELECTRODYNAMICS

DATE: TUESDAY, 3RD APRIL 2012 **TIME:** 4.30 P.M – 6.30 P.M

INSTRUCTIONS : Answer Question ONE and any other TWO Questions

Question 1

a. Define electric flux. Show that the flux of a vector field is zero if there is no net charge enclosed by the surface. (5mks)

b. Derive Gauss's law in differential form from the definition of divergence. (5mks)

c. What is a dielectric? Explain how a dielectric differs from a conductor. (2mks)

d. Differentiate between a polar and a non-polar molecule. Hence prove that polarization **P** is numerically equal to the surface charge density. (6mks)

e. Describe at least three differences between electrostatics and magnetic fields. (3mks)

f. write down Maxwell's equations (4mks)

   i. in vacuum

   ii. in material medium

g. Ampere's law $\nabla \times B = \mu_0 J$ does not hold good for time varying fields. How did Maxwell remove this difficulty? Derive the modified equation of Ampere's law. (5mks)

Question 2

a. The electric field at any point is the negative of the gradient of the potential at any point. Prove. Hence show that $\nabla^2 V = -\dfrac{\rho}{\varepsilon_0}$ where the symbols have their usual meaning. Under what condition dove the equation reduce to zero? (15mks)

b. A test charge q_0 moves through a uniform electric field from **a** to **b** along the path **acb** as shown in figure 1. Find the potential difference between **a** and **b.** (5mks)

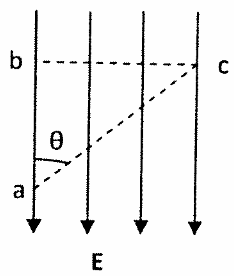

Figure 1

Question 3

a. Derive Gauss's law in dielectrics. 10mks)

b. Prove that the normal component of displacement vector **D** is continuous across a charge free boundary. (5mks)

c. The surface separating two dielectrics of dielectric constants K_1 and K_2 has a surface charge density σ. The electric fields on the two sides of the boundary are $\mathbf{E_1}$ and $\mathbf{E_2}$ making an angle of θ_1 and θ_2 with the common normal. Prove that $K_2 \cot\theta_2 = K_1 \cot\theta_1 \left[1 - \frac{\sigma}{\varepsilon_0 K_1 E_1 \cos\theta_1}\right]$ (5mks)

Question 4

a. Define magnetic vector potential. Derive an expression for the magnetic vector potential of a current loop. Hence find the electric field vector in terms of scalar and vector potential. (15mks)

d. Find the magnetic induction B at the center of a long straight solenoid having n turns per unit (5mks)

Question 5 (20mks)

Derive Maxwell's equations in vacuum