KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION (SCIENCE)

SPH 401: ELECTRODYNAMICS

DATE: Wednesday, 30th November, 2011 TIME: 8.00 a.m. – 10.00 a.m.

INSTRUCTIONS: Answer question **ONE** and any other **TWO**.

Q.1 a). Explain the flux of a vector field. *(3 marks)*

b). What is the physical significance of electrostatic potential? *(2 marks)*

c). Explain what happens to an isolated atom when placed in a electric field. *(3 marks)*

d). Differentiate between the Dirichlet and Neumann boundary conditions *(2 marks)*

e). Show that the equation $div\ \vec{E} = \frac{\rho}{\varepsilon o}$ is true in general *(3 marks)*

f). Show that $\boldsymbol{B} = Curl\ \boldsymbol{A}$ where $\boldsymbol{B}$ and $\boldsymbol{A}$ are the magnetic field vector and magnetic vector potential. *(3 marks)*

g). Show that the law of conservation of charge is contained in Maxwell's equations *(4 marks)*

h). Given that $\boldsymbol{E} = \boldsymbol{E_o} exp\ (j(\omega t - kz))$ is an expression of a linearly polarized wave. Show that $\boldsymbol{E_o}$ is in the x-y plane. *(4 marks)*

i). Differentiate between a polarized and un-polarized wave. *(2 marks)*

j). Show that the perpendicular component of the displacement vector and the parallel component of the electric vector are continuous across the boundary between two dielectrics.

(4 marks)

Q.2 a). (i) State the integral form of Gauss law *(1 mark)*

(ii) Starting from integral form of Gauss law, derive the differential form of Gauss law

(9 marks)

b). (i) What is a conservative field? *(2 marks)*

(ii) Show that an electric field due to a single charge is conservative *(8 marks)*

Q.3 a). Show that the capacitance *(C)* of a parallel capacitor filled with a dielectric of relative permittivity ε is given by εC_o where C_o is the capacitance when the plates are separated by air or vacuum. *(5 marks)*

b). Apply Gauss law to derive Poisson's and Laplace's equations *(5 marks)*

c). (i) Derive the equation of the electric displacement vector ***D*** in terms of the electric vector ***E*** and the polarization vector ***P.*** *(3 marks)*

(ii) Illustrate the application of ***D*** in calculating fields by calculating the electric field inside a coaxial cable when a potential difference is applied between the outer and the inner conductor. *(7 marks)*

Q.4 a). (i) What are electrostatic images *(2 marks)*

(ii) Use the method of electrostatic images to solve a problem of a point charge placed in front of plane infinite conductor held at zero potential. *(6 marks)*

b). (i) Derive the differential form of Faraday's law *(6 marks)*

(ii) Obtain the general solution of the Faraday's law *(6 marks)*

Q.5 a). Derive the wave equations of electromagnetic waves in conductors. *(10 marks)*

b).Derive the expression for energy flowing through unit area per second at a point in an electromagnetic wave. *(10 marks)*

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