EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCES - 2003/2004

SECOND SEMESTER

(JUNE/JULY 2005)

PH 207 ELECTRICITY AND MAGNETISM II

Time: 01 hour.

Answer ALL Questions

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1. The total charge density of a dielectric material can be written as;

$$\rho_{Total} = \rho_f + \rho_b$$

by using this, prove $\vec{D} = \varepsilon_0 \vec{E} + \vec{P}$.

Hence show that $Q_f = \oint_s \vec{D}\, d\vec{a}$

where ρ_{Total}, ρ_f *and* ρ_b are total, free and bound charge densities respectively and other symbols have their usual meanings.

A spherical capacitor of inner radius a and outer radius b charged with Q Coulombs, and contains a non-homogeneous dielectric which is assumed to vary according to

$$\varepsilon = \varepsilon_1 + \varepsilon_2 \, 1/r^2$$

where ε_1 and ε_2 are constants ($\varepsilon_2 > \varepsilon_1$) and r is Gaussian radius.

(i) Obtain an expression for the electric field **E** at a distance r from the center of the sphere when $r<a$, $r>b$ and $a<r<b$.

(ii) Hence determine the displacement vector **D** and polarization vector **P** at a distance r from the center of the sphere when $r<a$, $r>b$ and $a<r<b$.

(iii) Obtain an expression for the potential difference between the inner and the outer surfaces of the capacitor.

(iv) Hence determine the capacitance of the capacitor.

2. State and Prove Ampere's Circuital law for magnetic field.

A line current **I** is within a cylindrical wire of radius a that has permeability μ. The cylinder is surrounded by free space of permittivity ε_0. Find B-field, H-field and Magnetization M at a distance r from the axis of the cylinder when $r < a$, $r = a$ and $r > a$.

Find Magnetic energy of the cylinder U_m.