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EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2005/2006

SECOND SEMESTER

(MARCH/APRIL 2008)

PH 207 ELECTRICITY AND MAGNETISM-II

Time: 01 hour.

Answer ALL Questions

$\varepsilon_0 = 8.85 \times 10^{-12}\, Fm^{-1}$.

$\mu_0 = 4\pi \times 10^{-7}\, Hm^{-1}$.

$\vec{\nabla} \times \vec{\nabla} \times \vec{A} = \vec{\nabla}\left(\vec{\nabla} \cdot \vec{A}\right) - \nabla^2 \vec{A}$

The symbols have their usual meanings.

1. A parallel plate capacitor has plates of area A and a separation d. A dielectric slab of thickness b and dielectric constant k is placed symmetrically between the plates. Show that the capacitance of the capacitor is:

$$C = \frac{k\varepsilon_0 A}{k(d-b)+b}$$

Where ε_0 is the permittivity of free space.

A parallel plate capacitor has plates, area $0.12m^2$ and a separation of $1.2cm$. A battery charges the plates to a potential difference of $120V$ and is then disconnected. A dielectric slab of thickness $4.0mm$ and dielectric constant 4.8 is then placed symmetrically between the plates. Determine,

i. The capacitance of the capacitor before and after the slab is inserted.
ii. The electric field in the space between the plates and in the dielectric.
iii. The potential difference across the plates with the slab in place.
iv. The displacement vector $\vec{D}$ and the polarization vector $\vec{P}$ in the dielectric.

2. Write down the Maxwell's equations in free space.
   i. Starting from Maxwell's equations obtain the wave equation for the Electric field.
   ii. Show that the velocity c of an Electromagnetic wave in free space is given by:

$$c^2\varepsilon_0\mu_0 = 1$$

   iii. A plane electric wave traveling in vacuum is described by,

$$E = E_0 e^{j(\omega t - kz)}\hat{x}.$$

Using appropriate Maxwell's equations find the magnetic field and show that,

$$\frac{E_0}{B_0} = \frac{\omega}{k}$$

Hence show that $B_0 = \frac{E_0}{\sqrt{\varepsilon_0\mu_0}}$.

The symbols have their usual meanings.