

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

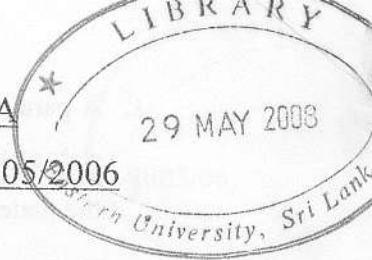
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$$\epsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1},$$

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

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

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:

$$C = \frac{k\epsilon_0 A}{k(d-b) + b}$$

Where  $\epsilon_0$  is the permittivity of free space.

A parallel plate capacitor has plates, area  $0.12\text{m}^2$  and a separation of  $1.2\text{cm}$ . A battery charges the plates to a potential difference of  $120\text{V}$  and is then disconnected. A dielectric slab of thickness  $4.0\text{mm}$  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:

$$c^2 \epsilon_0 \mu_0 = 1$$

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

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

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

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

Hence show that  $B_0 = \frac{E_0}{\sqrt{\epsilon_0 \mu_0}}$ .

The symbols have their usual meanings.