國　立　清　華　大　學　命　題　紙

九十三學年度 工科 4103 系（所）工、成 組碩士班入學考試

科目 電磁學 科號 4202 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

** ***Show your derivations in details !!***
Make clear all your assumptions/approximations!!

1. A cubical box consists of four metal sides which are welded together and grounded ($V = 0$), as shown in Fig. 1. The **top** and **bottom** are made of separate sheets of metal, insulated from the rest, and held at a constant potential V_0 by a power supply. Find the potential inside the box. The sides are all of **length** a. (20 %)

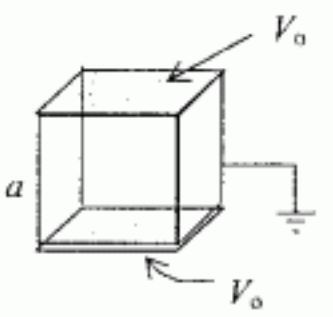

Figure. 1

2. An electron is placed 1.0 cm from a semi-infinite perfect conductor, as shown in Fig. 2. Find (20 %)
(a) force on the electron.
(b) electrostatic energy stored in the system.
(c) total surface charge density on the conductor.
(d) electrostatic pressure at $(x, y, z) = (0, 0, 0)$.

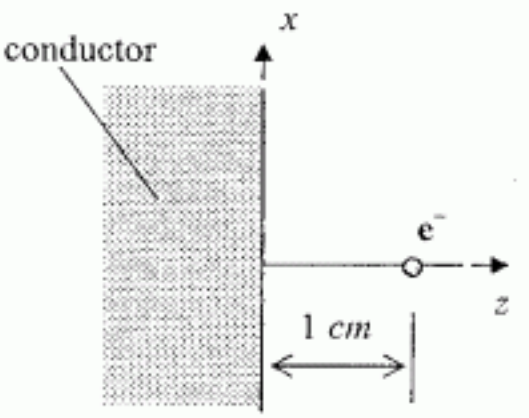

Figure. 2

3. For a long coaxial cable formed by two concentric perfect conducting tubes (assuming very **thin**) of radius 1.0 cm and 2.0 cm, respectively, and filled with a dielectric of dielectric constant 4.0 in between the tubes,
   (a) find the capacitance and inductance per unit length of the cable. (20 %)
   (b) for transverse electromagnetic waves propagating along the cable, find the characteristic impedance and phase velocity of the waves. (10 %)

4. For a sinusoidal electromagnetic plane wave propagating in free space with electric field given by (20 %)

$$\mathbf{E}(\mathbf{r},t) = E_0 \cos(\mathbf{k}\cdot\mathbf{r} - \omega t)\hat{\mathbf{y}}$$

where $\mathbf{k} = (k_0/\sqrt{2})(\hat{\mathbf{x}} + \hat{\mathbf{z}})$ is the wavevector, $\mathbf{r} = x\hat{\mathbf{x}} + y\hat{\mathbf{y}} + z\hat{\mathbf{z}}$ being the position vector, ω and E_0 are the angular frequency and amplitude of the wave, respectively, find the expression of
   (a) magnetic field,
   (b) Poynting vector. You need to explain the physical meaning of the Poynting vector,
   (c) time averaged electromagnetic energy density,
   (d) radiation pressure on a perfect conducting planar surface, assuming the plane wave incident normally on the surface.

5. For a conducting loop partially immersed in a uniform magnetic field ($B = 0.1$ T) pointing out of the paper, as shown in Fig. 3, find the current (including direction) through the resistor ($R = 1\ \Omega$) if the conducting loop moves in a speed of 1 m/sec to the left. (10 %)

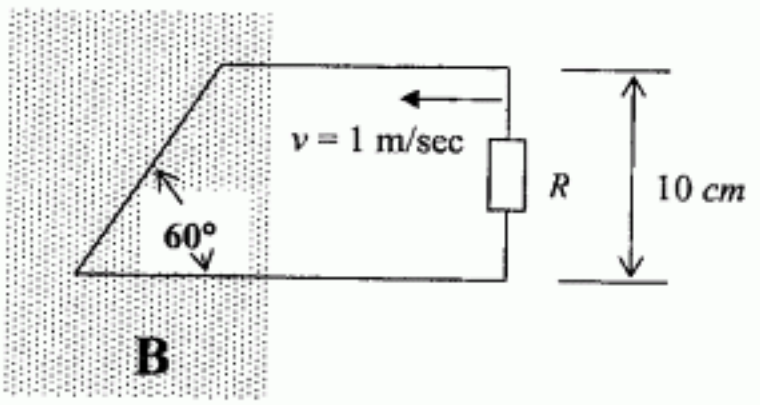

Figure. 3