1. Determine the electric field intensity $\vec{E}$ caused by a spherical cloud of electrons with a volume charge density $\rho = \rho_0 \left(\frac{R}{a}\right)^2$ for $0 \le R \le a$ and $\rho = 0$ for $R > a$. (Both ρ_0 and a are positive.) as shown in Figure 1. (20 %)

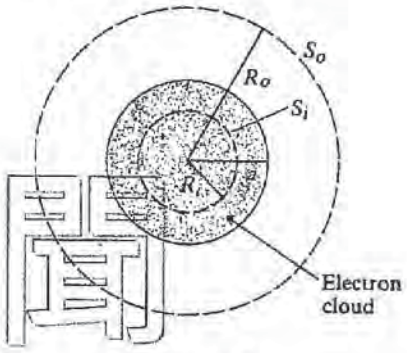

Figure 1

2. A potential difference of V_0 is maintained across the two ends of a copper wire with a length of l and its conductivity of $\sigma = 5.0 \times 10^7$. If A is the cross-sectional area of the wire, (a) obtain an expression for the resistance R of the copper wire. (10 %)

(b) What is the resistance R of the wire if $l = 200\ km$, and $A = 40\ mm^2$? (10 %)

3. Electromagnetic fields exist in a linear, homogenous, isotropic, source-free conductive region ($\rho = 0,\ \sigma \neq 0$). Show that

(a) the magnetic field $\vec{H}$ wave equation is $\nabla^2 \vec{H} - \mu\varepsilon \frac{\partial^2 \vec{H}}{\partial t^2} - \mu\sigma \frac{\partial \vec{H}}{\partial t} = 0$. (15 %)

(b) write the phasor form of the $\vec{H}$ wave equation. (5 %)

4. **Determine the polarization of each electric field intensity $\vec{E}$:**

(a) $\vec{E}(\vec{r}) = (2\hat{x} - j\hat{y})e^{-jkz}$. **(5 %)**

(b) $\vec{E}(\vec{r}) = (\hat{x} - j\hat{y})e^{+jkz}$. **(5 %)**

(c) $\vec{E}(\vec{r}) = (j\hat{x} - j2\hat{y})e^{-jkz}$. **(5 %)**

(d) $\vec{E}(\vec{r}) = (\hat{x} + j\hat{y})e^{+jkz}$. **(5 %)**

5. **A *y*-polarized uniform plan wave $(\bar{E}_i, \bar{H}_i)$ with $f = 100\ MHz$ propagates in air in $+x$ direction and impinges on a perfect conductor (PEC) plane at $x = 0$ as shown in Figure 2. Assuming the amplitude of $|\bar{E}_i| = 6\times10^{-3}\ \left(V/m\right)$, write the phasor and instantaneous expressions for**

(a) $\bar{E}_i$ **and** $\bar{H}_i$ **of the incident wave.** **(10 %)**

(b) $\bar{E}_r$ **and** $\bar{H}_r$ **of the reflected wave.** **(10 %)**

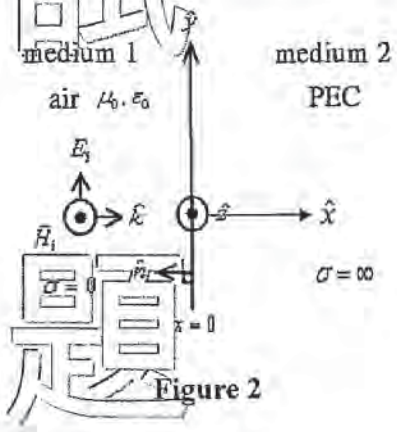

Figure 2