國立臺北科技大學 100 學年度碩士班招生考試

系所組別：2230 電腦與通訊研究所丙組

第一節　電磁學　試題

注意事項：

1. 本試題共五題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、 Consider the case of oblique incidence at multiple dielectric interfaces as shown in Figure 1. The amplitude of the perpendicularly-polarized incident plane wave is given by

$$E_i = E_0 = E_\perp e^{-j(k_{0x}x + k_{0y}y - k_{0z}z)}.$$

The medium 0 is characterized by $k_0^2 = k_{0x}^2 + k_{0y}^2 + k_{0z}^2 = \omega^2\mu\epsilon_0$, and the medium 1 is characterized $k_1^2 = k_{1x}^2 + k_{1y}^2 + k_{1z}^2 = \omega^2\mu\epsilon_1$. Assuming the reflection coefficient for this plane wave incident on the plane dielectric boundary at $z = 0$ with the given polarization is denoted by $\Gamma_\perp$, determine the following:

1. the amplitude of $\mathbf{E}_3$, (5%)
2. the amplitude of $\mathbf{E}_4$, (5%)
3. the amplitude of $\mathbf{E}_5$, (5%)
4. and the overall reflection coefficient at $z = 0$. (10%)

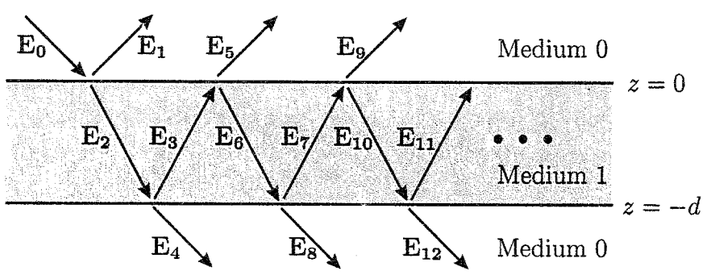

Figure 1.

二、 Determine the following quantities at any point (0, 0, z) on the z-axis,

1. the electric potential V in Figure 2-1, (3%)
2. the electric field intensity **E** in Figure 2-1, (7%)
3. the vector magnetic potential **A** in Figure 2-2, (3%)
4. and the magnetic flux density **B** in Figure 2-2. (7%)

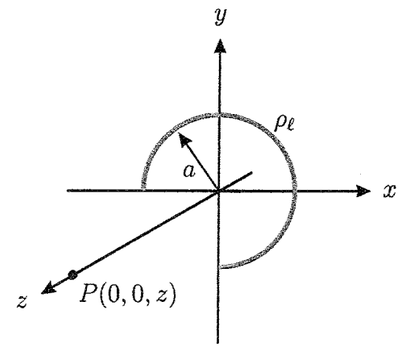

Figure 2-1.

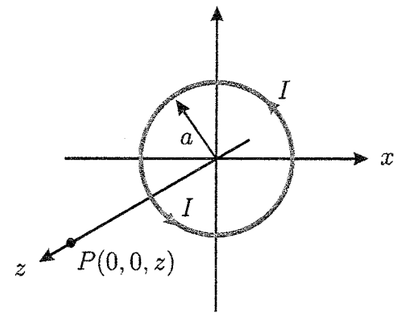

Figure 2-2.

三、 Derive the two equations describing the r- and x-circles of the **Smith chart**. (15%)

注意：背面尚有試題

四、 An element shown in Figure 3 below is defined by the following surface:

- $\rho = a$ and $\rho = b$,
- $\phi = 0$ and $\phi = \pi/2$,
- $z = 0$ and $z = h$.

Compute the following if the material of the element is characterized by a permittivity of ϵ:

1. The capacitance of the element if the surface at $z = 0$ has $V = 0$ and the surface at $z = h$ has $V = V_0$. Then, determine the resistance of this element if the material is characterized by a conductivity of σ. Neglect fringing. (5%)
2. The capacitance of the element if the surface at $\rho = a$ has $V = 0$ and the surface at $\rho = b$ has $V = V_0$. Then, determine the inductance of this element if the material is characterized by a permeability of μ. Neglect fringing. (8%)
3. The capacitance of the element if the surface at $\phi = 0$ has $V = 0$ and the surface at $\phi = \pi/2$ has $V = V_0$. Then, determine the resistance of this element if the material is characterized by a conductivity of σ. Neglect fringing. (7%)

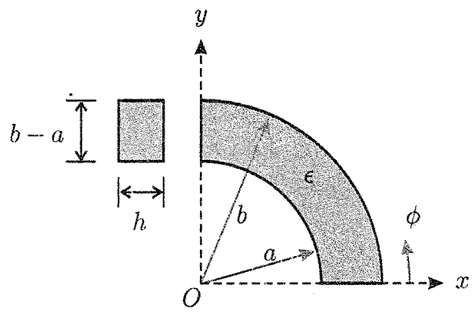

Figure 3.

Laplace's equation in cylindrical coordinates:

$$\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \frac{\partial V}{\partial \rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2} = 0,$$

and in spherical coordinates:

$$\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 \frac{\partial V}{\partial r}\right) + \frac{1}{r^2 \sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta \frac{\partial V}{\partial \theta}\right) + \frac{1}{r^2 \sin^2\theta}\frac{\partial^2 V}{\partial \phi^2} = 0.$$

五、 Given an inhomogeneous dielectric material with a permittivity ϵ specified below,

$$\epsilon = \frac{4\epsilon_0}{\left(1 + \frac{z}{d}\right)^2},$$

and subjected to an external applied field $\mathbf{E}_a = E_0 \hat{z}$ as shown in Figure 4 and under the conditions $\rho_s = 0$ at $z = 0$ and $z = d$, determine the following quantities within the region $0 < z < d$:

1. the electric flux density **D**, (3%)
2. the electric field intensity **E**, (3%)
3. the polarization vector **P**, (4%)
4. the polarization charge density ρ_p, (4%)
5. and the polarization surface charge density ρ_{ps} at $z = 0$ and $z = d$. (6%)

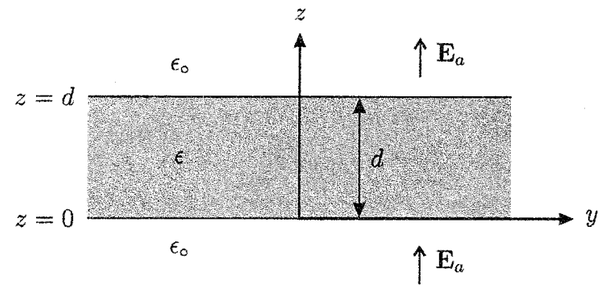

Figure 4.