國立臺北科技大學 102 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. 本試題共七題，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。

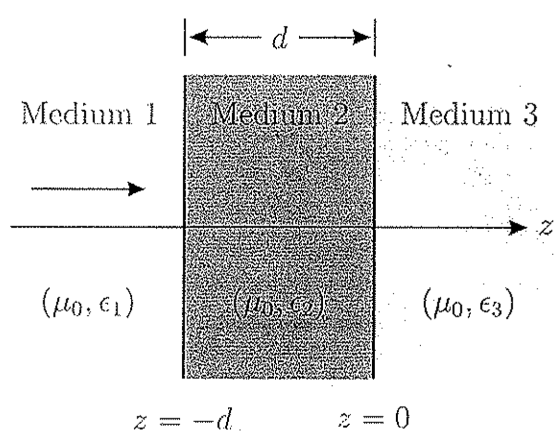
1. Explain why two polarizations (perpendicular and parallel) are used for the cases of oblique incident on a plane boundary but not for the cases of normal incidence. (8%)

2. The three regions shown in the figure below contain perfect dielectrics ($\epsilon_1 \neq \epsilon_3$). For a wave in medium 1, incident normally upon the boundary at $z = -d$, derive and explain in detail the following:

   (a) the wave impedances at $z = -d$ and $z = 0$, (7%)

   (b) the reflection coefficient at $z = -d$, (6%)

   (c) what combination of ϵ_2 and d produces no reflection at $z = -d$? (7%)



3. A right-hand circularly polarized plane wave represented by the phasor

$$\mathbf{E}(z) = E_0 (\hat{x} - j\hat{y})\, e^{-j\beta z}$$

   impinges normally on a perfectly conducting wall at $z = 0$.

   (a) Determine the polarization of the reflected wave. (5%)

   (b) Find the induced current on the conducting wall. (5%)

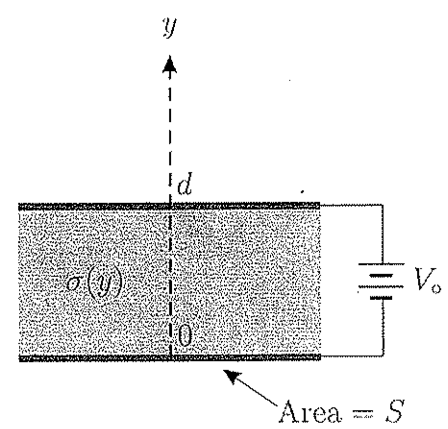
   (c) Obtain the instantaneous expression of the total electric field intensity based on a cosine time reference. (5%)

4. The space between two parallel conducting plates each having an area S is filled with an inhomogeneous ohmic medium whose conductivity varies linearly from σ_1 at one plate ($y = 0$) to σ_2 at the other plate ($y = d$). A d-c voltage V_o is applied across the plates as in the figure below. Determine

   (a) the total resistance between the plates, (5%)

   (b) the surface charge densities on the plates, (5%)

   (c) the volume charge density between the plates. (5%)



注意：背面尚有試題

5. An element shown in the figure below is defined by the following surfaces:

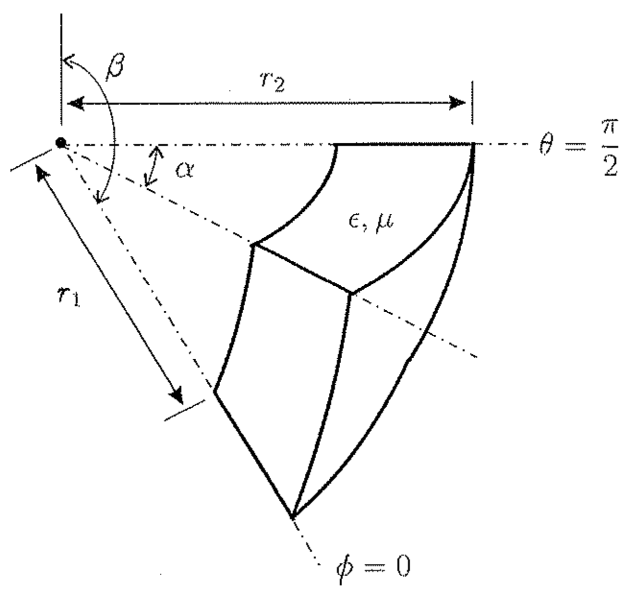
- $r = r_1$ and $r = r_2$,
- $\theta = \dfrac{\pi}{2}$ and $\theta = \beta$,
- $\phi = 0$ and $\phi = \alpha$.

Compute the following if the material of the element is characterized by (μ, ϵ):

(a) the capacitance of this element if the surface at $r = r_1$ has $V = 0$ and the surface at $r = r_2$ has $V = V_0$. (7%)

(b) the capacitance of this element if the surface at $\theta = \dfrac{\pi}{2}$ has $V = 0$ and the surface at $\theta = \beta$ has $V = V_0$. Neglect fringing. (7%)

(c) the capacitance of this element if the surface at $\phi = 0$ has $V = 0$ and the surface at $\phi = \alpha$ has $V = V_0$. Neglect fringing. (6%)



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:

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

Some useful integrals:

$$\int \sin x dx = -\cos x + C, \qquad \int \cos x dx = \sin x + C,$$

$$\int \tan x dx = -\ln(\cos x) + C, \qquad \int \cot x dx = \ln(\sin x) + C,$$

$$\int \sec x dx = \ln\left[\tan\left(\frac{\pi}{4} + \frac{x}{2}\right)\right] + C, \qquad \int \csc x dx = \ln\left(\tan\frac{x}{2}\right) + C,$$

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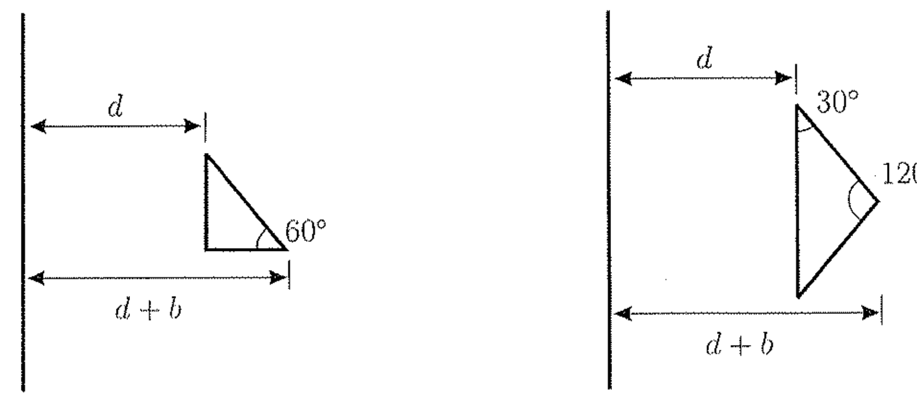
6. Determine the mutual inductance between a very long straight wire and a conducting triangular loop shown in the two figures below. (12%)



(a)　　(b)

7. For a three-quarter circular line charge of density ρ_ℓ located on the x-y plane, as shown in the figure below, determine the the electric potential V and the electric field intensity $\mathbf{E}$ at any point $(0, 0, z)$ on the z-axis. (10%)