110CE03

國立臺北科技大學 110 學年度碩士班招生考試

系所組別：2230 電子工程系碩士班丙組

第一節　電磁學　試題

注意事項：

1. 本試題共六題，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

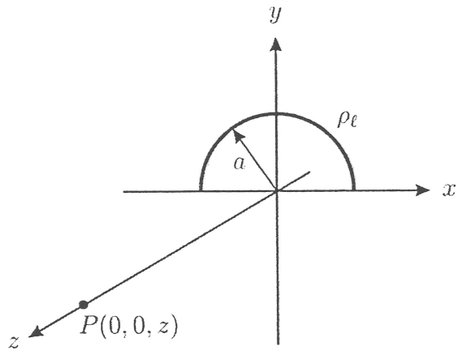
一、

For uniform plane waves incident on a plane boundary, explain why two polarizations (perpendicular and parallel) are presented to describe oblique incident waves, but NOT for normal incident waves. (10%)

二、

For a half circular line charge of density ρ_ℓ located on the x-y plane, as shown in the figure below, determine the following quantities at any point (0, 0, z) on the z-axis:

1. the electric potential V, (5%)
2. the electric field intensity $\mathbf{E}$. (10%)



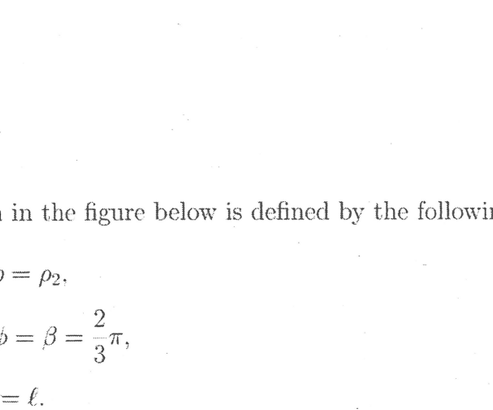
三、

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

- $\rho = \rho_1$ and $\rho = \rho_2$,
- $\phi = 0°$ and $\phi = \beta = \frac{2}{3}\pi$,
- $z = 0$ and $z = \ell$.

Computer the following quantities:

1. the resistance of this element if $V = 0$ is applied to a metallic plate on the surface of $\phi = 0$ and $V = V_0$ is applied to another metallic plate on the surface of $\phi = \beta$ if the material of the element is characterized by a conductivity of σ. Neglect fringing. (10%)
2. the capacitance of this element if $V = 0$ is applied to a metallic plate on the surface of $\rho = \rho_1$ and $V = V_0$ is applied to another metallic plate on the surface of $\rho = \rho_2$ if the material is characterized by a permittivity of ϵ. Also neglect fringing. (10%)



注意：背面尚有試題

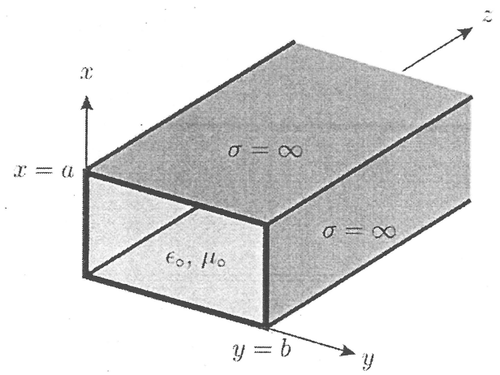
四、

The electromagnetic fields in a rectangular waveguide shown in the figure below are given by

$$\mathbf{E} = -H_\circ \frac{\omega\mu_\circ b}{2\pi} \sin\left(\frac{2\pi y}{b}\right) \sin(\omega t - \beta z)\hat{x}$$

$$\mathbf{H} = H_\circ \frac{\beta b}{2\pi} \sin\left(\frac{2\pi y}{b}\right) \sin(\omega t - \beta z)\hat{y} + H_\circ \cos\left(\frac{2\pi y}{b}\right) \cos(\omega t - \beta z)\hat{z}$$

where $H_\circ$ is a constant, β is the phase constant, and $\omega = 2\pi f$, with f being the frequency of excitation. The walls of the waveguide are assumed to be perfect conductors. Determine the surface charge densities and surface current densities on those walls. (20%)



五、

Determine the polarizations of the following uniform plane waves:

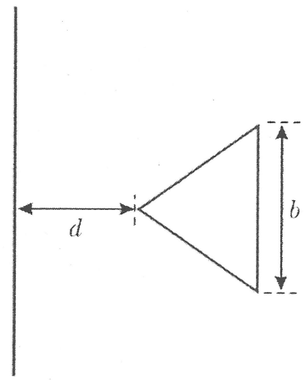
1. $\mathbf{E} = 3\cos(\omega t - \beta z)\hat{x}$,
2. $\mathbf{E} = 2\cos(\omega t + \beta z)\hat{x} + \cos(\omega t + \beta z)\hat{y}$,
3. $\mathbf{E} = \cos(\omega t + \beta z)\hat{x} - \sin(\omega t + \beta z)\hat{y}$,
4. $\mathbf{E} = \sin(\omega t - \beta z)\hat{x} - \sin(\omega t - \beta z)\hat{y}$.
5. $\mathbf{E} = 2\cos(\omega t - \beta z)\hat{x} + \sin(\omega t - \beta z + 45°)\hat{y}$.

(15%)

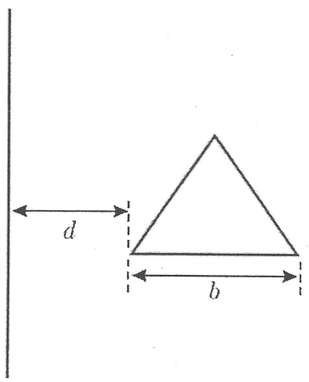
六、

Determine the mutual inductances of the following combinations:

1. A conducting equilateral triangular loop and a very long straight wire as shown in Fig.(a) below. (10%)
2. A conducting equilateral triangular loop and a very long straight wire as shown in Fig.(b) below. (10%)



(a)



(b)

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:

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