國立成功大學
111學年度碩士班招生考試試題

編　號：184

系　所：電腦與通信工程研究所

科　目：電磁學及電磁波

日　期：0219

節　次：第 2 節

備　註：可使用計算機

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※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

For your reference: $\varepsilon_0 = 10^{-9}/36\pi$ (F/m); $\mu_0 = 4\pi\times10^{-7}$ (H/m); $\eta_0 = 120\pi$ (Ω)

Permittivity ε ($=\varepsilon_r\varepsilon_0$); Permeability μ ($=\mu_r\mu_0$); Conductivity σ

1. Short answer questions:

(a) What is Gauss's Law in Electrostatics? Does Gauss's Law belong to the divergence theorem or the Stokes's theorem? Why? [5%]

(b) Please state the boundary conditions for the electric field $\vec{E}$ and the magnetic field $\vec{H}$ in Electromagnetics at an interface between two lossless dielectrics with (ε_1, μ_1) and (ε_2, μ_2). [5%]

(c) Given an instantaneous electric field of a wave as

$$\vec{E}(z,t) = \hat{a}_x E_1 \cos(\omega t - k z) + \hat{a}_y E_2 \cos(\omega t - k z + \frac{\pi}{3}) .$$

If $E_1 = E_2$, is it a circularly polarized wave or not? Why? [5%]

2. In the cylindrical capacitor shown in **Fig. A**, each dielectric occupies one-half the volume. Find

(a) Please calculate the total capacitance of this cylindrical capacitor; [5%]

(b) If ***b*** = 2 cm and the radius ***a*** can be selected arbitrarily. The breakdown field strengths of the dielectric-1 (with ε_{r1}) and the dielectric-2 (with ε_{r2}) are 200 kV/cm and 250 kV/cm, respectively. What is the maximum allowable voltage of this cylindrical capacitor? [10%]

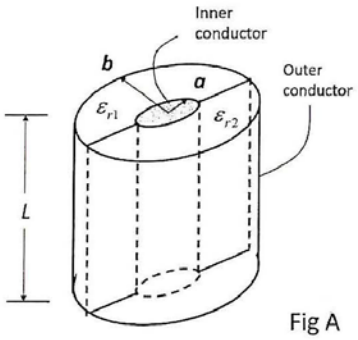

Fig A

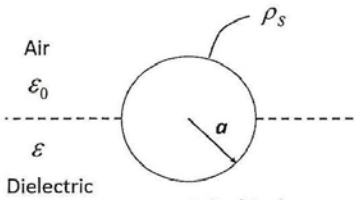

Fig. B

3. An infinitely-long cylindrical conductor with a radius of ***a*** and charge distribution of ρ_s per unit length. As shown in **Fig. B**, half of the cylindrical conductor is buried in the dielectric with the permittivity ε and half of the cylindrical conductor is buried in the air. Please find the potential function and the electric field intensity function by way of separation of variables. [15%]

(背面仍有題目，請翻頁繼續作答)

4. A thin, center-fed dipole antenna placed along the z-axis, as shown in **Fig. C**, with a length of *2h* and a current distribution of

$$\mathrm{I}(z)=\begin{cases} I_m \sin(\beta(h-z)), & for\ z>0, \\ I_m \sin(\beta(h+z)), & for\ z<0, \end{cases}$$

where I_m is the current amplitude and $\beta = 2\pi/\lambda(wavelength)$. As a result, the far-field contribution from the differential current element $I(z)dz$ is denoted as

$$dE_\theta(z)=\eta_0\, dH_\phi(z)=j\frac{I(z)dz}{4\pi}\left(\frac{e^{-j\beta R'}}{R'}\right)\eta_0\beta\sin\theta\,.$$

(a) Prove that the antenna pattern function $F(\theta)$ is

$$F(\theta)=\frac{\cos(\beta h\cos\theta)-\cos(\beta h)}{\sin\theta}$$

[hint: $\sin A\cdot\sin B=\frac{1}{2}(\sin(A-B)+\sin(A+B))$ and you can start with the Biot-Savart Law.] [10%]

(b) Show that for a short antenna when $\beta h<<1$, the above-mentioned pattern function can be simplified as

$$F(\theta)=A\cdot\sin\theta$$

and find the coefficient ***A***. [hint: $\cos(x)=(1-\frac{x^2}{2!}+\ldots)$.] [10%]

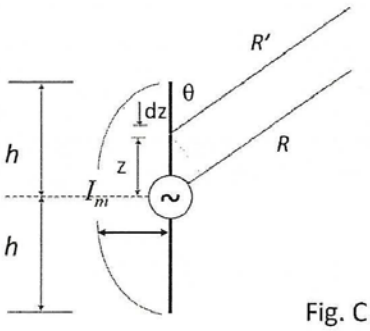

Fig. C

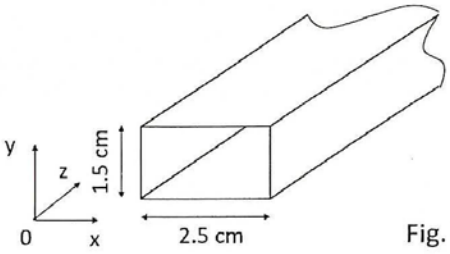

Fig. D

5. An air-filled rectangular metallic waveguide, as shown in **Fig. D**, is considered.

(a) What is its dominate mode according to the reference coordinates shown? TE_{ij} or TM_{ij}, i, j ∈ {0, 1, 2, ...}? Please also give the reason why. [5%]

(b) Find the allowed frequency band for single-mode operation for this waveguide. [10%]

(背面仍有題目，請翻頁繼續作答)

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6. A 600-Ω transmission line is 120 m long, operates at 400 kHz with $\alpha = 2.4 \times 10^{-3}$ Np/m and $\beta = 0.0212$ rad/m, and supplies a load impedance $Z_L = 300 + j300\,(\Omega)$. For a node voltage V_L at the load end is $50\angle 0^\circ$ V. Find

(a) the Length of the transmission line in wavelength, [5%]

(b) the reflection coefficient Γ_L at the load end, [5%]

(c) the reflection coefficient Γ_s at the source end, and [5%]

(d) the input impedance Z_{in} looking into the transmission line, towards to the load. [5%]