編號： 194

國立成功大學 104 學年度碩士班招生考試試題

系所組別：電腦與通信工程研究所丙組

考試科目：電磁學及電磁波

考試日期：0211，節次：2

※ 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

一、簡答題 (Short-Answer Questions): (20 分)

1. Please give Maxwell's equations in differential form with clear definitions of notations you used. (4%)
2. What is the time-average Poynting vector? Please give a formula expression of time-average Poynting vector with the field intensities $\vec{E}(\vec{R})$ and $\vec{H}(\vec{R})$. (4%)
3. What is the standing wave ratio (SWR) in a formula expression of reflection coefficient Γ? (4%)
4. What is the meaning of the degenerate modes in a cavity resonator? (4%)
5. What is the characteristic impedance Z_0 of a transmission line which has the transmission-line parameters of R (resistance per unit length), L (inductance per unit length), G (shunt conductance per unit length), and C (shunt capacitance per unit length) as operated at ω? (4%)

二、計算題 (Calculations): (80 分)

1. Determine the flux of a vector $\vec{F} = 3\hat{a}_R + 4\hat{a}_\theta + 2R\hat{a}_\varphi$ out of the closed surface bounded by R = 2, $0\le\theta\le90°$, and $0\le\phi\le90°$, as shown in **Fig.1**. (10%)

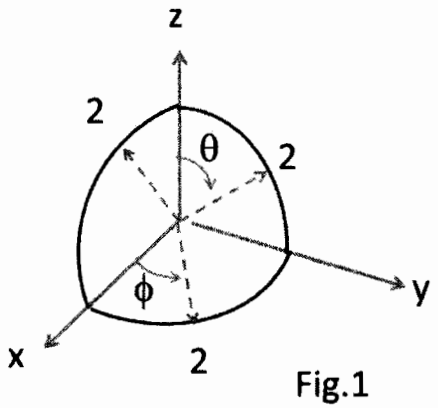

Fig.1

2. The conductivity of copper is 5.8×10^7 S/m and the relative permittivity and permeability are unity.
   (a) Find the intrinsic impedance of copper at 1-MHz. (5%)
   (b) A 1-MHz, 1-V/m uniform plane wave is traveling through a block of copper. Determine the power dissipated in the copper over a distance of 1 μm with a surface area of 2 m^2. (5%)

(背面還有題目，請繼續作答)

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3. An air-filled rectangular waveguide has a cross-section of area by a×b, as shown in **Fig. 2**, where the aspect ratio of a/b equals to two (that is, a/b = 2) and the dominant-mode cutoff frequency of this waveguide is 1.2 GHz. If the measured guided wavelength is 30 cm. Please find
   (a) What is the dominant-mode (that is, in the expression of TE_{mn} or TM_{mn}) in this case? (5%)
   (b) What is the operation frequency? (5%)
   (c) What is the cross section dimensions? (that is, a = ? and b = ?) (5%)

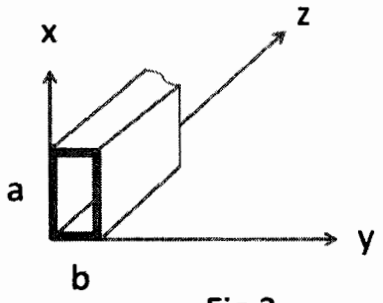

Fig.2

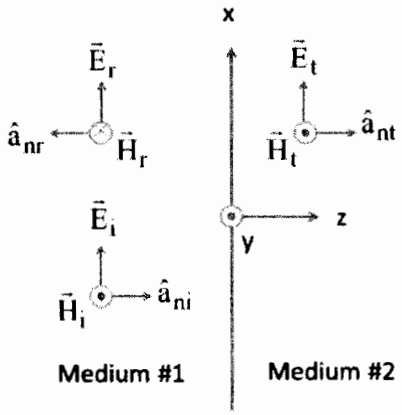

Fig.3

4. A plane wave propagates in the +z direction from Medium #1 to Medium #2, which is normally incident onward to the interface located at z = 0, as shown in **Fig. 3**. The incident wave is partly reflected back into Medium #1 (whose wave impedance is η_1) and partly transmitted into Medium #2 (whose wave impedance is η_2). Let the incident electric and magnetic field intensity phasors are given as

$$\begin{cases} \vec{E}_i(z) = \hat{a}_x E_{io} e^{-j\beta_1 z} \\ \vec{H}_i(z) = \hat{a}_y \dfrac{E_{io}}{\eta_1} e^{-j\beta_1 z} \end{cases}$$

According to the boundary conditions available, please prove that

(a) The reflection coefficient $\Gamma = \dfrac{\eta_2 - \eta_1}{\eta_2 + \eta_1}$. (5%)

(b) The transmission coefficient $\tau = \dfrac{2\eta_2}{\eta_2 + \eta_1}$. (5%)

(c) The utility relationship $1 - \Gamma^2 = \dfrac{\eta_1}{\eta_2} \cdot \tau^2$. (5%)

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5. Find the voltage drop across each dielectric in **Fig. 4**, where $\varepsilon_{r1} = 2$ and $\varepsilon_{r2} = 5$. The inner conductor is at $r_1 = 2$ cm and the outer at $r_2 = 3$ cm, with the dielectric interface halfway between r_1 and r_2. Assumed the voltage bias is 100 V. (10%)

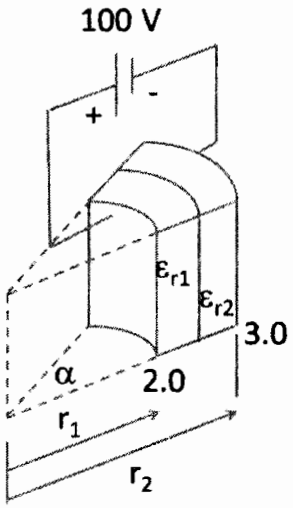

Fig.4

6. An electric dipole (taken as a Hertzian dipole antenna) is 0.1 m long and has an internal resistance of 0.05 Ω. The peak current in the dipole is 0.5 A. The dipole radiates in air at a wavelength of 5 m. Calculate
   (a) The radiation resistance of the dipole. (5%)
   (b) The radiated power from the dipole. (5%)
   (c) The antenna efficiency. (5%)
   (d) Maximum power gain (in dB) of this dipole antenna. (5%)