國立成功大學
111學年度碩士班招生考試試題

編　號：186

系　所：電腦與通信工程研究所

科　目：電磁場與波

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。

Problem 1 *(20 Points)*

A capacitor is formed by two coaxial conducting cylinders, along the z axis, separated by a dielectric. The outer and inner radii of the dielectric are b and a, respectively. Find the ***capacitance per unit length***, C, if the relative permittivity of the dielectric is given by $\varepsilon_r = 2 + \rho$, where ρ is the distance from the z axis.

Problem 2 *(20 Points)*

Medium 1 is at $z < 0$ with $\mu_1 = 2\mu_0$ and $\varepsilon_1 = 4\varepsilon_0$, while medium 2 is at $z > 0$ with $\mu_2 = \mu_0$ and $\varepsilon_2 = \varepsilon_0$. The interface, $z = 0$, between these two mediums contains both a current density $\bar{J}_s = \hat{a}_x (A/m)$ and a uniform surface charge density $\rho_s = 7\varepsilon_0 \ (V/m)$, where $\varepsilon_0 = 8.854 \times 10^{-12} \ (Farad/m)$. The static electric field intensity and static magnetic field intensity in medium 1 are $\bar{E}_1 = \hat{a}_x + 2\hat{a}_y - \hat{a}_z (V/m)$ and $\bar{H}_1 = 3\hat{a}_x + 3\hat{a}_y + 2\hat{a}_z (A/m)$. Find the ***electric field intensity*** and the ***magnetic field density*** in medium 2.

Problem 3 *(20 Points)* For a uniform electromagnetic plane wave defined by

$\bar{E} = \left[4\bar{a}_x + E_y \bar{a}_y + (2 + j5)\bar{a}_z\right] e^{j(\omega t + 6\pi x - 8\pi y)}$ and $\bar{H} = \left(H_x \bar{a}_x + H_y \bar{a}_y + H_z \bar{a}_z\right) e^{j(\omega t + 6\pi x - 8\pi y)}$,

where E_y, H_x, H_y, and H_z are all independent of x, y, and z, determine

(a) the components E_y, H_x, H_y, and H_z, assuming that $\mu = \mu_0$ and $\varepsilon = \varepsilon_0$.

(b) the wavelength and frequency, and (c) the wave polarization.

Problem 4 *(20 Points)*

(a) Plot a simple Smith chart with *constant normalized resistance* circles of $r_n = 0$, 0.5, 1.0, and 2.0.

(b) Plot a simple Smith chart with *constant normalized reactance* circles of $x_n = -2$, -1, -0.5, 0, 0.5, 1, and 2.

(c) Plot a simple Smith chart with the loci of $|Z_n| = 0.5$, 1, and 2.

(d) Plot a simple Smith chart with the loci of $x_n / r_n = -2$, -1, 0, 1, and 2.

(e) The position of a load Z_L on a Smith chart normalized to Z_0 is at *Point A*. If this load Z_L is now connected to the end of a $(3/8)\lambda$ transmission line of Z_0, and the input impedance at the other end of the line is called Z_{in}. How do you find Z_{in} on the Smith chart from *Point A*?

Problem 5 *(20 Points)* The electric field of a particular mode in a parallel-plate air waveguide with a plate separation of 5 cm is given by $E_x(y,z) = 10e^{-j30\pi y}\sin(40\pi z)$ (V/m).

(a) What is this mode?

(b) What is the operating frequency?

(c) What is the wave impedance looking in the guiding y direction?

(d) What is the highest-order mode, with the same operating frequency and polarization, that can propagate in this waveguide?