國立清華大學 103 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學　系（所）　甲　組

考試科目（代碼）：電磁學(2301)

一、(37%) 解釋、說明題 (非僅翻譯, 若有相關公式, 請說明相關符號之意義)

1) 請寫出 Biot-Savart's law 之公式, 並說明其三項重點 (5%)

2) 請說明 transmission line 和 wave guide 之異同　(5%)

3) 請說明 polarization bound surface/volume charges　(5%)

4) 請利用磁滯曲線, 說明 coercive force 及 remnant flux density 之意義(6%)

5) 請說明 radiation resistance (of an antenna) (4%)

6) 請請寫出動態馬克斯威爾方程式 Maxwell's equations (隨時間變化)

i) 積分型式(並請說明公式物理意義) (8%)

ii) 微分型式 (4%)

二、(63%) 計算、證明題 (請務必清楚標示單位; 因手寫符號不易辨別數量或向量符號, 若屬向量符號, 請在符號上方標示箭頭, 例如: $\vec{a}$; 若有公式, 請說明相關符號之意義), 常用常數: $\varepsilon_0 = (1/36\pi)\times10^{-9}$ (F/m), $\mu_0=4\pi\times10^{-7}$ (H/m)

1) (10%) In a slab of dielectric material for which $\varepsilon = 3.5\ \varepsilon_0$ and $V = 300z^2$ V, find: (a) **D** and ρ_v, and (b) **P** and ρ_{pv}.

2) (6%) Prove the displacement current density $\mathbf{J}_d = \partial\mathbf{D}/\partial t$
(Hint and conditions: $\nabla \times \mathbf{H} = \mathbf{J} + \mathbf{J}_d$, $\nabla \cdot \nabla\times\mathbf{M} \equiv 0$; (**M**: any vector), $\nabla \cdot \mathbf{J} = -\partial\rho_v/\partial t$, and the Gauss's law)

3) (12%) Calculate the attenuation constants in an air-filled rectangular wave guide with dimensions $a = 3$ cm and $b = 2$ cm when it is excited with TE_{10} mode at 6 GHz. The loss tangent in air is 0.001, and the conductivity of the copper wall is 5.76×10^7 S/m.

4) (6%) Given the magnetic vector potential $\mathbf{A} = -\rho^2/4\mathbf{a}_z$ Wb/m, calculate the total magnetic flux crossing the surface $\phi = \pi/2$, $1 \leqq \rho \leqq 2$ m, $0 \leqq z \leqq 5$ m.

5) (7%) Prove the capacitance of an isolated sphere (with radius a), $C = 4\pi\varepsilon a$.

6) (10%) Lightning strikes a dielectric sphere of radius 20 mm for which $\varepsilon_r = 2.5$, $\sigma = 5 \times 10^{-6}$ mhos/m and deposits uniformly a charge of 10 μC. Determine the initial charge density and the charge density 2 μs later.

7) (12%) Plot a simple Smith Chart, locate the positions of the following conditions.
(i) $0 + j\,0$; (ii) $1 + j\,0$; (iii) $\infty + j\infty$; (iv) $[Z_{in}/Z_0]_{min}$; (v) $[Z_{in}/Z_0]_{max}$
(vi) Matched load ($\Gamma = 0$)