國立成功大學

112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：0206

節　次：第 2 節

備　註：可使用計算機

國立成功大學 112 學年度碩士班招生考試試題

系　　所：電腦與通信工程研究所

考試科目：電磁學及電磁波

考試日期：0206，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: $\varepsilon_0 = 10^{-9}/36\pi\ (F/m)$　$\mu_0 = 4\pi\times10^{-7}\ (H/m)$　$\eta_0 = 120\pi\ (\Omega)$

Permitivity $\varepsilon = \varepsilon_r\varepsilon_0$　*Permeability* $\mu = \mu_r\mu_0$　*Conductivity* σ

1. (a) As shown in **Fig. A**, there is a positive charge sheet with charge density $+\rho_i$ located at the interface. Please do the analysis of electric field to show the boundary conditions for both the normal and the tangential components of electric fields. Note: The normal vector direction has been assigned in this situation as shown in the figure. [5%]

(b) Based on the source-free Maxwell's equations in free space, prove that $\nabla^2\vec{H} - \mu_0\varepsilon_0\dfrac{\partial^2\vec{H}}{\partial t^2} = 0$. [10%]

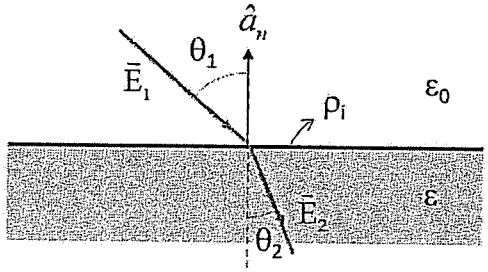

Fig. A

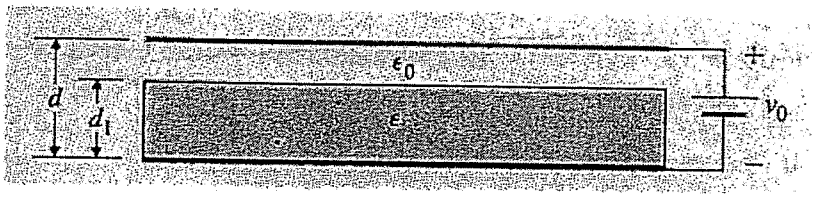

Fig. B

2. A constant voltage V_o is applied to a partially filled parallel-plate capacitor shown in **Fig. B** (the side view). The permittivity of the dielectric is ε and the area of the plates is *S*. Find the force on the upper plate. [15%]

3. Determine the mutual inductance between a conducting triangular loop and a very long straight wire as shown in **Fig. C**. [10%]

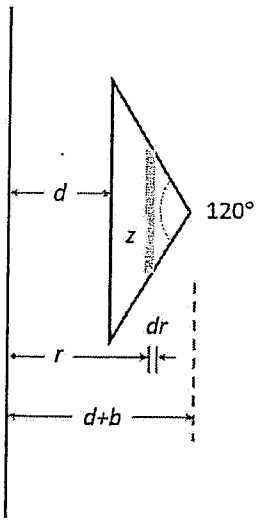

Fig. C

Table. A Zeros of $J'_n(x)$, x'_{np}

	n = 0	n = 1	n = 2
p = 1	3.832	1.841	3.054
p = 2	7.016	5.331	6.706

國立成功大學 112 學年度碩士班招生考試試題

系　　所：電腦與通信工程研究所

考試科目：電磁學及電磁波

考試日期：0206，節次：2

4. Consider the applications of a waveguide.

(a) What does the dominant mode of a waveguide mean? [5%]

(b) Find the inside radius of a lossless air-filled cylindrical waveguide so that the wave in the dominant TE-mode propagates at a frequency of 10 GHz, with the cutoff wavelength of the mode being 1.25 times the operating wavelength. The zeros of the derivative of Bessel functions of the first kind are listed in **Table. A.** [10%]

5. A plane wave travels along the $-\hat{a}_z$ direction in free space with a phase constant β of 30.0 rad/m and its $\vec{H}$ field has an amplitude of $\frac{1}{3\pi}$ (A/m) along the direction $-\hat{a}_y$ when t = 0 and z = 0.

(a) Write the suitable expressions of the instantaneous $\vec{H}$ and $\vec{E}$ fields. [10%]

(b) Also determine the frequency f and the wavelength λ. [5%]

6. A lossless transmission line with a length of 30 (m) and a characteristic impedance $Z_0 = 50\ \Omega$ operating at 1 MHz is terminated with a load $Z_L = 50+j100\ \Omega$. If the wave propagation velocity $v = 0.6\,c$ (where c is light speed) on the line, please find

(a) the reflection coefficient Γ; [5%]

(b) the standing wave ratio SWR; and [5%]

(c) the input impedance. [10%]

7. Consider the application of antennas.

(a) What does the radiation resistance mean for an antenna? [5%]

(b) For a half-wave dipole antenna, the radiation resistance is about 73 Ω and its phasor expression of electric field strength E_θ is give by

$$\mathrm{E}_\theta = \frac{j60\mathrm{I}_m}{R} e^{-j\beta R}\left\{\frac{\cos\left[\frac{\pi}{2}\cos\theta\right]}{\sin\theta}\right\}$$, where I_m is the input current amplitude, β is the phase constant, and R is the distance from the antenna to the observer. Meanwhile, its effective length $\ell_{eff}(\theta)$ is give by $\ell_{eff}(\theta)=\frac{2}{\beta}\left\{\frac{\cos\left[\frac{\pi}{2}\cos\theta\right]}{\sin\theta}\right\}$. Now if two half-wave dipole antennas are arranged as shown in **Fig. D**, with the antenna #1 transmitting 300 W at 300 MHz. Find the open-circuit voltage amplitude V_{oc} induced at the terminals of the antenna #2 away of 1000 (m) from the antenna #1. [5%]

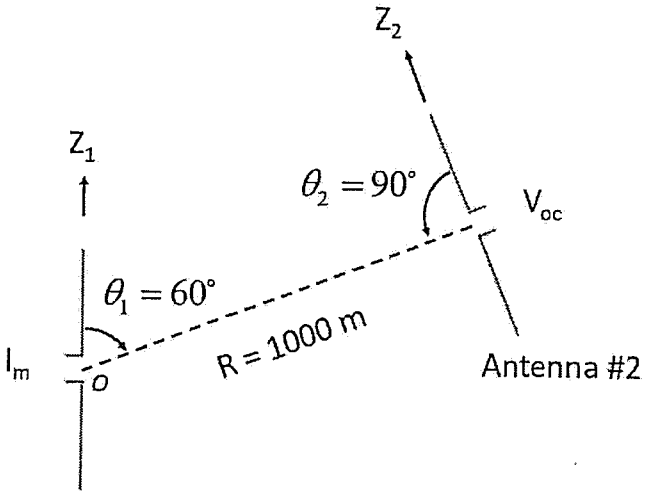

Fig. D