編號： 194

國立成功大學 106 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：0214，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

1. Please state the boundary conditions (including the normal component and the tangential component) of the static electric field $\vec{E}$ and the static magnetic field $\vec{H}$, respectively, at the interface between the air (ε_0, μ_0) and a lossless medium (ε,μ). (10%)

2. In the capacitor shown in **Fig. A**, the region between the plates is filled with a pure dielectric having $\varepsilon_r = 4.5$. Find
   (a) the capacitance, and (8%)
   (b) the resistance between the plates in case the dielectric has $\sigma = 0.01$ S/m. (7%)

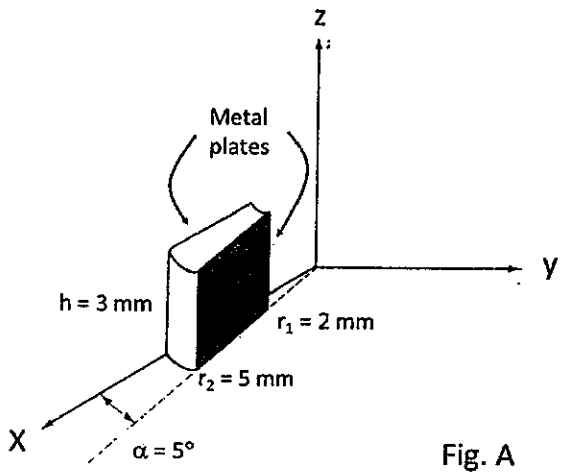

Fig. A

3. (a) What is the stored magnetic energy for a current ***I*** flowing in a single inductor with inductance **L**? (5%)
   (b) By using the stored magnetic energy, determine the inductance per unit length of an air coaxial transmission line that has a solid inner conductor of radius ***a*** and a very thin outer conductor of inner radius ***b***. (10%)

4. For a plane wave travels in the $-\hat{a}_z$ direction in free space with a phase constant β of 30 rad/m. If the $\vec{H}$ field, with an amplitude of $\left(\frac{1}{4\pi}\right)$ A/m, has the direction $-\hat{a}_y$ when **t** = 0 and **z** = 0, please write the suitable expression of the instantaneous fields $\vec{H}$ and $\vec{E}$. Also determine the frequency ***f*** and the wavelength λ. (15%)

5. As shown in **Fig. B** for a finite transmission line which has a characteristic impedance Z_0 and is terminated with a load impedance Z_L, prove that the input impedance Z_i at $z' = \ell$ can be expressed as $Z_i = Z_0 \dfrac{Z_L + Z_0 \tanh(\gamma \ell)}{Z_0 + Z_L \tanh(\gamma \ell)}$ (Ω). (15%)

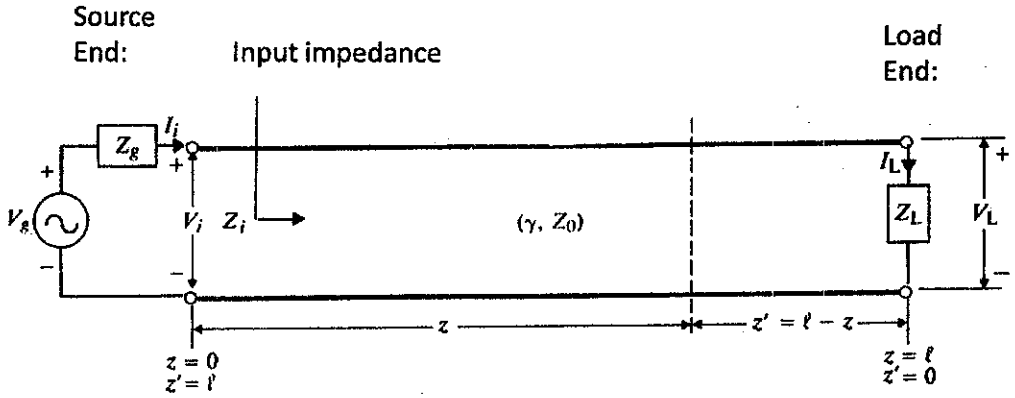

Fig. B

6. A lossless, air-dielectric cylindrical waveguide, of inside diameter 4 cm, is operated at 12 GHz. For the **TM_{11}** mode propagating in the +z direction, find the cutoff frequency, guide wavelength, and wave impedance. [hint: referred to **Table A** for the roots x_{np} of Bessel function $J_n(x)=0$.] (15%)

Table A Roots x_{np} of $J_n(x)=0$

	n = 0	n = 1	n = 2
p = 1	2.405	3.832	5.136
p = 2	5.520	7.016	8.417

7. A Hertzian dipole antenna of length ℓ = 2 m operates at 1 MHz. Assume the copper conductor of the antenna has $\sigma_c = 57\times10^6$ S/m, $\mu_r = 1$, and radius r = 1 mm. Find (a) the skin depth in the conductor and (b) the radiation efficiency of this antenna. (15%)