國立成功大學

112學年度碩士班招生考試試題

編　號：168

系　所：電機工程學系

科　目：電磁學

日　期：0206

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。

In cylindrical coordinate system:

$$\nabla\bullet\vec{A}=\frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho A_\rho\right)+\frac{1}{\rho}\frac{\partial A_\phi}{\partial\phi}+\frac{\partial A_z}{\partial z}$$

$$\nabla\times\vec{A}=\left[\frac{1}{\rho}\frac{\partial A_z}{\partial\phi}-\frac{\partial A_\phi}{\partial z}\right]\hat{a}_\rho+\left[\frac{\partial A_\rho}{\partial z}-\frac{\partial A_z}{\partial\rho}\right]\hat{a}_\phi+\frac{1}{\rho}\left[\frac{\partial\left(\rho A_\phi\right)}{\partial\rho}-\frac{\partial A_\rho}{\partial\phi}\right]\hat{a}_z$$

$$\nabla V=\frac{\partial V}{\partial\rho}\hat{a}_\rho+\frac{1}{\rho}\frac{\partial V}{\partial\phi}\hat{a}_\phi+\frac{\partial V}{\partial z}\hat{a}_z$$

In spherical coordinate system:

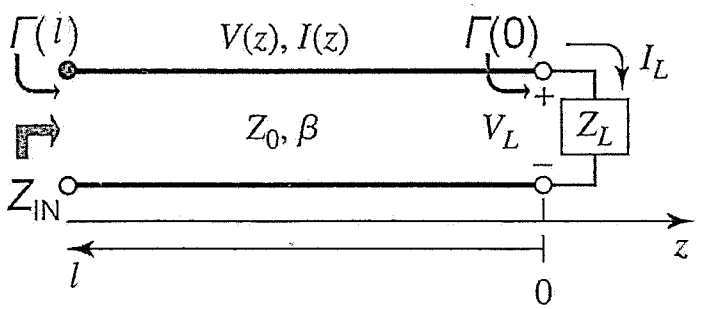
$$\nabla\bullet\vec{A}=\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2A_r\right)+\frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}\left(A_\theta\sin\theta\right)+\frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial\phi}$$

$$\nabla\times\vec{A}=\frac{1}{r\sin\theta}\left[\frac{\partial\left(\sin\theta A_\phi\right)}{\partial\theta}-\frac{\partial A_\theta}{\partial\phi}\right]\hat{a}_r$$

$$+\frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial A_r}{\partial\phi}-\frac{\partial\left(rA_\phi\right)}{\partial r}\right]\hat{a}_\theta+\frac{1}{r}\left[\frac{\partial\left(rA_\theta\right)}{\partial r}-\frac{\partial A_r}{\partial\theta}\right]\hat{a}_\phi$$

$$\nabla V=\frac{\partial V}{\partial r}\hat{a}_r+\frac{1}{r}\frac{\partial V}{\partial\theta}\hat{a}_\theta+\frac{1}{r\sin\theta}\frac{\partial V}{\partial\phi}\hat{a}_\phi$$

1. [10%] A 75-Ω lossless transmission line has $l = 0.75\lambda$ and $Z_L = 75 + j\,75\ \Omega$ as the load. (a) Find the load reflection coefficient, $\Gamma(0)$, and the reflection coefficient at input end, $\Gamma(l)$. (b) Find the standing wave ratio S of the line. (c) Find the line impedance at $\lambda/4$.



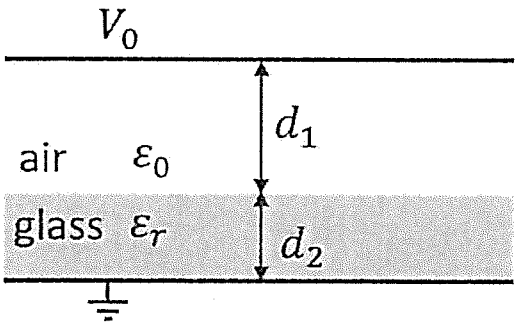
2. [15%] The magnetic field component of a uniform plane wave in air is given by

$$\bar{H}(x) = 2e^{j10\pi x}\left[\hat{y}e^{-j\pi/4} - \hat{z}e^{j\pi/4}\right] \text{ mA-m}^{-1}$$

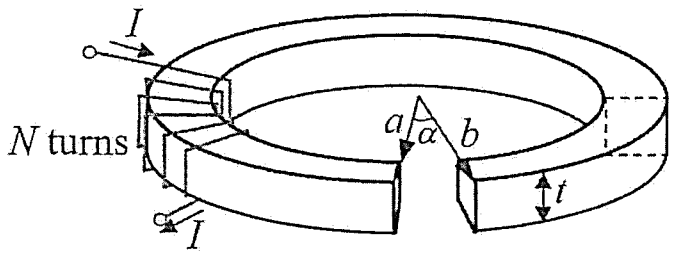
(a) Find the wavelength λ and frequency f. (b) Find the corresponding electric field. (c) Find the total time-average power density carried by this wave. (d) Determine the type (linear, circular, elliptical) and sense (right- or left-handed) of the polarization of this wave.

3. [10%] An air-filled rectangular metal cavity has its two lowest resonant frequencies at 3.9 GHz and 4.5 GHz. If the *shortest* dimension of the cavity is known as 4 cm, please find the other two dimensions.

4. [15%] A parallel-plate capacitor is partially filled with air of thickness of d_1 and a glass of thickness of d_2, as shown in the figure below. The voltage difference of the capacitor is V_0 and the relative permittivity of the glass is ε_r. (a) Find the expressions for the electric fields in the air and in the glass. (b) Assume the dielectric strengths be 30 kV/cm and 290 kV/cm for the air and for the glass, respectively. Find the maximal d_2 before the breakdown of the capacitor occurs if $\varepsilon_r = 6.5$ and $d_1 + d_2 = 10$ mm.



5. [20%] A toroidal core with a rectangular cross section as shown in the figure below has an air gap. The permeability of the core is μ and the open angle for the gap is α. The inner and outer radii of core are a and b, respectively, and the thickness of core is t. In addition, there is a current I flowing in the coil with N turns. In or on the magnetic core, find the magnetic flux density, magnetic field, magnetic flux, magnetization vector, surface magnetization current and reluctance of the core.



6. [15%] In free space, the vector potential $\vec{A} = \frac{\mu_0}{4\pi r}(\hat{a}_r \cos\theta - \hat{a}_\theta \sin\theta)\cos(\omega t - \beta r)$ satisfies the wave equation $\nabla^2\vec{A} - \mu_0\varepsilon_0\frac{\partial^2\vec{A}}{\partial t^2} = 0$, where $\frac{\omega}{\beta} = c$, the speed of light. Find (a) the corresponding electric scalar potential, and (b) the magnetic field and electric field in the far-field zone.

7. [15%] A point charge q is located at $(0,0,d)$ in air. The region $z < 0$ is filled with a dielectric medium of permittivity ε, as shown in the figure below. Find the electric field in the region of $z > 0$ if (a) there is a grounded conducting plane at $z = 0$, and (b) there is **no** grounded conducting plane at $z = 0$.