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國立臺北科技大學 114 學年度碩士班招生考試

系所組別：2230 電子工程系碩士班丙組

第一節　電磁學　試題

注意事項：

1. 本試題共 4 題，每題 25 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

Note: all numbers must have at least 3 digits of accuracy. Grades will not be awarded without rigorous description or mathematical proof.

1. Assume the vector function $\vec{A}(x,y,z)=3x^2y^3\hat{x}-x^3y^2\hat{y}$, where $\hat{x}$ and $\hat{y}$ are the unit vectors in x and y directions, respectively.

(a) Find $\oint\vec{A}\cdot d\vec{l}$ around the triangular contour shown in Figure 1. (10%)

(b) Evaluate $\int(\nabla\times\vec{A})\cdot d\vec{s}$ over the triangular area. (10%)

(c) Can $\vec{A}$ be expressed as the gradient of a scalar? Explain. (5%)

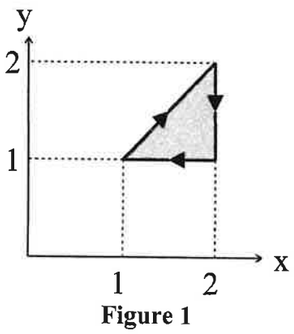

Figure 1

2. Assume a plane wave $\vec{E}(x,y,z)=(3\hat{x}+E_y\hat{y})e^{j(4x+3y)}$ is propagating in a source-free free space (ε_0,μ_0).

(a) Let $\hat{n}$ be a unit vector pointing to the propagation direction of the plane wave. Find $\hat{n}$. (5%)

(b) Find E_y. (5%)

(c) Find $\vec{H}(x,y,z,t)$. (10%)

(d) Find the frequency. (5%)

3. As shown in the Figure 2, a spherical cavity of radius a is located inside a spherical conducting sphere of radius b. The distance between the centers of the two spheres is c. A static point charge Q is located inside the cavity at a distance d to the center of the cavity. Determine the following.

(a) The total charge Q_a on the inner surface of the conducting sphere. (5%)

(b) The total charge Q_b on the outer surface of the conducting sphere. (5%)

(c) Let the origin be at the center of the conducting sphere with a spherical coordinate system (R,θ,φ). Let the voltage at infinity be zero. Find the voltage $V_{out}(R,\theta,\varphi)$ outside the outer surface of the conducting sphere. (5%)

(d) Let the origin be at the center of the cavity with a spherical coordinate system (R',θ',φ'). Find the voltage $V_{in}(R',\theta',\varphi')$ inside the cavity. (10%)

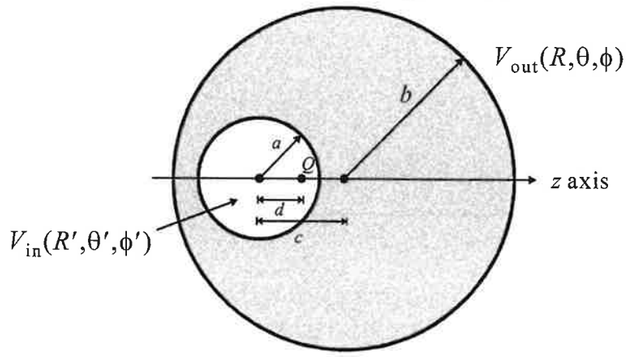

Figure 2

4. A transmission line has the following parameters:
$R=2\,\Omega/m$, $G=0.5\,m\mho/m$, $f=1\,GHz$, $L=8\,nH/m$, $C=0.23\,pF/m$.

(a) Calculate the characteristic impedance. (5%)

(b) Calculate the complex propagation constant. (5%)

(c) If 1 Watt power enters into this transmission line, after one guided wavelength, how much power is dissipated in the transmission line? (5%)

(d) If the transmission line is terminated to a $100\,\Omega$ load, what is the reflection coefficient at the load? (5%)

(e) What is the reflection coefficient at a distance of one wavelength away from the load? (5%)