國立臺灣科技大學101學年度碩士班招生試題

系所組別： 光電工程研究所碩士班

科　　目： 電磁學

（總分為100分）

1. (15%) For a vector field $\overline{A} = 5r\sin\phi\overline{a}_r + r^2\cos\phi\overline{a}_\phi$,
   a) Find its curl. (3%)
   b) Find its circulation around the contour shown in Fig.1. (5%)
   c) Verify the Stokes's theorem for $\overline{A}$. (5%)
   d) Can $\overline{A}$ be expressed as the gradient of a scalar? (2%)

2. (10%) A positive point charge Q is at the center of a spherical conducting shell of inner radius a and outer radius b.
   a) Find the electric flux density $\overline{D}$ everywhere. (5%)
   b) Find the electric potential V everywhere. (5%)

3. (15%) Two lossy homogenous dielectric media with dielectric constants $\varepsilon_{r1} = 2$, $\varepsilon_{r2} = 3$ and conductivities $\sigma_1 = 15(ms)$, $\sigma_2 = 10(ms)$ are in contact at the $x = 0$ plane. In the x>0 region (medium 1) a uniform electric field $\overline{E}_1 = 10\overline{a}_x + 5\overline{a}_y - 50\overline{a}_z$ (V/m) exist.
   a) Find the electric field $\overline{E}_2$ at the region 2. (5%)
   b) Find the current density at the region 2. (4%)
   c) Find the polarization at the region 2 (3%)
   d) Find the surface charge density at the surface. (3%)

4. (10%) An air coaxial transmission line has a solid inner conductor of radius a and a very thin outer conductor of inner radius b. Assuming that a current I flows in the inner conductor and returns via the outer conductor in the other direction.
   a) Find the magnetic flux density $\overline{B}$ everywhere. (4%)
   b) Find the magnetic energy per unit length store in the inner conductor. (4%)
   c) Find the internal conductance per unit length. (2%)

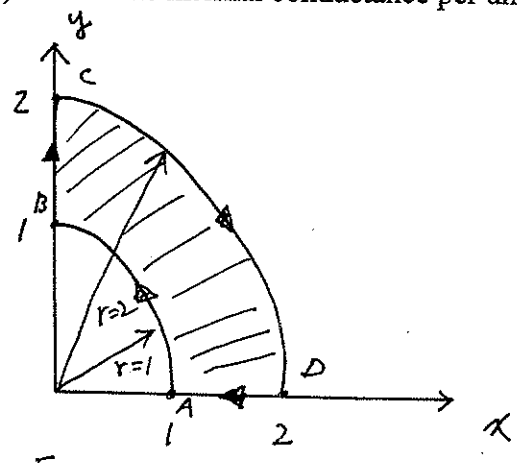

Fig. 1.

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5. (10%) Given a magnetic field in free space where there is neither charge nor current density, ($\rho = J = 0$),

$$\mathbf{B} = a\sin(\omega t - nx)\hat{\mathrm{i}} + \frac{ay}{n}\cos(\omega t - nx)\hat{\mathrm{j}}$$

where a, n, and ω are constants. Please use a Maxwell equation to derive the time-dependent part $\vec{E}$ of the electric field.

6. (20%) For the lossless transmission-line circuit shown in Figure 2, please find
   (a) the input impedance Z_{in}. (10%)
   (b) the instantaneous voltage at the load end v_L. (10%)

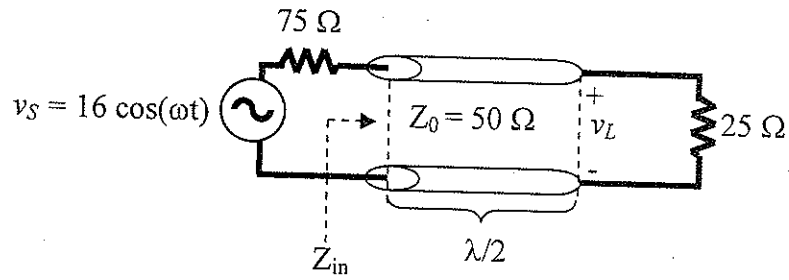

Figure 2.

7. (20%) A parallel-plate waveguide has plate separation $d = 0.01$ m and is filled with a material ($n = 1.5$). If the operating frequency is 36 GHz,
   (a) which modes will propagate? (10%)
   (b) at the 36 GHz frequency, determine the difference between the group delays of the highest order mode (TE or TM) and the TEM mode (assuming the TEM mode has no dispersion). Assume a propagation distance of 0.1 m. (10%)

   (You may use $\sqrt{11} \doteq 3.3$, if necessary.)