

國立臺北科技大學 100 學年度碩士班招生考試

系所組別：2401、2402、2403、2404 光電工程系碩士班

第二節 電磁學 試題

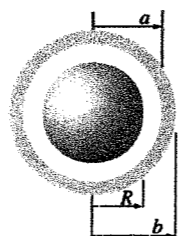
第一頁 共一頁

注意事項：

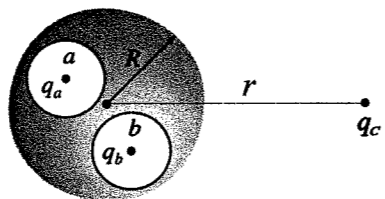
1. 本試題共 6 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Briefly answer the following questions:

- (a) A metal sphere of radius R , carrying charge q , is surrounded by a thick concentric metal shell (inner radius a , outer radius b), as shown in the figure. The shell carries no net charge. Assume the potential of the shell is V , and the electric field between the sphere and the shell is \vec{E} . How would the field \vec{E} and the potential V change if an electron were brought near the shell? (5%)



- (b) Two spherical cavities, of radii a and b , are hollowed out from the interior of a (neutral) conducting sphere of radius R , as shown in the figure. At the center of each cavity a point charge is placed – call these charges q_a and q_b . A third charge q_c is at a distance r from the center of the conductor, where $r \gg R$. What is the force on q_a , q_b , and q_c ? (5%)



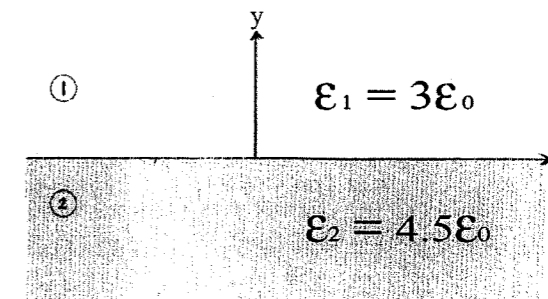
- (c) A parallel-plate capacitor connected to a battery stores twice as much charge with a given dielectric as it does with air as dielectric. What is the susceptibility of the dielectric? (5%)

- (d) A magnet is moving through a plastic ring. Is an emf induced in the plastic ring? (5%)

2. Given that $\vec{E}_1 = 6\hat{i} - 15\hat{j} + 8\hat{k}$ (V/m) in the region 1 as shown in the figure.

- (a) Find the polarization \vec{P}_1 in the region 1. (5%)

- (b) Determine \vec{E}_2 in the region 2, and find the angle \vec{E}_2 makes with the y-axis. (10%)

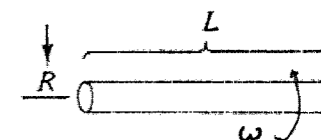


3. A current I flows down a long straight wire of radius R . The wire is made of linear material with susceptibility χ_m , and the current is distributed uniformly.

- (a) What is the magnetic field \vec{B} a distance r from the axis? (10%)
 (b) Find all the bound currents. (10%)

4. A cylindrical thin shell with surface charge density σ has length L and radius R , where $L \gg R$. The shell rotates about its axis with an angular velocity ω which increases slowly with time as $\omega = ct$, where c is a constant, as shown in the figure. Neglect the fringing effects. Determine:

- (a) the magnetic field \vec{B} inside the cylinder, (7%)
 (b) the electric field \vec{E} inside the cylinder. (8%)



5. An electromagnetic wave from an underwater source with perpendicular polarization is incident on a water-air interface at $\theta_i = 20^\circ$. Using $\epsilon_r = 81$ and $\mu_r = 1$ for fresh water.

- (a) Will the wave transmit into the air? (7%)
 (b) Find the reflection coefficient Γ_\perp . (8%)

6. An air coaxial transmission line has a solid inner conductor of radius a and a thin outer conductor of inner radius b . Determine the inductance per unit length of the line. (15%)

- In cylindrical coordinates (r, ϕ, z) , the curl of a vector \vec{A} is:

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