

國立彰化師範大學 97 學年度碩士班招生考試試題

系所： 光電科技研究所碩士班

科目： 電磁學

☆☆請在答案紙上作答☆☆

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1. (15%) A spherical charge distribution is given by

$$\rho(r) = \begin{cases} k \left(1 - \frac{r^2}{R^2} \right), & r \leq R, \\ 0, & r > R. \end{cases}$$

where k and R are constants.

(a) Calculate the total charge Q .

(b) Find the electric field \vec{E} and the potential V inside and outside the charge distribution.

2. (20 %) A sphere of linear dielectric material carries a polarization

$$\vec{P}(r) = \frac{k}{r} \hat{r},$$

where k is a constant and \hat{r} is the unit radial vector. Its radius is R and its dielectric constant is ϵ_r .

(a) Calculate the volume bound charge density ρ_b and the surface bound charge density σ_b .

(b) Calculate the volume free charge density ρ_f .

(c) Find the electric field \vec{E} inside and outside the sphere.

(d) Find the electric displacement \vec{D} inside and outside the sphere.

(e) Find the electric potential V inside and outside the sphere.

3. An infinitely long rectangular pipe, running parallel to the z -axis, has three grounded metal sides, at $y = 0$, $y = a$, and $x = 0$. The fourth side, at $x = b$, is maintained at a constant potential V_0 . Find the potential with the pipe. (15 %)

4. State the definition of scalar potential and vector potential. Express the electric field and magnetic field in terms of the scalar and vector potentials. Write down the Maxwell's equations in terms of the scalar and vector potentials. (15 %)

5. A plane circularly polarized electromagnetic wave is incident normally on a plane interface from the air to the medium with the refraction index n . Suppose the permeability (磁導率) μ of the air and the medium are equal. Write down the electric field of the incident, reflected, and transmitted waves. By considering the boundary conditions at the interface, determine the coefficient of reflection. (15 %)

6. Explain the following terms: phase velocity, group velocity, Coulomb gauge, and Lorentz gauge. (20 %)