淡江大學 98 學年度轉學生招生考試試題

系別：物理學系三年級　　　　　科目：電　磁　學

准帶項目請打「V」
計　算　機

本試題共　4　大題，　1　頁

$$\vec{\nabla} \cdot \vec{A} = \frac{1}{h_1 h_2 h_3} \left[\frac{\partial}{\partial u_1} (h_2 h_3 A_1) + \frac{\partial}{\partial u_2} (h_3 h_1 A_2) + \frac{\partial}{\partial u_3} (h_1 h_2 A_3) \right]$$

$$\vec{\nabla}\Phi = \frac{1}{h_1} \frac{\partial \Phi}{\partial u_1} \vec{e}_1 + \frac{1}{h_2} \frac{\partial \Phi}{\partial u_2} \vec{e}_2 + \frac{1}{h_3} \frac{\partial \Phi}{\partial u_3} \vec{e}_3$$

$$\vec{\nabla} \times \vec{A} = \frac{1}{h_1 h_2 h_3} \begin{vmatrix} h_1 \vec{e}_1 & h_2 \vec{e}_2 & h_3 \vec{e}_3 \\ \frac{\partial}{\partial u_1} & \frac{\partial}{\partial u_2} & \frac{\partial}{\partial u_3} \\ h_1 A_1 & h_2 A_2 & h_3 A_3 \end{vmatrix}$$

1. (a) Find the electric field a distance z above the midpoint of a straight line segment of length $2L$, which carries a uniform line charge λ.　(5%)

   (b) Find the electric field a distance z above the center of a flat circular disk of radius R, which carries a uniform charge density σ.　(5%)

   (c) Find the potential a distance z above the midpoint of a straight line segment of length $2L$, which carries a uniform line charge λ.　(5%)

   (d) Find the potential a distance z above the center of a flat circular disk of radius R, which carries a uniform charge density σ.　(5%)

   (e) Compute $\vec{E} = -\vec{\nabla} V$ directly from (c) and (d), and compare your answers with (a) and (b).　(10%)

2. (a) Find the electrical field $\vec{E}$ inside and outside a uniformly charged spherical shell of radius R and total charge Q.　(10%)

   (b) Find the curl of $\vec{E}$ directly from (a).　(10%)

   (c) Check your answers with the boundary conditions of $\vec{E}$.　(5%)

   (d) Find the energy W stored in the charged spherical shell.　(5%)

3. A thick spherical shell (inner radius a, outer radius b) is made of dielectric material with a "frozen-in" polarization $\vec{P}(\vec{r}) = \frac{k}{r}\hat{r}$, where k is a constant and r is the distance from the center.

   (a) Locate all the bound charges $\sigma_b = ?$ and $\rho_b = ?$　(10%)

   (b) Use Gauss's law to find $\vec{D} = ?$, and then get $\vec{E} = ?$　(10%)

4. A very long straight cylinder conductor of radius R carries a current I, uniformly distributed over its cross section.

   (a) Find the magnetic field $\vec{B}$ for inside and outside the conductor.　(10%)

   (b) Check $\vec{\nabla} \times \vec{B} = ?$ and $\vec{\nabla} \cdot \vec{B} = ?$ for inside and outside the conductor.　(10%)