淡江大學八十七學年度日間部轉學生入學考試試題

系別：物理系三年級　　科目：電磁學

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1. Explain why that in electrostatic situations (a) the electric field inside a conductor vanishes; (b) any net charge must reside on the surface of the conductor; and (c) the electric field just outside the conductor is perpendicular to its surface. (15 %)

2. Consider the electrostatic problem of a uniform charge distribution over a sphere of radius R. Let the total electrical charge be Q and the electric potential at infinity be zero.

(a) Find the electric field ($\vec{E}$) and potential (V) as a function of the radial coordinate.

(b) Calculate the electrostatic energy of the system.

(c) Show that $\frac{1}{2}\int_{\substack{whole\\space}} \rho V\, d\vec{r} = \frac{\varepsilon_0}{2}\int_{\substack{whole\\space}} \vec{E}^2\, d\vec{r}$,

where ρ is the charge density, and ε_0 is the electric permittivity of the vacuum. (25 %)

3. Show that the vector potential of a uniform magnetic field $\vec{B}$ may be expressed as $\vec{A} = \vec{B} \times \vec{r} / 2$, where $\vec{r}$ is the position vector, and that $\nabla \cdot \vec{A} = 0$. (10 %)

4. Find the magnetic field intensity ($\vec{H}$) and vector potential ($\vec{A}$) for the following two cases:

(a) A long solenoid of radius R with N turns (of very thin wires) per unit length and a constant current I;

(b) A long cylindrical wire of radius b with a constant current I, assuming the conducting wire is nonmagnetic and the current density is uniform within the wire. (20 %)

5. (a) Write down the integral form of the four Maxwell's equations for $\vec{E}$, $\vec{B}$, $\vec{D}$ (electric displacement), and $\vec{H}$, respectively; then (b) derive the boundary conditions for these field quantities at the interface between two nonconducting media (medium 1 and medium 2), assuming that there are no free charges and currents at the boundary. (30 %)