(橫書式) 國立東華大學 96 學年度 學士 班招生考試試題

科 目：電磁學 物理學系三年級 共 1 頁第 1 頁

本考科禁用掌上型計算機

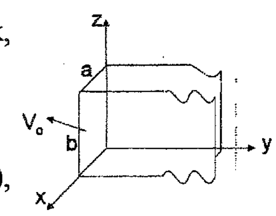
(請於此線以下開始出題)

(20%) 1. Suppose the electric field in some region is found to be $E = kr^3\hat{r}$, in spherical coordinates (k is some constant).

(a) Find the charge density ρ. (10%)

(b) Find the total charge contained in a sphere of radius R, centered at the origin. (10%)

(20%) 2. An infinity long rectangular metal pipe (sides a and b) is ground, but one end, at y=0, is maintained at a specified potential V(x, z) =V_o and the other four planes are V=0



(a) Write down the Laplace equation of rectangular coordinates. (4%)

(b) By using separation of variables, write down the solution of X(x), Y(y), and Z(z). (6%)

(c) Write down the total potential and find out the coefficient Cn,m. (10%)

(15%) 3. Show that vector potential $\vec{A} = \frac{1}{2}\vec{B}\times\vec{r}$ is a suitable solution for a uniform magnetic field of $\vec{B} = B_o\hat{z}$. (15 %)

(15%) 4. A sphere of linear magnetic material is placed in an otherwise uniform magnetic field B_o. Find the new field inside the sphere. (15%)

(30%) 5. A uniform current density $\vec{j} = J_o\hat{z}$ fills a slab standing the yz plane, from $x=-a$ to $x=+a$. A magnetic dipole $\vec{m} = m_o\hat{x}$ is situated at the origin.

(a) Find the force on the dipole. (5%)

(b) Do the same for a dipole pointing in the y direction: $\vec{m} = m_o\hat{y}$.(5%)

(c) In the electrostatic case the expression $F = \nabla(p\cdot\vec{E})$ and $F = (p\cdot\nabla)\vec{E}$ are equivalent, but this is not the case for the magnetic analogs (explain why).(10%) As an example calculate $(\vec{m}\cdot\nabla)B$ for the configuration in (a) and (b). (10%)