國立中央大學101學年度碩士班考試入學試題卷

所別：太空科學研究所碩士班 不分組(一般生)　科目：電磁學　共 1 頁 第 1 頁
太空科學研究所碩士班 不分組(在職生)

本科考試禁用計算器

＊請在試卷答案卷（卡）內作答

1. The electric field $\vec{E}$ in Cartesian coordinates (x, y, z) is given $\vec{E} = k[y^2\hat{x} + (2xy + z^2)\hat{y} + fz]$ where k is a constant with the appropriate units and $\hat{x}, \hat{y}, \hat{z}$ are Cartesian unit vectors parallel to the x, y, z axes, respectively.
   (a) Find the function f such that the given field is an electrostatic field. (5%)
   (b) For the electrostatic field, find the potential with the origin as the reference point. (5%)
   (c) Find the charge distribution for the electrostatic field. (5%)

2. A conducting sphere of radius R_1 with charge (Q) is surrounded a thick concentric conducting shell of inner radius $R_2 (> R_1)$ and outer radius $R_3 (> R_2)$. The shell carries net charge q.
   (a) Find the charge distribution at the conducting shell. (5%)
   (b) Find the electric field at $\vec{r} (|\vec{r}| > R_3)$. (5%)
   (c) Find the potential at the center, using infinity as the reference point. (5%)

3. A point charge q starts at the origin with the uniform electric field $\vec{E}$ in the x-direction, and the uniform magnetic field $\vec{B}$ in the y-direction.
   (a) Find the trajectory for the particle with positive charge $(q > 0)$ at rest initially. (5%)
   (b) Sketch the trajectory of the particle in (a). (5%)
   (c) Find the trajectory for the particle with negative charge $(q < 0)$ at initial velocity (E / B) in z-direction. (5%)
   (d) Sketch the trajectory of the particle in (c). (5%)

4. There are infinite uniform surface currents, current density $(\vec{K})$ in y-direction flowing over the $z = 0$ plane, surface current density $(-\vec{K} / 2)$ flowing over the $z = d (d > 0)$ plane, and surface current density $(-\vec{K} / 2)$ flowing over the $z = (-d)$ plane.
   (a) Find the magnetic field at $d > z > 0$. (5%)
   (b) Find the magnetic field at $(-d) < z < 0$. (5%)
   (c) Find the magnetic field at $z > d$. (5%)
   (d) Find the magnetic field at $(-d) > z$. (5%)

5. A conducting sphere of radius R with charge Q is spinning with constant angular velocity $\vec{\omega}$ along the z-axis.
   (a) Find the current distribution. (5%)
   (b) What is the magnetic moment (dipole) of the sphere? (5%)
   (c) Find the magnetic field at a point outside the sphere. (5%)

6. In a perfect conductor with infinite conductivity.
   (a) Find the electric field inside the perfect conductor. (5%)
   (b) Find the magnetic field inside the perfect conductor. (5%)
   (c) Find the current in a superconductor (perfect conductor with property $\vec{B} = 0$ inside). (5%)