國立中央大學104學年度碩士班考試入學試題

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

＊請在答案卷（卡）內作答

1. The given electric field $\bar{E}$ in spherical coordinates (r,θ,ϕ) is given,

$$\vec{E}(\vec{r}) = \frac{k}{r^3}(2\cos\theta\hat{r} + \sin\theta\hat{\theta})$$

where k is a constant with the appropriate units and $\hat{r},\hat{\theta}$ are unit vectors in spherical coordinates r,θ, respectively.

(a) Sketch the electric field lines in y-z plane. (5%)
(b) Find the corresponding electrostatic potential field. (5%)
(c) Sketch the equipotential lines in x-z plane. (5%)
(d) 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 surface charge density at R_1, R_2, R_3. (5%)
(b) Find the electric energy density. (5%)
(c) Find the potential at the center of the sphere. (5%)
(d) Find the capacitance of the system. (5%)

3. There are infinite uniform surface currents, current density $(\vec{K})$ in z-direction flowing over the $x=0$ plane, surface current density $(-\vec{K}/2)$ flowing over the $x=d(d>0)$ plane, and surface current density $(-\vec{K}/2)$ flowing over the $x=-d$ plane.

(a) Find the magnetic field at $x>d$. (5%)
(b) Find the magnetic field at $d>x>0$. (5%)
(c) Find the magnetic field at $0>x>-d$. (5%)
(d) Find the magnetic field at $x<-d$. (5%)

4. A conducting sphere of radius R with charge Q is spinning with constant angular velocity $\vec{\omega}$ along the y-axis.

(a) Find the current distribution. (5%)
(b) Find the magnetic dipole moment of the sphere? (5%)
(c) Find the magnetic field distribution. (5%)
(d) Find the electromagnetic energy density. (5%)

5. An alternating current $I(t)=I_0\sin(\omega t)$ flows down a long straight thin wire and returns along a coaxial conducting tube of radius R. Assuming that the magnetic field goes to zero outside the tube.

(a) Find the magnetic field under the quasi-static approximation. (5%)
(b) Find the induced electric field. (5%)
(c) Find the displacement current density. (5%)
(d) Find the energy flux density. (5%)