國立中央大學99學年度碩士班考試入學試題卷

所別：光機電工程研究所碩士班 乙組(光機)(一般生)　科目：電磁學　共 1 頁 第 1 頁

本科考試可使用計算器，廠牌、功能不拘　＊請在試卷答案卷（卡）內作答

1. Point charges of 5×10^{-9} C are located at each of three corners of a square whose side is 20 cm. Find the magnitude and direction of the electric field at the vacant corner point of the square. (10 分)
$\varepsilon_0 = 8.854\times10^{-12}$ F/m

2. A spherical charge density distribution is given by

$$\rho = \rho_0\left(1-\frac{r^2}{R^2}\right) \qquad (r \le R)$$
$$\rho = 0, \qquad (r > R)$$

where R is the radius
   (a) Find the total charge. (3 分)
   (b) Find the electric field and the potential outside the charge distribution. (7 分)
   (c) Find the electric field and the potential inside the charge distribution. (7 分)
   (d) Electric field is maximum when $r = x\cdot R$. Find x. (8 分)

3. A point charge Q is located inside and at distance d from the center of a grounded spherical conducting shell of radius b ($b<d$). Determine
   (a) the potential distribution inside the shell. (8 分)
   (b) the charge density induced on the inner surface of the shell. (7 分)

4. Two coaxial circular coils of radii b_1 and b_2 are separated by a distance d that is much larger than the radii, as depicted in Fig. 1. The coils consist of N_1 and N_2 closely wound turns and carry currents I_1 and I_2, respectively.
   (a) Find the vector magnetic potential $\bar{A}_{12}$, the mutual flux Φ_{12}, and the mutual inductance L_{12} at the point P on coil 2. (15 分)
   (b) Find approximately the force between two coaxial circular coils. (5 分)
   (c) If $b_1 = b_2 = b$ and $b = d$, they are known as Helmholtz coils. Derive the magnetic flux density at the midpoint between the coils and discuss the physical meaning. (10 分)

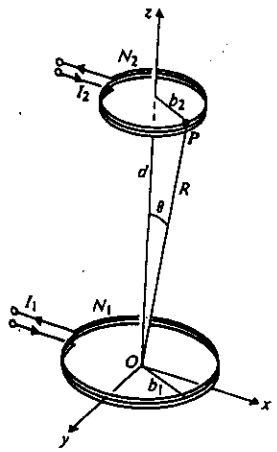

Fig. 1

5. For a harmonic uniform plane wave propagation in a simple medium, both $\vec{E}$ and $\vec{H}$ vary in accordance with the factor $\exp(-i\vec{k}\cdot\vec{r})$. Show that the four Maxwell's equations for uniform plane wave in a source-free region reduce to the following: (20 分)

$$\vec{k}\times\vec{E} = \mu\omega\vec{H}$$
$$\vec{k}\times\vec{H} = -\varepsilon\omega\vec{E}$$
$$\vec{k}\cdot\vec{E} = 0$$
$$\vec{k}\cdot\vec{H} = 0$$