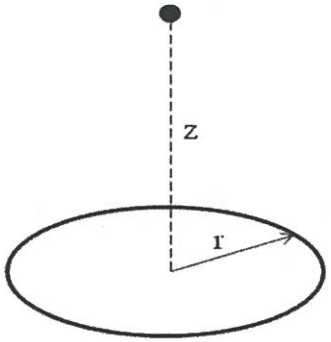
國立臺灣師範大學105學年度碩士班招生考試試題

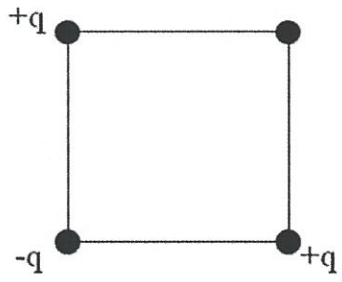
科目：**電磁學**　　適用系所：**光電科技研究所**

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣分。

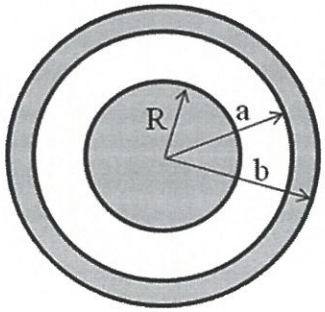
1. Find the electric field a distance z above the center of a circular loop of radius r, which carries a uniform line charge density λ. (10 分)



2. Three charges are situated at the corners of a square (side a). How much work does it take to bring in another charge, -q, from far away and place it in the fourth corner? (10 分)

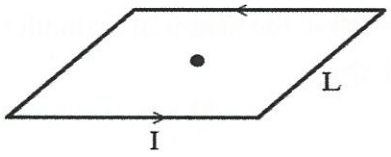


3. A metal sphere of radius R, carrying charge q, is surrounded by a thick concentric metal shell with inner radius a, and outer radius b. The shell carries no net charge.
   (a) Find the surface charge density σ at R, at a and at b. (10 分)
   (b) Find the potential at the center, using infinity as the reference point. (10 分)



4. Find the capacitance of two concentric spherical metal shells, with radius a and b. (15 分)

5. Find the magnetic field at the center of a square loop with the length of L which carries a steady current I. (15 分)



6. Find the magnetic vector potential of an infinite solenoid with n turns per unit length, radius R, and current I. (15 分)

7. The magnetic vector potential of a magnetic dipole can be written:

$$\vec{A}(\vec{r}) = \frac{\mu_0 \vec{m} \times \vec{r}}{4\pi r^2}$$

Please prove that the magnetic field of a magnetic dipole can be written as the equation below. (15 分)

$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi r^3}\left[3(\vec{m}\cdot\hat{r})\hat{r} - \vec{m}\right]$$