國立臺北科技大學九十九學年度碩士班招生考試

系所組別：2401、2402 光電工程系碩士班

第二節　電磁學　試題

注意事項：

1. 本試題共 6 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. One of the following fields is an impossible electrostatic field,

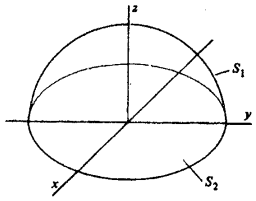
$\bar{E}_1 = k[xy\hat{x} + yz\hat{y} + xz\hat{z}]$;

$\bar{E}_2 = k[yz\hat{x} + xz\hat{y} + xy\hat{z}]$,

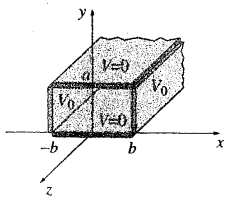
where k is a constant with the appropriate units.

(a) Which one is the impossible electrostatic field? Why? [10%]

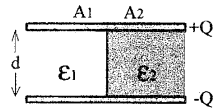
(b) For the possible one, use Gauss's law to find the total charge enclosed by the surface shown in the figure consisting of S_1, the hemisphere and S_2, its circular base in the xy-plane. [10%]



2. Two infinitely long grounded metal plates, at y = 0 and y = a, are connected at x = ±b by metal strips maintained at a constant potential V_0, as shown in the figure (a thin layer of insulation at each comer prevents them from shorting out). Find the potential inside this rectangular pipe. [20%]



3. A parallel-plate capacitor has free charges ±Q on its plates. The plates are separated by d and the space between them is filled with two dielectrics of areas A_1 and A_2. The permittivities of the slabs are ε_1 and ε_2. Find the electric field $\bar{E}$, electric displacement $\bar{D}$, and the polarization $\bar{P}$ in each slab. [20%]



4. A spherical shell, of radius R, carrying a uniform surface charge σ, is spinning at angular velocity ω. Find its magnetic dipole moment. [15%]

5. Please write down the boundary conditions that exist at the interface of free space and a magnetic material of infinite permeability. [10%]

6. A TE mode electromagnetic wave is propagating in the rectangular waveguide, with height a and width b, as shown in the figure. The walls of the waveguide are conducting and the inside is vacuum.

(a) What is the cutoff frequency in this mode? [10%]

(b) If the inside is filled with material with dielectric constant ε, how does the cutoff frequency change? [5%]