

# 100 學年度四年制二、三年級轉學生招生考試

## 四技三年級 光電工程系

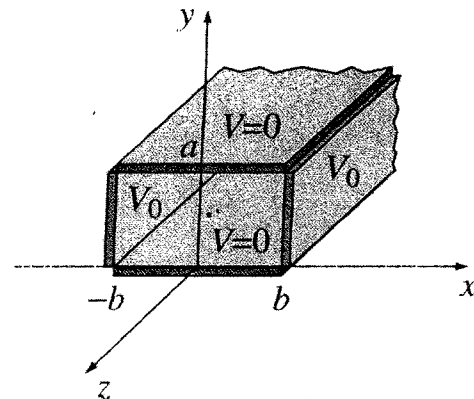
### 第三節 專業科目 (二) 電磁學 試題

第一頁 共一頁

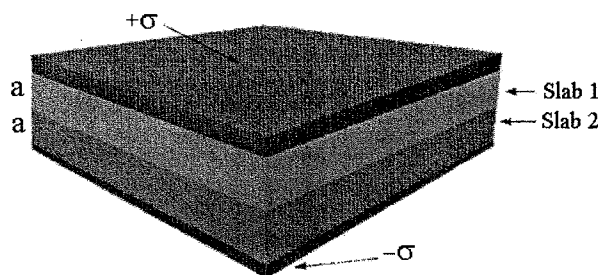
#### 注意事項：

1. 本試題共 5 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. Two infinitely long grounded metal plates at  $y = 0$  and  $y = a$  are connected at  $x = \pm b$  by metal strips maintained at a constant potential  $V_0$ , as shown in the figure (a thin layer of insulation at each corner prevents them from shorting out). Find the potential inside the resulting rectangular pipe. (20%)



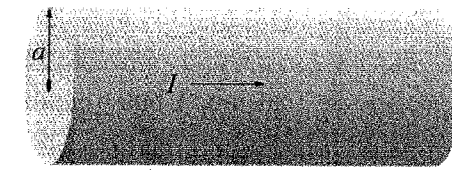
2. The space between the plates of a parallel-plate capacitor is filled with two slabs of linear dielectric material. Each slab has thickness  $a$ , so the total distance between the plates is  $2a$ . Slab 1 has a dielectric constant of 2, and slab 2 has a dielectric constant of 1.5. The free charge density on the top plate is  $\sigma$  and on the bottom plate  $-\sigma$ .
- (a) Find the electric field  $\vec{E}$  and the polarization  $\vec{P}$  in each slab. (10%)
  - (b) If the area of the plate is  $A$ , what is the capacitance? (10%)



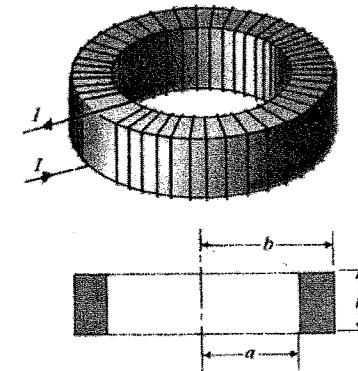
3. A steady current  $I$  flows down a long cylindrical wire of radius  $a$ . The current is distributed in such a way that  $J$  is proportional to  $r$ , the distance from the axis.
- (a) Find the magnetic field both inside and outside the wire. (10%)
  - (b) Calculate the vector potential inside and outside the wire. (10%)

For cylindrical coordinates, the curl of a vector  $\vec{A}$  is

$$\nabla \times \vec{A} = \left[ \frac{1}{r} \frac{\partial A_z}{\partial \phi} - \frac{\partial A_\phi}{\partial z} \right] \hat{r} + \left[ \frac{\partial A_r}{\partial z} - \frac{\partial A_z}{\partial r} \right] \hat{\phi} + \frac{1}{r} \left[ \frac{\partial}{\partial r} (r A_\phi) - \frac{\partial A_r}{\partial \phi} \right] \hat{z}$$



4. Assume that  $N$  turns of wire are tightly wound on a toroidal frame of a rectangular cross section with dimensions as shown in the figure. Calculate its self-inductance. (20%)



5. The electric field of a uniform plane wave in a medium with permittivity  $\epsilon = \epsilon_0 \epsilon_r$  and permeability  $\mu = \mu_0$  is given by  $\vec{E} = \hat{x} E_0 \cos \left[ \pi \left( 2 \times 10^8 t + \frac{1}{2} y - \frac{\sqrt{3}}{2} z \right) \right]$  (V/m).
- (a) What is the wavelength in  $y$ -direction  $\lambda_y$ ? [5%]
  - (b) Find the phase velocity  $u_p$ . [5%]
  - (c) What is the angle between the  $z$ -axis and the direction of propagation? [5%]
  - (d) Write down the reflected electric field as the wave impinges on an infinite perfectly conducting plane which is perpendicular to the  $z$ -axis. [5%]