國立中央大學101學年度碩士班考試入學試題卷

所別：光電科學與工程學系碩士班 不分組(一般生)
光電科學與工程學系碩士班 不分組(在職生)
科目：電磁學 共 4 頁 第 1 頁

本科考試可使用計算器，廠牌、功能不拘

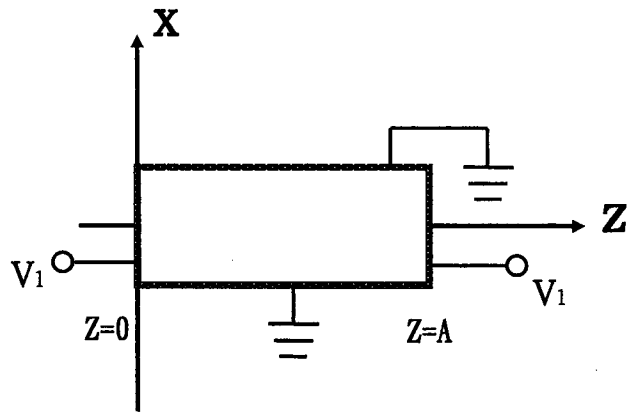
＊請在試卷答案卷（卡）內作答

1. (a) A spherical shell, of the radius D, with a surface charge density distribution $\sigma = \sigma_0 \cos\theta$, where θ is the polar angle evaluated from the z-axis, is centered at the origin of the coordinates. Find the electric field at the origin of the coordinates. (6%)

   (b) A dipole of moment $\bar{p}$ is lined up with the z –axis at the origin of coordinates. A second dipole of moment $\bar{p}$ is centered at the position $(R, 0, R)$ and is pointed toward the origin. Calculate the torque on the second dipole. (6%)

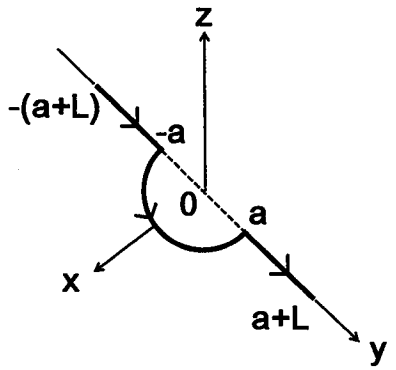
2. Consider an uniform electric field in the z-direction $\bar{E} = \hat{z} E_0$, where $\hat{z}$ denotes the unit vector in the z-direction. An uncharged conducting rod (of infinite length) of radius D is then introduced into this field with its symmetry axis lined up on the x-axis. Find the electric field everywhere outside this conducting rod. (12%)

3. Consider four flat-electrodes at $z = 0$, $z = A$, $x = B/2$, and $x = -B/2$, which form a hollow rectangular pipe (infinite length) with insulation at junctions, i.e., edges of this rectangular pipe. The two electrodes at $x = B/2$ and $x = -B/2$ are grounded while the two electrodes at $z = 0$ and $z = A$ are maintained at potential V_1. Find the electric potential everywhere within this rectangular pipe. (11%)

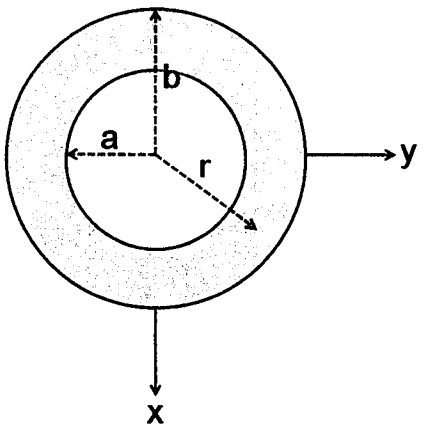


注意：背面有試題

4. In the figure shown below, a wire is extended from y = -(a+L) to y = a+L and is bent as a semicircle in the xy plane. If the wire carries a current I flowing along the direction indicated by the arrows in the figure and the magnetic flux density B in the region is along the +z direction, determine the magnetic force acting on the wire with the following parameters: I = 5 A, B = 3 T, a = 1 m, L = 2 m. (7%)



5. Below is the cross-sectional view of a hollow and infinitely long conductor. The conductor is placed along the z axis and carries a current of 6 A in the +z direction. If the inner and the outer radii are respectively 2 cm and 4 cm (i.e. a=2 cm and b=4 cm), determine the direction and the magnitude of the magnetic field intensities at r = 1cm, 3 cm, and 5 cm. (8%)



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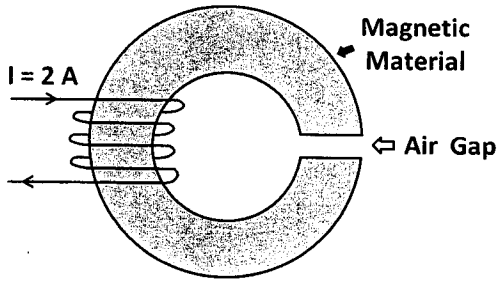
6. A magnetic circuit with an air gap is shown below. The outer and inner radii of the magnetic core are 12 cm and 10 cm, respectively. The length of the air gap is 1 cm. The magnetic material is tightly wound by a conducting coil with 3000 turns and the current in the coil is 2A. The relative permeability of the magnetic material is 1200. Assuming no fringing of magnetic flux in the air gap and the magnetic flux is restrictedly flow through the magnetic material, answer the following questions:

(a). What is the direction of the magnetic flux with the current flow shown in the figure? (clockwise or counterclockwise?) (3%)

(b). What is the total reluctance in the magnetic circuit? (6%)

(c). What is the flux density in the magnetic circuit? (6%)



7. Consider an example of total internal reflection as described in the figure on the next page. The oscillating direction of the E-field of the incident light is along y-axis. Given that the electric field in medium 2 as: $\overrightarrow{E_2} = E_2^0 e^{j(\omega t - \overrightarrow{k_2}\cdot\vec{r})}$

where $\overrightarrow{k_2} = \hat{x}\,k_{2x} + \hat{z}\,j\,k_{2z}$ **and** k_{2x} , k_{2z} **are real numbers and j is the unit imaginary number.**

(a) What is the oscillating direction of the electric field in medium 2, $(\overrightarrow{E_2})$**? Why? (5%)**

(b) Find all the components of the amplitude of the magnetic field in medium 2, (H_2^0)**, in terms of** E_2^0, k_{2x} **, and** k_{2z}**. (10%)**

(c) Do the components of the $\overrightarrow{H_2}$**-field oscillate in phase with** $\overrightarrow{E_2}$ **? If not, what is the difference, and which leads which? (10%)**

(d) Find the average Poynting vector or the average energy flux density in z-direction in medium 2. (10%)

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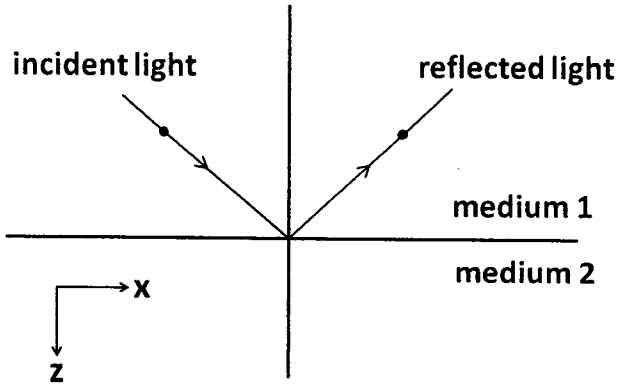

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