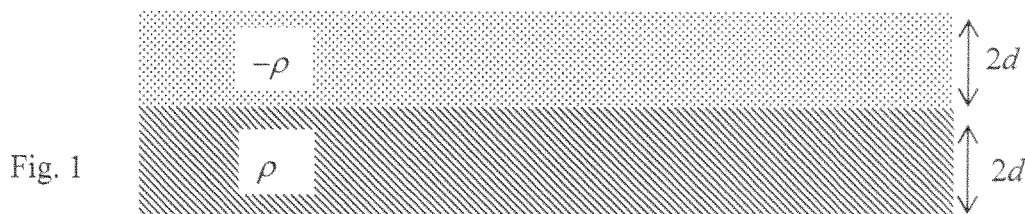


國立清華大學命題紙

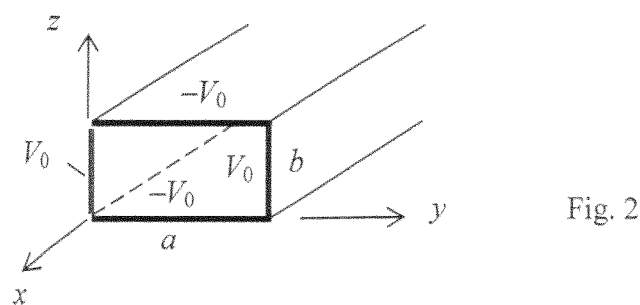
98 學年度工程與系統科學系丙組、先進光源科技碩士學位學程工程與系統科學組碩士班入學考試
科目電磁學 科目代碼 2802、3003 共 2 頁第 1 頁 *請在【答案卷卡】內作答

1. (a) Write down the expression for the “*divergence theorem*” and explain its geometric/physical meaning.
(b) Using the divergence theorem, show that $\nabla \cdot (\nabla \times \mathbf{A}) = 0$, where \mathbf{A} is a vector field (or function).
(note: in your hand writing, please write the vector as \vec{A} .) (10 %)

2. Two *infinite* plane slabs, of thickness $2d$, carry a uniform volume charge density of opposite types, ρ and $-\rho$, respectively, and are placed next to each other, as shown in Fig. 1 (cross sectional view).
Find the electric field everywhere. (15 %)



3. Consider a hollow infinite long rectangular pipe formed by perfect conductors of width a and height b , as illustrated in Fig. 2. Two sides of the pipe are held at electric potential V_0 while the other two are held at a potential $-V_0$. Find the potential distribution inside the pipe. (15 %)



4. (a) Write down the expression for conservation of charges, i.e., *continuity equation*, and explain the physical meaning of each term in the expression.
(b) Write down the expression for conservation of energy in the presence of electromagnetic field, i.e., the *Poynting theorem*, and explain the physical meaning of each term in the equation. (15 %)

98 學年度工程與系統科學系丙組、先進光源科技碩士學位學程工程與系統科學組碩士班入學考試
科目電磁學 科目代碼 2802、3003 共 2 頁第 2 頁 *請在【答案卷卡】內作答

5. (a) Write down the *Lorentz force law*. (15 %)
 (b) Show that magnetic forces do no work.
 (c) Describe the trajectory of an *electron* initially at rest ($\mathbf{v} = 0$) in a region having an electric field \mathbf{E} (in x -direction) and a magnetic field \mathbf{B} (in z -direction), i.e., $\mathbf{E} \perp \mathbf{B}$, and both are uniform, as shown in Fig. 3. Briefly explain why the electron follows such a trajectory (from the electric and magnetic force on the electron).

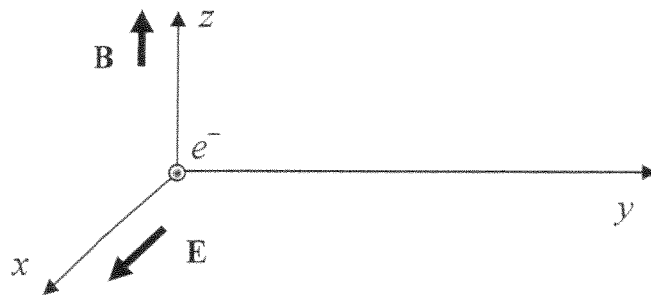


Fig. 3

6. For a very long cylindrical solenoid, consisting of current carrying thin wires of 100 turns/m tightly wound on a cylinder of radius 10 cm with a steady current 0.01 A and coaxially filled with a cylindrical rod of radius 5 cm and dielectric constant $\epsilon_r = 10$ and permeability $\mu = \mu_0$, as shown in Fig. 4, (15 %)
 (a) find the \mathbf{H} field everywhere. (b) find the \mathbf{B} field everywhere.

$I = 0.01$ A, 100 turns/m, radius 10 cm $\epsilon_r = 10$, radius 5 cm

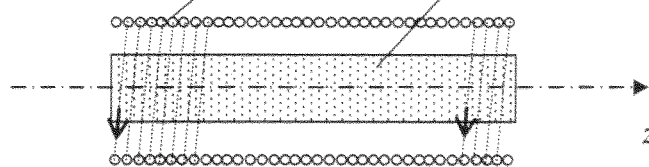


Fig. 4

7. Consider an oscillating electric dipole located at the origin and oriented along the z -direction, e.g.,
 $\mathbf{p} = p_0 \cos \omega t \hat{\mathbf{z}}$, where p_0 is a constant and ω is the angular frequency. (15 %)
 (a) Please qualitatively plot the “*radiation pattern*” in the far field zone.
 (b) An observer is located on the x -axis and at a distance d from the dipole.
 (i) What is the direction of the electric field and magnetic field seen by the observer?
 (ii) How much the “*intensity*” of the radiation from the dipole would change if the observer moves along the radial direction (away from the dipole) by a distance d (i.e., a distance $2d$ from the dipole)??