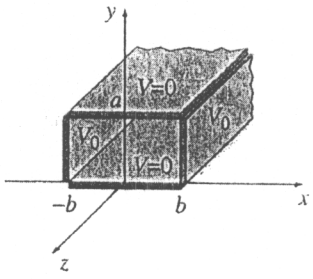
1. A soap bubble of radius R_o is slowly given a charge q and its radius increases slightly to R . If p is the atmospheric pressure, show that $q^2 = 32\pi^2\varepsilon_o p(R^3 - R_o^3)$.

(10)

2. Two infinitely long metal plates, at y = 0 and y = a , are connected at $x = \pm b$ by metal strips maintained at a constant potential V_o , as shown in the figure. Find the potential inside the rectangular pipe.

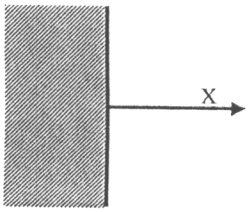


(10)

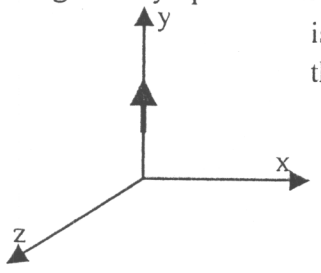
3. Two capacitors C_1 and C_2 are charged to voltage V_1 and V_2 , respectively , and then connected in parallel, i.e. positive to positive terminal and negative to negative.
   a) What is the final voltage of each capacitor ?
   b) What happen to the stored energy ?

(10)

4. a) A dielectric occupies the half-space x<0 while the other space x>0 is vacuum. The $\bar{D}$ field just inside the dielectric $x = 0_-$ is $\bar{D}_- = a\hat{i} + bz\hat{j} + c\hat{k}$, and the electric field $\bar{E}$ just outside the dielectric is $\bar{E}_+ = A\hat{i} + Bz\hat{j} + C\hat{k}$. Find the surface charges σ_{free} , σ_{pol} , and dielectric constant ε in terms of a, b, c and A, B, C.



   b) The region near the yz plane is empty except for a surface current $\bar{K} = K\hat{j}$ flowing in the yz-plane. The magnetic field just to the right of the plane, $x = 0_+$ is $\bar{B}_+ = A\hat{i} + Bz\hat{j} + c\hat{k}$. Find $\bar{B}_-$ just to the left of the plane.



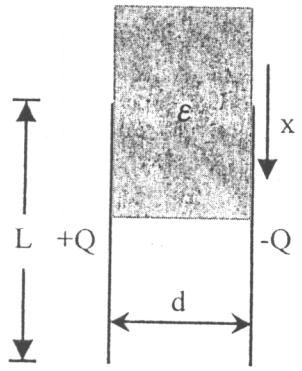
(15)

5. A short circular cylinder of radius a and length L, (L ~ a), carries a " frozen-in " uniform magnetization $\bar{M}$ parallel to its axis.
   a) Find the bound currents.
   b) Make careful sketch of bound surface current $\bar{K}$ 、$\bar{M}$ 、$\bar{B}$ and $\bar{H}$.

(10)

(背面仍有題目,請繼續作答)

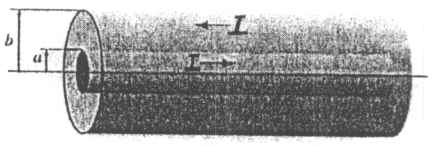
6. A condenser with square conductor plates L×L and separation d has a piece of linear dielectric ε , LxLxd, which is inserted part way into the conductor as shown. The plates carry free charge $\pm Q$.



a) Find $\vec{E}$ and $\vec{D}$ inside the conductor (two separated regions).
b) Find the energy W stored in the conductor .
c) Find the force on the dielectric. Which direction in the force.
d)Draw lines of $\vec{E}$ and $\vec{D}$ indicating clearly the regions of higher field intensity.
e)Find the surface charges σ_f , σ_p , σ_t (free, polarization, total).

(20)

7. A long coaxial cable carries current I (the current flows down the surface of the inner cylinder, radius a, and back along the outer cylinder, radius b) as shown in figure. Find the magnetic energy stored in a section of length L.



(10)

8. At time t = 0 , there are electromagnetic fields in empty space given by

$$\vec{E}(\vec{r},0)=\begin{cases}\hat{i}E_o, & z\le 0\\ 0, & z>0\end{cases};\quad \vec{B}(\vec{r},0)=\begin{cases}\hat{j}E_o, & z<0\\ 0, & z>0\end{cases}$$

a) Evaluate pointing vector $\vec{S}$, the momentum density $\vec{g}$, and energy density u everywhere in space.
b) Write down the electromagnetic fields at any later time , t . (Do **NOT** give a derivation of the results)

(10)

9. a) In regions of free space where there is no charge or current, write down the Maxwell's equations.
b) Derive from Maxwell's equations, the three dimensional wave equations of electromagnetic waves in vacuum ($\vec{E}$ & $\vec{B}$).

(10)