

1. A charge q sits at the back corner of a cube, as shown in Fig. 1. What is the flux of \mathbf{E} through the shaded side? (10%)
2. Suppose a point charge q is held a distance d above an infinite grounded conducting plane, Fig. 2. What is the potential in the region above the plane? Prove that the answer is unique? (15%)
3. A dipole \mathbf{p} is a distance r from a point charge q , and oriented so that \mathbf{p} makes an angle θ with the vector \mathbf{r} from q to \mathbf{p} . What is the force on the dipole \mathbf{p} ? Calculated by using the field produced by the point charge q . (10%)
4. A sphere, radius R , of homogeneous linear dielectric material is placed in an otherwise uniform electric field \mathbf{E}_0 in \hat{z} direction. Find the electric field inside the sphere. (15%) Hint: In the case of azimuthal symmetry, the most general separable solution to Laplace's equation is $V(r, \vartheta) = \sum_{l=0}^{\infty} (A_l r^l + \frac{B_l}{r^{l+1}}) P_l(\cos \vartheta)$, where $P_l(\cos \vartheta)$ are Legendre polynomials and satisfy the orthogonal relations:

$$\int_0^{\pi} P_l(\cos \vartheta) P_{l'}(\cos \vartheta) \sin \vartheta d\vartheta = \begin{cases} 0, & l \neq l' \\ \frac{2}{2l+1}, & l = l' \end{cases}$$

5. Find the vector potential of an infinite solenoid with n turns per unit length, radius R , and current I . (15%)
6. A coaxial cable consists of two very long cylindrical tubes, separated by linear insulating material of magnetic susceptibility χ_m . A current I flows down the inner conductor surface, Fig. 3. Find (a) the magnetic field in the region between the tubes, (b) the magnetization and (c) the bound currents. (15%)
7. Write down the differential form of Maxwell's equations in (a) free space with sources of free current and charge, and (b) good conductors. (c) Derive the wave equations of fields \mathbf{E} and \mathbf{B} in good conductor. (d) Find the plane wave solution \mathbf{E} of part (c). Assuming the wave is linearly polarized and propagates in $+z$ -direction. Express explicitly both the real and the imaginary part of the propagation vector. (e) What is the skin depth? (20%)

(背面仍有題目,請繼續作答)

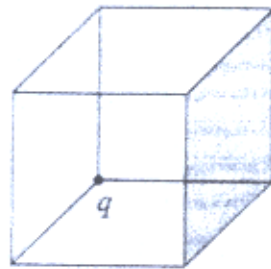


Fig. 1

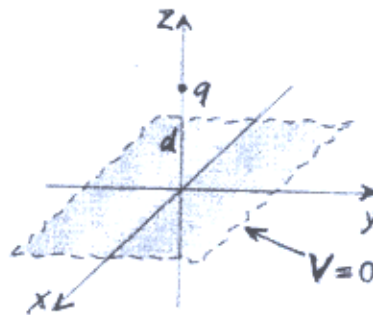


Fig. 2

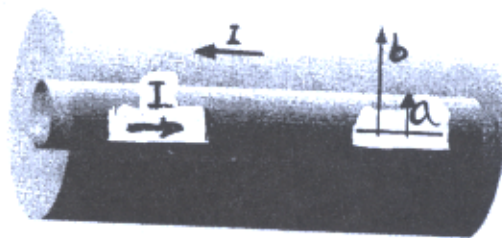


Fig. 3