(1) Two infinitely long coaxial cylindrical conducting surfaces, have radii a and b $(b>a)$, carry surface charge densities σ_a and σ_b, respectively.

(a) Determine the electric field everywhere. (10%)

(b) Determine the electric potential everywhere. (5%)

(c) What must be the relation between the two surfaces in order that the electric field vanishes for $r>b$. (5%)

(2) A point charge Q exists at a distance d above an infinite conducting plane which has a nonzero potential V.

(a) Determine the electric potential everywhere. (10%)

(b) Find the surface charge density on the plane. (5%)

(c) What is the electric force between the charge Q and the conducting plane ? (5%)

(3) An infinitely long wire in free space carrying a current I is at $z=d$ and a linear medium of permeability μ is filled in $z\leq 0$.

(a) Discuss the behavior of the normal and tangential components of the magnetic fields $\vec{B}$ and $\vec{H}$ at $z=0$. (8%)

(b) Find the magnetic fields $\vec{B}$ and $\vec{H}$ at an arbitrary point. (12%)

(c) Find the force acts on the wire per unit length. (5%)

(4)

(a) Show that the electric field is zero and the magnetic field is constant in time inside a perfect conductor. (4%)

(b) Show that the current in a superconductor (with infinite conductivity and vanishing $\vec{B}$) is confined to the surface. (6%)

(5) The electric field $\vec{E}$ of a uniform plane wave propagating in a medium is given by

$$\vec{E}=E_0[\hat{x}\cos(kz-wt)+2\hat{y}\sin(kz-wt+\pi/4)]$$

where E_0 is real.

(a) Find the magnetic field $\vec{B}$. (5%)

(b) Calculate the time average of energy density and energy flux density over one period. (15%)

(c) Describe the polarization of the wave. (5%)