1. A square-wave potential in x is in the xz plane and the plane at y=b is at zero potential as shown in the figure below. The problem is independent of z. Find the potential at all points between y=0 and y=b. (8%)
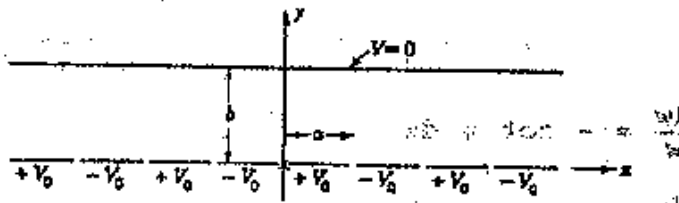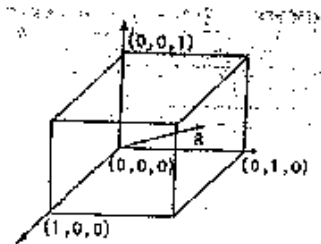

2. Calculate the capacity C of a spherical condenser of inner radius R_1 and outer radius R_2, which is filled with a dielectric varying as

$$\varepsilon = \varepsilon_0 + \varepsilon_1 \sin^2 \theta,$$

where θ is the polar angle. (8%)

3. A continuous volume charge defined as $\rho = (x^2 + y^2 + z^2)^{5/2}$ is distributed in the region $0 \le x \le 1$, $0 \le y \le 1, 0 \le z \le 1$ and is zero elsewhere. Find E_x at the origin. Refer to the figure below. (8%)

4. A conductor has the shape of an infinite conducting plane except for a hemispherical boss of radius a. A charge q is placed above the center of the boss at a distance p from the plane. Calculate the force on the charge. (8%)
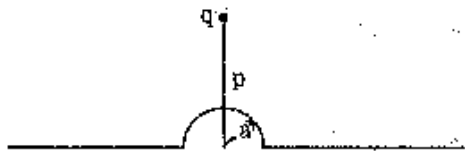
5. (a) What is the ratio of the skin depth in copper at 10Mc/sec to that at 10Kc/sec? (3%)

(b) A point charge Q is at a distance L from a conducting plane. How much energy is required to move the charge infinitely far from the plane? (3%)

(c) What is the magnetic field inside a long, straight, uniform wire of radius R which is carrying a current I? (3%)

(d) What is the electric potential inside an isolated conducting spherical shell of radius R carrying a charge Q? (3%)

(e) Suppose N identical capacitors are connected in parallel to a potential difference V. What is the potential difference obtained when these capacitors are reconnected in series, their charges being left undisturbed? (3%)

(f) What is the force on an electric dipole of strength P in a uniform electric field E? (3%)

6. A capacitor is constructed by two parallel metal plates. The spacing of the two metal plates is ℓ. The area of the metal is S, where $S \gg \ell^2$. A nonconductive material with dielectric constant ε and conductivity σ is filled in the spacing of the two metal plates. When a voltage $V = V_m \sin\omega t$ is applied on the capacitor, please find the total current within the interior of the capacitor. （ 10 分 ）

7. An infinite long cylindrical conductor with radius R, conductivity σ and dielectric constant ε. When a conduction current $i_c = I_m \cos\omega t$ flow through the conductor uniformly, please find the magnetic field within the interior （ at radius $r < R$ ） of the conductor. （ 15 分 ）

8. A lamp emits total power 500 W. 20% of the total power is isotropically and uniformly radiated as an electromagnetic wave. To find the root mean square electric field located at a distance of 20 m from the lamp. （ 15 分 ）

9. As shown in the figure below, two conductors, $AB = BC = 10$cm tilted at point B with a angle of $30°$, are placed within an uniform magnetic field $\beta = 2.5 \times 10^{-2}$ T. When the two conductors perpendicularly move through the magnetic field with a velocity of $v = 1.5$ ms^{-1}. To find the induced voltage between point A and C. （ 10 分 ）