VE230 HW4

Due: Thursday 25th June 2020

P.4–1 The upper and lower conducting plates of a large parallel-plate capacitor are separated by a distance d and maintained at potentials V_0 and 0, respectively. A dielectric slab of dielectric constant 6.0 and uniform thickness $0.8d$ is placed over the lower plate. Assuming negligible fringing effect, determine

a) the potential and electric field distribution in the dielectric slab,

b) the potential and electric field distribution in the air space between the dielectric slab and the upper plate,

c) the surface charge densities on the upper and lower plates.

d) Compare the results in part (b) with those without the dielectric slab.

P.4–5 Assume a point charge Q above an infinite conducting plane at $y = 0$.

a) Prove that $V(x, y, z)$ in Eq. (4–37) satisfies Laplace's equation if the conducting plane is maintained at zero potential.

b) What should the expression for $V(x, y, z)$ be if the conducting plane has a nonzero potential V_0?

c) What is the electrostatic force of attraction between the charge Q and the conducting plane?

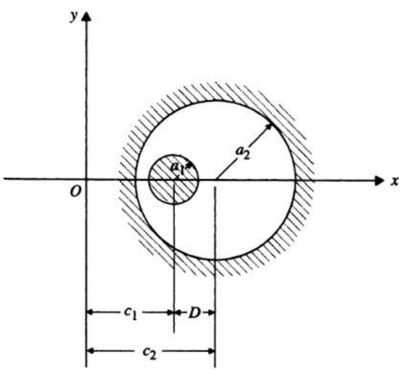
$$V(x, y, z) = \frac{Q}{4\pi\epsilon_0}\left(\frac{1}{R_+} - \frac{1}{R_-}\right), \qquad (4\text{–}37)$$

P.4–11 A very long two-wire transmission line, each wire of radius a and separated by a distance d, is supported at a height h above a flat conducting ground. Assuming both d and h to be much larger than a, find the capacitance per unit length of the line.

P.4–14 A long wire of radius a_1 lies inside a conducting circular tunnel of radius a_2, as shown in Fig. 4–10(a). The distance between their axes is D.

a) Find the capacitance per unit length.

b) Determine the force per unit length on the wire if the wire and the tunnel carry equal and opposite line charges of magnitude ρ_ℓ.



(a) A cross-sectional view.

P.4–17 Two dielectric media with dielectric constants ϵ_1 and ϵ_2 are separated by a plane boundary at $x = 0$, as shown in Fig. 4–23. A point charge Q exists in medium 1 at distance d from the boundary.

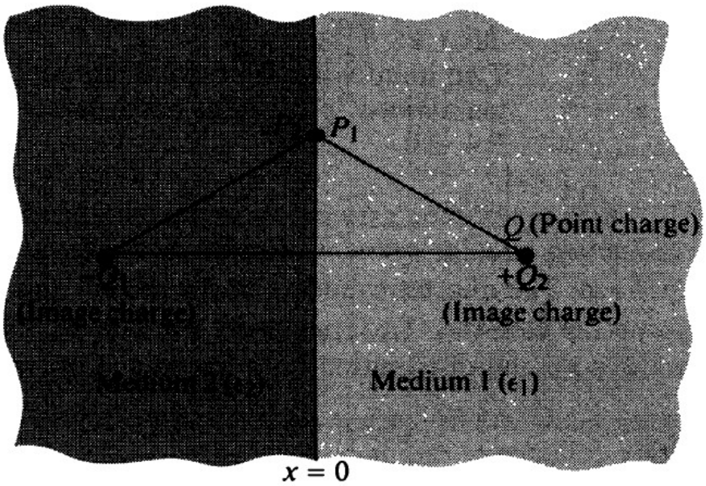


FIGURE 4–23
Image charges in dielectric media (Problem P.4–17).

P.4–23 Two infinite insulated conducting planes maintained at potentials 0 and V_0 form a wedge-shaped configuration, as shown in Fig. 4–24. Determine the potential distributions for the regions: (a) $0 < \phi < \alpha$, and (b) $\alpha < \phi < 2\pi$.

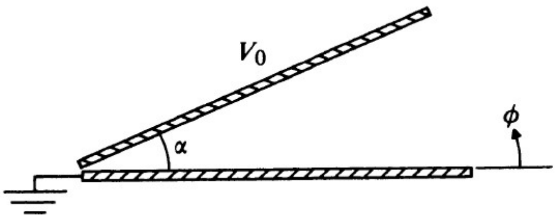


FIGURE 4–24
Two infinite insulated conducting planes maintained at constant potentials (Problem P.4–23).

P.4–28 Rework Example 4–10, assuming that $V(b, \theta) = V_0$ in Eq. (4–155a).

$$V(b, \theta) = 0^{\dagger} \qquad (4\text{–}155a)$$