



University of Michigan

• 交大密西根学院 •

UM-SJTU Joint Institute



Shanghai Jiao Tong University

VE230 HW4

Due: Tuesday 25th June 2019

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

- the potential and electric field distribution in the dielectric slab,
- the potential and electric field distribution in the air space between the dielectric slab and the upper plate,
- the surface charge densities on the upper and lower plates.
- 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 $y = 0$.

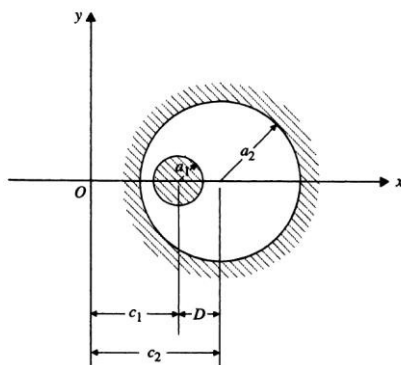
- Prove that $V(x, y, z)$ in Eq. (4-37) satisfies Laplace's equation if the conducting plane is maintained at zero potential.
- What should the expression for $V(x, y, z)$ be if the conducting plane has a nonzero potential V_0 ?
- What is the electrostatic force of attraction between the charge Q and the conducting plane?

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

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 .

- Find the capacitance per unit length.
- 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.

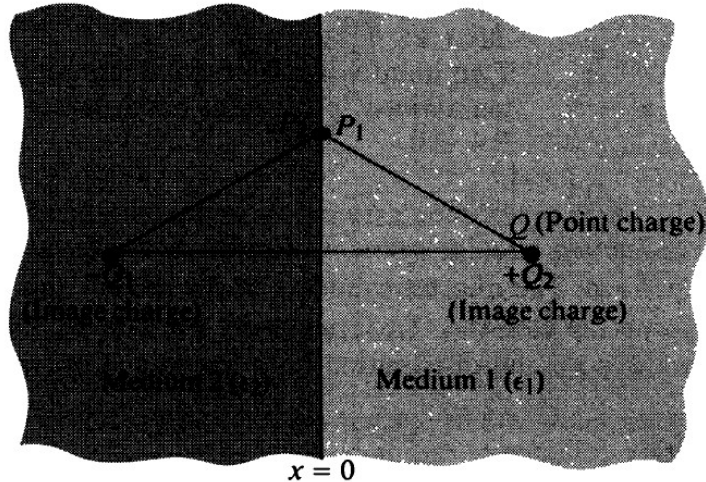


FIGURE 4-23
Image charges in dielectric media (Problem P.4-17).

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) $\alpha < \phi < 2\pi$.

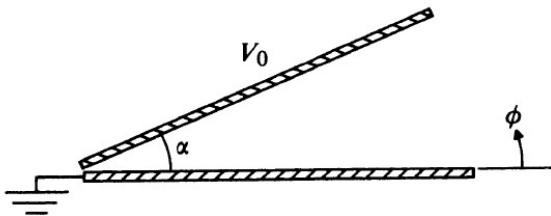


FIGURE 4-24
Two infinite insulated conducting planes maintained at constant potentials (Problem P.4-23).

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

$$V(b, \theta) = 0^+ \quad (4-155a)$$