8.02 ESG Independent Study

Unit 6: Capacitance and Dielectrics

In previous units, we've seen how fields near conductors can be expressed in terms of the charge distribution on the conductors. In this unit, we find a relation between the total charge on a conductor and its potential (remember, a conductor is an equipotential). This relation is expressed in terms of capacitance, which is defined in terms of charge on a conductor and potential difference (referred to infinity or another conductor). Capacitance depends only on the geometry of the conductors and the dielectric nature of the material near the conductor, but not on charge or voltage singly. We will also consider energy stored in a capacitor in terms of charge, voltage, and capacitance.

Objectives: After completing this unit, you should be able to:

1. Calculate the electrical capacitance of various configurations of conductors and the energy stored in them, and
2. Describe how polarization is induced in a piece of dielectric material and the effects of this polarization on the field.

Suggested procedure:

1. Read UP11 chapter 24. Suggested problems include 3, 15, 29, 39, 49, 58, 60 (slightly hard), 73ab, 75 (optional: unless you see the trick, this can be very hard, but those taking 18.06 might see what to do), 76 (involves numerical solution). Or,
2. Read in Purcell, chapter 3, sections 5 and 6, and chapter 10, sections 1, 7, 8, 11, 12. (The other sections in chapter ten are instructive but optional.) Suggested problems include pp. 115–120, #s 10, 11, 17, 20 (note that ϵ in this problem is *not* a dielectric constant), 29, and pp. 393–395, #s 12 (this should be familiar), 13, 16, 21. Number 30 on page 120–121 involves numerical methods, and might be of interest to those of the computer persuasion.
3. Take a unit test.