8.02 ESG Independent Study

Unit 10: Ampère's Law

Magnetic fields are known to be produced by currents, either a conventional current passing through a wire or the "equivalent current" associated with the motion of the electrons in the atoms that comprise a magnet. The relation between magnetic field and current is given by the Biot-Savart law in differential form or Ampère's law in integral form. The two are mathematically equivalent, analogous to Coulomb's law for the electric field due to point charges and Gauss' law for the net effect of a charge distribution.

As in unit nine, the approach of University Physics differs from that of Purcell, in that UP regards Ampère's law as following from experiment and calculation, while Purcell regards magnetism as a consequence of the relativistic effects of the moving charges that comprise a current.

Objectives: After completing this unit, you should be able to use Ampère's law or the Biot-Savart law to explain qualitatively and compute quantitatively magnetic fields due to simple charge and current distributions.

Suggested Procedure: These suggested procedures are admittedly long, but the plethora of problems should be taken as an indication of the extent of applications of Ampère's law, and hence its importance to E&M.

1. Read chapter 28 in UP11. Suggested problems include 2, 5, 15, 21, 25, 32, 55, 61, 65, 77, 80 (which needs the result of 79. Sneaky, aren't we?), 85 (don't disdain the hint!).

   or,

2. Read the rest of Purcell's chapter six. Vector potentials are not used in 8.02, but prospective physicists or mathematicians should appreciate their convenience and utility. Similarly, the relativistic transformations of the fields (eqns. 60, 60′) should be known by all, and appear on loan applications in many states. Suggested problems include pp. 245–253, #s 3, 8, 12, 14, 16, 22, 33, 37.

3. Take a unit test.