PROBLEM SET 1
ECE 312 Winter Quarter 2012

Assigned: Wed. Jan. 4th
Due: Wed. Jan. 11th in class
Instructor: Joel T. Johnson

Problem 1
A current density $\mathbf{J} = 2x\hat{x} + y\hat{y} + 3z\hat{z}$ $A/m^2$ flows throughout a region of space where $\sigma = 10 S/m$.

(a) Find the electric field.

(b) Calculate the total current $I$ flowing out of a cubical volume centered on the origin 10 cm on a side.

(c) Is this a steady current? If not, find the rate of change of the total charge inside the cubical volume. Is the total charge inside increasing or decreasing with time?

(d) Find the power dissipation in the cubical volume.

Problem 2
A 1 nC point charge moves with velocity $\vec{u}$ (m/s) in a magnetic flux density $\vec{B}$ (T). Find the force on the point charge for the following cases:

(a) $\vec{u} = 2\hat{x}$, $\vec{B} = \hat{x}$

(b) $\vec{u} = 2\hat{x}$, $\vec{B} = 2\hat{y}$

(c) $\vec{u} = 2\hat{x} + \hat{y}$, $\vec{B} = \hat{x} - 2\hat{y}$

(d) Provide an interpretation of the amplitude and direction of the force for each of your part (a)-(c) results.

Problem 3
A small piece of current of length 6 cm carries 1.5 Amps of current in the $\hat{y}$ direction. The current is located in free space at coordinates $(x = 0, y = 0, z = 0.5)$ m in a Cartesian coordinate system.

(a) Find the magnetic flux density produced by the current at the origin. Interpret the direction of your answer.

(b) Find the magnetic field intensity produced by the current at the point $(x = 0, y = 0.5, z = 0.5)$ m. Interpret your answer.

(c) A second small current of length 2 cm is located at the origin and carries 1 Amp of current in the $\hat{z}$ direction. Find the force on this second current due to the first current.

(d) A second small current of length 2 cm is located at the point $(x = 0, y = 0, z = 1)$ m and carries 1 Amp of current in the $\hat{y}$ direction. Find the force on this second current due to the first current. Interpret the direction of the force.