Electricity and Magnetism, PHYS 340 Problem set 6

1. Consider a volume current in a slab infinite in the *x, y* directions and that varies in the *z* direction and points in the *x* direction:

$$\underline{J}(x,y,z) = \begin{cases} \hat{x}\left(\dfrac{j_0|z|}{a}\right); & -a \le z \le a \\ 0 & \textit{otherwise} \end{cases}$$

a) What is $\underline{B}$ inside the slab, and above and below it?
b) Sketch a plot of B_y(z).

2. Problem 6.1 (6.1).
6. Problem 6.7 (6.7).
7. Problem 6.9 (6.9).
8. Problem 6.15 (6.15). *Optional (Laplacian in spherical geometry).*
9. Problem 6.17 (6.17).
10. Problem 7.8 (7.8).
11. Problem 7.15 (7.15).
12. A magnetohydrodynamic (MHD) generator is a device that has been proposed for generating power from flow of ionized plasma, e.g., in nuclear fusion reactors. The plasma flows in the z direction through a rectangular pipe, whose cross section is parallel to the x-y plane, and there is a magnetic field $\underline{B} = B\hat{x}$ in the plasma ($\hat{x}$ is the unit vector in the x direction). The *x, y, z* dimensions of the pipe are *w, h, l* respectively. The walls at $x = \pm w/2$ are insulating, and the walls at $y = \pm h/2$ are conducting.

a) Show that the potential between the conducting walls is $V = vBh$, where v is the fluid velocity.
b) Suppose the conducting walls are connected by a wire with resistance R. Determine the current in the wire, if ρ is the resistivity of the plasma.
(Hint: There are currents in series in the wire and in the plasma.)

Supplementary problems F:

F1. Problem 5.24 (5.23).
F2. Problem 5.41 (5.39).
F3. Problem 6.8 (6.8).
F4. Problem 6.25 (6.23).
F5. Problem (7.16).
F6. Problem 7.18 (7.18).

(Numbers from Griffiths book, 4th edition; in parentheses, to the 3rd edition)