EP440: ENGINEERING ELECTROMAGNETICS

Fall 2014, J. B. Snively

Homework #6: Due 10/13/2014 at 5:00!

For this assignment... Work out the following problems on separate sheets. Staple all, including this front page, for your submission.

1) Your textbook derives an expression for the dipole field at a position **r**=(R,θ,π/2)=(0,y,z). Note that in class we have been deriving an expression for the dipole magnetic field at a point **r**=(x,0,z), which should produce equivalent results. Please derive step-by-step an expression for the dipole magnetic vector potential **A** and the dipole magnetic flux density **B**, as we have done in class, but filling in the following important details (each being required for full credit):

- **a.** Prove that the radial distance between your "dl" differential element and your observation point "p" is given by:

$$R = |\mathbf{r} - \mathbf{r}'| = \sqrt{r^2 - 2ar\sin\theta\cos\phi' + a^2}$$

- **b.** Prove that for distances *r*>>*a*, the following approximation may be used for 1/R:

$$\frac{1}{R} \simeq \frac{1}{r}\left(1 + \frac{a\sin\theta\cos\phi'}{r}\right)$$

- **c.** Determine expression for **A** in terms of magnetic dipole moment.
- **d.** Determine whether the divergence of **A** is zero or nonzero.
- **e.** Determine expression for **B**.
- **f.** Compare and comment on the expression for the *electric* dipole field.

2) Zahn P.5-24 (a, b - noting that **K** is equivalent to surface current $\mathbf{J_s}$).

3) Cheng P.6-21.

4) Cheng P.6-22.

5) Cheng P.6-1 or Zahn P.5-1. Solving the Zahn version of this problem, which is more general, is worth 5 extra credit points.