Homework Set No. 1, Physics 835

Deadline – Wednesday, January 18, 2006

1. (10 pts) Jackson Problem 6.9 (ignore the last question about ϵ and μ being functions of position)

2. (10 pts) Jackson Problem 6.10

3. (10 pts) Consider a monochromatic electromagnetic plane wave moving along the z-axis in vacuum and described by electric and magnetic fields

$$\vec{E} = \hat{x}\, E_0 \cos(kz - \omega t)$$
$$\vec{B} = \hat{y}\, B_0 \cos(kz - \omega t),$$

where $\omega = ck$ and c is the speed of light.

(a). Show explicitly that these fields satisfy Maxwell equations in vacuum for a particular value of E_0/B_0, and find that value.

(b). Calculate the energy density and momentum density in the wave.

(c). Calculate the time-averaged Poynting vector. Show that its magnitude is related to the time-averaged energy density in the wave and interpret. (Time averaging should be done over the times greater than or equal to the period of the wave $T = 2\pi/\omega$.)

(d). Calculate the components of the time-averaged Maxwell stress tensor, and show that the non-zero component is again related to the time-averaged energy density, and interpret.

4. (20 pts) Jackson Problem 6.4. (Hint: Ohm's law is the statement that in the rest frame (!) of the conductor $\vec{J} = \sigma\vec{E}$. You'll also need to recall Galilean transformation of electric field between different frames and refresh your memory on how to solve electrostatic problems.)