PHYS 3330 Electricity and Magnetism II
Spring 2019 – Assignment 7

1. The electric field of a wave is given by

$$\boldsymbol{E}=47000\left[\cos\left(4\,x\,10^{7}\,y+3\,x\,10^{15}\,t+0.3\right)\boldsymbol{i}-\sin\left(4\,x\,10^{7}\,y+3\,x\,10^{15}\,t+0.3\right)\boldsymbol{j}\right]$$

   a. In which direction is it traveling, and with what speed?
   b. What is the wavelength?
   c. What are the frequency and period?
   d. What is the corresponding magnetic field?

2. The power per unit volume fed to the electric field is given by

$$\frac{\partial u_E}{\partial t}=\boldsymbol{E}\cdot\frac{\partial \boldsymbol{D}}{\partial t}$$

   Assuming a LIH material find the average energy density contained in the electric field of an electromagnetic wave. (Note: this is easier if you use complex fields, but if you do be careful that **E** and **D** are only the real parts of the expressions. See the class notes for the Poynting vector.)

3. Show that for an electromagnetic wave traveling in any LIH material the energy stored in the electric field, and the energy stored in the magnetic field are equal.

4. Find the electric and magnetic field amplitudes for the following:
   a. Sunlight, with a Poynting vector of 1400 W/m².
   b. A HeNe laser, with a rating of 1 mW in a spot which is 2 mm in diameter.
   c. The laser at the National Ignition Facility in Livermore, with a rating of 10.4 kJ in a light pulse which is 3.5 ns long and 40 cm in diameter.

   (See http://www.llnl.gov/nif/milestones/world_record.html)
   Note for comparison: you will produce a ‘lightning’ strike in dry air if the electric field exceeds about 30 MV/m.