Last E&M Homework of the Year!

Homework #11 (10 points) - Show all work on the following problems:

Problem 1 (4 points): In reference frame *S*, a static uniform line charge λ extends along the z-axis.

2a (1 point). Write the electric field in *S*, in Cartesian coordinates x,y,z.

2b (1 point). Find the electric field in a frame *S'* that moves with speed *u* in the x-direction with respect to *S,* in terms of x,y,z.

2c (1 point). Express your answer in terms of the *S'* coordinates x',y',z'.

2d (1point). Express your answer in terms of a vector from the present location of the wire, and the angle θ between that vector and a unit vector in the x' direction. Is the field still radially outward from the instantaneous location of the wire?

Problem 2 (1 point): Show that the dot product between the electric and magnetic fields is invariant.

Problem 3 (3 points): Consider an electromagnetic plane wave traveling in the x direction, polarized in the y direction, with amplitude E_0 and angular frequency ω in frame *S*. Use the real forms of *E* and *B* for this problem.

3a (2 points): Find the electric and magnetic fields in a frame *S'* moving with speed *u* in the x-direction with respect to frame *S*. Write the resulting fields in the *S'* coordinates x',y',z',t'.

3b (1 point): What is the frequency ω' of the wave in *S'?* What is the wavelength λ' of the wave in *S'?* What does this imply for the speed of the wave in *S'?*

Problem 4 (2 points): A straight wire along the z axis carries a uniform line charge λ, which moves at speed *v* in the +z direction. Construct the tensors $F^{\mu\nu}$ and $G^{\mu\nu}$, at the point (x,y,z) = (x,0,0).