PHYS422 Assignment 6

Due: April 4, 2019

You **must** show all work - if your solution is not supported by your work, you will not be given points for either. It is not the marker's responsibility to *decode* your work; they will not award marks if they cannot understand your work. **Solutions should be reasonably simplified to assist the marker.** Simplifying is an important aspect of readability.

1. Find the force per unit volume for the radiation field produced by an oscillating electric dipole.
2. A non-conducting ring has a static charge of $\lambda = \lambda_o \sin\phi$ and is rotating about its central axis (aligned along $\hat{z}$) at a rate of ω_o. Calculate the power radiated by this configuration.
3. Solve $\vec{S}_{rad}$ for the case of a point charge that is accelerating perpendicular to its velocity.
4. Show that the ordinary acceleration ($\frac{d\vec{v}}{dt}$) of a particle of mass m, charge q, moving at velocity $\vec{u}$ and exposed to electric field $\vec{E}$ and magnetic field $\vec{B}$ is given by:

$$\vec{a} = \frac{q}{m}\sqrt{1 - u^2/c^2}\left(\vec{E} + \vec{u} \times \vec{B} - \frac{1}{c^2}\vec{u}(\vec{u} \cdot \vec{E})\right)$$

   Explain how and why this is in contradiction with Maxwell's and Newton's view of acceleration. (Hint: It may be useful to first find an expression for the force in terms of the ordinary acceleration.)

5. Show that $\vec{E} \cdot \vec{B}$ and $E^2 - c^2B^2$ are relativistically invariant. Explain why it is impossible for $\vec{E}' = 0$ in frame $\vec{S}'$ if $\vec{E} \neq 0$ and $\vec{B} = 0$ in frame $\vec{S}$.
6. COMPUTATION: A point charge follows the path $\vec{w}(t) = v_o t\hat{z} + x_o \sin\omega t\hat{x}$. Produce ten plots of the electric and magnetic field in the $\hat{x} - \hat{z}$ plane between $t = 0$ to $t = 2\pi/\omega$. Take $v_o = 0.1c$ and $x_o = v_o/\omega$. (You are free to choose ω.) You should include an overlay of the particle's trajectory on your plot, as well as showing its current location. Note: You may need to use root solving to find the retarded location of the charge for every single $x - z$ point on your plot.