Electrodynamics, spring 2003

Exercise 11 (Thu 24.4., Fri 25.4.)

1. Go through the details of deriving the Liénard and Wiechert potentials (lecture section 13.1).
2. Show by differentiating the vector potential of a moving charge that

$$\mathbf{B}(\mathbf{r},t) = \frac{1}{c}\left[\frac{\mathbf{R}}{R}\right]_{ret} \times \mathbf{E}(\mathbf{r},t)$$

3. Assume that the electron is a classical point charge circulating the hydrogen nucleus at the distance of Bohr's radius $0.529 \cdot 10^{-10}$ m. Calculate radiation losses and estimate the lifetime of hydrogen according to classical physics.
4. Show that the wave equaation

$$\frac{\partial^2 f}{\partial x^2} - \frac{1}{c^2}\frac{\partial^2 f}{\partial t^2} = 0$$

   a) is not invariant in the Galilei transformation,
   b) is invariant in the Lorentz transformation.
5. a) Calculate the inverse matrix $g^{\alpha\beta}$ of the metric tensor $g_{\alpha\beta}$ so that $g^{\alpha\beta}g_{\beta\gamma} = \delta^{\alpha}{}_{\gamma}$.
   b) Calculate the inverse Lorentz transformation using the formula $\Lambda_{\gamma}{}^{\alpha} = (\Lambda^{-1})^{\alpha}{}_{\gamma} = g^{\alpha\beta}\Lambda^{\nu}{}_{\beta}g_{\nu\gamma}$.
   c) Show that $c^2t^2 - x^2 - y^2 - z^2$ and the square of the four-velocity are Lorentz invariant.

Return answers until Tuesday 22.4. at 14 o'clock.

Note: there are no lecture nor exercises on Thursday 17.4.. Electrodynamics continues on Thursday 24.4.