Electrodynamics, spring 2008
Exercise 11 (24.4., 25.4.; Friday group in English)

1. Assume that a charged particle is accelerated parallel to its velocity vector. Show that it does not radiate into the direction of velocity.

2. Assume that the electron is a point charge circulating the hydrogen nucleus at the distance of Bohr's radius $0.529 \cdot 10^{-10}$ m. Show by estimating radiation losses that such atoms have disappeared for a long time ago according to classical physics.

3. There are two long parallel rods at a distance of d from each other, and they are moving at a constant velocity $\mathbf{v}$ parallel to their axis. They both have a line charge density λ. Determine the non-relativistic force between them if
a) The observer moves at the same velocity as the rods.
b) The observer is at rest.
c) What restriction do you get for the velocity v from the result of b)?

4. 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.

5. a) Starting from the field tensor $(F^{\alpha\beta})$ expressed in terms of the electric and magnetic fields, show that the homogenous Maxwell equations can be written as

$$\partial_\alpha F_{\beta\gamma} + \partial_\beta F_{\gamma\alpha} + \partial_\gamma F_{\alpha\beta} = 0$$

Note that there are more tensor equations than Maxwell equations. Show that the "extra equations" are identically fulfilled.
b) Express $F_{\alpha\beta}F^{\alpha\beta}$ by using the fields.

Return the answers until Tuesday 22.4. 12 o'clock.