Electrodynamics Exam

1 February 2017, 18.30-21.30 uur

Rules:

- Closed book part $\leq$ 2 hours, open book part all remaining time.
- Please formulate clearly and concisely. Read carefully.
- Grade = $1 + \frac{score}{10}$.

1. **Radiation and Special Relativity [8+8+8+8+8=40 points]**

   (a) Explain how causality plays a role in the creation of radiation (hint: you could draw a picture).

   (b) Use the fundamental principles underlying special relativity to explain the relativity of simultaneity.

   (c) Can a relativistically moving observer and one in rest agree on the work done by a four-force? Explain why or why not.

   (d) Construct three Lorentz invariants that contain the frequency of light.

   (e) Derive a classical order of magnitude expression for the Thomson scattering cross section.

2. **Radiation Basics and Dynamics [5+5+5+5=20 points]**

   (a) Explain a fundamental progression in gamma factor γ that underlies relativistic radiation processes.

   (b) Derive how a Lorentz boost affects the solid angle into which a source radiates (hint: use the notion of beaming).

   (c) Argue what unique similarity in emitted power exists between inverse Compton scattering and synchrotron emission.

   (d) Explain the difference between thermal and thermodynamic equilibrium.

> end of closed book part, please hand in questions 1 and 2.

3. **An Observable Spectrum [10+10+10=30 points]**

   (a) Consider figure 5.5 of the book. How would self-absorption modify this spectrum? Provide formulas.

   (b) Consider figure 6.14 of the book. In what aspect(s) can this synchrotron source mimic inverse Compton effects? Provide formulas.

   (c) Consider figure 7.4 of the book. What happens to this spectrum if the saturation limit is not reached? Provide formulas.

> end of exam, please hand in question 3.