

Write an essay on the following topic:

### **Electrodynamics from Hamiltonian and Lagrangian Principles**

The essay should be approximately five to seven pages (A4), preferably written in  $\text{\LaTeX}$ . It must contain at least one of the following topics:

1. Maxwell's equations as the Euler-Lagrange equations of a Lagrangian;
2. how to obtain the Lorentz force on a charged point particle from the Hamiltonian;
3. Noether's theorem and conservation laws for electrodynamics;
4. Gauge invariance, covariant derivatives, and Lagrangian field theories.

The assessed homework is worth 15% of the module mark. Points will be given in particular for mathematical rigour, the use of correct English, a coherent narrative, and general presentation. The essay should be handed in at G12 before the last day of the semester.

Suggested reading:

1. *Classical Electrodynamics*, 3<sup>rd</sup> edition, by J. D. Jackson, Wiley (1998).
2. *Modern Electrodynamics*, by A. Zangwill, Cambridge University Press (2013).
3. *Classical Electromagnetism in a Nutshell*, by A. Garg, Princeton (2012).
4. *Classical Mechanics*, 2<sup>nd</sup> edition, by H. Goldstein, Addison-Wesley (1980).
5. *Lagrangian Interaction*, by N. A. Doughty, Westview Press (1990).