Exercises Electrodynamics	**Sheet 6**

[Tutorial 2.11.]

Exercise 1: We consider a conductor, in which a current is carried by particles of mass m, charge q and constant charge density ρ (the total charge density vanishes, because of non-moving particles of the opposite charge density). The current is caused by a spatially constant electric field, but there are no magnetic fields. Apart from the Lorentz force, the particles feel a Stokes friction, $\vec{F}_R = -\alpha\,\vec{v}$.

(a) Derive the Ohm law,

$$\vec{j} = \sigma\,\vec{E}\ ,$$

in the limit that $\vec{E}$ is approximately constant and time is large.

(b) The electric field cannot, however, be exactly constant. Can you estimate how it decays?

Exercise 2: We consider a square wire, of side length L. The wire is not closed, but rather there is a device placed at one point, which measures the induced voltage U. The wire rotates around a principal axis which is parallel to two sides and runs through the center of gravity. The angular velocity ω is constant, and there is a constant homogeneous magnetic field $\vec{B}$ that is orthogonal to the axis of rotation. Determine U as a function of time.

Exercise 3: A round-shaped wire, of radius R, is placed in the (x, y)-plane and moves with constant velocity $\vec{v} = v\,\vec{e}_x$ in the x-direction. In the domain $x > 0$ there is a constant magnetic field $\vec{B} = B_0\,\vec{e}_z$. Compute the induced voltage $U(t)$ as a function of time, and sketch the result.