1. Two small metal balls with masses $m_1 = m_2 = 25 \cdot 10^{-5}$ kg are hanging from dielectric cords having a length of 0.5 m each and touching each other. The balls are charged with equal charges. Therefore, the balls repulse each other and move until the both cords form an angle of 45° with the vertical. How large is the charge of each ball?

2. A capacitor of capacitance C is charged to a potential difference V_0. The terminals of the charged capacitor are then connected to those of an uncharged capacitor with capacitance $C/2$. Find a) the original charge of the system, b) the final potential difference across each capacitor, c) the final energy of the system, and d) the decrease in the energy of the system.

3. The cross section of a long straight wire is circular (radius R). The current I carried by the wire has an inhomogeneous distribution. The current density as a function of the distance from the center axis (r) of the wire is $J = \alpha r$, where α is constant.
   a) Calculate α expressed with R and I.
   b) Calculate $B(r)$, when $r \leq R$ and when $r \geq R$, using Ampere's law.

4. A toroidal solenoid with $N = 2000$ turns has area of cross section $A = 0.400$ cm^2 and radius $r = 9.00$ cm. Calculate the inductance while the toroidal solenoid is filled with a) air, b) ferromagnetic material having relative permeability of $K_m = 600$.

5. a) Homogenous electric field $\overline{E}$ and homogenous magnetic field $\overline{B}$ are detected in the same spot in vacuum. The energy densities of the fields are equal. Calculate E if $B = 1,2 \cdot 10^{-5}$ T. (3 p)
   b) Unpolarised light hits the planar surface of a glass plate at an angle of 57°. The reflected light is totally linearly polarised. Calculate the refractive index of the glass and the refraction angle. (3 p)

6. Electron is in a one-dimensional box of width L. The potential energy is zero in the box and infinity at the walls.
   a) Derivate the relation for the allowed energy states of the electron using Schrödinger equation. (4 p)
   b) Calculate the energy separation of the two lowest states, if L = 1.5 nm. (2 p)

Constants: mass $m = 9.11 \cdot 10^{-31}$ kg and charge $e = 1.60 \cdot 10^{-19}$ C of electron, mass of proton and neutron $m = 1,67 \cdot 10^{-27}$ kg, $c = 3.00 \cdot 10^8$ m/s, $\mu_0 = 4\pi \cdot 10^{-7}$ Tm/A, $\varepsilon_0 = 8.85 \cdot 10^{-12}$ F/m

Name, student number, degree programme (EST, TLT, AUT, ...), course code and the date on each examination paper.