Many-body problem 1. Exercises
(**Deadline**: 17. May 2017.)

1. Consider a non-interacting 3D electron gas in the presence of a localized impurity with potential $U(\mathbf{r}) = \gamma\delta(\mathbf{r})$. Show, that Friedel oscillations show up in this case as well to first order in γ! (10)

2-3. Using the results in arxiv.org/abs/1111.5337, determine the Friedel oscillations in 1D (15) and 2D (15) in an interacting electron gas around localized charged impurity with charge Ze! Pay attention to the Fourier transform of the Coulomb interaction which decays as $1/r$ in any dimension!

4-5. Calculate the ground state energy per particle of the Jellium model in the (Hartree-)Fock approximation in 1D and 2D! (15+15)
a. Determine the k_F dependence of the total number of particles!
b. Calculate the average kinetic energy!
c. Using the Fock diagram, evaluate the first order correction to the ground state energy from the interaction!
d. Determine the optimal interparticle distance or fermi wavenumber, which minimizes this energy. When do you expect the perturbation theory to be valid?