Name: ______________________________

Advanced Solid State Physics
Winter semester 2014/2015
14th (and last) exercise sheet

Prof. Dr. W. Kuch

Submission: Tuesday, 03. February 2015, before the lecture
(or drop until 10 o'clock on the same day in mailbox between rooms 1.2.38 and 1.2.40)

38. Macroscopic magnetic moment (*) (4 points)

Using a magnetometer, the total magnetic moment of a sample is measured as $4.8 \cdot 10^{-8}$ Am^2. The sample consists of an ultrathin Fe film with (001) surface orientation on a circular substrate of 8.0 mm diameter. The Fe film is 4.0 atomic layers thick. Fe has a bcc crystal structure with lattice constant a = 2.87 Å.

a) What is the magnetic moment (in μ_B) of a single Fe atom in that film?
b) What is the magnetization of the Fe film?

39. Finite-size scaling (**) (4 points)

A magnetic material has a Curie temperature of 860 K. A thin film of 1.5 nm thickness of the same material exhibits a Curie temperature of 600 K. Use finite-size scaling to estimate the thickness at which the Curie temperature of a thin film of this material is equal to room temperature (300 K), assuming

a) the mean-field model,
b) the two-dimensional Ising model, and
c) the three-dimensional Heisenberg model.

40. XMCD sum rules (*) (4 points)

X-ray magnetic circular dichroism (XMCD) is the difference between x-ray absorption spectra taken for opposite helicity of circularly polarized x rays. Use the XMCD sum rules introduced in the lecture to evaluate the ratio of orbital to spin magnetic moment μ_L/μ_S resulting from the following experiment, performed on a Co sample:
The integral of the XMCD difference curve (absorption spectrum for positive minus spectrum for negative helicity) over the photon energy range of the Co L_3 absorption edge (corresponding to $2p_{3/2} \rightarrow 3d$ transitions) is measured to be 1.6 times larger and opposite in sign than the integral of the XMCD difference curve over the photon energy range of the Co L_2 absorption edge (corresponding to $2p_{1/2} \rightarrow 3d$ transitions).