

3. *Response of materials to an external magnetic field*

- (a) Magnetism is a quantum-mechanical phenomenon. How the response of a material to the external magnetic field \mathbf{B}_0 is described in the quantum-mechanical formalism? (3 p)
- (b) Describe the response of atoms to \mathbf{B}_0 also in terms of magnetic moments, quantized energy levels, and their filling at a finite temperature. How the resulting susceptibility depends on the temperature (4 p)

4. *Spontaneous magnetism*

- (a) Which are the competing effects in the Stoner model determining whether or not a metal is ferromagnetic? (1 p)
- (b) What type of theories there exists to describe the temperature behaviour of ferromagnets? Are the theoretical models in agreement with experiments? What is the role of spin waves? (4 p)
- (c) Which effects cause the existence of domains and the details of the domain structure in ferromagnets? (2 p)