

PHYS 711: Statistical Mechanics

Postulates of thermodynamics. Thermodynamic equilibrium. The fundamental equation in the entropy and energy representations. Temperature, pressure, chemical potential. Maxwell relations among thermodynamic properties.

Thermodynamic potentials: free energy, Gibbs energy, enthalpy, etc. The Gibbs-Helmholtz equations. Second derivatives of thermodynamic potentials: heat capacity, thermal expansion, compressibility. The Jacobian method and other techniques of thermodynamic calculations.

The Gibbs and Gibbs-Duhem equations for homogeneous systems. Multicomponent systems. Thermodynamics of electric and magnetic systems.

Reversible and irreversible processes. Thermodynamic inequalities. Direction of thermodynamic processes. Thermodynamic stability.

Elements of combinatorics. The microcanonical distribution. Two-level systems and the two-level model of paramagnetics. Negative temperature. A system of non-interactive quantum oscillators. The Einstein model of solids.

Canonical ensemble. The canonical formalism for thermodynamic calculations. Fluctuations in canonical systems. Application to a system of non-interacting quantum rotators.

Density of states. Thermodynamics of solids: the phonon density of states, Debye model. Thermodynamics of black-body radiation.

Grand-canonical formalism. The grand potential. Application to surface adsorption.

Classical canonical formalism. Phase space and the quasi-classical approximation. Linear momentum distribution for non-relativistic and relativistic particles. Classical theories of paramagnetic and rotating particles. Classical ideal gas of polyatomic molecules. The equipartition rule.

Quantum gases of material and non-material particles. The Fermi-Dirac and Bose-Einstein distributions. The grand potential of a quantum gas. Degenerate Fermi gas and application to electrons in metals. Bose gas of material particles and Bose-Einstein condensation.

Recommended texts:

L. D. Landau and E. M. Lifshitz "Statistical Physics", Part 1 (Course of Theoretical Physics, Volume 5), Third Edition, Butterworth-Heinemann, 2000, Oxford, ISBN 0-7506 -3372-7

W. Greiner, L. Neise and H. Stocker " Thermodynamics and Statistical Mechanics", Springer-Verlag, NY, 1995. ISBN 0-387-94299-8