Spring 2019

PHYS 641-102: Statistical Mechanics

Andres Jerez
Spring 2019, Physics 641: Statistical Mechanics
Mondays, 6:00pm to 8:50pm, FMH 321

Instructor:

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Office hours: M 10:00 am -11:00 am, W 11:30am - 2:30 pm

Course Textbooks:

Introduction to Modern Statistical Mechanics by David Chandler

Grade Decomposition:

Total course grade = 30% Homework + 30% Midterm Exam + 40% Final Exam

Learning Objective: Students are expected to learn the basic formalism of
thermodynamics, including the 3 laws of thermodynamics, the various thermodynamic
potentials and their relations with various thermodynamic variables, as well as the equation
of states, and Maxwell relations. Students are also expected to learn the basic formalisms
of statistical mechanics, including the canonical, micro-canonical and grand-canonical
ensemble theories, classical Maxwell-Boltzmann distribution and quantum statistical
mechanics including Fermi-Dirac and Bose-Einstein distributions. Special topics including
paramagnetic spin systems, Bose-Einstein condensation, continuous phase transitions,
Landau’s mean field approach to phase transition and Ising model are also required.

Learning Outcome Evaluation Metrics: Through in-class quiz and discussion, instructor
can evaluate students’ understanding of basic physical concepts. Through homework,
instructor can evaluate students’ problem solving capability. Mid-term and final exams
offer instructor the opportunity to comprehensively test students’ understanding of course
material and problem solving capability.

At the end of the semester, students should be able to
• Solve thermodynamic potentials using equation of state and vice versa.
• Using thermodynamic basic equations and Maxwell relations to obtain various
thermodynamic equilibrium properties.
• Using Clapeyron equation to solve first order phase transition problems.
• Using Maxwell velocity distribution to solve various molecular gas problem.
• Using Maxwell-Boltzmann distribution to solve paramagnetic salt problem
• Using canonical ensemble theory and partition function method to solve statistical
mechanics problem, particularly for weak-interaction system
• Using Fermi-Dirac distribution to solve ideal Fermi gas system problem, in particular for those highly degenerate systems.
• Using Bose-Einstein distribution to solve ideal Bose gas system problem, in particular Bose-Einstein condensation problem.
• Solve 1d Ising model using transfer-matrix method
• Using Bose distribution to solve black-body radiation and phonons in solid.

**Course Schedule:**

Week 1  Thermodynamics of homogeneous system I
Week 2  Thermodynamics of homogeneous system II
Week 3  Statistical Mechanics: Math and Principles
Week 4  Ensemble theory (micro-canonical and canonical ensembles)
Week 5  Grand canonical ensemble, occupation number and distribution function for non-interacting system
Week 6  Boltzmann Statistics and its application
Week 7  Midterm exam (3/11)
Week 8  Bose statistics and its application
Week 9  Fermi statistics and its application
Week 10  Thermodynamics of phase transition
Week 10  Statistical mechanics of Phase transitions I
Week 11  Statistical mechanics of Phase transitions II
Week 13  Non-equilibrium statistical mechanics