Spring 2019

PHYS 641-102: Statistical Mechanics

Andres Jerez

Spring 2019, Physics 641: Statistical Mechanics

Mondays, 6:00pm to 8:50pm, FMH 321

Instructor:

Andres Jerez: **Office: Tiernan 455,**
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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
Statistical Mechanics (2nd Edition) by Kerson Huang, John Wiley.

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-matric 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**