Guelph-Waterloo Physics Institute

PHYS*7040 – Statistical Physics I

Fall 2010

Instructor: Rob Wickham
University of Guelph, MacN 448
(519) 824-4120 × 53704
rwickham@uoguelph.ca

Lectures: Mondays and Wednessdays, 8:30 am – 9:50 am, Main Link Room

First Lecture: Monday, September 13^{th}
Last Lecture: Wednesday, December 8^{th}

Office Hours: Guelph: Mondays, 4 pm – 6 pm
Waterloo: Mondays, 10 am – 11 am (Coffee Shop)

Required text: D. Chandler, *Introduction to Modern Statistical Mechanics*, (Oxford, 1987).

Suggested texts: R. K. Pathria, *Statistical Mechanics*
H. B. Callen, *Thermodynamics and an Introduction to Thermostatistics*
J. P. Sethna, *Statistical Mechanics: Entropy, Order Parameters and Complexity*
G. Mazenko, *Equilibrium Statistical Mechanics*
M. Kardar, *Statistical Physics of Particles*
M. Plischke and B. Bergersen, *Equilibrium Statistical Mechanics*
D. L. Goodstein, *States of Matter*

Evaluation:

Assignments	50%
Midterm	10%
Final Exam	40%

Assignments will be due every two weeks.

Students may discuss problems amongst themselves but their written solutions must not be shared with anyone (this would be an example of plagiarism).

Plagiarism is the act of appropriating the "...composition of another, or parts or passages of his [or her] writings, or the ideas or language of the same, and passing them off as the product of one's own mind..." (Black's Law Dictionary). A student found to have plagiarized will receive zero for the work concerned. Collaborators shown to be culpable will be subject to the same penalties.

Midterm date: Wednesday, November 3^{rd}, in class.

Exam date: Wednesday, December 15^{th}, 1 pm – 4 pm, Main Link Room

(A medical certificate is required if the exam is missed.)

Course and Instructor Evaluation:

The Department of Physics requires student assessment of all courses taught by the Department. These assessments provide essential feedback to faculty on their teaching by identifying both strengths and possible areas of improvement. In addition, annual student assessment of teaching provides part of the information used by the Department Tenure and Promotion Committee in evaluating the faculty member's contribution in the area of teaching.

The Department's teaching evaluation questionnaire invites student response both through numerically quantifiable data, and written student comments. In conformity with University of Guelph Faculty Policy, the Department Tenure and Promotions Committee only considers comments signed by students (choosing "I agree" in question 14). Your instructor will see all signed and unsigned comments after final grades are submitted. Written student comments may also be used in support of a nomination for internal and external teaching awards.

NOTE: No information will be passed on to the instructor until after the final grades have been submitted.

Course Outline

This is a course about the structure and methods of statistical physics and thermodynamics. The first half of the course deals with thermodynamics, ensemble theory and quantum gases, and should provide researchers with a solid background in the fundamentals. The remainder of the course is devoted to more advanced topics: phase transitions, model interacting systems, response and correlation functions, and scaling concepts. Whenever possible, examples of applications of these concepts to experiment will be provided. This course should be a point-of-departure into many areas of current interest, including: studies of novel materials, interacting many-body systems (both quantum and classical), and renormalization group theory. The 24 lectures will cover the following topics:

Topic I: Thermodynamics (2 weeks)

Microscopic and statistical basis of thermodynamics, thermodynamic formalism. Representations of thermodynamics, potentials, extremum principles, response functions

Topic II: Ensemble Theory (1.5 weeks)

Ensemble theory, fluctuating variables and distributions, ideal systems

Topic III: Dense Gases and Liquids (2 weeks)

Virial expansion, cluster integrals, van der Waals fluid, pair correlation functions, relation to scattering and response

Topic IV: Quantum Ideal Gases (3 weeks)

Quantum statistical mechanics, the quantum limit, indistinguishability, Fermi and Bose statistics. Thermodynamics of quantum gases, Bose-Einstein condensation

Topic V: Phase Transitions and Critical Phenomena (3.5 weeks)

Thermodynamic stability, van der Waals fluid, Ising model, mean-field theory, Landau theory and effective Hamiltonians, breakdown of mean-field theory, criticality, scaling