PHYS 3680 STATISTICAL MECHANICS 2015

INSTRUCTOR: J. Sirker
Office: Room 515, Allen Building
Tel: 474-6192 Email: sirker@physics.umanitoba.ca

LECTURES: Monday, Wednesday and Friday, 9:30-10:20 am, Allen Building 330

Attendance at all lectures is expected. It is advisable to take detailed notes, and to review them after each lecture. Please come and see me during consultation times if you have any questions.

CONSULTATION TIMES:

- Regular consultation times are from 10:30 - 11:30 am on Mondays and Wednesdays.
- Please send me an email if you want to see me at a different time.

TEXTBOOKS:

1) Roger Bowley and Mariana Sánchez, *Introductory Statistical Mechanics*, 2nd ed. (Oxford University Press, 1999).

This book is the main reference. Supplementary material for specific chapters will be announced in class.

2) LD Landau and EM Lifshitz, *Statistical Physics, Part 1* (Elsevier Butterworth-Heinemann, 1980).
This is a more advanced book which offers a different point of view on many of the subjects covered.

3) For chapter I: J.R. Taylor, *Classical Mechanics,* (University Science Books, 2005).
Relevant is chapter 13 (Hamiltonian Mechanics), pages 521 - 550.

ASSIGNMENTS:

Homework problems will be assigned on a regular basis (usually every two weeks) and collected for marking (usually one week later).

EVALUATION PROCEDURE:

The final course grade will be made up as follows:

Assignments:	25%
Midterm test:	25%
Final exam:	50%

POLICY ON LATE SUBMISSION OF ASSIGNMENTS:

Late assignments will be penalized 5% of the total mark per day overdue, unless a satisfactory reason for the delay is given.

POLICY ON PLAGIARISM AND CHEATING:

The Faculty of Science guidelines on plagiarism and cheating are found on the web at:
http://umanitoba.ca/science/student/webdisciplinedocuments.html
Acts of academic dishonesty include, but are not limited to bringing unauthorized materials into a test or exam, copying from another individual, using answers provided by tutors, plagiarism, and examination personation. Penalties that may apply, as provided for under the University of Manitoba's Student Discipline By-Law, range from a grade of zero for the assignment or examination, failure in the course, to expulsion from the University. The Student Discipline By-Law may be accessed on the web at:
http://umanitoba.ca/admin/governance/policies/section_1200/1202.shtml

COURSE OUTLINE:

This course serves as an introduction to statistical mechanics. An important goal of the course will be to present the basic principles and illustrate these principles using contemporary examples.

1. INTRODUCTION: Objectives of Statistical Mechanics
2. PROBABILITY AND STATISTICS
   - Introduction to the basics of Probability Theory
   - Permutations and Counting the number of events
   - Distributions
3. THE IDEAS OF STATISTICAL MECHANICS
   - Entropy and Probability
   - Simple Examples
   - Quantum states and the Microcanonical Ensemble
   - The Second Law of Thermodynamics
4. THE CANONICAL ENSEMBLE
   - The Partition Function
   - General definition of Entropy
   - Free Energy
   - Thermodynamic Relations
   - Simple Examples
   - Thermal Equilibrium: Minimizing the Free Energy
5. IDENTICAL PARTICLES
   - Symmetric and antisymmetric wavefunctions
   - Bose and Fermi particles
   - Partition function for identical particles
6. MAXWELL VELOCITY DISTRIBUTION
   - Density of states
   - Distribution of particle speeds in a classical gas
7. PLANCK'S DISTRIBUTION
   - Planck's distribution and radiation law
   - Thermodynamics of the photon gas
   - Thermal vibrations in solids (models of Debye and Einstein)
8. SYSTEMS WITH VARIABLE NUMBERS OF PARTICLES
   - The chemical potential
   - The Grand Canonical Ensemble and Potential
9. FERMI AND BOSE QUANTUM STATISTICS
   - Fermi-Dirac and Bose-Einstein distributions
   - The ideal Fermi gas: properties and examples
   - The ideal Bose gas: Bose-Einstein condensation.
10. PHASE TRANSITIONS
    - Ising Model: Mean Field Theory and the One-Dimensional Case
    - Classification of Phase Transitions: Landau theory
    - Basics of Renormalization Group Theory: Critical exponents