

**INSTRUCTOR:** J. Sirker (Allen 515), Email: sirker@physics.umanitoba.ca

**FORMAT:** Online lectures on Tuesdays and Thursdays at 1pm or agreed upon times

**TEXTBOOKS:** There is no required textbook for this course. Course notes will be published online. However, you might want to consult some of the textbooks listed below:

- 1) LD Landau and EM Lifshitz, *Statistical Physics, Part 1* (Elsevier Butterworth-Heinemann, 1980). Excellent discussion of many of the core concepts.
- 2) RK Pathria, *Statistical Mechanics* (Butterworth-Heinemann). Another good introduction into the classical topics of Stat. Mech.
- 3) Roger Bowley and Mariana Sánchez, *Introductory Statistical Mechanics* (Oxford Univ. Press, 1999). This is an undergraduate textbook. It contains helpful explanations of the main ideas and is easy to read.

1. INTRODUCTION:

- Objectives of Statistical Mechanics
- Hamiltonian mechanics, phase space
- Liouville theorem, Poincare theorem
- Density operators classical and quantum
- Dirac notation

2. BASICS OF EQUILIBRIUM STATISTICAL MECHANICS

- Ensembles
- Entropy
- Partition functions, thermodynamic relations, fluctuations

3. THE IDEAL GASES

- The classical ideal gas
- Identical particles: Fermions and Bosons
- The ideal Bose gas (Photon gas, vibrations of solids, Bose-Einstein condensation)
- The ideal Fermi gas

4. BOSE-EINSTEIN CONDENSATION IN WEAKLY INTERACTING GASES

- Cold atomic gases, traps, optical lattices

5. MAGNETIC SYSTEMS

- The Ising model (Solution in one dimension)
- The Hubbard and the Heisenberg model

6. PHASE TRANSITIONS

- Mean Field Theory
- Classification of Phase Transitions: Landau theory
- Critical exponents