PHYSICS 7500 FALL 2014

Instructor: P.H. Keyes, 239 Physics Research Bldg., 577-2606, keyes@wayne. edu.

Office Hours: M & W, 3-4 p.m., and by appointment.

Text: R.K. Pathria, Statistical Mechanics, Third Edition.

Class: 12:50 - 2:50 p.m., Tu. & Th., room 185, Physics

Exams: I - Oct. 16; II - Nov. 20; Final - Tu., Dec. 16, 10:40 a.m. - 1:10 p.m.

Grading: 20% for each hour exam, 40% for the final exam, 20% for homework.

Homework will be assigned weekly and collected one week later. Late homework will not be accepted.

Course Outline:

FUNDAMENTALS

0. Review of Thermodynamics *(most of this material is not covered in the textbook so review whatever thermodynamics text you have used previously)* : First and Second Laws, Entropy, Third Law, Equations of State, Thermodynamic Potentials, Maxwell Relations, Method of Reduction of Derivatives, Stability Conditions, Phase Equilibrium and Phase Transitions.

1. Statistical Basis of Thermodynamics: Entropy and Probability, Microcanonical Ensemble, Two Level System, Classical Ideal Gas, Gibbs's Paradox, "Correct" Counting.

2. Elements of Ensemble Theory (reading assignment)

3. Canonical Ensemble (*skip Sec. 3.2 and the end of 3.10)* Partition Function, Energy Fluctuations, Equipartion of Energy, Paramagnetism.

4. Grand Canonical Ensemble Particle Reservoirs, Number and Density Fluctuations.

5. Quantum Statistics (reading assignment).

NON-INTERACTING SYSTEMS

6. Simple Gases (*skip Secs. 6.4 and 6.5.C*) Quantum Statistics, Occupation Numbers, Diatomic Molecules.

7. Ideal Bose Systems *(skip Secs. 7.4 and 7.5)* Bose-Einstein Distribution, Photons, Phonons, Bose-Einstein Condensation, Superfluids.

8. Ideal Fermi Systems *(skip Secs. 8.3 - 8.6)* : Ideal Fermi Gas, Fermi-Dirac Distribution, Electrons in Metals, Landau Diamagnetism, Pauli Paramagnetism.

9. Skip this chapter.

INTERACTING SYSTEMS

10. Cluster Expansions (*SKIP sECS. 9.4 - 9.6)* Virial Coefficients, The Pair Correlation Function.

. **11.** Skip this chapter.

12. Phase Transitions and Critical Phenomena van der Waals Model; Ising Model for Magnetism; Binary Alloys, Binary Liquids, and the Lattice Gas; Bragg-Williams Approximation and Mean Field Theory; Bethe Approximation; Order Parameter and Correlation Function; Critical Exponents; The Landau Theory of Phase Transitions; Scaling; Critical Points, Tricritical Points, Nearly-Second-Order Transitions; Fluctuations and the Ginsburg Criterion; Upper and Lower Critical Dimensionalities;

13. Exact Results *(Secs. 13.1, 13.2 and 13.4 only)* One Dimensional Ising Model-Complete Solution; The Onsager Problem-Discussion of the Exact Solution..

14. The Renormalization Group *(skip Sec. 14.5)* : Block Spins (The Kadanoff Transformation), Fixed Points, Scaling Fields, Relevant and Irrelevant Variables, Position Space RG, Momentum Space RG, The ε Expansion.