# Statistical mechanics

### Physics 715, Natalia Perkins

### Jan. 21, 2008

**Textbook:** Statistical Physics, L.D. Landau and E.M. Lifshitz.

**Additional reading:** Statistical Mechanics, K. Huang (on reserve in library).

**Lectures:** 2120 Chamberlin, MWF, 9:55am.

**Grading:** Grades will be a weighted average: 0.40 homework, 0.20 mid-term exam, 0.40 final exam.

HW will be handed out approximately every two weeks. Working together on the homework is encouraged. We will grade the homework based on the following scale: 3 essentially correct, 2 strong effort, 1 some progress, 0 little or no progress. At the end of the semester the homework will then be linearly scaled to 90/80/70 corresponding to A/B/C. We will do this a couple of times in the middle of the semester as well, for your feedback.

**Office Hours and Contact Information:**
11:00am, Fridays, 5324 Chamberlin, 263-4168, perkins@physics.wisc.edu

| Tentative Schedule of Topics | | |
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| *Week 1* | | |
| Wed. | 01/23/08 | Introduction. Fundamental Priciples of Statistical Physics. |
| Fri. | 01/25/08 | Statistical distribution.Liouville's theorem. |
| *Week 2* | | |
| Mon. | 01/27/08 | The statistical matrix. Quantum statistics. |
| Wed. | 01/29/08 | Thermodynamic variables. |
| Fri. | 02/01/08 | The laws of Thermodynamics (Part I). |
| *Week 3* | | |
| Mon. | 02/04/08 | The laws of Thermodynamics (Part II). |
| Wed. | 02/06/08 | The Gibbs distribution. |
| Fri. | 02/08/08 | The Maxwell distribution. |
| *Week 4* | | |
| Mon. | 02/11/08 | The derivation of the thermodynamic relations from the Gibbs distribution. |
| Wed. | 02/13/08 | The Bolzmann distribution. |
| Fri. | 02/15/08 | Monoatomic and diatomic ideal gases. |
| *Week 5* | | |
| Mon. | 02/18/08 | Magnetism of gases. |
| Wed. | 02/20/08 | The Fermi and Bose distributions. |
| Fri. | 02/22/08 | Mid-term exam. |
| *Week 6* | | |
| Mon. | 02/25/08 | Ideal electron gas. |
| Wed. | 02/27/08 | Landau diamagnetism. Pauli paramagnetism. |
| Fri. | 02/29/08 | Liquid He. |
| *Week 7* | | |
| Mon. | 03/03/08 | Superfluidity. |
| Wed. | 03/05/08 | The Bose-Einstein Condensate. |
| Fri. | 03/07/08 | Solids. Thermal expansion of solids. |
| *Week 8* | | |
| Mon. | 03/10/08 | Non-ideal gases. Deviation of gases from the ideal state. |
| Wed. | 03/12/08 | Van der Waals' formula. Virial coefficients. |
| Fri. | 03/14/08 | Phase equilibrium. The critical point. |
| *Week 9* | | |
| MWF | 03/17/08-03/21/08 | Spring recess. |
| *Week 10* | | |
| Mon. | 03/24/08 | Fluctuations of the fundamental thermodynamic quantities. |
| Wed. | 03/26/08 | Fluctuations in an ideal gas. |
| Fri. | 03/28/08 | The fluctuation-dissipation theorem. |
| *Week 11* | | |
| Mon. | 03/31/08 | Magnetism. The Ising Model (Part I). |
| Wed. | 04/02/08 | The Ising Model (Part II). |
| Fri. | 04/04/08 | Phase transitions. |

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| | *Week 12* | |
| Mon. | 04/07/08 | Second order phase transitions. |
| Wed. | 04/09/08 | The order parameter. Fluctuations of order parameter. |
| Fri. | 04/11/08 | Critical phenomena. |
| | *Week 13* | |
| Mon. | 04/14/08 | Critical exponents. |
| Wed. | 04/16/08 | Scalling approach. |
| Fri. | 04/18/08 | Goldstone excitations. |
| | *Week 14* | |
| Mon. | 04/21/08 | The importance of dimensionality. |
| Wed. | 04/23/08 | The Landau approach. Free energy. |
| Fri. | 04/25/08 | Derivation in simple models. |
| | *Week 15* | |
| Mon. | 04/28/08 | The Ginsburg criterium. |
| Wed. | 04/30/08 | Renormalization group (Part I) |
| Fri. | 05/02/08 | Renormalization group (Part II) |
| | *Week 16* | |
| Mon. | 05/05/08 | Renormalization group (Part III) |
| Wed. | 05/07/08 | Conclusions. |
| Fri. | 05/09/08 | Final exam. |