UNIVERSITY OF MARYLAND

Department of Physics
John S. Toll Physics Bldg. No. 082
College Park, Maryland 20742-4111

Spring 2011 Syllabus for

PHYS 603 - CHEM PHYS 718F

THE BASIS AND ESSENTIALS OF STATISTICAL MECHANICS

Instructor: **Michael E. Fisher** xpectnil@umd.edu
Physics Bldg (082), Room 2220C, 301-405-4121
IPST, Bldg. (085), Room 2100A, 301-405-4819

Class Days/Time: Tuesdays and Thursdays at 9:30 am to 10:45 am
Place: Room 1410, Physics Bldg. (082)

Credits: 3 hours

Prerequisites: An undergraduate course in thermal physics or thermodynamics and statistical mechanics; some basic quantum mechanics. This course is planned as a graduate level introduction.

OUTLINE *(subject to some changes in scope and emphasis)*:

I. Thermodynamics: Macroscopic/microscopic variables, extensivity; First and Second Laws; Assemblies: thermo-potentials, Legendre transforms, thermodynamic relations.

II. Foundations of Statistical Mechanics:

Classical mechanics, Hamiltonians, phase space; Ergodic approach; Ensemble approach, microcanonical postulate; canonical and grand-canonical ensembles; classical ideal gas; fluctuations of energy and particle number.

Entropy and information. ***Partition functions*** and ensembles, equivalence, microcanonical ensemble.

Quantum statistical mechanics, indistinguishability, Bose, Fermi, and Boltzmann statistics.

III. Introductory Applications: Ideal gas of particles with structure: rotational specific heats; ortho-, para-, normal-H_2; metastability. ***Chemical Equilibria.*** ***Ideal Crystals*****:** Einstein model, normal modes, low temperature specific heats, Debye model, T^3-law; ***Black body radiation*****;** Third Law of Thermodynamics; ***Imperfect Gases and Fluids*****:** virial expansion, Mayer cluster idea. ***Ideal Quantum Gases*****:** free electrons, Bose-Einstein condensation; ***Ideal Paramagnets*****:** Curies' law, interacting Ising spins, low-T and high-T expansions. ***Correlation Functions,*** radial distribution function and its uses; Density Fluctuations and Compressibility, scattering of radiation.

Assignments: Problem sets are an important part of the course and will be handed out about every two weeks. There will be a Mid-term and Final Examination, most probably both in a ***take-home format.***

Textbook: There is ***no required text*** for this course: Notes taken in class will be important. However, in the past, many students with a physics background have found the following book helpful and similar in approach to the course:-

Statistical Mechanics (2nd ed.) by **R.K. Pathria** (Butterworth/Heinemann, 1996).

Books also recommended are, first,

(a) at a somewhat lower level:-

Statistical Mechanics: A concise introduction for chemists by **B. Widom** (Cambridge, 2002);

and, with rather full coverage, also:-

Thermodynamics and Statistical Mechanics by **W. Greiner et al.** (Springer, 1995); and,

(b) at course level, especially for chemical physicists:-

Statistical Mechanics by **D.A. McQuarrie** (Harper and Row, 1975); and,

(c) for condensed matter physicists:-

Equilibrium Statistical Physics by **M. Plischke & B. Bergersen**, 2nd ed.(World Scientific, 1994);

(d) and rather more advanced:-

Equilibrium Statistical Mechanics by **G. Mazenko** (Wiley, 2000).

However, other textbooks and references will be discussed in class in an early lecture and should be **on reserve in the Library.**

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