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April 17, 2017

Physics 442- Statistical Mechanics, Spring 2017

Instructor: Yong W. Kim (Office: Rm LL403; email: ywk0; Phone: #8-3922)

Place: Lewis Lab Rm 514 Time: M, W, F @10:10AM-11:00AM

Course Topical Content

Basic Goals of Statistical Mechanics

Review of Thermodynamics

The four laws of thermodynamics; Thermodynamic functions and their derivatives

Elementary Kinetic Theory

Particle distribution function; Derivation of Maxwell velocity distribution; Pressure, kinetic basis of temperature; Free path distribution and mean free path

Boltzmann Kinetic Theory

Derivation of Boltzrnann's kinetic equation; H-theorem; Equilibrium distribution function; Boltzmann program for derivation of thermodynamic laws

Classical Statistical Mechanics

Review of classical (Hamilton's) mechanics; Liouville's theorem; Microcanonical and canonical ensembles; Partition functions; Continuous versus bound single-particle states; Internal degrees of freedom; Specific heat calculation; Calculation of canonical ensemble partition function; Grandcanonical ensemble

Quantum Statistical Mechanics

Occupation number representation of system state; Pauli exclusion principle; Bose-Einstein versus Fermi-Dirac statistics; Grandcanonical partition function and Mayer equations of state; Ideal quantum gas, low-density equation of state; High density equation of state; Bose-Einstein condensation; Photon gas and blackbody radiation; Electrons in metal

Theory of Non-Ideal Gases

Virial expansion; Ursell-Mayer theory of cluster expansion; Calculation of virial coefficients

Critical Phenomena

Critical fluctuations and critical exponents; Treatment of site percolation by renormalization group method

Recommended Texts

Huang, Statistical Mechanics, 2nd ed. (John Wiley, 1987)

Pathria and Beale, Statistical Mechanics, 3rd ed, (Elsevier, 2011), main textbook

Kardar, Statistical Physics of Particles (Cambridge University Press, 2007)

Plischke and Bergersen, Equilibrium Statistical Mechanics, 3rd edition (World Scientific, 2006)

Landau and Lifshitz, Statistical Physics, 3rd edition (Butterworth-Heinemann, 1980)

Reichl, A Modem Course in Statistical Physics, 3rd edition (Wiley-VCH, 2009)

McQuarrie, Statistical Mechanics (University Science Books, 2000)

Hill, An Introduction to Statistical Thermodynamics (Dover Books on Physics, 1987)

Present, Kinetic Theory of Gases (McGraw Hill, 1958)

Uhlenbeck and Ford, Lectures in Statistical Mechanics (Am. Math. Soc., 1963)

For review of thermodynamics consult:

Thermal Physics, David Schroeder, Addison Wesley Longman (2000)

Thermal Physics, Ralph Baierlein, Cambridge University Press (1999)

Assignments and Examinations

Weekly assignments, each due in one week from the date of assignment

Mid-semester examinations: Hour Exam I and Hour Exam II (75 min for each hour exam)

Term papers

Final examination (150 minutes for the final exam)

The expected final competencies: gain working knowledge of the formulation of statistical mechanical models of large thermodynamic systems by working through the theoretical foundation and implementation by means of ensembles.

Accommodations for Students with Disabilities: *If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, University Center C212 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.*

Academic Integrity

Please visit and read the sample vignettes of how University's policy on academic integrity applies in different circumstances at the provost's website: www.lehigh.edu/~inprv/faculty/academicintegrity.html.