Phys 741
Graduate Statistical Mechanics
Fall 2017

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Lectures: Monday and Wednesday 3:30 - 5:00 Pm, Physics Building, Room # 128
Office hours: Monday and Wednesday 2:00 - 3:30 Pm or by an appointment, office location: physics Building Room # 107
Email: Gassem@hu.edu.jo
Textbook: Pathria and Beale, Statistical Mechanics , Third edition (Elsevier, 2011)
Excellent reference: Kerson Huang, Statistical Mechanics, Second edition (Wiley, 1987)
course webpage: Lecture notes and homework problems will be posted at ***staff.hu.edu.jo/gassem***
Grading: First exam (25%), Second exam (25%), Final exam (40%), Homeworks (10%)

Topics to be covered (tentative):

1. **The Statistical Basis of Thermodynamics:** Basic review of thermodynamics, thermal equilibrium, heat capacity, the first and second laws of thermodynamics, heat and TdS equations, statistical definition of entropy, the conditions of equilibrium between two objects in contact, Maxwell relations, thermodynamics potentials, Macro and Micr-states, the classical ideal gas, entropy of mixing and the Gibb's paradox,

2. **Elements of Ensemble Theory:** Phase space, the microcanonical ensemble (ME), classical ideal gas, the 1D harmonic oscillator, phase space density and ensemble averages, Liouvilles theorem and phase space incompressibility

3. **The Canonical Ensemble (CE):** Equilibrium between a system and heat reservoir, a system in the CE, the most probable configuration and the method of Lagrange multipliers, the partition function for CE, Boltzmann distribution, Helmholtz free energy, entropy and other thermodynamics quantities in the CE, classical ideal gas in the CE, energy fluctuations in the CE, equipartition and virial theorems; examples: a system of N free particles, a system of N harmonic oscillators (classical and quantum treatments), the statistics of paramagnetism (classical and quantum treatments), thermodynamics of magnetic systems

4. **The Grand Canonical Ensemble (GCE) :** Equilibrium between a system and a particle-energy reservoir,the partition function for the GCE, a system in the GCE, the most probable configuration and the method of Lagrange multipliers, using the grand potential Ω to derive various thermodynamics quantities, the classical ideal gas in the GCE, density and energy fluctuations in the GCE

5. **Formulation of Quantum Statistics,:** The density matrix, microstates representation in QM, obsevables and averages, quantum density in the microcanonical, canonical, and grand canonical ensembles, single free particle in a box, two identical particles, N identical particles and the product state, symmetry requirements of the product state of Fermions and Bosons

6. **Statistics of Quantum Gases:** Quantum gas of N identical particles in the GCE, probability density, grand potential, occupation number and product state representations, the partition function, and equation of state of quantum gases, Boltzmann limit of quantum gases

7. **Ideal Bose Systems :** Thermodynamic behavior of an ideal Bose gas (classical and quantum limits), Bose−Einstein integrals, Bose−Einstein condensation, blackbody radiation, lattice vibrations and phonons, Einstein and Debye models

8. **Ideal Fermi Systems :** Thermodynamic behavior of an ideal Fermi gas (classical and quantum limits), Fermi Dirac integrals, Sommerfield expansion, electrons in metals and heat capacity, energy and particle fluctuations, Pauli paramagnetism and Landau diamagnetism, behavior of magnetization and magnetic susceptibility of gas of fermions placed in a weak magnetic field for both Pauli paramagnetism and Landau diamagnetism

Good Luck