Jimma University, College of Natural Sciences
Department of Physics
Statistical Physics II (Phys 3092) Course Outline

Course Title and Code: Statistical Physics II (Phys 3092)
Credit hours: 3 ≡ Lecture (3 hrs) + Tutorial (1 hr)
Academic Year: 2019/20, Semester: II
Program: Undergraduate, Enrollment: Regular
Instructor's Name: Tesema Kebede (Lecturer)

Learning Outcomes

Upon completion of this course students should be able to:

- identify simple application of classical and quantum statistics,
- apply statistical approaches in studying different properties of a system,
- derive and apply equi-partition theorem,
- explain the applications of laws of thermodynamics,
- employ Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics in describing a given system,
- explain magnetic properties of substances at low temperature,
- discuss about different properties of substances related with their movement by using kinetic theory of transport process,
- understand the ways of incorporating the interaction term while studying dynamics of interacting particles.

Course Description

Review of the Laws of Thermodynamics, Thermodynamic Potentials, Conditions for Equilibrium and Stability, Legendre Transformations, Maxwell's Relations, Maxwell's distribution, Phase Transitions, Simple Application of Statistical Mechanics, Quantum and Classical Statistics, Fermi-Dirac and Bose-Einstein System of Interacting Particles, Kinetic Theory of Transport Processes

Course Outline

1) **Review of Thermodynamics (7 hrs)**
1.1) State of variable and equation of state
1.2) Laws of thermodynamics
1.3) Thermodynamic potential
1.4) Gibbs-Duhem's and Maxwell's relations
1.5) Response functions
1.6) Condition for equilibrium
1.7) Thermodynamics of phase transitions

2) Simple Applications of Statistical (13 hrs)
2.1) Partition function and their properties ideal monatomic gas
2.2) Calculations of thermodynamic quantities
2.3) Gibbs paradox
2.4) Validity of the classical approximation
2.5) Proof of equipartition
2.6) Simple applications

2.7) Specific heat of solids
2.8) General calculation of magnetism
2.9) Maxwell's velocity distribution
2.10) Related velocity distribution
2.11) Number of molecule striking a surface
2.12) Effusions
2.13) Pressure and momentum

3) Quantum Statistics of Ideal Gases (13 hrs)

3.1) Isolated systems: micro canonical ensembles
3.2) System at mixed temperature
3.3) Grand canonical ensembles
3.4) Identical particles and symmetry requirement
3.5) Formulation of statistical problems
3.6) The quantum distribution functions
3.7) Maxwell-Boltzmann statistics
3.8) Photon statistics
3.9) Bose-Einstein statistics
3.10) Fermi-Dirac statistics
3.11) Quantum statistics in the classical limit
3.12) Evaluation of the partition function
4) System of Interaction Particles (6 hrs)

4.1) Lattice Vibration and Normal Mode

4.2) Debye approximation
4.3) Calculation of the partition function for low densities
4.4) Equation of state and virial coefficients
4.5) Alternative derivation of the van Der Waals equation

5) Kinetic Theory of Transport (6 hrs)

5.1) Collision time
5.2) Collision time and scattering cross section
5.3) Viscosity
5.4) Thermal conductivity
5.5) Self diffusion
5.6) Electrical conductivity

Method of Teaching

Presentation of the course is through lecture, tutorial and problem solving. Online learning resources can also be employed.

Assessment

• Homework will consist of selected end of chapter problems: 20%
• In-class participation (asking questions, discussing homework, answering questions): 5%
• Assignment (25%),
• Semester final examination (50%)

Recommended References

Course Textbook

F. Reif, Fundamentals of Statistical and Thermal Physics, Wave Land Price, 2008.

References

1. B. B Laud, Fundamentals of Statistical Mechanics, India, 2009.
2. C. Kittel, Elementary statistical Physics, Rieger Pub Co., 1988.
3. Michel D. Sturge, Statistical and Thermal Physics: Fundamentals and Applications, 2003.