UNIVERSITY OF PUERTO RICO
RIO PIEDRAS CAMPUS
COLLEGE OF NATURAL SCIENCES
DEPARTMENT OF PHYSICS
UNDERGRADUATE PROGRAM

Title: Thermodynamics and Statistical Mechanics

Code: PHYS 4057

Number of Credits: 3

Prerequisites: PHYS 4031 (Mathematical Physics I)
PHYS 4051 (Classical Mechanics I)

Co-requisites: PHYS 4032 (Mathematical Physics II)

Description

The zeroth law of thermodynamics and the concept of temperature. The First law and the conservation of energy. The Second law and the direction of natural process. Carnot's engine. Concept of entropy. Absolute scale of temperature. The Third law and simple applications. The principle of statistical mechanics: Thermodynamic weight, Statistical mechanical ideas of entropy and the connection with thermodynamics; the Maxwell-Boltzmann, the Bose-Einstein, and the Fermi-Dirac distributions.

Objectives

After completing this course the students will know the basic principles and laws of thermodynamics and statistical mechanics and their mathematical formulation as well as methods of investigations of basic thermodynamic phenomena and clear idea about the limits of applicability of physical model and theories used in this course. The students will know the role of thermodynamics and statistical mechanics in the scientific and technical progress and will be able to apply these to actual physical problems. The student will have mastered and practiced the application of simple mathematical techniques to solve basic problems.

Course Content

Topic	Assigned time (hours)
1. Fundamental concepts of thermodynamics like scope of thermodynamics, thermodynamic systems, thermodynamic equilibrium, temperature and pressure.	3
2. The zeroth law. Equation of state.	3
3. The first law of thermodynamics. Work. Internal energy. Heat flow. Heat capacity.	3

4. Enthalpy. Adiabatic process. The Carno cycle. The heat engine and refrigerator.	3
5. Entropy and the second law of thermodynamics. Thermodynamic temperature, Entropy.	3
6. The principle of increase of entropy, The Clausius and Kelvin-Plank statements of the second law. Combined first and second law.	3
7. Thermodynamic potentials. The Helmholtz and the Gibs functions. Phase transitions.	3
8. The third law of thermodynamics. Applications of thermodynamics to simple systems.	3
9. Kinetic theory. Classical theory of specific heat capacity.	3
10. Intermolecular forces. Transport phenomena.	3
11. Statistical mechanics. Macrostates and microstates. Thermodynamic probability.	3
12. The Bose-Einstein, Fermi-dirac and Maxwell-Boltzmann statistics.	3
13. Application of statistics to gases.	3
14. Applications of statistics to other systems, heat capacity of solid.	3
15. Blackbody radiation, paramagnetism, the electron gas.	3
Total hours	45 contact hours

Instructional Strategy

The main instructional tool in this class is lecturing. The emphasis in this course is to introduce and train the student in solving thermodynamics and statistical mechanics problems using elementary mathematical methods which are mainly based on solving differential equations. As such pure theoretical derivations are kept to a minimum and are only used to introduce the basic concepts. Weekly homework assignments allow the student to practice problem solving techniques discussed in class and to develop a deeper understanding of the material. Solutions of homework problems are subsequently discussed in class, where a student usually presents his/her solution.

Minimum Require Facilities

Traditional lecture room.

Student Evaluation

Since the emphasis of this course is on problem solving techniques, the grades are mainly based on three exams where the student will work on problems similar to the ones encountered in class and in the homework problems, as well as on the performance in homework assignments.

Grading System

The overall score is determined by calculating the percentage of points obtained by the student. Grades are then assigned according to the standard curve: 100-90% = A, 89-80% = B, 79-70% = C, 69-60% = D, 59-0% = F.

Bibliography

1. F.W. Sears and G.L. Salinger, Thermodynamics, Kinetic Theory, and Statistical Thermodynamics, Addison-Wesley Publishing Company.
2. Jefferson W. Tester and Michael Modell, Thermodynamics and Its Applications
3. Dilip Kondepudi and Ilya Prigogine, Modern Thermodynamics: From Heat Engines to Dissipative Structures, Wiley
4. Charles E. Hecht, Statistical Thermodynamics and Kinetic Theory

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