ME 118 THERMODYNAMICS

2004

INSTRUCTOR

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GRADING

The grades for the course will be determined by homework (30%), midterm (20%) and final (50%). You may discuss homework problems with other students; however, I expect each student to turn in work that represents his or her own efforts. Exams are never a collaborative effort; materials may be restricted during an exam.

HONOR CODE

All members of the Caltech community are expected to adhere to the Honor Code, which states "No member of the Caltech community shall take unfair advantage of any other member of the Caltech community." Honor Code violations will be reported to the appropriate governing body. Students are also reminded that "every member must share the responsibility of protecting the Caltech community and perpetuating the Honor System."

ME 118

This course covers the fundamentals of classical and statistical thermodynamics. The classical thermodynamics material covers the basic postulates, heat and work, equilibrium, properties of solids, liquids and gases, reversible work and maximum work, chemical and phase equilibrium. The statistical mechanics portion introduces basic concepts including probability and statistics, microstates and macrostates, partition functions, entropy and property definitions, translational, rotational, vibrational and electronic energies, specific heat variations, phonon and electron gasses, and black body radiation. Kinetic theory.

ME 118

I. Introduction: Basic Thermodynamic Postulates and Definitions

1. Course overview
2. Thermodynamics and statistical mechanics
3. Closed system, internal energy, simple systems
4. Thermodynamic equilibrium
5. Work and heat
6. Energy conservation
7. Entropy
8. Temperature, pressure, chemical potential
9. Euler, Gibbs-Duhem relations

II. Properties of Pure Substances and Mixtures

1. Enthalpy, gibbs function, helmholz function
2. Maxwell's relations
3. Specific heats
4. Ideal gas
5. Mixtures
6. Real gases

III. Chemical and Phase Equilibrium

1. Heat of reaction
2. Equilibrium of heterogeneous substances
3. Perfect gases
4. Phase equilibria and transitions

IV. Introduction to Statistical Thermodynamics

1. Probability and statistics
2. Microstates and macrostates
3. Basic ideas from quantum mechanics
4. Connection to entropy, internal energy
5. Bose-Einstein statistics
6. Fermi-Dirac statistics
7. Maxwell-Boltzmann statistics
8. Partition function
9. Thermodynamic properties

V. Application of Statistical Thermodynamics

1. Monatomic ideal gas
2. Distribution of molecular velocities
3. Specific heat of a diatomic, polyatomic gasses: rotational, vibrational, electronic modes
4. Phonon gas

5. Electron gas
6. Blackbody radiation

VI. Introduction to kinetic theory
1. Molecular speeds, velocities
2. Ideal gas
3. Thermal conductivity, diffusivity, viscosity

REFERENCE TEXTS

H.B. Callen, **Thermodynamics and an Introduction to Thermostatistics,** John Wiley & Sons, New York, 2nd edition, 1985

J.A. Fay, **Molecular Thermodynamics**, Addison-Wesley, Co., 1965

F. W. Sears and G.L. Salinger, **Thermodynamics, Kinetic Theory, and Statistical Thermodynamics,** Addison-Wesley Publishing Co., Reading, MA, 3rd edition, 1986