Fall 2024

MTSE 602 - 101: Thermodynamics of Materials

Trevor Tyson

Thermodynamics of Materials (MTSE 602)
Course Outline

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Fall 2024

- Class will meet on Wednesday from 6:00 to 9:00 PM in Faculty Memorial Hall Room 314
- (3 Credits)
- Office hour is Wednesday from 5:00 to 6:00 PM (or by appointment)
- Class WWW page can be found at http://web.njit.edu/~tyson/mtse602.html (under construction)
- Assignments are due each week at the beginning of class
- Textbook: *Introduction to the Thermodynamics of Materials* **(6th Edition)** by D. R. Gaskell and D. E. Laughlin
- Supplementary Texts:
  (1) *Thermodynamics of Materials* Vol I and II, by D. V. Ragone (Wiley)
  (2) *Thermal Physics* by C. Kittel and H. Kroemer (2nd Edition, Freeman)
  (3) *Thermodynamics* by E. Fermi (Dover)
  (4) *Physical Chemistry* by R. A. Albert and R. A. Silbey (3rd Edition, Freeman)
- Study Guides:
  (1) Schaum's Outline Series: *Thermodynamics* (2nd Edition, McGraw-Hill)
  (2) *REA's Problem Solvers*: Thermodynamics (REA)

Learning Outcomes:

You can expect to be assessed on learning outcomes by means of two exams, a final exam, in-class quizzes, scores on homework assignments, and a small class participation component.

- The principal learning outcome is to demonstrate understanding and mastery of the fundamental concepts of thermodynamics from a phenomenological perspective and from an atomic-level perspective. Specifically, the course will provide an understanding of classical thermodynamics and will also incorporate a statistical mechanics treatment. The topics covered will include the fundamental laws of thermodynamics, the behavior of ideal and non-ideal gases, statistical mechanics computations utilizing partition functions, and the link to phenomological approach. Specific applications covered are phase transitions, heat capacity of materials, phases of multicomponent systems, the behavior of solutions, binary system phase diagrams, reactions and transformation of phases, reactions involving gas and condensed phases, reaction equilibria and phase transition.
- In any/all of the above subject areas, you should be able to:
  - recall and use the conceptual and mathematical definitions and be able to explain them.
  - explain the conceptual and mathematical relationships between quantities used.
  - use symmetry arguments, sketches and diagrams, and graphs to intuitively understand systems
  - explain and manipulate equations and techniques developed in the text, lectures, problem examples, and in the course of working problems.

- apply the skills above to successfully solve textbook-level problems with numeric, symbolic, or conceptual answers.
- critically evaluate the soundness and precision of your own answers, explain and interpret your solutions to problems in a way that shows understanding, and identify and appraise the range of applicability of your results, and their limitations.

Final Letter Grades will be based on a term average for the semester's work that includes the common exam scores, the final exam, in-class quizzes, and a class project.

Grade Decomposition

Homework	8%	**(Posted on the class website, after lectures)**
Quizzes	12%	
Exam I	15%	
Midterm Exam	22%	
Final Exam	23%	
Class Project	20%	

Grade Cutoffs
87% − A
82% − B+
72% − B
65% − C+
55% − C
45% − D
Below 45% − F

Class Project Details

Find paper relevant to material covered in class
Read and research paper (look-up references)
Present paper in class in 15 min. talk
Write 7 page report (1.5 space, not including figures)
See list of research project papers on main class WWW page

Extra Credit Project

Students can obtain 4% extra credit towards the total score (100%) by submitting an experimental or modeling project at the same time as the final exam. The outline of the project is given below. We can discuss the project before you start it.
1. The experiments or modeling should cover the topics listed in the syllabus of the class
2. Students are expected to conduct original experiments or original modeling work (ask your research advisor for assistance)
3. A theoretical foundation with references should be given as part of the write-up (10-page write-up including figures)
4. The project should be independent and distinct from the class presentation and paper

Examples include (but not limited to these items):
a. Multicomponent alloy or oxide synthesis
b. DSC or specific heat measurements
c. Modeling, machine learning, or data analysis of chemical processes

Honor Code Violations or Disruptive Behavior: NJIT has a zero-tolerance policy for cheating of any kind and for disruptive student behavior. Violations will be reported to the Dean of Students. The penalties range from a minimum of failure in the course plus disciplinary probation up to expulsion from NJIT. Avoid situations where your own behavior could be misinterpreted as dishonorable.

- **Students are required to agree to the NJIT Honor Code on each exam and quiz.** By taking an exam or quiz you agree to abide by the code.

Turn off all smart and cellular phones, wireless devices, computers, and messaging devices of all kinds during classes and exams. Please do not eat, drink, or create noise in class that interferes with the work of other students or instructors.

Homework problems are posted on the class web site

TOPIC	TEXT STUDIES
Week 1 (Sept. 4 to Sept 10) Introduction and Definition of Terms The First Law of Thermodynamic	Chapter 1 Chapter 2
Week 2 (Sept. 11 to Sept 17) The Second Law of Thermodynamics	Chapter 3
Week 3 (Sept. 18 to Sept. 24) The Statistical Interpretation of Entropy	Chapter 4
Week 4 (Sept. 25 to Oct. 1) Fundamental Equations and Relationships	Chapter 5
Week 5 (Oct. 2 to Oct. 8) Heat Capacity Enthalpy, Entropy, and the Third Law of Thermodynamic	Chapter 6
Exam I (Oct. 9)	
Week 6 (Oct. 16 to Oct. 22) Phase Equilibrium in a One-Component System	Chapter 7
Week 7 (Oct. 23 to Oct. 29) The Behavior of Gases	Chapter 8
Week 8 (Oct. 30 to Nov 5) The Behavior of Solutions	Chapter 9
Midterm Exam (Nov. 6)	
Week 10 (Nov. 13 to Nov. 19) Gibbs Free Energy- Composition and Phase Diagram of Binary Systems	Chapter 10
Week 11 (Nov. 20 to Nov. 26) Reactions and Transformation of Phases	Chapter 11
Last Day to Drop Class- Nov. 26	
Week 12 (Nov. 28 to Dec. 4) Reactions Involving Pure Condensed Phases and a Gaseous Phase	Chapter 12
Thanksgiving Recess- Nov. 28 to Dec. 1	
Week 14 (Dec. 5 to Dec. 10) Reaction Equilibria in Systems Containing Components in Condensed Solution	Chapter 13

Week 15 (Dec. 5 to Dec. 10) Thermodynamics of Phase Transformations	Chapter 15
Reading Days:	Dec 12 and Dec. 13
Final Exam Period:	