Syllabus
MTEN 301, Thermodynamics of Materials, Fall 2025

Otto H. York Department of Chemical & Materials Engineering
New Jersey Institute of Technology

Fall 2025 AcademicCalendar

Sept	**1**	Labor Day. University Closed
Sept	2	First Day of Classes
Sept	8	Last Day to Add/Drop a Class
Sept	8	Last Day for 100% Refund, Full or Partial Withdrawal
Sept	9	W Grades Posted for Course Withdrawals
Sept	15	Last Day for 90% Refund, Full or Partial Withdrawal - No Refund for Partial Withdrawal after this date
Sept	29	Last Day for 50% Refund, Full Withdrawal
Oct	2	Wellness Day
Oct	20	Last Day for 25% Refund, Full Withdrawal
Nov	10	Last Day to Withdraw from Classes
Nov	25	Thursday Classes Meet
Nov	26	Friday Classes Meet
Nov	27	Thanksgiving Recess Begins. No Classes
Nov	30	Thanksgiving Recess Ends
Dec	11	Last Day of Classes
Dec	12	Reading Day
Dec	13	Saturday Classes Meet
Dec	14	Final Exams Begin
Dec	20	Final Exams End
Dec	22	Final Grades Due

Credits and contact hours: 3 credits, 3 contact hours (3;0;0).

Days/ Times/Location: Tuesday and Thursday, 4:00 PM - 5:20 PM, Faculty Memorial Hall 407

Course Instructor: Dr. Boris Khusid
Faculty Memorial Hall 215 (office); 973-596-3316 (phone)
Please use khusid@njit.edu (email for communication)
https://people.njit.edu/profile/khusid (website)
Office Hours: Faculty Memorial Hall R215, Tuesday, 9:00 am-11:30 am by arrangement to ensure proper social distancing. ***Note:*** You can always schedule an appointment or a virtual session by email if the Office Hour time conflicts with your classes.

Instructional Materials: David R. Gaskell; David E. Laughlin, Introduction to the Thermodynamics of Materials, 7th Edition, 2024, CRC Press, Boca Raton, FL https://doi.org/10.1201/9781003375388

Specific Course Information:

a. Description: Laws of thermodynamics and their correlation with molecular phenomena describing materials systems in equilibrium. Applications to properties, reactions and phase equilibria in materials. Thermodynamic foundation, interpretation and utilization of binary phase diagrams. Contemporary software for phase diagram calculation. Thermodynamic principles describing liquid and solid solutions, chemical reactions, and order-disorder phase transitions

b. Prerequisites: MATH 211 or MATH 213, MTEN 201

Educational Objectives:

The student should be able to solve the problems on the following topics:

1. Empirical properties of materials.
2. The first law of thermodynamics – temperature, work, and heat. Heat capacities.
3. Reversibility and Entropy. The second law of thermodynamics – Carnot engine.
4. Maxwell relations and examples. Competing entropic and energetic forces: vapor pressure, vacancy formation, and liquid and solid solutions.
5. Phase equilibrium for pure species. Clapeyron equation and LeChatelier's principle.
6. Thermodynamic functions. The third law of thermodynamics. Use of tabulated thermodynamic data. Experimental calorimetric methods.
7. Chemical reaction equilibria. Standard Gibbs energy of reaction in gaseous phase. Combustion. Condensed phase equilibria with gases and the reduction of metals. Extractive metallurgy. Gibbs-Helmholtz relation.
8. Thermodynamics of liquid and solid solutions – Raoult's and Henry's laws. Vapor pressure measurement. PXY diagrams. Properties of mixing. Gibbs free energy of mixing.
9. Binary phase equilibria – Fully miscible solids and liquids. Basics of separations. Regular solutions and intermediate compounds.
10. The Gibbs phase rule – Applications to unary equilibria, reaction equilibria, and binary phase equilibria.
11. Ternary phase equilibria – Phase rule analysis with pure solids. Solid solutions.

Topics:

1. First and Second Laws of Thermodynamics. Reversibility. Entropy.
2. Thermodynamic Cycles.
3. Phase Equilibrium for Pure Species.
4. Thermodynamics of Solutions.
5. Phase Equilibria for Binary and Ternary Mixtures.
6. Chemical Reaction Equilibria.

Course delivery: Face-to-face mode

The Canvas class website is the main platform for delivering information about the course.

- All relevant course materials and assignments will be posted on Canvas, so a student should check it regularly.
- Lecture notes will be posted on the Canvas class website to provide a summary of the course material. Please print and have them along with your textbook and computer in the class. You will make additional notes during the lectures.
- Long questions which require derivations will be discussed only during the Office Hours and will not be answered by email.
- Questions regarding grades can be discussed only during the Office Hours.

- E-mail correspondence is intended only for quick questions. Questions which require detailed discussion should be discussed in person during the Office Hours.
- For quick response to your emails, please add “MTEN 301" in the subject of your emails.

Required Software:

MS Office, Adobe Reader. All software can be downloaded from NJIT IST webpage. Students should have access to/accounts in Webex and Canvas via NJIT directly. If you do not have access for any reason, please contact NJIT Help Desk as soon as possible.

MATLAB could be used for solving home, class, and exam problems. You can download MATLAB from https://ist.njit.edu/software-available-download ;

MATLAB Tutorial: https://matlabacademy.mathworks.com/details/matlab-onramp/gettingstarted https://www.mathworks.com/help/matlab/getting-started-with-matlab.html

Tentative weekly listing of topics (15-week schedule)

Weak	Topic	Resources
1	Introduction and Basic Concepts	Ch 1
2-3	The First Law of Thermodynamics	Ch 2
3-5	The Second Law of Thermodynamics	Ch 3 & Ch 4
5-7	Fundamental Equations and Basic Relationships	Ch 5
7-8	Heat Capacity, Enthalpy, Entropy, and Third Law of Thermodynamics	Ch 6
8-9	Exam 1	
9-10	Phase Equilibrium in One-Component Systems	Ch 7 & Ch 8
10-11	Thermodynamics of Solutions	Ch 8 & Ch 9
11-12	Gibbs Free Energy and Phase Diagrams of Binary Systems	Ch 10
12-13	Exam 2	
13-14	Reactions and Phase Transformations	Ch 11-13, Ch 15

Changes to the above outline may occur, depending on the overall performance of the class and the time required to cover the most important concepts and approaches.

Grading

Your performance will be graded on an absolute scale, so your grade is not affected by how others do. Final letter grades will be awarded based on your weighted average score as follows:

Homework +Quizzes + Short Projects	20%
Midterm exam 1	25%
Midterm exam 2	25%
Final exam	30%

Letter grades will be assigned automatically by an Excel code based on the following totals:

A (Superior)	85% and above
B+ (Excellent)	80%-84.9%
B (Very Good)	75%-79.9%
C+ (Good)	70%-74.9%
C (Acceptable)	65%-69.9%
D (Minimum)	55%-64.9%
F (Inadequate)	Below 54.9%

For success, you are strongly advised to

Review/work on the material of the previous lecture before the next class.
Read the lecture notes and sections of the required textbook.
Use printed lecture notes in class along with the computer and calculator.
Take additional notes during the lectures.
Work out all derivations and examples in the lecture notes and in-class examples on your own after each lecture.
In case of questions, please see the instructor during the Office Hours or raise questions in the class. Do not delay it to the exam week.

Policies on assignments/exams and classroom policy
Homework is an integral part of the course:

- Homework (HW) assignments will be posted on Canvas and **must be uploaded into Canvas in DOC or PDF format by the due date**. *Do not send images using your cell phone!* Late HW will not be accepted for grading without an excuse authorized by the NJIT Dean of Students Office. All HW assignments will be individual.
  - **Homework format:** Failure to observe the following HW conventions will result in a downgrade of the HW score.
  - **File name** should include your first and last names, HW assignment No.
  - **Header:** The top of each sheet of HW assignment must contain the following information from left to right:

First & last names	Course No	HW assignment No	Date due	Page No/total pages

  - **Writing**: Homework should be printed carefully and legibly. If it cannot be read, it cannot be graded!
  - **Problem-solution format**: Problems should be clearly labeled and include the HW problem number, brief problem statement and diagram to illustrate the process, and present basic steps and calculations.
  - **Calculations** - Homework should include complete calculations for every calculation presented to demonstrate how results are obtained.
    - Include all units for each term in each equation.
    - Indicate the final solution by boxing it in with a rectangular.
- Feedback on the homework will be provided during lectures; solutions will be discussed and posted on the class website. **Therefore, late homework will not be accepted!**
- Each problem will be graded individually (up to five points). You are allowed to discuss HW problems with peer students but cannot copy the solution.

Project Assignment
Carry out a short review project on applications of the course topics to chemical processes & equipment, prepare and post the progress/final reports & slides on the **class website**, and give an **oral presentation** to the class.

Guidelines for preparing a project and **detailed criteria** for grading the project report and oral presentation are posted on the class website.

CME Department policy on electronic devices: Electronic devices (i.e., cell phones, tablets, and laptops) are allowed to use in class only when the work assigned requires live external connection for data, WebEx online meetings or during in-class presentations.

Classroom policies:

- Attendance at the classroom meeting is required. There is a high correlation between failure and poor class attendance.
- Eating and drinking are not allowed during the class.
- Behave professionally and show respect to fellow students and the instructor.
- Cellphones should be turned off during the class.

Quizzes:
There will be quizzes occasionally in the class. If you miss the class, you will miss the quiz that day. *There will be no makeup quiz*.

Exams:
There will be midterm and final exams. The date of the midterm exam will be announced a couple of weeks before.

- The comprehensive final exam during Finals' week will cover the course materials.
- The midterm and final exams must be completed individually, in accordance with the NJIT Honor Code.
- Use the assignment format for presenting solutions of exam problems.
- Each exam problem will be graded independently (up to 5 points).
- A missed exam will be averaged into the final grade as zero unless an excuse is obtained. Excuses are granted only for profoundly serious circumstances attested to by the NJIT Dean of Student Office. A student who has been excused will be required to take a makeup exam.
- In the case of an excused absence from the final examination, a student will receive an incomplete grade until a make-up exam is completed.

Disputing a grade on tests/assignments:
If a student has questions about the grade received for an exam, assignment, or classwork he/she must talk to the instructor (or the teaching assistant where appropriate) **no later than a week** after the graded activity has been returned to students. Exam scores can only be disputed during official Office Hours, not during class time or via email.

Accommodations due to disability: If you need accommodations due to a disability, please contact Center for Student Success Disability Support Services to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodation will be required.

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree on which you are working. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the code of Academic Integrity policy that is found at NJIT Academic Integrity Code *NJIT Academic Integrity Code*

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Office of the Dean of Students. Any student found in violation of the code by cheating, plagiarizing, or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Office of the Dean of Students at dos@njit.edu.