UNIVERSITY OF ILLINOIS
Grainger College of Engineering
Department of Materials Science and Engineering

Fall 2026: **MSE 401**
Thermodynamics of Materials

Instructor: Pascal Bellon (he/him), bellon@illinois.edu
1st part of semester: 2016 Superconductivity Center (MRL); then 312d MSEB

TAs Thomas Alling (he/him); talling2@illinois.edu
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UG Course assistant Joe Yang (he/him); joeyang2@illinois.edu

Lecture: MWF 9:00 am – 9:50 am

Office Hours: Pascal Bellon: M+W, 10:00 am – 10:50 am, my office
TAs: M+Th, 5:00 pm – 6:00 pm, MSEB 4101

Websites: https://canvas.illinois.edu/ ; www.campuswire.com ; https://media/space/illinois.edu

Prerequisites: credit in MSE 201 or MSE 280 or instructor approval.
credit or concurrent registration in MATH 285
credit is not given for both MSE 401 and CHEM 444 or PHYS 427

Course description: Thermodynamic principles including energy, entropy, enthalpy, and Gibbs energy; macroscopic properties of materials systems, such as equilibrium states, phases, and phase transitions. Application of phase diagrams. Statistical interpretation of thermodynamics on the atomistic level.

Course Objectives: Upon completion of the course, students will be able to:
• Define heat and work and explain the concepts of thermodynamic efficiency and reversibility
• State the first and second laws of thermodynamics and describe their significance
• Recognize relationships between thermodynamic state variables and enthalpy, Helmholtz energy, and Gibbs energy.
• Use the laws of thermodynamics to define equilibrium
• Explain the statistical basis for entropy
• Calculate the change in Gibbs energy associated with various processes
• Apply ideal and non-ideal solution models
• Use the thermodynamics of heterogeneous mixtures to construct multicomponent phase diagrams
• Evaluate electrochemical reactions

Primary textbooks (required readings):

Thermodynamics in Materials Science, R. DeHoff, CRC Press, 2nd edition
The laws of Thermodynamics, A very short introduction, Peter Atkins

Additional books and sources:

Fundamentals of Statistical and Thermal Physics, F. Reif (1965, 2009)
CALPHAD: Calculation of Phase Diagrams, a comprehensive guide, N. Saunders, A.P. Miodownik, 530.474 Sa87c (online).
Thermo-Calc: https://thermocalc.com (access via EWS)

Course Expectations and Teaching Philosophy

The design of the course combines lectures, assigned readings, classroom discussion, online discussion forums, weekly homework, and assessment by weekly quizzes and a final exam. The homework will include short essay responses to the text, solving problems, calculations, making plots, and drawing diagrams. You will be expected to use a science engineering computational tool of your choice in some of the homework problems to do calculations and make plots. We will strive to clearly articulate the assignments, due dates, and grading criteria.

MSE 401 is a 3-credit-hour course and therefore requires a time commitment of approximately 9 hours per week. I expect you to spend approximately 3 hours per week attending lectures. You should spend approximately 6 hours per week reviewing lecture material, reading the texts, doing homework, contributing to online discussions, and preparing for quizzes and the final exam. I recommend that you schedule a regular time to study.

Web Applications

URL	Purpose
Canvas	Course schedule, homework assignments via Gradescope, gradebook, and posting of text-based resources, e.g., syllabus, homework solutions, and readings in addition to the required texts.
Campuswire	Discussion form, communications with TAs and Instructor
iClicker	In-class polling

Grade breakdown:

- Participation: 10 %. Will be assessed using iClicker polling. Points will not be deducted for incorrect answers. Remote participation is forbidden and will be sanctioned.

- Homework assignments: 30%. Homework is due and submitted electronically in Canvas by 5 pm on the assigned day. Submit your homework as a single pdf or a scanned document. Cell phone pictures of your homework are not acceptable. You are strongly encouraged to submit a typed document, as opposed to a handwritten one. Since solutions will be distributed when the homework is due, late submissions will not be accepted. If you have a documented, extenuating circumstance, please communicate with Prof. Bellon for accommodation. The two lowest relative homework scores will be dropped when assigning the 30% of the course grade that comes from homework.

- Quizzes: 35%. Quizzes will be administered in person during the first 20 minutes of the class period on Fridays. The two lowest quiz scores will be dropped when assigning the 35% of the course grade that comes from homework. The first quiz will be on Friday, September 11.

- Final exam: 25%. A comprehensive Final Exam will take place during finals week from 8-11 AM, Monday, December 14 (room location to be confirmed).

- The overall course grade will be converted to a letter grade on a curved scale. The curved scale will not be harsher than a straight scale (97-100 = A+; 93-97 = A; 90-93 = A-; 87-90 = B+; etc.)

Course communication:

The instructor and TAs will use Canvas to make announcements. The default settings of Canvas are that new announcements are also sent immediately by email. You can change that default setting within Canvas if you prefer.

Tentative lecture schedule. Adjustments may be made during the semester.
Textbooks: A = Atkins, The law of thermodynamics: A very short introduction
D = DeHoff, Thermodynamics in Materials Science

Week	Date	Topic	Reading assignment	HMWK # set – due		Quiz #
1	Aug-24	1.1 The Laws of Thermodynamics	A. Chaps. 1-3			
2	Aug-31	1.2 The Laws of Thermodynamics	A. Chaps. 4-5 D. Chap. 3	1		
3	Sep-7*	2.1 Thermodynamic Variables and Relations	D. Chap. 4.1	2	1	1
4	Sep-14	2.2 Thermodynamic Variables and Relations	D. Chap. 4.2	3	2	2
5	Sep-21	3. Equilibrium criteria	D. Chap. 5	4	3	3
6	Sep-28	4.1 Statistical Thermodynamics	D. Chap. 6.1-2	5	4	4
7	Oct-5	4.2 Statistical Thermodynamics	D. Chap. 6.3	6	5	5
8	Oct-12	5.1 One Component Heterogeneous Systems	D. Chap. 7.1-2	7	6	6
9	Oct-19	5.2 One Component Heterogeneous Systems	D. Chap. 7.3-5	8	7	7
10	Oct-26	6.1 Multicomponent Homogeneous Systems	D. Chap. 8.1-2	9	8	8
11	Nov-2	6.2 Multicomponent Homogeneous Systems	D. Chap. 8.3-6	10	9	9
12	Nov-9	6.3 Multicomponent Heterogeneous Systems	D. Chap. 9	11	10	10
13	Nov-16	7. Thermodynamics of Phase Diagrams	D. Chap. 10	12	11	11
14	Nov-30	8.1 Chemical Equilibrium and Electrochemistry	D. Chap. 15	13	12	12
15	Dec-7*	8.2 Electrochemistry	D. Chap. 15		13	
16	Dec-14	8-11 am: Final Exam				

*: Only 2 class sessions on these weeks

HOMEWORK POLICY

For the homework sets in this class, you are welcome to work alone or in groups, at your own discretion, so long as the final result is your own.
• _You understand and can explain in your own words each step in the solution.
• _You independently verified all results and analysis.
• _You are personally responsible for the correctness of the answers.
• _You gained the knowledge and skills intended from the assignment.

ABSENCE POLICY

You are expected to attend all lectures, all in-class quizzes, and all exams. The Student Code outlines those circumstances in which a student may be eligible to obtain a letter from the Office of the Dean of Students for missed class. When eligible, students must submit an absence letter request within two weeks of returning to class following the absence. Make sure also that you keep me informed of any situation that would prevent you from attending class, completing an assignment on time, or attending an exam.

ACADEMIC INTEGRITY

The University of Illinois Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/
Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/ Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

USE OF GENERATIVE AI TECHNOLOGY

Generative AI, such as ChatGPT, Bard, and Microsoft Copilot/Bing Chat, can answer questions and generate text, images, and other media. The appropriate use of generative AI varies from course to course. In MSE401, there are times when generative AI may be useful in the course. If you choose to use generative AI as permitted below, you **must** document and attribute all AI contributions to your coursework and take full responsibility for the contributions including the accuracy of the information and reliability of sources. When using generative AI, keep a journal documenting prompts, AI responses, and your usage. Your instructor may ask you to provide this documentation.
You may use generative AI in MSE401 for the following:

- Revising your own text for spelling and grammar
- Creating study aids (e.g., flashcards) for quizzes or exams
- Testing and practicing your knowledge of course topics
- Conducting basic research on the course and assignment topics

You MAY NOT use generative AI in MSE401 for the following:

- Writing entire sentences, or paragraphs to complete class assignments

If you have a question about the use of Generative AI, please reach out to your instructor. Failure to abide by these guidelines is a violation of academic integrity. We will investigate suspected uses of generative AI that do not follow these guidelines and apply sanctions as outlined in the Illinois Student Code.

FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT (FERPA)

Please visit http://registrar.illinois.edu/ferpa for information about the Family Educational Rights and Privacy Act (FERPA).

MENTAL HEALTH

Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings which are covered through the Student Health Fee. If you or someone you know experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do for yourself and for those who care about you.

Counseling Center (217) 333-3704
McKinley Health Center (217) 333-2700
National Suicide Prevention Lifeline (800) 273-8255
Rosecrance Crisis Line (217) 359-4141 (available 24/7, 365 days a year)
If you are in immediate danger, call 911.

COMMUNITY OF CARE

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regard to their well-being or yours, we encourage you to refer this behavior to the Connie Frank CARE Center (formerly the Student Assistance Center) in the Office of the Dean of Students. You may do so by calling 217-333-0050 or by submitting an online referral. Based on your report, staff in the Student Assistance Center will reach out to offer support and assistance.

Further, as a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the Connie Frank CARE Center (formerly the Student Assistance Center) in the Office of the Dean of Students for support and referrals to campus and/or community resources.

STUDENTS WITH DISABILITIES

The University of Illinois is committed to ensuring that all students, including those with disabilities, do not experience barriers to learning and participating fully in class. If you have a letter of accommodation from DRES and have not already given it to me, please do so as soon as possible to ensure your accommodation needs are met.
To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-1970, email: disability@illinois.edu, or go to the DRES website.

DISRUPTIVE BEHAVIOR

Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students' ability to learn and an instructor's ability to teach. A student responsible for disruptive behavior may be required to leave class pending discussion and resolution of the problem and may be reported to the Office for Student Conflict Resolution (https://conflictresolution.illinois.edu; conflictresolution@illinois.edu; 333-3680) for disciplinary action.

EMERGENCY RESPONSE RECOMMENDATIONS

Emergency response recommendations and campus building floor plans can be found at the following website: https://police.illinois.edu/em/run-hide-fight/. I encourage you to review this website within the first 10 days of class.

RELIGIOUS OBSERVANCES

It is the policy of the University of Illinois Urbana-Champaign to reasonably accommodate its students' religious beliefs, observances, and practices that conflict with a student's class attendance or participation in a scheduled examination or work requirement, consistent with state and federal law. Students should make requests for accommodation in advance of the conflict to allow time for both consideration of the request and alternate procedures to be prepared. Requests should be directed to the instructor. The Office of the Dean of Students provides an optional resource on its website to assist students in making such requests.

SEXUAL MISCONDUCT REPORTING OBLIGATION

The University of Illinois is committed to combating sex-based misconduct. Faculty and staff members are required to report any instances of sex-based misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/#confidential.

Other information about resources and reporting is available here: wecare.illinois.edu.