

Fall Semester 2024

COURSE: Materials Science and Engineering 201 (MSE 201)
TITLE: Phases and Phase Relations
LEVEL: Undergraduate
CREDIT: 3 hours lecture; 3 semester hours.
TIME: TR, 9:30-10:50 AM, CDT.
LOCATION: 112 Transportation Building. Announcements, Assignment alerts, Discussions, Lecture notes and Links to lecture videos will be available on <https://canvas.illinois.edu/courses/50928>

DESCRIPTION: This course covers intermediate-level topics in materials science and engineering that bridge the introductory content of MSE 182 and the greater depth of the junior year curriculum. The topics to be covered are in general: bonding, crystal structures, phase equilibria and microstructure, quantitative examination of phases (crystalline and non-crystalline structures), and the relationships between phases (phase diagrams and phase transitions).

INSTRUCTOR: Cecilia Leal (She/her)
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OFFICE HOURS: Grace Lu, TA –Mondays 4-6 pm, MSEB205. Prof. Leal – Fridays noon-1 pm MSEB302

DISCUSSION FORUM: Questions related to MSE 201 homeworks, exams, and all course contents should be posted in Canvas [discussion platforms](#).

TEACHING ASST: Grace Lu (She/her), email: graceml2@illinois.edu

PREREQUISITES: MSE 182; credit or concurrent enrollment in CHEM 104, MATH 231 and PHYS 211. (The prerequisite of MSE 182 is often waived for students that were not enrolled in the MatSE degree program in the fall semester of their first year)

ASSESSMENT:

Problem sets (8 <i>estimate</i> + 2 computational)	25%
i>clicker sessions (8 <i>estimate</i>)	5%
2 mid-semester exams, 50 min.	40%
Final, comprehensive exam, 1h 50 min.	30%

TEXTBOOK: The **primary** textbook is “*Materials Science, an Intermediate Text*” by William **Hosford**. Some **introductory** concepts are discussed in MSE182’s primary textbook: William D. **Callister**, Jr. and David G. Rethwisch, “*Fundamentals of Materials Science and Engineering, An Integrated Approach*”, any edition (Wiley, NY). **Supplementary** textbooks: **Waseda**, Y.; Matsubara, E.; Shinoda, K., “*X-Ray Diffraction Crystallography: Introduction, Examples and Solved Problems*”. Springer: 2011. **Sholl**, D.S.; Steckel, J. A. “*Density Functional Theory: A Practical Introduction*”. All the textbooks are free to download as eBooks for U. Illinois students.

INSTRUCTION BREAKS

October 17: Midterm 1, November 21: Midterm 2, November 23 - December 1: Fall Break

ASSESEMENT

1. ATTENDANCE

Class attendance is not required but is strongly recommended and may be mandatory on certain occasions (e.g. the Ethics lectures).

2. HOMEWORKS

Homeworks (HWs) will be offered on PrairieLearn (<https://prairielearn.engr.illinois.edu/>). **Please log in with your Illinois netID and enroll at MSE 201 Fall 2024 semester.** You will have infinite attempts to provide the right answer. If you complete the HW late you get 30% up to a week late. Past that, you get no credit but you can still practice the HW. Homeworks must be completed by the due date and time established. Leaving HW to the last-minute results in overloading of the system and errors leading to late delivery of the HW. Do your homework early! **Homework solutions:** homework questions will be solved in office hours after the HWs are due. No solutions will be posted otherwise.

Two computational assignments will be posted on Canvas (not on PrairieLearn). You will submit these assignments as pdf on Canvas. There will be a computational TA (Gillian Nolan: gnolan2@illinois.edu) and extra office hours - **When:** 4:00pm-5:00pm, Tue & Wed. **Where:** Room 322, Ceramics Building (the Ceramics computer lab) - to assist you. Grading of the computational assignments is however done by the "regular" course TAs.

James Scholar Homeworks

MSE 201 is not designated for honors credits on campus. However, a student may select any course in their schedule to take as an honors course. To do this, students need to do extra and independent work/study. It is the student's responsibility to propose a project to the instructor. **I request that students do this within the first 4 weeks of the start of the semester.** Students also have to submit a learning agreement (HCLA form) to the College stating their proposed extra work <https://my.engr.illinois.edu/james-scholar/hcla.asp>. Once students submit their proposal, I will evaluate and make a decision to approve, deny, or deny with revisions. **In MSE 201 extra work will be available in the form of an additional James Scholar homework (JCHW)** on PrairieLearn. If students would like to do this, they should state in the HCLA form that they will do additional James Scholar Homework questions. Questions will be added to JCHW gradually as the topics are introduced in class. The homework will be **due at full credit on reading day, and at 30% credit on the last day of exam's week.** This JCHW is available for all students who are interested to study the questions but it is only required for James Scholars aiming to take MSE 201 as honors credit.

3. EXAMS

All exams will be performed at the CBTF facility that have their own proctors. You normally have a period of a week to book and do the exam. The time and duration of the exam will be adjusted to accommodate DRES and/or different time zones. (See more information below).

TENTATIVE MIDTERM SCHEDULE

Midterm Exam No. 1 October 15-17, 50 min

Midterm Exam No. 2 November 19-21, 50 min

FINAL EXAM Exams week, 1h 50 min

Computer-based testing facility (CBTF)

- a. This course uses the Grainger College of Engineering's [Computer-Based Testing Facility](#) for its exams.
- b. The policies of the CBTF are the policies of this course, and academic integrity infractions related to the CBTF are infractions in this course.
- c. If you have accommodations identified by the [Division of Rehabilitation-Education Services \(DRES\) \(http://www.disability.illinois.edu/\)](#) for exams, please submit your Letter of Accommodations (LOA) through the CBTF website (<https://cbtf.illinois.edu/students/dres>) as soon as possible. It can take up to five days for your LOA to be processed and if you make a reservation before your LOA has been processed, your reservation will not include your testing accommodations and you will be required to reschedule. This must be done each semester you use the CBTF.
- d. If you have any issue during an exam, inform the proctor immediately. Work with the proctor to resolve the issue at the time before logging off. If you do not inform a proctor of a problem during the test then you forfeit all rights to addressing the problem you experienced during your exam.
- e. Take the [CBTF Orientation \(https://go.illinois.edu/student-orientation\)](https://go.illinois.edu/student-orientation) (10 minutes) and review all instructions on the [CBTF website \(https://cbtf.illinois.edu/students\)](https://cbtf.illinois.edu/students) before your first exam.

4. i>CLICKERS

i>clicker sessions will occur during class. **Students should get the i>clicker Reef App. It is offered as a bundle if you get the physical i>clicker remote.** Students are strongly encouraged to participate but no points will be registered. i>clicker questions will then be posted on PrairieLearn and students can answer to obtain points. i>clicker questions will be made available after each class. Answers are due on the last day of class **but I strongly recommend that you do them gradually as they are posted after each class.**

TENTATIVE TOPIC SCHEDULE

Introduction	Callister 1
Crystal Structures and Symmetries	Hosford 3, 4 (Waseda 2)
Scattering and Diffraction	Waseda 3 (Callister 3)
Defects in Crystalline Solids	Hosford 5
Bonding	Hosford 13
Density Functional Theory – <i>primer</i> (+ Data Analysis)	Sholl 1, 2 (+ Hosford 21)
Phase Diagrams	Hosford 6, 7
Phase Diagrams Calculation (Thermocalc) - <i>primer</i>	Hosford 7
Diffusion	Hosford 9
Phase Transformations	Hosford 10, 11
<u>If time allows:</u>	
Amorphous materials and the glass transition	Hosford 15
Polymer Structures	Callister 4
Basics of Calculations and Data Analysis	Hosford 21
Ethics in Science and Engineering (<u>tentative</u>)	Guest Lecture, mandatory

COURSE OBJECTIVES

- Understand the relationship between bonding and crystal structures
- Describe and interpret the crystal structures of common metals, ceramics, polymers, and semiconductors
- Contrast the structure and properties of crystalline and non-crystalline materials
- Use concepts of point defect diffusion and nucleation to predict the kinetics of phase transformations
- Define a thermodynamic phase
- Interpret a phase diagram and categorize transformations between phases
- Become familiar with computational tools to calculate phase diagrams and the cohesive energy of a crystal

Global Health Considerations

MSE 201 is planned to in-person instruction for the entirety of the Fall 2024 semester. However, we will fully abide to the recommendations of the Center of Disease Control (CDC), the State and the University of Illinois, as needed in case a health crisis arises such as COVID19.

Diversity, Equity, and Inclusion (DEI) Statement

The University of Illinois (UIUC), the Grainger College of Engineering, the Materials Science and Engineering department (MatSE), and MSE 201 operate under the guiding principle that “Our entire community benefits when individuals from different personal, cultural, and disciplinary perspectives are working together.” ***MSE 201 will be a safe and inclusive place for active learning with no tolerance for discrimination of any kind.*** I encourage all students to learn more about DEI activities in MatSE and MatSE’s DEI committee here: <https://matse.illinois.edu/dei>. (Make sure to scroll down to see all content!). More generally, aspects of DEI in the UIUC community are well covered by the IDEA institute: <https://idea.illinois.edu>.

Academic Integrity Policy

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. According to the Student Code, “It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.”

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: <http://studentcode.illinois.edu/>. Ignorance is not an excuse for academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity. See also this quick reference guide to academic integrity: <https://provost.illinois.edu/policies/policies/academic-integrity/students-quick-reference-guide-to-academic-integrity/>

Academic Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TDD), or e-mail a message to disability@uiuc.edu. <http://www.disability.illinois.edu>. DRES accommodations will be implemented in the CBTF.

Family Educational Rights and Privacy Act

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of

their attendance in this course. See <https://registrar.illinois.edu/academic-records/ferpa> for more information.

Sexual Misconduct Policy and Reporting

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability 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 at <https://wecare.illinois.edu/resources/students/#confidential>. Other information about resources and reporting is available at: <https://wecare.illinois.edu>

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 regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (217-333-0050 or <http://odos.illinois.edu/community-ofcare/referral/>). Based on your report, the staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe. Further, we understand the impact that struggles with mental health can have on your experience at Illinois. Significant stress, strained relationships, anxiety, excessive worry, alcohol/drug problems, a loss of motivation, or problems with eating and/or sleeping can all interfere with optimal academic performance. We encourage all students to reach out to talk with someone, and we want to make sure you are aware that you can access mental health support at the Counseling Center (<https://counselingcenter.illinois.edu/>) or McKinley Health Center (<https://mckinley.illinois.edu/>). For mental health emergencies, you can call 911 or walk in to the Counseling Center, no appointment needed.