MBSE 210: Structure of Materials

Fall 2021

Lecture:	MW 3-4:15 pm
Discussion:	W 4:30-6:10 pm
Final:	December 15, Wednesday, 8-11 am, in COB 272
Lecture location:	COB 272
Zoom link:	https://ucmerced.zoom.us/j/84965230188 (for all class related activities)

Instructor:	Prof. Yue Jessica Wang
Email:	Preferably through CatCourses; work email: yuewang@ucmerced.edu
Office Hour:	T 1:30 – 2:30 pm (via Zoom), and after class for quick questions

COURSE DESCRIPTION

This course will cover the following topics for inorganic and organic solids. Bonding and structure of materials and their relationship to the mechanical, thermal, electrical, optical, and magnetic properties of materials, within the context of structure-properties-processing-performance relationships. Crystal structures including units cells, crystal lattices, Miller indices, crystal systems, Bravais lattices, space groups, point groups. Defects. Diffraction from crystal structures. Special topics include dielectrics, superconductors, layered compounds. Characterization methods and device applications will also be discussed.

CatCourses will be used for course announcements, and for the distribution of class materials.

TEXT

There are no required textbooks for this class. Your class notes and assigned readings from electronic book chapters and recent literature will be your primary source of reference material. The following textbooks are recommended as additional resources if necessary.

- **Materials Engineering: Bonding, Structure, and Structure-Property Relationships,** 1st Ed., Susan Trolier-McKinstry, Robert E. Newnham (*primary textbook*)
- **Basic Solid State Chemistry**, 2nd Ed., Anthony R. West
- **The Solid State**, 3rd Ed., Harold M. Rosenberg
- **Introduction to Polymers**, 3rd Ed., Robert J. Young, Peter A. Lovell

GRADE DETERMINATION

Your final grade will be based on the following components:

- Homework (10%)
- Midterm (30%)
- Final exam (40%)
- Writing assignment (20%)

a. Homework

Homework will be posted on CatCourses. Email notifications will not be sent, so please check the course website regularly or enable notifications for new postings.

Due dates will be stated on each homework assignment. Late homework is generally not accepted, but please do reach out to me in case of unexpected events.

Photographs or scanned copies of your homework should be uploaded to the Assignments tab on CatCourses unless otherwise stated.

Homework will be graded on completion, not accuracy. It is your responsibility to review the posted answer keys and compare them to your answers.

b. Midterm & final exams

There will be one in-class midterm exam and a comprehensive final exam. *If you score higher on the final than the midterm, the midterm score can be replaced by the final exam score.*

In general, make-up exams will not be given. However, if special circumstances, scheduled or unexpected, prevent you from taking an exam, please reach out to me at your earliest convenience. I will work to find solutions on a case-by-case basis.

c. Writing assignment

The topics covered in this class are permeated through all aspects of materials science and engineering. The purpose of the writing assignment is for you to make connections between the course content and emerging research or real-world applications. More details on this assignment will be provided at a later time. The due date for this paper will be in the last 1/3 of the semester. However, you are always welcome to submit earlier in the semester to get it out of the way.

COVID-RELATED GUIDELINES

Most of us are holding our breath for the first semester of in-person instruction after nearly 3 semesters of remote instruction. As the instructor, I will be as flexible as possible with accommodations. The only thing I ask is for you to communicate your needs and situations with me promptly. I expect everyone to abide by the guidelines provided by the university. At the current moment, all students and faculty, regardless of vaccination status, are required to wear masks indoor.

LEARNING OUTCOMES

Course learning outcomes:

After successful completion of this course, you will be able to:

- Describe general approaches for the synthesis and growth of inorganic and organic crystals;
- Have a good understanding of a variety of crystal structure systems;
- Have a good understanding of crystal structures and its relationship to the electrical, thermal, magnetic, optical, and mechanical properties of solid-state materails.

Relationship to MBSE program learning outcomes (PLOs):

PLO-1: Core Knowledge – Possess a broad foundation in the fundamentals and current topics in either materials or biomaterials science and engineering, as well as an in-depth understanding of their chosen research topic area.

PLO-2: Analytical Skills – Exhibit the quantitative experimental and analytical skills necessary to conduct and lead independent research and contribute to knowledge in their chosen area.

PLO-4: Scientific Communication – Communicate both fundamental concepts and details of their own research effectively, both in written and oral form, including in a classroom setting to expert and non-expert audiences.

SPECIAL ACCOMMODATIONS

The University of California, Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. If you qualify for accommodations because of a disability, please submit a letter from the Disability Services Center to me in a timely manner (during the first three weeks of the semester, except for unusual circumstances) so that your needs may be addressed. Student Affairs determines accommodations based on documented disabilities.

ACADEMIC HONESTY AND CONDUCT

Students are expected to complete their own work and to abide by the UC Merced academic honesty policy, which can be found on the Student Life website http://studentlife.ucmerced.edu/ under the “Student Judicial Affairs” link. Any work submitted by a student in this course for academic credit will be the student's own work.

Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work.

You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting"

help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e mail, an e mail attachment file, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action.

During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

Note that the slides and handouts provided in this course are protected by copyright. They are for your *personal* use only. Re-posting the files or their contents on sites such as (for example) "Course Hero" is an explicit violation of this copyright.

Students and instructors are expected to honor UC Merced's Founding Principles of Community: http://www.ucmerced.edu/about_ucmerced/values.asp.

WEEKLY SCHEDULE (*tentative and subject to change*)

Week	Lecture Topics
1	Crystal growth for key classes of MSE-relevant materials.
2	Bonding: inorganic compounds; organic and polymeric compounds.
3	Crystal structures: unit cells, crystal lattices/basis, Miller indices and directions.
4	Crystal structures: crystal systems, Bravais lattices.
5	Crystal structures: symmetry.
6	Crystal structures: point groups, space groups.
7	Crystal structures: close-packed structures, common ionic structures.
8	Midterm 1. Crystal structures: common ionic structures (continued).
9	Crystal structures: perovskite, spinel.
10	Crystal structures: distortions. Defects in crystals: point, line.
11	Defects in crystals: plane, volume.
12	Diffraction from crystal structures: waves, diffraction from periodic structures. X-ray diffraction.
13	Diffraction from crystal structures: waves-vector space, reciprocal lattice, Ewald sphere.
14	Diffraction from crystal structures: form factor and structural factor.
15	Catch-up week, *or* structure-property relations: How bonding type and structure determine mechanical, electrical, optical, catalytic properties and applications.