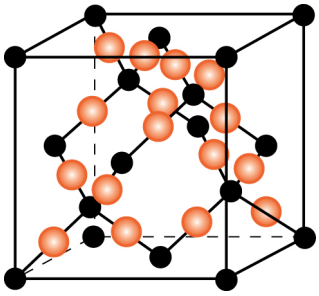

Mechanical and Aerospace Engineering 251

Structure and Analysis of Solids

Department of Mechanical and Aerospace Engineering
Jacobs School of Engineering
University of California, San Diego

Fall 2023 Syllabus

COURSE DESCRIPTION

Key concepts in the atomic structure and bonding of solids. Symmetry operations, point groups, lattice types, space groups, inorganic compounds, structure/property comparisons, X-ray diffraction, electron diffraction. Prerequisites: Consent of instructor.

GENERAL COURSE INFORMATION

Instructor: Prof. Olivia A. Graeve
Phone: (858) 246-0146
E-mail: professorgraeve@ucsd.edu
Office: EBUII 359
Course web site: http://graeve.ucsd.edu/MAE251.html
Course meetings: Mondays and Wednesdays, 7:30 – 8:50 AM
Classroom: Franklin Antonio Hall 1450

Class and office hours connection: Zoom meeting ID: 998 2375 5601
Password: 689228

Office hours:
Monday, October 11, 1:00-2:00 PM (in person)
Tuesday, October 17, 5:00-6:00 PM (online)
Monday, October 23, 6:00-7:00 PM (online)
Monday, October 30, 11:30 AM-12:30 PM (in person)
Wednesday, November 8, 3:00-4:00 PM (online)
Monday, November 13, 11:30 AM-12:30 PM (in person)
Tuesday, November 21, 11:00 AM-12:00 PM (in person)
Wednesday, November 29, 11:00 AM-12:00 PM (online)
Monday, December 4, 11:30 AM-12:30 PM (in person)

Teaching Assistant: Fabián Martinez-Pallares
TA E-mail: fmm003@ucsd.edu

TA Office hours: Wednesday, October 4, 2:00-3:00 PM (online)
Wednesday, October 11, 2:00-3:00 PM (online)
Wednesday, October 18, 2:00-3:00 PM (online)
Wednesday, October 25, 2:00-3:00 PM (online)
Wednesday, November 1, 2:00-3:00 PM (online)
Wednesday, November 8, 2:00-3:00 PM (online)
Wednesday, November 15, 2:00-3:00 PM (online)
Wednesday, November 22, 2:00-3:00 PM (online)
Wednesday, November 29, 2:00-3:00 PM (online)
Wednesday, December 6, 2:00-3:00 PM (online)

TOPICS

- Bravais lattices
- Unit cell planes and directions
- Unit cell distances, angles, and volumes
- Closed-packed structures
- Prototype structures
- Secondary bonding
- Ionic bonding
- Metallic bonding
- Covalent bonding
- X-ray diffraction
- Electron diffraction
- Amorphous materials

COURSE OBJECTIVES

All students who participate in MAE 251 / MATS 227 / CHEM 222 / NANO 227 should come away with:

- Knowledge of how bonding and crystal structure are interdependent.
- A recognition of the different close-packed and prototype crystal structures.
- An identification of ways that bonding and structure define compound and structure formation.
- A recognition of secondary, ionic, metallic, and covalent bonding.
- Knowledge of diffraction techniques and their uses.

LEARNING OUTCOMES

Students who follow course requirements and practices can expect, at the end of the semester, to be able to:

- Apply the basic principles of chemistry for the formation of crystal structures.
- Describe secondary, ionic, metallic, and covalent bonding.
- Describe the essential properties of the elements that result in specific crystal structures.
- Describe diffraction and its use in the characterization of crystal structures.

EXAMINATIONS

There will be two midterm examinations and one final examination.

GRADING Students will be graded using the following breakdown:

Midterm examination 1	30%
Midterm examination 2	30%
Final examination	40%
TOTAL	100%

MAE 251 / MATS 227 / CHEM 222 / NANO 227 STUDENT HONOR CODE

I have read the honor code below and agree with its provisions. My continued enrollment in this course constitutes full acceptance of this code:

I will not:

- give information or receive information from another person during an exam,
- use more reference material during an exam than is allowed by the instructor,
- plagiarize information from books, journals, or the Internet,
- alter an examination after it has been graded and return it to the instructor for regrading, and
- copy another person's examination solutions and submit them as my own.

HOMEWORK, QUIZ AND EXAMINATION SOLUTIONS

Solutions to all homework and examination solutions will be posted electronically on the course web site.

E-MAIL ETIQUETTE

Email is a very public means of information exchange, which should be treated with respect. As such, I expect that all students will write and respond to emails in a respectful manner.

An example of an appropriate email is:

> October 2, 2023
>
> Dear Dr. Graeve:
>
> Could you please inform me of the reading assignment for this week?
>
> Thank you,
>
> Alice

An example of an inappropriate email is:

> Hey you what is the homewrk this week

This last email has misspellings, inappropriate punctuation, no salutation, no signature, no date, and is extremely disrespectful.

DISABILITIES ACCOMMODATION

All students with disabilities who wish to request accommodations should contact the Office for Students with Disabilities. All information disclosed to this office by students will remain confidential, but the office will provide documentation that supports accommodations within the classroom (*e.g.*, examination accommodations, notes, *etc*.). Please keep in mind that many accommodations require early planning, so requests should be made as soon as possible.

IDEA ENGINEERING STUDENT CENTER

The IDEA Engineering Student Center, located just to the right of the lobby of Jacobs Hall, is a hub for student engagement, academic enrichment, personal/professional development, leadership, community involvement, and a respectful learning environment for all. The Center offers a variety of programs, listed in the IDEA Center Facebook page at http://www.facebook.com/ucsdidea/ (you are welcome to Like this page!) and the Center web site at http://idea.ucsd.edu/.

PUBLIC HEALTH EXPECTATIONS AND BEST PRACTICES

We will be meeting in virtual and in-person formats during this course. This requires taking health precautions. Public health is a collective effort. Keeping the UC San Diego community healthy takes all of us following campus safety recommendations to help prevent infection. These include:

If possible, wear a well-fitting mask that covers your nose and mouth at all times
Everyone is encouraged to wear masks in the classroom regardless of vaccination status.

Stay home if you are feeling ill
If you are not feeling well, get tested for COVID-19. Do not come to campus until you test negative.

LECTURE SCHEDULE

Date	**Topic**	**Textbook Reading**
Mon, October 2	Bonding and crystal systems Lecture type: Online	pp. 23-74 (Reading 1; Chapter 2 is only for general review of basic chemistry concepts)
Wed, October 4	Crystallographic computations Lecture type: Online	pp. 75-103 (Reading 2)
Mon, October 9	Crystallographic computations Lecture type: In person	
Wed, October 11	X-ray diffraction Lecture type: In person	pp. 259-319 (Reading 3)
Mon, October 16	X-ray diffraction Lecture type: In person	
Wed, October 18	Metallic structures Lecture type: In person	pp. 425-465 (Reading 4)
Mon, October 23	Space groups Lecture type: In-person	pp. 236-252 (Reading 5)
Wed, October 25	Space groups Lecture type: Online	
Mon, October 30	Metallic bonding Lecture type: In person	pp. 466-496 (Reading 6)
Wed, November 1	Quasicrystals Lecture type: Online	pp. 497-530 (Reading 7)
Mon, November 6	Amorphous metals Lecture type: In-person	pp. 531-549 (Reading 8)

Wed, November 8	Electron diffraction I Lecture type: Online	pp. 125-131 (Reading 9)
Mon, November 13	Electron diffraction II Lecture type: In-person	
Wed, November 15	Ceramic structures Lecture type: Online	pp. 561-591 (Reading 10)
Mon, November 20	Point defects in ceramics Lecture type: In-person	pp. 592-593 (Reading 11)
Wed, November 22	High-temperature superconductors and minerals Lecture type: Online	pp. 597-652 (Reading 12)
Mon, November 27	High-temperature superconductors and minerals Lecture type: In-person	
Wed, November 29	Molecular solids; secondary bonding Lecture type: Online	pp. 653-687 (Reading 13)
Mon, December 4	Polymer crystallization Lecture type: In-person	
Wed, December 6	Extraterrestrial materials Lecture type: Online	
Mon, December 11 8:00 – 11:00 AM	Final Examination	