

**Materials Science and Engineering (MTSE) 5010**  
**(Bonding, Structure and Crystallography)**

*Fall 2023*

*Credits: 3*

During this course we will discuss how elements can be combined to produce non-crystalline and crystalline solids with specified properties in order to understand the links between chemical bonding, crystal structures and physical properties. We will also specify the microstructure, and the mesoscale structure of materials, such as metals, ceramics, electronic materials, and polymers.

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Office Hours:	Wednesday 3 PM – 4:30 PM (email for appointment)
Class Hours:	T/R 5:30-6:50 PM
Class Location:	Discovery Park B190

**Main Textbook**

Structure of Materials - An Introduction to Crystallography, Diffraction & Symmetry  
by Marc De Graef and Michael McHenry (2<sup>nd</sup> edition, 2012)  
ISBN# 978-1-107-00587-7 Cambridge University Press  
<http://som.web.cmu.edu/>

**Supplementary Textbook**

Structure and Bonding in Crystalline Materials  
By Gregory S. Rohrer  
ISBN# 0-521-66379-2 Cambridge University Press

**Course Notes**

Course notes for each class will be posted on Canvas in “Modules” link. The Instructor will also supply additional handouts and references uploaded to Canvas

**Homework**

Four homework sets will be assigned. I will post last year’s homework and solutions on Canvas. The purpose of the homework is to aid in learning the material. To this end, some collaboration among students in preparing the homework is acceptable. However, in the main, the work should be primarily yours and blatant copying will result in failing grade. Late homework will not be accepted.

**Exams**

There will be two exams: midterm and a comprehensive final. I will post last year’s midterm, final exam, and their solutions on Canvas.

### Grading

Homework is 35%, Midterm is 30%, Final is 35%

### Attendance

I consider attendance mandatory. If you are going to miss class notify me. Also, no cell phones

### Academic Integrity

As is understood by the vast majority of students, our basic relationship is based on trust.

### Course Syllabus (*Subject to Change*)

<b>Date</b>	<b>Topic</b>	<b>Homework</b>
Aug 22	Introduction and Review of Simple Bonding Models	
Aug 24	Periodic Trends & Bonding Force/Energy	
Aug 29	Lennard-Jones Model	
Aug 31	Lennard-Jones Model (cond.)	
Sept 5	Born-Mayer-Huggins Model	
Sept 7	Crystal Lattice & Unit Cells	Hwk 1 out
Sept 12	Metallic Crystal Structures	
Sept 14	Ceramic Bonding & Crystal Structures	
Sept 19	Ceramic Bonding & Crystal Structures (cond.)	<b>Hwk 1 in</b>
Sept 21	Interstitial Compounds	
Sept 26	Introduction to Crystallography	Hwk 2 out
Sept 28	2-D & 3-D Bravais Lattices	
Oct 3	Primitive and Basis Vectors in Crystal Structures	
Oct 5	Basic Symmetry Operations	<b>Hwk 2 in</b>
Oct 10	2-D Point & Plane Groups	
Oct 12	<b>Midterm</b>	
Oct 17	3-D Point Groups	
Oct 19	3-D Point Groups (cond.)	
Oct 24	Neumann's Law and Tensor Properties	Hwk 3 out
Oct 26	3-D Space Groups	
Oct 31	3-D Symmetry Elements in Crystalline Materials	
Nov 2	3-D Symmetry Elements in Crystalline Materials (cond.)	<b>Hwk 3 in</b>
Nov 7	Relationships between planes and directions	
Nov 9	Introduction to XRD & Indexing Crystal Systems	
Nov 14	Structure Factors	Hwk 4 out
Nov 16	XRD Intensity Calculations	
Nov 28	XRD Intensity Calculations (cond.)	
Nov 30	Texture Determination and Pole Figures	
Dec 5	Stereographic Projection and Texture/Anisotropy	<b>Hwk 4 in</b>
Dec 7	Diffraction Applications Review	
Dec 12	<b>Final Exam 5:00 p.m. - 7:00 p.m.</b>	Dec 12