

# MSE 450 / 510

## Introduction to Materials Characterization

### Spring 2016

<b>Lectures</b>	Mon, Wed 10:30 am – 11:45 am	<b>Grading</b>	<b>MSE 450</b>	<b>MSE 510</b>
<b>Instructor</b>	Prof. Qing Hua Wang Office hours: Tues 10 am – 12 pm Or by appointment	Homework Quizzes Project Reflections	30% 45% 20% 5%	25% 45% 25% 5%

#### Course description

This course will cover microscopy and spectroscopy methods used to characterize the structure and composition of materials. The underlying principles, advantages and disadvantages, and applications of each technique will be studied. The characterization techniques to be covered include optical and electron microscopy, scanning probe microscopy, x-ray and electron diffraction and spectroscopy, vibrational spectroscopy, and ion beam spectroscopy.

#### Learning objectives

After taking this course, students will be able to: describe the operating principles of various characterization techniques; choose the appropriate characterization tool to obtain particular desired information about materials; interpret and analyze data from different characterization methods to determine materials structure and properties; and read and assess research literature related to and making use of materials characterization techniques.

#### Textbook and resources

Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd edition

Additional readings, handouts, and resources will be provided throughout the course either in class or on Blackboard

#### Grading details

##### 1. Undergraduate (MSE 450) and graduate (MSE 510) student grading

The grading components will be the same for undergraduate and graduate students, but weighted differently. The graduate students will also be graded to a more advanced standard for the final project.

##### 2. Homework (5 assignments: 6% each for MSE 450, 5% each for MSE 510)

Homework assignments will have a combination of quantitative problem solving and qualitative questions and are due in class at the start of lecture at 10:30 am. Solutions will be posted to Blackboard after all assignments are handed in.

##### 3. Quizzes (3 quizzes: 15% each)

Quizzes will be held during class periods, with a review session in class before each quiz. They will be closed book and closed notes, but a reference sheet of equations and data will be provided, and non-programmable calculators will be allowed. More details will be announced later in the semester. Questions will be both quantitative and qualitative.

##### 4. Final project (20% for MSE 450, 25% for MSE 510)

The final project will be a choice of in-class presentation or written paper. MSE 510 students will be expected to incorporate a greater research-related component and will be graded to a more advanced standard. There will be 20 slots available for presentations during the last four class periods; the sign-up process will be described later in the semester. The paper is due during final exam week. The topic will be your choice of: (a) describe a characterization technique that is not covered in lectures and discuss its operating principles, sample preparation and requirements, data and information produced, and how it is used for characterizing, or (b) describe how the structure, composition, and properties of a particular material or materials system is characterized using different techniques, or (c) a topic of your choice subject to instructor approval. Additional details for the project will be announced later in the semester.

##### 5. Late submissions

Late assignments (homework and project) will be subjected to a 20% penalty per day (24 hrs), up to 3 days, after which they will not be accepted.

##### 6. Reflections (5%, completion only)

Reflections are designed to help you guide your studying, link this course to your other classroom and research work, and to help improve the course delivery. All reflections submissions will only be counted for completion. **Muddiest points:** Each week you will write down the topics from lectures that were the least clear or need more explanation ("muddiest" points), and submit them anonymously on Blackboard. Selected muddiest points will be answered in more detail in class the following week. **Lab tours:** We will visit several ASU characterization facilities for tours and demonstrations on two dates during the semester, after which you will write reflections on the tours. **Study charts:** You will make tables or charts, either from a template or your own design, to summarize and organize course material.

## Class policies

### 1. Communications

Announcements, handouts, lectures slides, homework, etc., will be posted on the Blackboard site for this course. You are encouraged to come to office hours to ask questions and receive help. Please write "MSE 450" or "MSE 510" in the subject heading on emails to make sure they are seen.

### 2. Classroom behavior

Please do not eat or drink anything that is disruptive to the class. Please silence all electronic devices (phone, tablet, laptop) and do not make phone calls or send texts during class. Laptops and tablets can be used for taking notes. If you need to arrive late or leave early, please do so quietly without disrupting the class. Please treat all members of the class including instructor, grader, and students with respect and courtesy.

### 3. Academic integrity

All students must follow the ASU Student Academic Integrity Policy, which applies to all homework assignments, quizzes, and project. Any violations such as plagiarism, cheating, misrepresentation of work, etc., may result in a zero score for the assignment, may result in a failing grade for the course, and will be reported to the graduate program chair(s), school director(s), academic advisor(s), and/or dean of academic and student affairs. Please see details here:

<https://provost.asu.edu/academicintegrity>, <https://catalog.asu.edu/policies/engineering>

### 4. Requests for regrading

Homework assignments and quizzes can be re-graded by request, but the entire work will be subject to review, not just the particular question in dispute. Errors in adding up or recording points can be fixed immediately.

### 5. Special arrangements

Arrangements for additional time or resources for students with disabilities can be made by contacting me and by registering with the ASU Disability Resource Center (<https://eoss.asu.edu/drc>). If you need to reschedule a quiz or presentation due to emergencies or ASU excused absences such as religious holidays or university-sanctioned activities, please contact me as soon as possible in advance (see policies: [ACD 304-02](#) and [ACD 304-04](#)). Make-up quizzes and presentations will not generally be given for any other reasons.

## Course Schedule (tentative)

Date	Lec	Topics	Suggested Readings	Assignments
1/11/16	M	1	Introduction: syllabus; overview of course topics	Handouts
1/13/16	W	2	Background on materials 1: bonding and structures	Handouts (HW 1 assigned)
1/18/16	M	No class - Martin Luther King, Jr. Day		
1/20/16	W	3	Background on materials 2: defects and properties	Handouts
1/25/16	M	4	Optical microscopy	Ch. 1 <b>HW 1 due</b>
1/27/16	W	5	X-ray diffraction	Ch. 2; Handouts (HW 2 assigned)
2/1/16	M	6	Electron microscopy 1: TEM	Ch. 3
2/3/16	W	7	Electron microscopy 2: SEM	Ch. 4 <b>HW 2 due</b>
2/8/16	M	8	Review for Quiz 1; finish up any unfinished topics	
2/10/16	W	<b>QUIZ 1</b>		
2/15/16	M	9	Quiz 1 solutions; Project description	(Project assigned)
2/17/16	W	7	Electron microscopy 2: SEM	
2/22/16	M	<b>Lab tour 1: TEM, SEM, FIB</b>		
2/24/16	W	10	X-ray spectroscopy: WDS, EDS, XRF Fundamentals of surfaces and vacuum technologies (briefly)	Ch. 6; Handouts <b>Project signups due</b>
2/29/16	M	11	Scanning probe microscopy 1: AFM and variations	Ch. 5; Handouts <b>HW 3 due</b>
3/2/16	W	12	Scanning probe microscopy 2: STM and STS	Ch. 5 (HW4 assigned)
3/7/16	M	No class - Spring Break		
3/9/16	W	No class - Spring Break		
3/14/16	M	13	Review for Quiz 2; finish up any unfinished topics	<b>HW 4 due</b>
3/16/16	W	<b>QUIZ 2</b>		
3/21/16	M	14	Quiz 2 solutions; Background on electronic structure	Handouts
3/23/16	W	15	Electron spectroscopy: AES, XPS	Ch. 7 <b>Project outline due</b>
3/28/16	M	16	Ion beam spectroscopy: SIMS and RBS	Ch. 8; Handouts (HW 5 assigned)
3/30/16	W	17	Light-matter interactions: molecular vibrations, optical transitions	Ch. 9
4/4/16	M	18	Vibrational/optical spectroscopy: FTIR, Raman, UV-vis, fluorescence	Ch. 9 <b>HW 5 due</b>
4/6/16	W	<b>Lab tour 2: XRD, XPS, RBS</b>		
4/11/16	M	19	Review for Quiz 3; finish up any unfinished topics	(extra problems)
4/13/16	W	<b>QUIZ 3</b>		
4/18/16	M	PRESENTATIONS 1		
4/20/16	W	PRESENTATIONS 2		
4/25/16	M	PRESENTATIONS 3		
4/27/16	W	PRESENTATIONS 4		
5/2/16	M	<b>Papers due</b>		