Intro Scan Probe Microscopy

MSE2320 001

Instructor Information

Phone:
Email:
Office Location:
Office Hours

Course Description

Theory and practice related to the use of Scanning Probe Microscopes, including Atomic Force Microscopes (AFM) and Scanning Tunneling Microscopes(STM) . Experience with Contact Mode, Tapping Mode and Friction Mode and lithographic applications such as dip pen lithography and nano shaving. Students will create their own samples as well as imaging commercially available samples.

Prerequisite: CHEM 1110
Semester(s) taught: Fall

Course Student Learning Outcomes

- Students will identify the principal components of atomic force microscope (AFM) systems including probes, the laser, the photodiode, the scanner, and the feedback loop and recognize how each component affects basic AFM operation.

- Students will demonstrate an understanding of the intermolecular forces present during AFM imaging including Keesom forces, Debye forces, London Dispersion forces, Van der Waals forces, and repulsive forces and recognize how forces affect the ability of the AFM system to achieve images with the desired spatial resolution.
- Students will recognize the significance of AFM imaging parameters including setpoint, integral gain, proportional gain, vibrational amplitude, and resonance frequency, and identify the effects of each parameter on image quality.
- Students will examine AFM modes including contact mode, tapping mode, non-contact mode, frictional force, conductive, and phase and recognize how the probe-sample interactions vary between each mode.
- Students will interpret force curves to determine the adhesive forces acting between the AFM probe and sample; students will also utilize force curves to determine the elasticity of samples.
- Students will examine the basic operation of scanning tunneling microscope (STM) systems and identify the components in the system responsible for image collection.
- Students will demonstrate an understanding of image processing software techniques such as flatten, histogram adjust, line profile, and filter and utilize image processing software to improve the quality of AFM and STM images.
- Students will operate AFM and STM systems during weekly, hands-on training sessions to demonstrate proficiency in the utilization of scanning probe microscope systems.

Communication Plan

I will respond to email within 24 hours.

You will receive immediate feedback when you submit Canvas assignments.

I will return exams approximately one-week after the test date.

The best way to contact me is via the Canvas Inbox, as I will prioritize this email over other modes of communication.

Keys for Success (how to succeed in the course)

For students to be successful in this course, the following actions and student engagement activities are strongly recommended and encouraged:

1. Attend class, take notes, and participate in class activities. Complete all your assignments, and do your best.

2. Read and study the lecture notes, slides, and the relevant handouts.

3. Dedicate at least three hours outside of class for assignments for every one hour spent in class.

4. Use the STEM Learning Resource Center for free tutoring. See their hours here: https://www.slcc.edu/stem/tutoring/stem-learning-resources-hours.aspx

5. Do not hesitate to ask questions.

6. Turn on your Canvas Notifications so that when announcements are posted about the course you get notified immediately.

7. Be familiar with the late policy for this course.

Required Text or Materials

Title: Atomic Force Microscopy - Fundamental Concepts and Laboratory Investigations
ISBN: 978-0-367-21864-5
Authors:
Publisher: Taylor and Francis

For more information on textbook accessibility, contact Accessibility & Disability Services at ads@slcc.edu.

Brief Description of Assignments/Exams

Lecture and Assignment Information: Lectures will be presented in-person weekly. Labs will take place in-person in the microscopy lab (SI-88) The supplemental lecture

videos, associated PowerPoint lectures, Canvas quizzes, and post-lab quizzes can be accessed by clicking on the appropriate weekly module.

Chapter Quizzes and Post-Lab Quizzes: Will be administered through Canvas. You are allowed to use the textbook, PowerPoint lectures, and notes while completing chapter and post-lab quizzes.

Lab Attendance: If you need to miss lab session, contact the instructor as soon as possible to provide notice of your absence.

Exams: There will be two in-class exams and a final exam. Exams will be administered in the testing center. The exams are closed book and closed notes. A 3 in x 5 in notecard is allowed.

Exam Make Up: You will be allowed one make-up for each exam that is missed.

Late Work Policy: You can request two assignment unlocks. You have one week after the due date to request an assignment unlock by email. Assignments will not be unlocked past the one-week request period.

Assignment Schedule

Due Date	Assignment Name	Assignment Type	Points
	Introduce Yourself	Discussion	0
10/8	Exam 1	Assignment	100
10/11	Force Curve Analysis of Polymer and Metal Nanogrids	Quiz	100
10/11	Lecture 1: Introduction to AFM (Chapter 1)	Quiz	100
10/11	Lecture 2: Intermolecular Forces (Chapter 2)	Quiz	100

Due Date	Assignment Name	Assignment Type	Points
10/11	Lecture 3: AFM Electronics (Chapter 3)	Quiz	100
10/11	Lecture 4: AFM Cantilevers and Probes (Chapter 4)	Quiz	100
10/11	Lecture 5: Contact Mode AFM (Chapter 5)	Quiz	100
10/11	Lecture 6: Lateral Force Microscopy (Chapter 6)	Quiz	100
10/11	Standard Operating Procedure (SOP) for the Nanosurf EasyScan 2 AFM	Quiz	100
10/18	Contact Mode Imaging of PDMS Stamp and CD Master	Quiz	100
11/8	Lecture 7: Conductive AFM (Chapter 7)	Quiz	100
11/8	Lecture 8: Oscillating Modes of AFM (Chapter 8)	Quiz	100
11/8	Phase Imaging of Metal/Polymer Nanostructures	Quiz	100
11/8	STM Imaging Post-Lab Quiz	Quiz	100

Due Date	Assignment Name	Assignment Type	Points
11/8	Surface Roughness and Lateral Force Microscopy Analysis of Polyvinylpyrrolidone Patterns Deposited on Glass	Quiz	100
11/15	Exam 2	Assignment	100
12/5	AFM Practicum_Fall 2023	Quiz	100
12/10	Final Exam	Assignment	100

Grading Scale

A 93-100
A- 90-92
B+ 87-89
B 83-86
B- 80-82
C+ 77-79
C 73-76
C- 70-72
D 61-69
E <60

Grading Criteria

(25%) Cumulative Final Exam

(25%) Two In-Class Exams

(15%) Chapter/Lecture Quizzes

(15%) Post-lab Quizzes

(20%) Practicum

How to Navigate to Canvas

Institutional Policies

As members of our academic community, we would like to invite you to review the Institutional Syllabus which covers important policies and procedures. This document contains important links for students on the code of student rights and responsibilities, academic integrity, and grading policies, Title IX and other important acknowledgements. By familiarizing yourself with this information, you can help us create a safe and respectful environment for everyone.

You can access the document by clicking on the following link: https://slcc.instructure.com/courses/530981/pages/institutional-syllabus

Learning Support and Tutoring Services

We are pleased to offer a range of tutoring and learning support services to help you achieve your academic goals. Whether you need assistance with a specific subject or want to improve your study skills, you have many options for tutoring or other support.

To learn more about the services we offer and how to access them, please visit the Institutional Syllabus under the Tutoring and Learning Support tab: https://slcc.instructure.com/courses/530981/pages/institutional-syllabus. We encourage you to take advantage of these resources to help you succeed in your studies. If you have any questions or would like to schedule a tutoring session, please don't hesitate to reach out to us. We are here to support you in any way we can.

Advising and Counseling Support Services

At our institution, we are committed to supporting your academic and personal growth. That's why we offer a range of advising and counseling services to help you navigate the challenges of college life. To learn more about the resources available to you and how to access them, please visit the Institutional Syllabus under the Advising and Counseling Support Services tab: https://slcc.instructure.com/courses/530981/pages/institutional-syllabus. Our advising team and the support centers across campus are here to support you in achieving your goals and overcoming any obstacles you may face.

Student Academic Calendar

As students you should be aware of all important dates in the semester, such as the day that courses begin and end, as well as the drop date and the last day to withdraw. To learn more about those dates, navigate to the Student Academic Calendar below:

SLCC Student Academic Calendar

Course Timeline

Week of August 19th	AFM Course Overview	Lab Scheduling Microscopy Lab Overview
Week of August 26th	Lecture 1: Introduction to AFM	Lab: Standard Operating Procedure (SOP) for the Nanosurf EasyScan 2 AFM Setting imaging parameters
Week of September 2nd	Lecture 2: Intermolecular Forces	Lab: SOP/Imaging Parameter Review - Supervised Operation
Week of September 9th	Lecture 3: AFM Electronics	Lab: Contact Mode Imaging of PDMS Stamp and CD Master
Week of September	Lecture 4: AFM Probes	Lab: Force Curve Analysis of

16th		Polymer and Metal Nanogrids
Week of September 23rd	Lecture 5: Contact Mode AFM	Surface Roughness and Lateral Force (Friction) Analysis of PVP Patterns on Glass (Printing and Surface Roughness)

Week of September 30th	Lecture 6: Lateral Force Microscopy	Lab: Lateral Force Microscopy Surface Roughness and Lateral Force (Friction) Analysis of PVP Patterns on Glass (LFM) Imaging
Week of October 7th	Exam 1 The following assignments are due by 11:59 pm Friday, October 11th: Chapter Quizzes: Lecture 1: Introduction to AFM Lecture 2: Intermolecular Forces Lecture 3: AFM Electronics Lecture 4: AFM Cantilevers and Probes Lecture 5: Contact Mode AFM Lecture 6: Lateral Force	No Lab

	Microscopy Post - Lab Quizzes: • SOP for the Nanosurf Easyscan AFM • Contact Mode Imaging of PDMS Stamp and CD Master • Force Curve Analysis of Polymer and Metal Nanogrids • Surface Roughness and Lateral Force Microscopy Analysis of PVP Patterns Deposited on Glass	
Week of October 14th	Lecture 7: Conductive AFM	Fall Break – No Lab
Week of October 21st	Lecture 8: Oscillating Modes of AFM (Tapping, Noncontact, and Phase)	Lab: Phase Imaging of Metal-Polymer Nanostructures
Week of October 28th	Lecture 9: Image Processing	Lab: Conductive AFM Analysis of Silver Nanowires
Week of November 4th	Exam 2 The following assignments are due by 11:59 pm Friday, November 8th:	No Lab

	Chapter Quizzes: Lecture 7: Conductive AFM Lecture 8: Oscillating Modes of AFM Post - Lab Quizzes: • Phase Imaging of Metal/Polymer Nanostructures • Conductive AFM Analysis of Silver Nanowires	
Week of November 11th	Lecture 10: STM (Part 1)	Lecture 10: STM (Part 2)
Week of November 18th	Lab: STM Demonstration	Lab: STM Demonstration

Week of November 25th	Lab: Open Imaging/Practicum Review	Lab: Open Imaging/Practicum Review
Week of December 2nd	AFM Practicum	AFM Practicum
Week of December 9th	Final Exam Scheduled for Tuesday. December 10th 1:30 pm - 3:30 pm	