

Section 1

Syllabus

Course Information

Description

Physics 588 is an introductory course to Scanning Electron Microscopy. Students are expected to learn to use the scanning electron microscope (SEM) and several associated analytical tools for the characterization of inorganic and/or organic material samples. The students are exposed to basic theoretical aspects of the SEM, X-ray energy dispersive spectrometry (XEDS), electron back-scattered diffraction (EBSD), low-vacuum operation, sample preparation, and other techniques.

Prerequisites

The students are expected to have completed the basic SEM training prior to the beginning of class. The basic training for the SEM consists of a few online training videos and several "hands-on" sessions on one of our three scanning electron microscopes with either Mike Standing in the McDonald building (MB) or Paul Minson in the underground lab facility of the Eyring Science center (ESC). Please go through all the videos and then contact Paul or Mike, depending on the microscope for which you want training, and let them know you have completed the training videos. Let them know if you are registered for the SEM class.

Permission-to-add code can be obtained in person by contacting Dr. Felipe Rivera.

- Due to the limited space in the course, a small interview will be requested to discuss the purpose and scope of the class, as well as the student's motivation for taking the course.

Recommended (but not required) courses:

- Electricity and Magnetism (PHSCS220 or higher)
 - Physics 105-108 series will suffice
- Modern Physics (PHSCS222 or higher)
- Solid State Physics (PHSCS281 or 581)
- Experimental Methods in Physics (PHSCS145 or similar)

Instructors' Contact Information

Michael Standing	Paul Minson	Dr. Felipe Rivera
108 McDB	U183 ESC	115 McDB
michael_standing@byu.edu	paul_minson@byu.edu	felipe.rivera@byu.edu
801-422-4011	801-422-2010	801-422-9911

Office hours for Paul and Mike: By appointment.
Office hours for Dr. Rivera: Tuesdays and Thursdays from 3:00 pm to 3:30 pm, and by appointment

Materials

Scanning Electron Microscopy and X-Ray Microanalysis by Goldstein, J — (link to the BYUstore above)	\$129.00
---	----------

The class textbook is also available as a download from the Harold B. Lee Library:

<https://link-springer-com.erl.lib.byu.edu/book/10.1007/978-1-4939-6676-9>

(Download accessible within BYU campus' network)

Scanning Electron Microscopy and X-Ray Microanalysis by Goldstein, J — (link to the BYUstore above)	\$129.00
---	----------

Learning Outcomes

Purpose of the Course

The purpose of this course is to teach students to use the scanning electron microscope (SEM) and several associated analytical tools for the characterization of inorganic and/or organic material samples. The students are exposed to basic theoretical aspects of the SEM, X-ray energy dispersive spectrometry, electron back-scattered diffraction, low-vacuum operation, sample preparation, and other techniques.

Proficiency in basic SEM operation

Lab-based: The student will show proficiency in basic SEM operation. Skills comprise:

1. Sample loading and unloading
2. Proper selection of imaging conditions for the specimen
3. Adequate image acquisition (e.g. focus and stigmat) and
4. Interpretation of acquired micrographs.

Overall knowledge on SEM analytical techniques

Class-based: The student will be familiar with several imaging and analytical techniques available for scanning electron microscopy. For example:

- secondary electron imaging
- back-scattered electron imaging
- x-ray energy-dispersive spectrometry
- electron back-scattered diffraction
- variable pressure SEM
- cathodoluminescence
- voltage contrast
- stage biasing
- focused ion beam microscopy and micro-machining
- others

Proficiency in at least one analytical technique for the SEM

Lab-Based - the student will demonstrate proficiency in at least one of the above-mentioned analytical techniques available in our SEMs.

Grading Policy

In addition to the coursework and assignments given during the course lectures, there will be a significant portion of time dedicated to hands-on equipment utilization during the lab sections. The lab sections may be conducted on the scanning electron microscopes in the underground physics research lab of the Eyring Science Center, as well as in the electron microscopy facility in the McDonald building. It is expected that the students will learn to perform basic and more advanced imaging and analytical techniques on the instruments.

Students will be required to attend lectures and labs, participate in classroom discussion and complete lab work, lab write-ups, reading questions, midterms and final projects.

Reading Assignments = 10%

Weekly lab reports = 10%

Project Proposal = 12%

Midterm Hands-on Labs and Write-ups = 20%

Midterm Written Exams = 20%

Final Lab Presentation = 12%

Final Lab Report (Poster) = 12%

Participation/Attendance = 4%

Attendance Policy

Full attendance is expected for lectures in order to motivate in-class discussion.

Equipment time will be blocked off for the duration of the semester for each section of the course. The students are expected to communicate, a week in advance, which piece(s) of

lab equipment they expect to use. This should be communicated in-person or via e-mail. The plans for the usage of the equipment should also be included in the weekly lab report. When additional time is needed for class-related work, the equipment may be scheduled by sending a request to Mike/Paul so that the microscope time can be billed to the course.

Microscope availability will be allocated in a first-come-first-served basis.

Grading Scale

Grades	Percent
A	93%
A-	90%
B+	87%
B	83%
B-	80%
C+	77%
C	73%
C-	70%
D+	67%
D	63%
D-	60%
E	0%

Teaching Philosophy

I consider myself, this lab, and this course as resources in your pursuit of education. As such:

- I'd place the onus on me to:
 - not compromise the course content such that you may obtain the skills you will need to succeed outside of academia
 - be well-prepared to provide the information you need or at least point you in the right direction to find the answer
 - ensure the lab resources are adequate to meet your needs
 - add enough flexibility to the course to build on your interests
 - share my experiences that you may benefit from them
- I'd place the onus on you to:
 - be proactive in seeking the time to utilize the tool
 - take ownership of the material for this course
 - seek out help when needed

In my opinion, scanning electron microscopy is as much a scientific tool, as it is a skill/art. While the science ensures the reproducibility of the results, obtaining the skills only comes from consistent practice at the tool.