

# Physics 451/551 – Scanning Electron Microscopy

Winter Quarter 2011

**Credits:** 4 credits – 5 hours per week for 10 weeks (2 hours lecture, 3 hours lab per week)

**Instructor:** Prof. Jun Jiao  
Office Hours: Wednesday 15:00 – 17:00  
Office Location: SB 2, room 376  
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**Required Textbook:** *Scanning Electron Microscopy and X-Ray Microanalysis* (Third Edition) by Joseph I. Goldstein, Dale E. Newbury, Patrick Echlin, David C. Joy, Charles E. Lyman, Eric Lifshin, Linda Sawyer, Joseph R. Michael.

**Lectures:** Thursday 14:00 – 16:50. Location: check online class schedule two weeks before the start of the each term.

**Labs:** Friday 09: 00 – 11:50. Location: SB1, room 22

**Course Description:** The course is designed to introduce the theoretical and practical concepts of scanning electron microscopy (SEM), and to provide extensive laboratory work. Topics studied include SEM optical principles, specimen preparation, SEM imaging, and microchemical analysis including qualitative and quantitative X-ray analyses. Lectures consider basic design of the SEM and energy-dispersive X-ray (EDX) systems and are intended to relate operational procedures to functions or features of these electronic systems. Through "hands-on" SEM operation, students will become proficient in the operation of SEM and EDX system.

**Instrument:** Scanning electron microscope (SEM) used in this class is the FEI Sirion FESEM and the ISI SS-40 SEM both equipped with Oxford EDX microanalysis systems.

<u>Lec. #</u>	<u>Date</u>	<u>Probable Topics</u>	<u>Chapters</u>
1	Jan. 6	Introduction & Electron Optics	1, 2
2	Jan. 13	Electron-Specimen Interactions	2, 3
3	Jan. 20	The Role of Specimen and Detector in Contrast Formation	4
4	Jan. 27	Image Formation and Interpretation	4
5	Feb. 3	Special Topics in SEM	5
6	Feb. 10	Energy Dispersive X-Ray Spectroscopy	6, 7
7	Feb. 17	Qualitative X-Ray Analysis	8, 10
8	Feb. 24	Quantitative X-Ray Analysis	9, 10
9	Mar. 3	Specimen Preparation	11 – 15
10	Mar. 10	Oral Presentation	
11	Mar. 14	Final Exam (10:10 – 12:05)	

## Lab Schedules:

WEEK 1 (Jan. 6) – Introduction, Lab Tour and SEM Demo.

WEEK 2 (Jan. 13) – SEM Operation, Start-Up Procedure, Specimen Loading (Stage), Filament Saturation, Main Controls & Parameters, Shut-Down Procedure, SEM Orientations.

WEEK 3 (Jan. 20) – SEM Specimen Preparations and Continue Practice SEM Operations.

WEEK 4 (Jan. 27) – EDX Qualitative Analysis, Identify Unknown Materials.

WEEK 5 (Feb. 3) – EDX Quantitative Analysis. Materials Microchemical Analysis.

WEEK 6 (Feb. 10) – Continue Practice for the Qualitative and Quantitative Analysis.

**WEEK 7 (Feb. 17) – Operation Exam for SEM and EDX System.**

WEEK 8 (Feb. 24) – Individual Project.

WEEK 9 (Mar. 3) – Individual Project.

WEEK 10 (Mar. 10) – Finish Project.

**Laboratory Requirement:** Two written lab reports are required:

- Report I: “SEM Imaging”.
- Report II: “EDX Qualitative and Quantitative Analyses”.

Your lab reports should include: (i) Title and purpose of the experiment. (ii) Information about the specimen and specimen preparation procedures. (iii) General description of the analytical techniques used. (iv) All data taken (including SEM images and EDX spectra). (v) Discussion of results. (vi) References. The lab reports should be submitted before the final exam.

**Term Paper:** For graduate students, a term paper focused on the application of SEM and EDX is required. The format of the paper should follow the same format as the lab report. The detailed requirement for the term paper will be discussed in the class.

**Oral Presentation:** There will be a 10-min oral presentation for each student to report on his/her individual project using SEM and EDX techniques. Power Point presentation is required.

**Grading:** The final grade for this course will be based on students’ performance in the following categories:

For Graduate Students:	Lab Report 1	15%
	Lab Report 2	15%
	Project Report (term paper)	20%
	Project Presentation	10%
	Lab Practical Exam	10%
	(Sample preparation, SEM and EDX operation)	
	Final Exam	30%
For Undergraduate Students:	Lab Report 1	25%
	Lab Report 2	25%
	Project Presentation	10%
	Lab Practical Exam	10%
	(Sample preparation, SEM and EDX operation)	
	Final Exam	30%