Term Information

Effective Term	Spring 2018
Previous Value	*Summer 2012*

Course Change Information

What change is being proposed? (If more than one, what changes are being proposed?)

Change the grading of the course from S/U to graded.

What is the rationale for the proposed change(s)?

The course is a lecture and lab course with a significant component of homework and project; this is not an independent studies course

What are the programmatic implications of the proposed change(s)?

(e.g. program requirements to be added or removed, changes to be made in available resources, effect on other programs that use the course)?

None

Is approval of the requrest contingent upon the approval of other course or curricular program request? No

Is this a request to withdraw the course? No

General Information

Course Bulletin Listing/Subject Area	Earth Sciences
Fiscal Unit/Academic Org	School of Earth Sciences - D0656
College/Academic Group	Arts and Sciences
Level/Career	Graduate, Undergraduate
Course Number/Catalog	5675
Course Title	Scanning Electron Microscopy
Transcript Abbreviation	SEM
Course Description	Basic theoretical concepts and practical applications of scanning electron microscopy (SEM).
Semester Credit Hours/Units	Fixed: 2

Offering Information

Length Of Course	14 Week, 12 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Previous Value	*Satisfactory/Unsatisfactory*
Repeatable	No
Course Components	Laboratory, Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prereq: Chem 1210 or 1220, or equivalent; or permission of instructor.
Exclusions	
Electronically Enforced	No

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	40.0602
Subsidy Level	Doctoral Course
Intended Rank	Junior, Senior, Masters, Doctoral

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- 1. To introduce students to theoretical concepts of Scanning Electron Microcopy.
- 2. To give students hands-on experience with the Quanta 250 FEG SEM in the SES.
- 3. To provide students an opportunity to apply SEM to a research problem.

Previous Value

Content Topic List

- electron beam generation
- Beam/specimen interactions
- Secondary electron imaging
- Backscattered electron imaging
- Qualitative and quantitative microanalysis

Sought Concurrence No

Attachments

- SEM 5675 Syllabus graded 9-29-2017.pdf: Syllabus

(Syllabus. Owner: Panero,Wendy R)

Comments

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Panero,Wendy R	09/29/2017 01:51 PM	Submitted for Approval
Approved	Panero,Wendy R	09/29/2017 01:52 PM	Unit Approval
Approved	Haddad,Deborah Moore	09/29/2017 02:27 PM	College Approval
Pending Approval	Nolen,Dawn Vankeerbergen,Bernadette Chantal Oldroyd,Shelby Quinn Hanlin,Deborah Kay Jenkins,Mary Ellen Bigler	09/29/2017 02:27 PM	ASCCAO Approval

EARTH SCIENCES 5675
Scanning Electron Microscopy
Spring Semester 2018

Instructors

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Recommended Textbook
Goldstein, Newbury, Joy, Lyman, Echlin, Lifshin, Sawyer, and Michael, Scanning Electron Microscopy and X-ray Microanalysis, 3rd ed. (2003)
Two copies of the textbook is on reserve at the Geology Library in Orton Hall.

Course Description
Concepts of electron beam generation and image formation in the scanning electron microscope (SEM) are presented. Topics include electron beam/specimen interactions, secondary electron imaging, back scattered electron imaging, qualitative and quantitative microanalysis, and variables that limit the quality of SEM images and microanalyses. Small groups of students will gain hands-on experience with an FEI Quanta 250 SEM. Students experiment with the effects of changing accelerating voltage, beam current, and specimen tilt in order to observe how these operating conditions influence the resolution and contrast of an SEM image. Sample preparation methods and SEM applications of interest to students are explored.

Course Objectives
1. To introduce students to theoretical concepts of Scanning Electron Microcopy.
2. To give students hands-on experience with the Quanta 250 FEG SEM in the SES.
3. To provide students an opportunity to apply SEM to a research problem.

Lecture
Students are required to attend lectures as part of the credit for this course. All of the lecture and laboratory material will be posted on Canvas, but you should not rely on this. The readings are an important complement to lectures, and it will be advantageous for you to read about a weekly topic before attending class.

Grading (2 credits)
In addition to class participation grading will be based on five problem sets and a project based on use of the SEM to interrogate samples of relevance to the student (see grading scheme below). The project outcome will be in the form of a report that details the science objective, approach (e.g., sample types, sample prep), observations (e.g., images; analyses), interpretation and summary.

Laboratory
There will be one 2-hour laboratory in Mendenhall Room 29 per week. Laboratory is an important component of your grade, and you are expected to attend and participate in all lab activities. You will prepare a lab notebook that you will use as an aid for project work on the SEM for class or later on for your thesis if applicable.

Research Project/Oral Presentation
You will be required to prepare an annotated bibliography on an SEM topic relevant to your research interests. There will be time during the last 3-4 weeks of the semester for you to prepare at least one sample to analyze, and then prepare an oral presentation based on your results and the work of other researchers where appropriate.

CarmenCanvas Website
There is a Carmen website for the course where you can check for ancillary course material. The site should be accessible to all currently enrolled students. An introduction to Carmen can be found at the office of Distance Education and Learning: https://odee.osu.edu/

Academic Misconduct
Cheating will NOT be tolerated, and will be reported as academic misconduct that may result in a failing grade. Cheating is an unpleasant process for everyone concerned and can significantly impact your student career. It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student misconduct. The term **academic misconduct** includes all forms of student academic misconduct wherever committed: illustrated by, but not limited to, cases of plagiarism and dishonest practices. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct: http://studentaffairs.osu.edu/csc/

OSU Statement on Disability Services
Students with disabilities (including mental health, chronic or temporary medical conditions) that have been certified by the Office of Student Life Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office of Student Life Disability Services is located in 098 Baker Hall, 113 W. 12th Avenue; telephone 614- 292-3307, slds@osu.edu; slds.osu.edu.

Helpful Tips
The syllabus is a guide to the topics covered. Days during which topics are covered are subject to change, but any changes will be announced in class. Read materials before class, and take your own notes. Working with classmates is encouraged, but when it comes to producing your own class project to turn in, that should be done independently.

Spring Semester Schedule (2018)

Week	Planned Lecture/Lab Topic	Assignments (pp.) Goldstein et al. Reading; problems
1	**Lecture:** electron beam generation electron optics overview **Lab 1:** tour of SEM and ancillary equipment (inside and out)	Chapter 1 Chapter 2: pp. 21-23; 30-40
2	**Lecture:** secondary electron (SE) generation Everhart-Thornley detector (ET) (hi vacuum mode), LFD detector (low vacuum mode), gaseous secondary electron detector (GSED) ("ESEM" mode) **Lab 2:** sample exchange, stage navigation, interpretation of sample topography (light-optical analogy)	Ch. 2, p. 24 Ch. 3, pp. 61-72; 88-97 Ch. 4, pp. 127-133; 151-158 Problem set #1
3	**Lecture:** backscattered electron (BSE) generation backscattered electron detector (hi vac and low vac modes) **Lab 3:** atomic number (Z) contrast	Chapter 3: pp. 75-88; Chapter 4: pp. 127-132; 133; 136-138; 158-165
4	**Lecture:** image generation in the SEM scan rastering, magnification, resolution **Lab 4:** magnification, focus, lens defects, resolution	Ch. 2, pp. 48-54 Ch. 4, pp. 99-118 Ch. 5, pp. 195-203 Problem set #2
5	**Lecture:** principle variables in SEM operation: electron beam energy (keV), condenser lens strength (spot size), objective lens aperture, working distance (WD) **Lab 5:** experiments with keV, spot size, working distance	Ch. 2, pp. 25-29; 40-50; 54-60 Problem set #3

6	**Lecture:** applications of SEM in the Earth Sciences; SEM sample preparation **Lab 6:** sample preparation tailored to students' interests ; carbon coater, precious metal sputter coater demos	Ch. 11, Ch. 15 Problem set #4
7	Lecture: SEM as a chemical analytical instrument: history, characteristic X-ray generation, SEM (EDS) v. EPMA (WDS) **Lab 7:** qualitative energy dispersive spectroscopy (EDS), data analysis using Lecture: SEM as a chemical analytical instrument: history, characteristic X-ray generation, SEM (EDS) v. EPMA (WDS) **Lab 7:** qualitative energy dispersive spectroscopy (EDS), data analysis using Bruker Quantax (Esprit) software	Ch. 8
8	**Lecture:** SEM as a chemical analytical instrument, cont'd: atomic number (Z), Absorption (A), Fluorescence (F) matrix effects. **Lab 8:** quantitative energy dispersive spectroscopy (EDS) data analysis using Bruker Esprit software (standardless v. standard-based quantification)	Ch. 9 Problem set #5
9	**Lecture:** Quantitative Evaluation of Minerals by Scanning Electron Microscopy (QEMSCAN) **Lab 9:** working with the QEMSCAN analytical sample holder; setting up a field scan thin section run with iMeasure software	
	Spring Break: no classes	
10	**Lecture:** QEMSCAN (cont'd) **Lab 10:** data analysis of field scan using iExplorer imaging software	
11	**Lecture:** in-class discussion/help session with individual project topics **Lab 11:** ion mill demonstration	
12	Lab time for student projects (lecture) **Lab 12:** Bruker Quantax X-ray mapping	
13	Lab time for student projects (lecture, lab)	
14	Student presentations on final exam day	
15	**FINAL EXAMS******Annotated bibliographies and project report due!	

Problem sets: (due 1 week from the date assigned)

1 Secondary Electron signal attenuation calculation

2 Calculation of image resolution relating to magnification (horizontal field width) and number of pixels.

3 Calculation of optimal final lens aperture r, and relationship among r, beam convergence angle alpha, and working distance (WD).

4 Image stitching of a Back Scattered Electron field area; of between 25-100 images using ImageJ (Figi)

5 Calculation of olivine and plagioclase compositions from EDXS data using Bruker Quantax software. ZAF calculation "by hand" to see the effect of these variables on measured composition.

Grading: (*All grades use the standard OSU scheme*)

Class participation: 25%

Problem sets: 5% for each one x 5 = 25%

Project report and class presentation = 50%

Grading Scale (OSU Standard Grade Scheme):

A (93 - 100), A- (90 - 92.9), B+ (87 - 89.9), B (83 - 86.9), B- (80 - 82.9), C+ (77 - 79.9),

C (73 - 76.9), C- (70 - 72.9), D+ (67 - 69.9), D (60 - 66.9), E (< 60)