MATSCEN 6741 (Approved): Practical Transmission Electron Microscopy Lab

Course Description

Transmission Electron Microscopy with emphasis on practical methods.

Prior Course Number: 741
Transcript Abbreviation: Elect Micrscpy Lab
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Graduate
Student Ranks: Masters, Doctoral
Course Offerings: Autumn, Spring, May, Summer
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 2.0
Repeatable: No
Time Distribution: 1.0 hr Lec, 3.0 hr Lab
Expected out-of-class hours per week: 2.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Graduate standing; or permission of instructor
Exclusions:
Cross-Listings: None

Course Rationale: One credit hour is not indicative of the student's time in lecture and lab. Two credits--i.e., 3-

5 hours per week of the student's time--is correct.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1801
Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
MATSCEN	Materials Science and Engineering

General Information

Please note that knowledge provided in MATSCEN 6715, Principles of the Characterization of Materials, while not a prerequisite, is helpful for students. Students should have some knowledge of elementary crystallography and reciprocal lattice construction, as well as an understanding of Bragg's Law and the Ewald sphere construction.

Course Goals

Operation, alignment, and calibration of the TEM
Electron Diffraction, Bright Field, Dark Field, and STEM imaging.
X-ray analysis in the S/TEM.
Biological sample imaging and preparatory imaging for cryo-TEM

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Basic Operation I--SEM vs. TEM, identification of column parts, gun operation, saturation, gun tilt/trans, condenser aperture, condenser stig	1.0		3.0					
Basic Operation II--Eucentric height, rotation center, objective aperture, focus (grain, fresnel fringes), Objective stig. FEG vs. Thermionic	1.0		3.0					
Imaging--Taking photos, exposure, film exchange, loading & developing	1.0		3.0					
Diffraction--basic powder diffraction, reciprocal space	1.0		3.0					
Objective aperture--function of Objective aperture, BF/DF, CTF, defocus	1.0		3.0					
STEM--microprobe/nanoprobe, HAADF	1.0		3.0					
Kikuchi Lines/Orientation; Negative staining	1.0		3.0					
EDX; Screening of Negatively Stained Sample	1.0		3.0					
EELS; Tissue Sample Preparation I	1.0		3.0					
HRTEM/HRSTEM; Tissue Sample Preparation II	1.0		3.0					
Image Analysis--MIPAR, ImageJ/FIJI, Photoshop	1.0		3.0					
Tomography; Preparation of Cryo-EM Samples	1.0		3.0					
Titan condenser system; Screening of Cryo-EM Samples (Lecture only)	1.0							

Representative Assignments

Basic operation: scope alignment, gun operation, FEG alignment; flat field, magnification calibration; diffraction calibration; image with different apertures & defocus
Materials samples: Tilt to several zones, predict 3rd zone from stereo projection; determine k-factor; convergence and acceptance angles;
Biological samples: Prepare grids for imaging during next lab session; Fix a tissue sample for sectioning and staining; learn about various staining methods; Prepare collected images for publication; discuss image processing ethics; Demo on Glacios

Grades

Aspect	Percent
Lab reports (6 at 16.7% each)	83%
Practical Exam	17%

Representative Textbooks and Other Course Materials

Title	Author
Transmission Electron Microscopy: A Textbook for Materials Science	D.B. Williams and C.B. Carter

Title	Author
Practical Electron Microscopy in Materials Science	J.W. Edington
Electron Microscopy of Thin Crystals	P. Hirsch, A. Howie, R.B. Nicholson, D.W. Pashley, M.J. Whelan

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
	a	An ability to apply knowledge of mathematics, science, and engineering.
	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
	e	An ability to identify, formulate, and solve engineering problems.
	f	An understanding of professional and ethical responsibility.
	g	An ability to communicate effectively.
	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
	i	A recognition of the need for, and an ability to engage in life-long learning.
	j	A knowledge of contemporary issues.
	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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