Course Information

Course times and location: A lecture/demonstration and a 3-hour laboratory per week. Location: CEMAS Digital Theatre (room 144).
- Lecture/demonstration on Monday, 3 p.m. – 5 p.m.
- Lab day/time TBD
Credit hours: 2
Mode of delivery: In-person

Instructors

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Teaching Assistant

Name: Brittany Ford
Email: ford.1027@buckeyemail.osu.edu

Course Prerequisites

You should have some knowledge of elementary crystallography and reciprocal lattice construction. You should understand Bragg's Law and the Ewald sphere construction.
Course Description

Objective: students will develop a basic understanding of practical aspects of transmission electron microscopy (TEM) operation

Content: Topics will include:
• Operation, alignment, and calibration of the TEM
• Electron Diffraction, Bright Field, Dark Field, and STEM imaging.
• X-ray analysis in the S/TEM.
• Crystal orientation and diffraction indexing.
• Biological sample imaging and preparatory imaging for cryo-TEM.
How This Course Works

Mode of delivery: Each week have a lecture/demonstration session on Monday from 3 to 5 p. m. and a 3-hour lab session. Both will take place in within Digital Theatre (room 144) and Tecnai 30 (room 140) at CEMAS. Lab sessions start the second week of the course, and day/time will be decided during the first week of the semester.

Credit hours and work expectations: This is a 2 credit-hour course. Students should expect around 5 hours of work per week, divided in 1-2 hours per week of lecture/demo, 3 hours per week of practical lab, and 1-2 hour of homework (assignments/lab reports).

Grading: This course is graded A-E. Grading is based on lab reports and on a practical exam at the end of the term. The practical exam counts the same as one lab report.

Attendance and participation requirements:
- You are expected to attend all lecture/demonstration and lab sessions. If you have a situation that might cause you to miss a class, discuss it with instructor as soon as possible. Unexcused class absences will factor into the grade.
- You are expected to present a lab report after each lab session. Lab reports are due one week after the lab. In any event, lab reports will not be accepted any later than 5:00 pm on the final day of class. See assignment section below for more information about lab reports.
- You may practice for the practical exam any time after the last lab has finished. You should contact the instructor to schedule time for practice.
- It is your responsibility to contact instructor to schedule your practical exam. It may be scheduled any time before the end of finals.

Descriptions of Major Course Assignments

Lab Assignments/Reports

- Each laboratory session will have an assignment/lab report. The laboratory notebook should be a record of all your observations during the lab sessions as well as discussion of your results.
- Photomicrographs and diffraction patterns should be printed and included in your notebooks/reports and sized to be legible.
- You must include all your data so that we can follow your analysis.
- You may share the micrographs of your lab session with your partners, but you are expected to write the lab report individually.
Course Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Day</th>
<th>Lecture</th>
<th>Labs</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>9-Jan</td>
<td>Course Intro &amp; Specimen Interactions</td>
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<td><strong>16-Jan</strong> Martin Luther King Jr. Day</td>
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<tr>
<td>2</td>
<td>23-Jan</td>
<td>Operation 1</td>
<td>Lab 1</td>
</tr>
<tr>
<td>3</td>
<td>30-Jan</td>
<td>Operation 2</td>
<td>Lab 2</td>
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<tr>
<td>4</td>
<td>6-Feb</td>
<td>Imaging &amp; Sample Loading</td>
<td>Lab 3</td>
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<td>5</td>
<td>13-Feb</td>
<td>Electron Diffraction</td>
<td>Lab 4</td>
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<td>6</td>
<td>20-Feb</td>
<td>Objective Aperture &amp; TEM Imaging Modes (BF and DF)</td>
<td>Lab 5</td>
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<td>7</td>
<td>27-Feb</td>
<td>STEM</td>
<td>Lab 6</td>
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<td>8</td>
<td>6-Mar</td>
<td>Operations &amp; Alignment review</td>
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<td><strong>13-Mar</strong> Spring Break</td>
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<thead>
<tr>
<th>Crystalline Materials</th>
<th>Biologic Materials</th>
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<tbody>
<tr>
<td>9 20-Mar</td>
<td>EDX</td>
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<tr>
<td></td>
<td>Negative Staining &amp; Single Particles Imaging</td>
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<tr>
<td></td>
<td>Lab 7C // Lab 7B</td>
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<td>10 27-Mar</td>
<td>Kikuchi Lines Sample Orientation</td>
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<td>Cryo-EM vs RT Imaging</td>
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<td></td>
<td>Lab 8C // Lab 8B</td>
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<td>11 3-Apr</td>
<td>Crystallographic Imaging</td>
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<td>Sample Preparation and Imaging of Tissues Part 1</td>
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<td></td>
<td>Lab 9C / Lab 9B</td>
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<tr>
<td>12 10-Apr</td>
<td>Sample Preparation</td>
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<td></td>
<td>Sample Preparation and Imaging of Tissues Part 2</td>
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<td></td>
<td>Practice</td>
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<td>13 17-Apr</td>
<td>Practice / Exam</td>
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<tr>
<td>14 24-Apr</td>
<td>Practice / Exam</td>
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This is a tentative schedule. It may be revised due to instrument availability, holidays, conferences, etc.
Lab outline

Lab 1: Basic Operation
   **Goal:** Learn knobs, initial alignment, and operation of illumination system
   **Sample:** Au islands
   **Task:** Scope alignment, gun operation

Lab 2: Basic Operation
   **Goal:** Learn knobs, initial alignments, and operation of imaging system
   **Sample:** Au islands
   **Task:** Scope alignment, gun operation

Lab 3: Imaging
   **Goal:** Learn digital camera and software operation
   **Sample:** Grating replica
   **Task:** Flat field, magnification calibration

Lab 4: Diffraction
   **Goal:** Learn optimization and collection of electron diffraction patterns
   **Sample:** Polycrystalline Al or Au sample
   **Task:** Electron diffraction collection and calibration

Lab 5: Objective aperture
   **Goal:** Understand function of Objective aperture, formation BF/DF images
   **Sample:** MoO$_3$
   **Task:** Image with different apertures & defocus

Lab 6: STEM
   **Goal:** Familiarize with microprobe/nanoprobe, HAADF
   **Sample:** Al-Cu Alloy, Pt nanoparticles
   **Task:** Image nanoparticles, image diffraction sample with different CL

**Crystalline Materials**

Lab 7C: EDX
   **Goal:** Familiarize with EDX detector and analysis, CL method, and statistics
   **Sample:** NiAl sample
   **Task:** Determine k-factor, Uncertainty calculation

Lab 8C: Crystal orientation/Kikuchi lines
   **Goal:** Identify Kikuchi lines, learn to set up crystal orientation using Kikuchi lines
   **Sample:** [001] Si
   **Task:** Tilt to several zones, predict 3rd zone from stereo projection; index patterns

Lab 9C: Review
   **Goal:** Put in practice acquired knowledge by working on a case sample
Sample: -
Task: It will be specified at the starting of the lab

Biologic Materials

Lab 7B: Negative Staining & Single Particles Imaging
Goal: Learn negative staining of protein samples. Identify and image individual stained protein molecules
Sample: Apoferritin
Task: Determine the radius of apoferritin

Lab 8B: Cryo-EM vs RT imaging
Goal: Familiarize with FFTs and defocus
Sample: -
Task: Identify “good” vs. “bad” images based on FFTs

Lab 9B: Sample preparation and imaging of tissue
Goal: Learn basics of tissue sample preparation.
Sample: -
Task: Fix a tissue sample for sectioning and staining. Tissue samples imaging and identify sample prep. artifacts

Recommended/Optional Materials and/or Technologies

- MyScope - http://myscope.training/
- Grant Jensen videos (series of 48 videos) - https://www.youtube.com/playlist?list=PLhiuGaXIZZenm7lu5qv_A59zEWkRKKbN5
Other Course Policies

Accessibility Accommodation for Students with Disabilities

Requesting Accommodations
The university strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability including mental health, chronic or temporary medical conditions, please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services (SLDS). Students that have been certified by the Office for Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs.

Disability Services Contact Information
- Phone: 614-292-3307
- Website: slds.osu.edu
- Email: slds@osu.edu
- In person: Baker Hall 098, 113 W. 12th Avenue

Ohio State’s Academic Integrity Policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university’s Code of Student Conduct (studentconduct.osu.edu), and that all students will complete all academic and scholarly assignments with fairness and honesty.

Students must recognize that failure to follow the rules and guidelines established in the university’s Code of Student Conduct and this syllabus may constitute “Academic Misconduct.” Academic misconduct is defined as “Any activity that tends to compromise the academic integrity of the university or subvert the educational process” by Ohio State University’s Code of Student Conduct (Section 3335-23-04). Examples of academic misconduct include, but are not limited to, plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487).

Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (go.osu.edu/ten-suggestions)
- Eight Cardinal Rules of Academic Integrity (go.osu.edu/cardinal-rules)
Creating an Environment Free from Harassment, Discrimination, and Sexual Misconduct

The Ohio State University is committed to building and maintaining a community to reflect diversity and to improve opportunities for all. Members of the university community have the right to be free from harassment, discrimination, and sexual misconduct. Ohio State does not discriminate on the basis of age, ancestry, color, disability, ethnicity, gender, gender identity or expression, genetic information, HIV/AIDS status, military status, national origin, pregnancy (childbirth, false pregnancy, termination of pregnancy, or recovery therefrom), race, religion, sex, sexual orientation, or protected veteran status, or any other bases under the law, in its activities, academic programs, admission, and employment.

To report harassment, discrimination, sexual misconduct, or retaliation and/or seek confidential and non-confidential resources and supportive measures, contact the Office of Institutional Equity:

1. Online reporting form at equity.osu.edu,
2. Call 614-247-5838 or TTY 614-688-8605,
3. Or email equity@osu.edu

Your Mental Health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University's Student Life Counseling and Consultation Service (CCS) is here to support you. If you find yourself feeling isolated, anxious or overwhelmed, on-demand mental health resources (go.osu.edu/ccsondemand) are available. You can reach an on-call counselor when CCS is closed at 614-292-5766. 24-hour emergency help is available through the National Suicide Prevention Lifeline website (suicidepreventionlifeline.org) or by calling 1-800-273-8255(TALK). The Ohio State Wellness app (go.osu.edu/wellnessapp) is also a great resource.