

Syllabus MSE 581: Advanced Electron Microscopy

Schedule:

Tuesday/Thursday 2:00 pm–3:20 pm, 0018 Campus Instructional Facility

Instructor

Prof. Jian-Min Zuo, 1006 Materials Research Laboratory

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Course Websites:

<https://canvas.illinois.edu/courses/55889>

Course description: Present the theory of transmission electron microscopy and electron diffraction in relationship to materials structure characterization and microanalysis. Topics include physics of particle waves, dynamical electron diffraction theory, high resolution electron microscopy, magnetic lens aberrations and aberration correction, electron probe formation, STEM and electron inelastic scattering and microanalysis. Prerequisite MSE 405, 481 or equivalent, or with consent of the instructor.

Textbook and Reading Materials:

J.M. Zuo and J.C.H. Spence, **Advanced Transmission Electron Microscopy, Imaging and Diffraction in Nanoscience**, Springer, 2017 (Available online through UIUC library)

D. Williams and B. Carter, "**Transmission Electron Microscopy-A Textbook for Materials Science**", Plenum Press, New York, 2nd Edition, 2009 (Good introductory textbook, recommended for background reading; available online through UIUC library)

"**Springer Handbook of Microscopy**", Edited by P.W. Hawkes and J.C.H. Spence, Springer, 2006 (An advanced reference book; Available online through UIUC library)

Lecture Topics:

Subject	Hours
1. Electron waves, electron optics and microscopes	6
2. Electron diffraction, kinematical theory	6
3. Electron diffraction, dynamical theory	6
4. Scanning transmission electron microscopy, magnetic lens, probe formation, lens aberrations, aberration correction	9
5. Scanning electron nanobeam diffraction and 4D-STEM	6
6. Inelastic Scattering and Electron Energy Loss Spectroscopy	7
Total hours	40

Grade: Homework assignments 30% (about 2-3 problems each and 6 to 8 assignments in total). Midterm (35%) and final project and report (35%).

Office hours

Friday, 11am to 12 pm

or by appointments

Expectations:

This class is to build the theoretical background for learning transmission electron microscopy and diffraction for materials characterization. As such, certain physical concepts, materials knowledge and mathematics are involved. We expect some familiarity with quantum physics and crystal structure. To succeed in class, be on time and be prepared with assigned readings, actively participate in discussions, ask questions when needed, complete assignments on time, demonstrate respect for the teacher and classmates, and maintain a positive learning attitude.

Special Accommodations:

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact their lecturer and the Disability Resources and Educational Services (DRES, disability.illinois.edu) as soon as possible, and no later than Jan. 31, 2025.

Academic Integrity, Harassment, and Discrimination:

You are bound by the University Honor Code in this course. Any violation of the Honor Code will result in disciplinary action. In addition, harassment or discrimination of any kind will not be tolerated. Please report any concerns immediately to your professor.