

Physics 6450
Introduction to Materials and Device Characterization

Instructor: Zhixian Zhou
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Time: Lecture: T 9:35 am – 11:30 am, Th 9:35 am – 11:30* am
 Lab: Th 11:35* am – 2:00 pm
 *There will be a short break between the lecture and lab on Thursdays.
Room: 245 Physics
Office Hours: TBA
Text: No required text. Lecture notes will be posted on Blackboard. Occasional handouts
Prerequisites: Basic physics at PHY217/218 level (Halliday Resnick). Suggested co-requisites: PHY7050/ECE5500

This course deals with modern techniques used in the characterization of materials and devices. A number of techniques based on diffraction, microscopy, spectroscopy, optical, magnetic, and electrical properties will be discussed. For each technique, the basic principles, the information that can be obtained using the technique, and an introduction to the practicalities of the technique will be provided, either by the instructor or by guest lecturers who are experts in the field. One of the goals of this course is to provide students with the tools necessary to design and implement experiments for their own graduate research projects.

Students will be required to participate in the laboratory sessions, where a first-hand experience into each technique will be provided. For each experiment the students will complete laboratory reports. At the end of the semester, groups of 3 students each will complete a research project based on the presented techniques, in which they perform 2-3 characterization experiments on a sample or device. The results of the project will be written up in a report, and an oral presentation will be given.

Tentative schedule
(subject to change)

Week of	Lecture topic	Lab (Th)
Jan 7	Overview of course, Introduction: Materials characterization, Crystallography General Data Analysis	General Data Analysis
Jan 14	Diffraction methods: X-ray diffraction	XRD: Simulation
Jan 21	Diffraction methods: Electron diffraction Diffraction methods: Neutron diffraction	XRD: Experiment
Jan 28	Microscopy: optical, electron (SEM, TEM)	SEM, TEM
Feb 04	Microscopy: Scanning Probe Microscopy	AFM
Feb 11	Optical spectroscopy (IR/Visible/UV)	UV/VIS
Feb 18	Electrical characterization of devices	Resistivity
Feb 25	Light scattering (Raman/Photoluminescence)	Raman/PL, IR
Mar 4	Magnetic Characterization: Magnetometry/NMR	VSM/SQUID
Mar 11	Spring Break	
Mar 18	APS March Meeting, No Class	
Mar 25	Electron spectroscopy (AES, XPS, UPS)	AES, XPS Lab starts on Thursday morning

Apr 1	Low Temperature techniques	Low Temperature Lab Tour
April 8	Mossbauer spectroscopy (Tuesday only, Dr. Prem Vaishnava)	No Lab
Apr 15	Project	

Grading: Laboratory Reports: 20%

Technical Report: 20%

Oral Presentation: 20%

Quizzes: 40%

Note: There are no exams in this course.

Laboratory notebooks: Students will participate in 10 laboratory sessions where they experience first-hand many of the techniques discussed in the lecture. Students will collect data and write lab reports. The lab reports consist of answering questions about the technique used, the samples, data interpretation and analysis and conclusion. Questions will be provided during the lab session. Each student will maintain a bound lab notebook to record all the lab reports. Each lab will be 2% of the total grade of the course. The lab notebook grade will also be based on neatness, organization/ presentation of data etc. **THERE ARE NO MAKE-UP LAB SESSIONS.**

Technical Report: In the last three weeks of the class, student teams will be formed of 3 students each. These teams will characterize samples using at least 2-3 techniques discussed in the class or any other relevant characterization technique. The teams will then prepare technical reports on their findings, which should be written as if submitted to a technical/ scientific journal. They should include a review of the relevant background literature, experimental methods, results, and discussion, as well as all relevant plots, tables etc.

Oral Presentation: Each team will present their work in form of an oral presentation, similar to a presentation given at a scientific meeting. Every student will be allotted the same amount of time for their presentation. There will be short question & answer sessions. Grades will be based on knowledge and presentation style.

Quizzes: There will be unannounced short quizzes during class.