

MSE 404 TE1: Thin Film Electrical Properties, Fall 2026

Lab Times: Monday and Wednesday 2:00 pm – 4:50 pm,
113 Ceramics Building
Course information will be made available online via [Canvas](#).

Instructor: Prof. Axel Hoffmann
Office: Materials Research Laboratory 1021 **Email:** axelh@illinois.edu

Office Hours: Anytime during lab hours or via prior appointment.

Teaching Assistants:
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Office Hours: Anytime during lab hours or via prior appointment.

Course Description:

Introduce seniors and new graduate students to electrical properties of thin-film materials and semiconductors through hands-on experiments in Materials Science and Engineering instructional laboratories. Covers both the principles and measurements of

- Thin-film resistance;
- Modification of electrical properties by thermal processing;
- Carrier mobility and Hall effect;
- Size-effect of thin-film resistance.

Prerequisites:

MSE 307 and MSE 308; senior or graduate standing. *If you have not passed a prerequisite course, please see the instructor before continuing.*

Course Objectives:

The objective of this course is to provide lab experience to students in Thin Film Processing and Electrical Property Characterization. The lab is organized using a set of experimental modules performed in laboratory sessions, problem solving and presentation/final report. Students are encouraged to read background materials before the class. Each experimental module is expected to be done by students with minimal help from the lab's technical specialist.

Course Topics:

1. Measurement of thin films resistivity, 2, 3, 4 points probe
2. Van der Pauw method of measuring resistivity
3. Hall effect and carrier mobility
4. Thin-film resistivity and microstructure
5. Size dependence of electron mobility and resistivity

Course Structure:

In the first part of the course, there will be three short labs where students will learn about different techniques for measuring resistance and mobility of thin films. These labs can be accomplished in any order as tool availability allows. However, the prelab for each short of all team members must be submitted before starting the associated experiments. There will be a deadline every week to maintain progress through the semester. The last part of the course, there will be two longer lab where students have to use multiple tools to understand how thermal annealing or thickness affects material conductivity.

At the start of the course, students will be organized into groups of 2 or 3 within their own session for instrument sign up and laboratory work. Students are encouraged to self-select their own group on the first day of class. Instructor will assign remaining students to teams. You will stay with the same team for the entire course. You should notify Prof. Hoffmann immediately if you decide to drop the course.

Attendance: Teams should only attend lab days during their assigned sessions (i.e., MW). Teams are only required to attend the lab if they have a tool booked. Every member of a team is expected to be present during measurements or when using reserved tools unless they have specific exemption ahead of time from the instructor. If one team member is more than 10 minutes late from the start of experiments of the rest of the team, it will be marked as an absence. Teams are not required to attend lab if they are performing analysis or working on reports, but they are encouraged to use the lab time for group work or as office hours to get help from the instructors. Every student will be responsible for their own reports and analysis.

Laboratory Instrument Schedule:

Every day, there will be a signup where teams can reserve instruments in 1:30 to 3 hour increments. Teams must reserve instruments as a full group. TAs have the right to reorganize based on progress.

Instrument	2:00–3:30 pm	3:30–5:00 pm
Hall Effect 0.32 T		
Hall Effect 0.5 T		
Hall Effect 1 T		
4 pt/ hot probe		
Denton Sputter coater		
Quorum Sputter coater		
Annealing oven		

Assignments:

All assignments will be submitted and graded on [GradeScope](#). For the group presentation, students will also upload a video to [Canvas](#).

*Part 1: Short labs on thin film techniques*Pre-lab thinking questions

Before the start of each short lab activity, students will need to individually submit pre-lab report addressing concept questions needed for understanding the underlying physics that is being probed by the technique, and what to expect. The group members are encouraged to discuss the solutions, but each member should hand-in their own pre-lab written in their own words. These assignments may be treated as homework assignments and can be handwritten or typed.

Post-lab report

At the end of each lab activity, students will individually need to submit a post-lab report analyzing and interpreting the data. The post-lab report should include answers to the thinking questions and a summary of your measurement results, and be written as a coherent document rather than a set of separate questions and answers. See the report guidelines on [Canvas](#). The group members are encouraged to discuss the solutions, but each member should hand-in their own post-lab report written in their own words.

Part 2: Structure and process labs

Teams will perform two longer labs which require using more involved measurements to understand how the conductivity of thin films changes under annealing or from thickness. For each lab, each student will have to prepare a postlab report analyzing the data.

Laboratory Projects:*Part I: Measuring the electronic properties of thin films*

- Every team should complete Module 1 first, to get used to electrical measurements.
 - Then half the teams will start on Module 2, half will start Module 3, then swap.
 - Finally, half the teams will start on Module 4, and half will start on Module 5, then swap.
1. Thin Film Resistivity
 - Resistivity of TiN Thin Film, 2-pt, 3-pt and 4-pt resistance measurements
 - Measurement of contact resistance by varying contact probe distances
 2. Van der Pauw method of measuring resistivity
 - Prepare Au/Al Films of designed shapes on Glass Slides by sputtering deposition
 - Measurement of resistivity using Van der Pauw method
 3. Hall Effect and Resistivity
 - Measurement of Resistivity and Hall Voltage of GaAs,
 - Measure and identify unknown Samples,

Part II Relating thin film conductivity and microstructure

4. Modifying conductivity and microstructure via temperature Annealing

- Prepare Au/Al Films on glass by sputtering deposition,
- X-ray diffraction of as-deposited film,
- Thermal Annealing and In-situ Resistivity Measurement,
- X-ray diffraction of annealed film

5. Size scaling of thin-film resistivity and mobility

- Prepare Au Films of different thicknesses on Glass Slides
- Measurement of thin-film resistivity and electron mobility, versus thickness

Grading:

Short Lab: 4 point resistance: 15%

Short Lab: Van der Pauw: 15%

Short Lab: Hall Effect: 15%

Longer Lab: Conductivity and processing: 20%

Longer Lab: Conductivity and microstructure: 20%

Attendance and participation: 15%

All assessment scores will be stored in the gradebook in [Canvas](#).

Numerical total score corresponds to the following final grades:

A+ (97–100)	B+ (87–89)	C+ (77–79)	D+ (67–69)	
A (93–96)	B (83–86)	C (73–76)	D (63–66)	F (0–59)
A- (90–92)	B- (80–82)	C- (70–72)	D- (60–62)	

Grade Reporting:

All assessment scores are stored in the gradebook in [Canvas](#). Any errors in grade reporting appearing in the gradebook must be reported within 2 weeks of the grade being posted in the gradebook or by the last day of class, whichever is earlier. If you have a missing grade, contact the instructor.

Late Submission:

You get one “free” late assignment submission on any pre/postlab except the team video presentation. This is an up to 48-hour extension with no penalty that can be used over the entire semester. We will automatically apply this to the first assignment submitted late by any amount of time on [GradeScope](#). Any additional late assignments after this one will automatically get a 20% penalty for assignments between 1 second up to 1 day late, and 40% penalty for assignments between 24 and 48 hours late. You will not receive credit for late assignments over this time limit.

Absences:

Excused Absence Request Form: <https://forms.illinois.edu/sec/45404944>

1. Excuses from assessments will only be given in the following circumstances:
 - a. Illness
 - b. Personal crisis (*e.g.*, car accident, required court appearance, death of close relative)
 - c. Required attendance at an official UIUC activity (*e.g.*, varsity athletics, band concert)
 - d. Religious observances, see the following website for further information: <https://odos.illinois.edu/community-of-care/resources/students/religious-observances/>.
2. In all cases you must complete the online Excused Absence Request Form and upload a scan of the official written documentation explaining your absence.
3. In cases (a) or (b) an official excuse letter from the Dean on Duty must be submitted via the online form within 2 weeks of the due date of the missed assessment, but no later than the last day of instruction (December 9). In cases of extended or unusual illness, late submission of excuse documentation will be considered. See [Student Assistance Center](#).
4. In case (c) an official letter from the designated university official must be submitted via the online form at least one week prior to the due date of the missed assessment.
5. If you will not be able to take an exam due to illness or any other reason, you must send email to your professor at the earliest possible opportunity. Excused exams will be replaced by a weighted average of the other exam scores at the end of semester.
6. Notwithstanding the above, at the professor's discretion you may be required to make up any excused work or attend substitute instruction or assessment.

Course Materials, Discussions and Announcements:

Course materials, including instructions for lab projects will be made available through our course [Canvas](#) website at <https://canvas.illinois.edu>.

Discussions and announcements related to course material will be facilitated by using the discussion boards of [Canvas](#). This site will be used for all communication between the instructor, TAs, and students. If you desire, then you can post anonymously or make a private post just to the instructor (rather than sending an email). TAs are scheduled to be checking [Canvas](#) regularly during the week. *Note that [Canvas](#) should be used to communicate with your instructors, rather than email.*

Laboratory Safety Policy:

- All students and staff are REQUIRED to wear long pants, closed shoes, and safety glasses while working in the instructional labs. Any student not wearing correct attire will not be allowed to do lab work and will be marked as missing attendance for the day.
- No eating or drinking in the labs
- Students are responsible for cleaning up after themselves. The lab should be left in good condition before you are allowed to leave.

Obtaining help:

The main two ways to obtain help are online at [Canvas](#) or in person during the lab hours. Please do not send email directly to TAs or professors for routine help or absences. In cases of emergencies (e.g., illness) you should email your professor at the earliest possible opportunity.

Accommodations:

To obtain disability-related academic adjustments and/or aids, students should contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, e-mail disability@illinois.edu, or go to the DRES website: <https://www.disability.illinois.edu>. If you are concerned you have a disability related condition that is impacting your academic progress, academic screening appointments are available on campus that can help diagnose a disability.

For rare circumstances, such as extended illness and family emergencies that make it difficult for you to keep up with coursework, you should contact Professor Hoffmann via a [Canvas](#) private message as soon as possible to discuss options. In these cases, I encourage you to reach out to the Dean of Students office, which can help you contact and manage accommodations with all of your courses.

Academic Integrity:

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: <http://studentcode.illinois.edu/>. Academic dishonesty will result in a sanction proportionate to the severity of the infraction, with possible sanctions described in 1-404 of the Student Code (<https://studentcode.illinois.edu/article1/part4/1-404/>). Every student is expected to review and abide by the Academic Integrity Policy as defined in the Student Code: <https://studentcode.illinois.edu/article1/part4/1-401/>. As a student, it is your responsibility to refrain from infractions of academic integrity and from conduct that aids others in such infractions. A short guide to academic integrity issues may be found at <https://provost.illinois.edu/policies/policies/academic-integrity/students-quick-reference-guide-to-academic-integrity/>. Ignorance of these policies is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Individual Work:

You are welcome to use publicly available resources (library, faculty, academic literature, computers, etc.) to do your reports. This includes discussions with other students in the class. However, each student is expected to turn in their own work on every assignment. In addition, every student should refrain from using reports from previous semesters, regardless of whether these are obtained from a friend, or posted to an online source.

Changes to syllabus:

May occur as deemed necessary by the professor; they will be announced.

Calendar and Topics:

Changes to the schedule will be announced; see the MSE 404 TE website on [Canvas](#) for exact schedule, assignments, and to remain up to date.