

MSE 597: Artificial Intelligence in Semiconductor Microstructure Analysis

Course Information

Course credit hours: 1

Instructional Modality: Asynchronous online

Course Brightspace Page: <https://purdue.brightspace.com/d2l/login>

Prerequisites: Graduate standing; or junior/senior undergraduate in engineering.

Instructor Contact Information

- **Professor Mohamad Zbib**
- **Email:** mzbib@purdue.edu
- **Virtual Office Hours:** Students are encouraged to request virtual meetings. To schedule a meeting, please email me with a few preferred 30-minute time slots. I will then send a Microsoft Teams calendar invite to confirm the appointment.
- **Communication Expectations:** Email is the primary method of communication for this course. When contacting the instructor, please include “MSE 597” in the subject line to ensure a timely response. I will do my best to get back to you within 48 hours.

Course Description

This online course introduces the application of artificial intelligence (AI) and data-driven methods to semiconductor microstructure analysis. Students explore how microscopy images and characterization datasets are analyzed using machine learning techniques for defect detection, phase identification, and microstructure–property relationships in semiconductor materials. Emphasis is placed on practical workflows, model selection, data quality, and interpretation of results in both research and industrial contexts.

Course Learning Outcomes (CLOs)

By the end of the course, you will be able to:

1. **CLO1:** Apply AI-based data analysis methods to microscopy images and characterization datasets to identify defects, phases, and microstructural features in semiconductor materials.
2. **CLO2:** Evaluate the suitability and limitations of AI models for semiconductor microstructure analysis, including data quality, model assumptions, and interpretation of results.
3. **CLO3:** Use data-driven approaches to relate microstructure to properties, demonstrating how AI tools can support prediction, diagnostics, and decision-making in semiconductor research and manufacturing contexts.

Learning Resources, Technology & Texts

Brightspace learning management system (LMS)

Access the course via Purdue's Brightspace learning management system. Begin with the Start Here tab, which offers further insight into the course and how you can be successful on it. It is strongly suggested that you explore and become familiar not only with the site navigation, but also with the content and resources available for this course. See the Student Services widget on the campus homepage for resources such as Technology Help, Academic Help, Campus Resources, and Protect Purdue.

Supporting Materials Resources

All supporting materials will be provided through the Brightspace system. These resources will be organized by module and include links to journal articles, websites, etc. There is no textbook required for this course.

Recommended AI Tools

This course includes demonstrations of several third-party AI tools (e.g., Teachable Machine, ilastik, Orange Data Mining, and LandingLens) to support student learning of AI-assisted semiconductor microstructure analysis. While you may be encouraged to use these tools in assignments, the learning outcomes focus on applying AI methods and interpreting results rather than mastering a specific software package. Equivalent alternative materials and activities can be provided, if needed, to ensure all students can achieve the course learning outcomes. If you encounter any issues with finding or accessing an appropriate tool (one of the recommended tools or an equivalent alternative), please feel free to reach out to me for help as soon as possible. If you need additional accessibility support, you may also contact [Purdue's Disability Resource Center \(DRC\)](#) for help. Links to access the recommended tools are provided below:

- [Teachable Machine](#) (no download needed; available online)
- [ilastik - ilastik](#) (install version 1.4.1)
- [Orange Data Mining](#) (install Orange3-3.40.0)
- [LandingLens](#)

Purdue Libraries and School of Information Studies

I encourage you to visit [Ask a Librarian](#) to connect with helpful resources and services provided by the Purdue Libraries and School of Information Studies for course assignments and projects.

Academic Support

The Helen Bass Williams [Academic Success Center](#), provides a variety of proactive, practical and approachable academic support services for you to strengthen your approaches and strategies for learning, including study skills consultations, peer coaching, workshops, and online handouts. [Visit the ASC website](#) for more information and to access resources.

Assignments

Category	Description	% of Final Grade
Individual Assignments	Five individual assignments will be administered throughout Weeks 1–5 of the course (one per module). Instructor feedback will be provided within one week of each due date. Please refer to Brightspace for specific deadlines. • Assignment 1 – Discussion Board (10%) ○ Initial response to the assigned topic (5%) ○ Response to another student's post (5%) • Assignment 2 (10%) – Covers Modules 1–2 • Assignment 3 (10%) – Covers Modules 2–3 • Assignment 4 (10%) – Covers Modules 3–4 • Assignment 5 (10%) – Reflection activity	50%
Quizzes	A total of six quizzes will be administered throughout the course. One quiz will be given per module. Quiz 0 is an Honor Code Quiz designed to unlock access to all subsequent assignments and quizzes. The remaining quizzes, scheduled during Weeks 1–5, assess comprehension of module content. All quizzes are timed, must be completed individually, and will include instructor feedback. • Quiz 0 (0%) – Honor Code Quiz • Quiz 1 (10%) – Covers Module 1 material • Quiz 2 (10%) – Covers Module 2 material • Quiz 3 (10%) – Covers Module 3 material • Quiz 4 (10%) – Covers Module 4 material • Quiz 5 (10%) – Covers Module 5 material	50%

Assignment NOTES

- Late submissions of any activity will **only** be accepted if requested in advance and granted.
- **Regrade Requests:** If you have concerns regarding a graded activity, please express your concerns by writing an email to the instructor. Additionally, attach a scanned image of the activity of concern to the email. Regrade requests must be submitted **within 24 hours** after receiving your grade.

Grading Scale

Letter Grade	Percentage
A	Value $\geq$ 94.0
A-	$90.0 \leq$ Value $<$ 94.0
B+	$87.0 \leq$ Value $<$ 90.0
B	$84.0 \leq$ Value $<$ 87.0
B-	$80.0 \leq$ Value $<$ 84.0
C+	$77.0 \leq$ Value $<$ 80.0

Letter Grade	Percentage
C	$74.0 \leq$ Value $<$ 77.0
C-	$70.0 \leq$ Value $<$ 74.0
D+	$67.0 \leq$ Value $<$ 70.0
D	$64.0 \leq$ Value $<$ 67.0
D-	$60.0 \leq$ Value $<$ 64.0
F	$<$ 60 %

Course Schedule

Module (#, Title)	Learning Activities/Assessments
Course Introduction & Expectations	• Welcome & Introduction (Video 0) • Honor Code Quiz
Module 1 – Introduction to AI in Semiconductor Characterization	• Lecture Video 1A: Fundamentals of AI and Semiconductor Characterization • Lecture Video 1B: Course Tools, Resources, and Accessibility • Lecture Video 1C: Training a Simple AI Image Classifier for Semiconductor Microstructures • Reading 1 • Assignment 1 (Discussion Board) • Quiz 1
Module 2 – AI for Microscopy Image Analysis	• Lecture Video 2A: Image Processing and Feature Extraction • Lecture Video 2B: AI-Based Defect Detection in Semiconductor Microstructures • Reading 2 • Assignment 2 • Quiz 2
Module 3 – AI Models and Data Interpretation	• Lecture Video 3A: Machine Learning Models for Materials Characterization • Lecture Video 3B: Data Quality, Bias, and Model Limitations • Reading 3 • Assignment 3 • Quiz 3
Module 4 – Microstructure–Property Relationships and Predictive AI	• Lecture Video 4A: Linking Microstructure to Semiconductor Properties • Lecture Video 4B: Predictive Analytics and AI-Assisted Decision-Making • Reading 4 • Assignment 4 • Quiz 4
Module 5 – Industrial Applications and Future Directions of AI in Semiconductor Characterization	• Lecture Video 5A: AI Applications in Semiconductor Research and Manufacturing • Lecture Video 5B: Closing Lecture for the Course • Assignment 5 (Reflection Activity) • Quiz 5

Materials (lectures, videos, readings, discussions, assignments, and quizzes) will be available on a weekly basis. For assigned activities, please refer to the Brightspace course for specific due dates and times.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on the Academic Resources table on your Brightspace homepage.

Use of Artificial Intelligence (AI) Tools

Generative AI is like any other tool—it has both strengths and weaknesses. Just as good engineers use tools to improve problem-solving and critical-thinking skills, it's essential to understand and use generative AI ethically. Before using it, make sure you know how it can assist you and what its limitations are. Your responsibility is to use generative AI in a way that supports and enhances your learning while adhering to the **course's academic integrity policy**. Make sure to be familiar with all course policies, as they are outlined in more detail to guide your appropriate use of generative AI.

Nondiscrimination Statement

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in the Academic Resources table on your Brightspace homepage.

Accessibility

Purdue University strives to make learning experiences accessible to all participants. If you anticipate or experience physical or academic barriers based on disability, you are encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247, as soon as possible.

If the Disability Resource Center (DRC) has determined reasonable accommodations that you would like to utilize in my class, you must release your Course Accommodation Letter to me. Instructions on sharing your Course Accommodation Letter can be found by visiting [this link](#). Additionally, you are strongly encouraged to contact me as soon as possible to discuss the implementation of your accommodation.

Mental Health/Wellness Statement

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try [Therapy Assistance Online \(TAO\)](#), a web and app-based mental health resource available courtesy of Purdue Counseling and Psychological Services (CAPS). TAO is available to all students at any time by creating an account on the [TAO Connect website](#), or downloading the app from the App Store or Google Play. It offers free, confidential well-being resources through a self-guided program informed by psychotherapy research and strategies that may aid in overcoming anxiety, depression and other concerns. It provides accessible and effective resources including short videos, brief exercises, and self-reflection tools.

If you need support and information about options and resources, please contact or see the [Office of the Dean of Students](#). Call 765-494-1747. Hours of operation are M-F, 8 a.m.- 5 p.m.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc., sign up for free one-on-one virtual or in-person sessions in West Lafayette with a [Purdue Wellness Coach at RecWell](#). Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect. Students in Indianapolis will find support services curated on the [Vice Provost for Student Life website](#).

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact [Counseling and Psychological Services \(CAPS\)](#) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS offices in [West Lafayette](#) or [Indianapolis](#).

Basic Needs Security

If you ever face challenges meeting your basic needs — like food, housing, transportation, healthcare, childcare or access to technology — Purdue can help. Contact the Office of the Dean of Students to seek help with immediate needs and support on campus. Visit www.purdue.edu/odos or email odos@purdue.edu. The Purdue Basic Needs Program connects students with off-campus resources and provides one-on-one basic needs consultation. Visit them at www.purdue.edu/studentsuccess/basicneeds or email basicneeds@purdue.edu.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

Useful Links and Resources

- [Purdue's Student Guide for Academic Integrity](#)
- [Use of Copyrighted Materials](#)
- [Office of the Dean of Students: Class Absences](#)
- [Violent Behavior Policy](#)
- [Nondiscrimination Policy Statement](#)
- [Engage in Your Learning](#)
- [Electronic Information, Communication & Technology Accessibility](#)
- [Academic Regulations: Attendance](#)
- [Amorous Relationships](#)
- [Emergency Preparedness](#)
- [Accessibility Standards in Brightspace](#)

Disclaimer

This syllabus is subject to change. You will be notified of any changes as far in advance as possible via an announcement on Brightspace. Monitor your Purdue email daily for updates.