EEC 245 / EMS 245 / ECH 245 / MAE 245 – Micro- and Nano-Technology in Life Sciences
4 units – Spring Quarter 2025

Objective: The integration of microfabrication, nanotechnology, and the life sciences has generated powerful tools to study biological questions, as well as to diagnose and treat diseases. The unifying objective of this interdisciplinary course is to train students from different backgrounds to be conversant across multiple disciplines and acquire skills to approach complex biomedical problems.

Class Times/Location: Tuesday and Thursday 2:10PM-4:00PM; Bainer Hall 1062

Prerequisite: Graduate Standing (or instructor approval)

Instructor: Prof. Erkin Şeker (eseker@ucdavis.edu); Office: 3177 Kemper Hall

Virtual Office Hours: Wednesday 2:00PM-3:00PM; Zoom link on Canvas

TA: Hyehyun Kim (hyhkim@ucdavis.edu) – Please contact via email regarding homework questions and grading.

Grading: Letter; final grade will be based on homework assignments (40%), an in-class exam (20%), a proposal assignments (30%), and elevator pitch (10%).

Homework: There will be 5-6 homework sets which will be assigned approximately a week before they are due.

Exam: There will be an **in-class exam on Tuesday (May 27)**, which will cover the topics up to the midterm. Please hold the midterm date for mandatory attendance. A make-up exam will not be given unless cases of extreme extenuating circumstances arise.

Proposal Project: Students will be asked to propose a microdevice and provide a thorough analysis at mechanical, electrical, and biological levels. The project report will be formatted to serve as a foundation for pre-doctoral fellowship applications, thereby training students on essential proposal writing skills.

Elevator Pitch: Students will be asked to record a 1-min elevator-pitch on their proposal. Specific instructions will be given.

Attendance & Late Submission Policy: Assignment submissions (including homework, in-class exam, proposal tasks, elevator pitch, peer-reviews) will be done electronically on Canvas. Assignments submitted after deadline up to 24 hours will have 20% deducted; between 24 hours and 48 will have an additional 20% deducted. Any submission later than 48 hours will not be accepted.

Computer Use: ImageJ (NIH free image processing software) will be used for some homework assignments. Specific instructions will be given.

Textbooks: Relevant reading material and exercises will be provided by the instructor.

Note on Generative Artificial Intelligence (GenAI) Tools: Unless otherwise noted during class activities, you may only use ChatGPT or any other GenAI technologies to *aid* or *nuance* your thinking, communication, and learning; but not to *replace* or *subvert* it. See the table at the end of the syllabus for some examples of allowable and non-allowable uses of GenAI technologies in this class (NOTE: This is not an exhaustive list of examples).

Academic Integrity: Cheating and plagiarism will absolutely not be tolerated. Professional integrity is an important aspect of all engineering disciplines and understanding the material in these courses is integral to becoming a proficient and productive engineer. As such, it is imperative that you spend the time and effort to fully understand the material, and seek help when necessary. Please read the UC Davis "Code of Academic Conduct" at participate.ucdavis.edu .

Course Materials: My lectures and course materials, including PowerPoint presentations, tests, outlines, and similar materials, are protected by U.S. copyright law and by University policy. I am the exclusive owner of the copyright in portions that I create. There are sections from third-parties that may also be protected by copyright. You may take notes and make copies of course materials for your own use. You may also share those materials with another student who is enrolled in or auditing this course. You may not reproduce, distribute or display (post/upload) lecture notes or recordings or course materials in any other way — whether or not a fee is charged — without my express prior written consent. You also may not allow others to do so. If you do so, you may be subject to student conduct proceedings under the UC Davis Code of Academic Conduct. Similarly, you own the copyright in your original papers and exam essays. If I am interested in posting your answers or papers on the course web site, I will ask for your written permission.

Frequently Asked Questions - Student Resources: https://ebeler.faculty.ucdavis.edu/resources/faq-student-resources/

Course Content:

1. **Micro- and Nano-Manufacturing**. We will examine key micro- and nano-fabrication techniques and discuss relevant processing and characterization instruments. There will be a special emphasis on the challenges and design considerations in process development.
2. **Surface Science and Mass Transfer.** We will review techniques to engineer advanced surfaces by modulating morphology and chemistry. In addition, we will discuss 3D morphology and its implications on molecular transport within and from functional device coatings.
3. **Essential Biology.** Following an introduction to basic anatomy, physiology, and pathology, we will study how living organisms interact with inorganic devices. We will emphasize the ways tissues respond to biomedical devices and how this response can be tuned by modulating device properties.
4. **Devices.** We will survey important device components such as biosensors and actuators that are built using the tools discussed in Sections 1 and 2 with a special emphasis towards addressing the biological requirements/constraints outlined in Section 3.
5. **Applications.** The fundamental knowledge acquired up to this point will be put in context by deconstructing existing and developing technologies. Examples will include implantable devices for treating medical disorders. Additional examples will be discussed in accordance with the interests of the class.

Approximate Timeline

Week	Date	Day	Topic
1	4/1	T	Introduction & Course Outline
	4/3	H	Surface Science
2	4/8	T	Mass Transfer
	4/10	H	Anatomy & Physiology
3	4/15	T	Pathology
	4/17	H	Grant Proposal
4	4/22	T	Microfabrication
	4/24	H	Microfabrication
5	4/29	T	Nanofabrication
	5/1	H	Characterization
6	5/6	T	Materials & Packaging
	5/8	H	Sensors
7	5/13	T	Actuators
	5/15	H	Biological models
8	5/20	T	Biointerface
	5/22	H	Big Picture & Exam Review
9	5/27	T	IN-CLASS EXAM
	5/29	H	Office Hour (Zoom)
10	6/3	T	Guest Lecture (Sangwoo Kim)
	6/5	H	NO CLASS

Details on GenAI Use (Acknowledgement: Dr. Torrey Trust, University of Massachusetts, Amherst)

Example of an Allowable Use	**Why is this Allowed?**	**Things to Keep in Mind**
Prompting GenAI technologies to **generate ideas** for a class project.	This might enhance your creative thinking by **exposing you to different ideas** compared to what you might come up with on your own (GenAI technologies, like ChatGPT, draw from a massive dataset of billions of parameters, which means these tools can introduce you to ideas and concepts from various fields that you might not be familiar with). GenAI writing technologies are also helpful for **idea iteration** – you can prompt these technologies to give you 50 different iterations of the same idea in less than a few seconds.	It is important to start with **brainstorming your own ideas first** (to aid your creative thinking), rather than letting GenAI do that initial work for you. Also, beware that GenAI might introduce biases into the topic when prompted to generate ideas.
Using GenAI technologies for writing support (e.g., using Grammarly to **improve writing quality, clarity, and expression**).	GenAI writing technologies and AI-powered writing assistants (e.g., Grammarly) can provide ideas for how to revise a sentence, begin a paragraph, express your thinking more clearly, and identify grammar and spelling errors. Used in this way, GenAI technologies might allow you to focus more on expressing your thinking and demonstrating your learning through writing as opposed to focusing on how to write and spell properly (although it is important to learn the foundations of writing, too!).	Make sure to **get your thoughts written down first** rather than asking GenAI technologies to write the first draft. Writing and thinking are interconnected processes, if you prompt GenAI technologies to write the first draft for you, you are not actively engaging in thinking about the material. NOTE: We also have a wonderful Writing Center on campus! Use it!
Using GenAI technologies as a **study or assignment aid.**	GenAI technologies can offer study tips, provide example text/quiz practice questions, design a personalized study guide, design flashcards, give directions for how to complete an assignment, create learning simulations and interactive scenarios to help you develop your understanding of the class content, and it can even provide a rubric so you can self-assess your own work.	GenAI tools are known for making up information and presenting biased output. Make sure to double-check the accuracy, credibility, and reliability of any AI-generated information that you use to support your studying or assignment completion.
Prompting GenAI technologies to help **make information easier to understand** (e.g., explaining technical or academic jargon, providing concrete examples of an abstract idea).	GenAI technologies could potentially be used in ways that reduce cognitive load, such as breaking material into smaller chunks, summarizing and simplifying material, providing an outline of an article to support pre-reading, translating text into your native language, making content more accessible, scaffolding learning, and providing concrete examples.	If GenAI technologies are used in ways that reduce germane load (the cognitive effort required to build mental schema) it can negatively impact learning. For example, asking ChatGPT to summarize an article for you instead of reading the article reduces your germane load as well as your ability to learn from the reading. Start with doing the reading first, then if you are still struggling to understand the text, consider if AI might help you with a summary or podcast overview of the content.