

THE UNIVERSITY OF NEW MEXICO

SYLLABUS

From Silicon to Systems: The A-Z of Semiconductor & Microsystem Engineering

ENG195

Fall 2024

Instructor: Matthias W. Pleil, Sang Han, Nathan Jackson, Daniel Feezell, Christina Salas

- Email: mpleil@unm.edu - prefer courses messages through Blackboard/Canvas messaging
- Office Location: ME403 or MTTC (Manufacturing Technology Training Center) Rm 165
- Office Hours: After Lab, After Lecture, by Appointment
- Office Phone: MTTC: 505 272 7157, Mobile: 505 363 3428 (I do TEXT)

Note: There will be other members of the UNM engineering community that will participate in this course, including but not limited to, TA's, Processes Engineer, and other Faculty.

Lecture times/location: Fridays 1-3:30pm, Centennial 1032– *Note: the lectures include hands on, the last 3-4 weeks, students will be going to one of five laboratories depending on their interest.*

Lab times/location: Various faculty labs

MTTC Location:

Address: 800 Bradbury Dr SE, Albuquerque, NM 87106

Map link: <https://mfg.unm.edu/contact/map-directions.html>

Course Description

Explore the dynamic field of microsystems technology in our cutting-edge course, This course is for freshman and sophomore level students in engineering and science, aiming to ignite interest in this rapidly growing area and its myriad career paths. Taught by a diverse team of five esteemed faculty members, the interdisciplinary course spans five distinct but interconnected modules. Delve into the world of Optoelectronics with Prof. Daniel Feezell, learning about optical materials and devices like LEDs and lasers, coupled with hands-on characterization techniques. Prof. Sang Han will guide you through Semiconductor Process Engineering, offering a theoretical counterpart to cleanroom practices, including microchip manufacturing essentials. Matthias Pleil offers a practical cleanroom experience in Micro Fabrication, where you'll perform actual wafer processing. Unpack the complexities of Microelectronics Packaging with Prof. Nathan Jackson, covering everything from design to thermal management. Lastly, Prof. Christina Salas leads the Micro-additive manufacturing module, introducing advanced manufacturing at micro and nano scales, with a special focus on bioMEMS device fabrication. Get ready to engage with both theory and hands-on practice, preparing you for the next steps in your academic and professional journey.

Course Goals:

1. To provide a comprehensive understanding of the principles and applications of semiconductors and microsystems.
2. To foster interdisciplinary knowledge among engineering, chemistry, and physics students in the areas of semiconductor and microelectronics fabrication.
3. To equip students with practical skills through hands-on experience in cleanroom processes and micro-additive manufacturing techniques.
4. To engage students to consider career in microelectronics, photonics, and microelectromechanical systems by exposing them to current technologies and methodologies.

Student Learning Outcomes (aka Objectives):

Semiconductor Process Engineering (Dr. Sang)

- Comprehend the principles behind microchip manufacturing unit operations.
- Describe the processes of lithography, thermal oxidation, diffusion, and thin film deposition.
- Understand the significance of dry etching, interconnections, contacts, and yield in semiconductor fabrication.
- Explain the integration process for metal-oxide-semiconductor (MOS) transistors.

Micro Fabrication Cleanroom Experience (Dr. Pleil)

- Gain practical experience in wafer processing.
- Perform lithography, metrology, etching (wet and dry), and thin film deposition.
- Integrate the theoretical knowledge of semiconductor processing with cleanroom practices.

Micro-additive Manufacturing (Dr. Salas)

- Introduce various micro and nano-scale additive manufacturing techniques such as electrospinning and direct write bioprinting.
- Emphasize the role of bioMEMS device fabrication in the medical field.
- Train on the usage of additive manufacturing equipment and software tools.

Optoelectronics and Photonic Integration and Characterization (Dr. Feezell)

- Understand the fundamental concepts of optics and optical materials.
- Explain the basic operation and applications of LEDs, lasers, and photodetectors.
- Perform electrical and optical characterization techniques, such as light-current-voltage (LIV), photoluminescence (PL), and optical spectrum analysis.
- Apply transfer length method (TLM) for contact resistance and Hall measurements for assessing mobility and carrier concentration.

Microelectronics Packaging (Dr. Jackson)

- Outline the basics of electrical package design and its reliability concerns.
- Discuss thermal management and its importance in packaging.
- Compare and contrast single and multiple chip packaging approaches.
- Understand the differences in packaging technologies for RF, IC, MEMS, and optoelectronics.

By the end of the course, students will have a foundation in semiconductor and microsystem fundamentals, practical experience with laboratory techniques, and an appreciation for the interdisciplinary nature of the field, setting the stage for further education or entry into the semiconductor industry.

Textbooks/Supplies/Materials/Equipment/ Technology or Technical Requirements:

Required reading and lecture materials will be provided in class and through links in UNM's online learning management system, Canvas. It is recommended the students have access to high-speed internet; they are allowed to bring laptops, phones and/or tablets into the classroom and cleanroom labs to keep notes.

Course Requirements:

Students will complete projects, assessments, projects, and homework assignments on time. Students will be assessed on their understanding of key concepts and terminology, laboratory skills through online and/or take home exams, in class assessments, student presentations, required documentation and demonstrated knowledge of content.

Grading:

Individual assignments, lab and project writeup, presentation assessments will be weighted according to the difficulty and time required. Final grades will be calculated by Activity Area:

Activity

Lab/Hands-on Activities	20%
Individual Assignments	20%
Assessments (i.e., quizzes, team presentations, class participation and attendance...)	20%
Attendance/Participation	20%
Final Presentation	20%

Final grades are assigned based on the UNM schema and will be a combination from all instructors.

Undergraduate Students:

Grade	Cutoff	Grade	Cutoff	Grade	Cutoff	Grade	Cutoff	<60%
A+	97%	B+	87%	C+	77%	D+	67%	F
A	94%	B	84%	C	74%	D	64%	
A-	90%	B-	80%	C-	70%	D-	60%	

Course Schedule:

The course schedule is subject to change and will be posted online. This is to allow for lab equipment issues, weather, desire to delve more deeply into a topic and/or skip activities for other ones as new processes become available.

Note: the order and topic specifics will vary depending on time and interest of the students, and instructor and lab equipment availability. Topics and Activities which are considered are listed:

Lecture Topics by week:

Week - Date	Topic
1 - 8/23	Introductions, Expectations, Topic Overview - All
2,3 - 8/30, 9/6	Semiconductor Process Engineering – Sang Han
3,4 - 9/13, 9/20	Micro Fabrication – Matthias Pleil
5,6 - 9/27, 10/4	Micro-additive Manufacturing – Christina Salas
7 - 10/11	Fall Break – no class
8,9 - 10/18, 10/25	Optoelectronics and Photonic Integration and Characterization – Daniel Feezell
10,11 - 11/1, 11/8	Microelectronics Packaging - Nathan Jackson
12,13 - 11/15, 11/22	Choose between one of five labs, prepare posters - All
14 - 11/29	Thanksgiving Break – no class
15 - 12/6	Poster Preparation
16 - Finals Week	Poster Presentation

Lab Topics will support the key topics listed through a variety of different opportunities. Students will be able to rank the areas that they are most interested in, selection will be based on the number that each lab can support.

Response Time Policy

The individual instructors will do his best to answer your questions as quickly as possible, typically within one business day, and provide feedback on assignments within one week of submission.

Safety and Equipment Use Compliance

All students are required to follow laboratory safety protocols, this means students must complete required safety training. If the student does not follow safety, equipment or process protocols, they may lose access to the lab and may fail the course. Minor infractions will be dealt with on a case-by-case basis at the discretion of the laboratory faculty and staff. Students need to be accepting to coaching and are expected to ask questions and clarification if any process or safety procedure is not fully understood.

Students' Online Classroom Participation May Be Monitored

You are encouraged to take advantage of the online resources including chat, forums, messaging. However, it is expected you act professionally. When communicating to your instructors, it is the same as communicating with your (future) boss. When communicating with your classmates, it is expected you act as if they are co-workers – show the respect you expect from others. It's good practice for your future job. Write clearly, using proper grammar, spelling and cite the work done by others.

Computer Requirements

Since this course is taught partially online, frequent use of a computer is required. Students must have access to a computer and to the Internet, and you will need to be familiar with the use of a browser such as Internet Chrome, Safari, or Firefox. Access at least part time to a broadband (high speed) internet network, such as DSL, cable, and wireless, is recommended since some of the assignments involve audio and video clips. Students can access a broadband network at many libraries and buildings on campus. The engineering department has a computer center open 24x7.

It is recommended you have a backup plan for your assignments. UNM has free online storage available, One Drive, as well as free Microsoft office products. Don't rely on one machine to back up all your work. A crashed computer for losing an assignment is not an acceptable excuse.

UNM Computer Account Policy

All students are required to have a UNM campus account (NetID). Students will use this account to access this course via the current learning management system.

See: <https://policy.unm.edu/university-policies/2000/2500.html> for the UNM Computer use policy.

Course Email Policy

We prefer that you contact the instructors and student partners through the UNM LMS platform rather than external email. This system keeps track of the communication within the course.

Academic Integrity – do not take credit for another’s work without proper citations

Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, including dismissal, against any student who is found responsible for academic dishonesty. Any student who has been judged to engage in academic dishonesty in course work may receive a reduced or failing grade for the work in question and/or for the course. Academic dishonesty includes, but is not limited to, dishonesty on quizzes, tests, or assignments; claiming credit for work not done or done by others (plagiarism); and hindering the academic work of other students.

See: <https://policy.unm.edu/regents-policies/section-4/4-8.html>

Students should take care not to leave their computers or thumb drives where others can steal or copy their work or make their files “public.”

Accommodation Statement:

Accessibility Resources Center (Mesa Vista Hall 2021, 277-3506) provides academic support to students who have disabilities. If you think you need alternative accessible formats for undertaking and completing coursework, you should contact this service right away to assure your needs are met in a timely manner.

Support: Contact Dr. Pleil through email or in office/check-in hours and contact [Accessibility Resource Center](https://arc.unm.edu/) (<https://arc.unm.edu/>) at arcsrvs@unm.edu (505) 277-3506.

Title IX Statement:

Our classroom and our university should always be spaces of mutual respect, kindness, and support, without fear of discrimination, harassment, or violence. Should you ever need assistance or have concerns about incidents that violate this principle, please access the resources available to you on campus. Please note that, because UNM faculty, TAs, and GAs are considered "responsible employees" by the Department of Education, any disclosure of gender discrimination (including sexual harassment, sexual misconduct, and sexual violence) made to a faculty member, TA, or GA must be reported by that faculty member, TA, or GA to the university's Title IX coordinator. For more information on the campus policy regarding sexual misconduct, please see: <https://policy.unm.edu/university-policies/2000/2740.html>.

Support:

- [LoboRESPECT Advocacy Center](#) and the support services listed on its website,
- the [Women's Resource Center](#) and the
- [LGBTQ Resource Center](#) all offer confidential services and reporting.

Course Evaluations

Students will be requested to participate in an online course evaluation near the end of the course. Please fill these out with consideration to the instructors with clear feedback, include what you found useful and interesting as well as opportunities for continuous improvement. We will look at these reviews critically and make adjustments to better meet future students needs.

You are also encouraged to make use of external rating systems, such as “Rate My Professor,” this allows other students to ascertain the quality of the professor and allows the instructor to review comments and improve his or her teaching. Engineering follows a continuous improvement methodology. Of course, integrity counts– be honest, clear, and objective in your assessment of instructors.

Land Acknowledgement:

Founded in 1889, the University of New Mexico sits on the traditional homelands of the Pueblo of Sandia. The original peoples of New Mexico Pueblo, Navajo, and Apache since time immemorial, have deep connections to the land and have made significant contributions to the broader community statewide. We honor the land itself and those who remain stewards of this land throughout the generations and acknowledge our committed relationship to Indigenous peoples. We gratefully recognize our history.

Resource: [Division for Equity and Inclusion](#).

Citizenship and/or Immigration Status:

All students are welcome in this class regardless of citizenship, residency, or immigration status. Your professor will respect your privacy if you choose to disclose your status. As for all students in the class, family emergency-related absences are normally excused with reasonable notice to the professor, as noted in the attendance guidelines above. UNM as an institution has made a core commitment to the success of all our students, including members of our undocumented community. The Administration’s welcome is found on our website: <http://undocumented.unm.edu/>.

Respectful and Responsible Learning:

We all have shared responsibility for ensuring that learning occurs safely and equitably. UNM has important policies to preserve and protect the academic community, especially policies on student grievances (Faculty Handbook D175 and D176), academic dishonesty (FH D100), and respectful campus (FH CO9). These are in the Student Pathfinder (<https://pathfinder.unm.edu>) and the Faculty Handbook (<https://handbook.unm.edu>). Please ask for help in understanding and avoiding plagiarism or academic dishonesty, which can both have very serious consequences.

Support: [Center for Academic Program Support](#) (CAPS). Many students have found that time management workshops can help them meet their goals (consult ([CAPS](#)) website under "services").

Connecting to Campus and Finding Support:

UNM has many resources and centers to help you thrive, including [opportunities to get involved](#), [mental health resources](#), [academic support including tutoring](#), [resource centers](#) for people like you, free food at [Lobo Food Pantry](#), and [jobs on campus](#). Your advisor, staff at the [resource centers](#) and [Dean of Students](#), and I can help you find the right opportunities for you.

The ESS Center at The University of New Mexico helps engineering and computer science student success by providing them with support through a holistic co-curricular experience. Additionally, we engage the country's future engineers through various outreach activities. <https://ess.unm.edu/>