

Semiconductor Device Fabrication Laboratory

EEE 5354L Section 262E

Class Periods: Lectures on Mondays, Period 7-8 (1:55 PM – 3:50 PM); Labs on other days

Lecture Location: NANO 115; **Lab Location:** NRF Teaching Lab

Academic Term: Spring 2020

Instructor:

Yong-Kyu Yoon

ykyoon@ece.ufl.edu

(352) 392-985

Office: 225 Larsen Hall

Office Hours: Tuesdays and Wednesdays 1:00-2:00 pm, Larsen 225

Teaching Assistants:

Please contact through the Canvas website

Name	Tim Clingenpeel	Mehrdad Ramezani	Haoran Wang	Saeyeong Jeon
Office	Benton 200	Benton 200	Benton 200	Benton 200
Phone	704-280-5111	352-328-7462	352-888-1422	
Email	tclinge1@ufl.edu	Mehram@ufl.edu	Wanghaoran@ufl.edu	s.jeon@ufl.edu
Office Hour	TBA	TBA	TBA	TBA

Course Description

The overall goal is to provide students with hands-on experience in semiconductor material characterization and device-fabrication techniques. (3 credits)

Course Pre-Requisites / Co-Requisites: None

Course Objectives

This course enables students to gain hands-on experience with semiconductor-based processes, units, and corresponding equipment, such as photolithography, oxidation, thin film deposition, etching, and packaging; and also let students gain experience on the design, fabrication, and characterization of electronic devices, micro sensors and actuators.

Materials and Supply Fees: N/A

Required Textbooks and Software

- No required textbooks; lecture notes will be distributed
- Required software: Klayout
 - Download link: <http://www.klayout.de/build.html>

Recommended Materials

- R.C. Jaeger, Introduction to Microelectronic Fabrication, 2nd ed., Prentice Hall, 2002. ISBN-13: 978-0201444940.
- Stephen A. Campbell, The Science and Engineering of Microelectronic Fabrication, Second Edition ed.: Oxford University Press, 2001. ISBN-13: 978-0195136050.
- Dieter K. Schroder, Semiconductor material and device characterization, Third Edition ed.: John Wiley & Sons, Inc., 2006.
- G.S. May and S.M. Sze, Fundamentals of semiconductor fabrication.: Wiley, 2004.

Course Schedule

Week	Monday	Lecture	Lab	Note
1	Jan. 6	Syllabus/Lab Safety	No lab	Grouping/Lab tour
2	Jan. 13	Photolithography/BOE	Lab#1: Photolithography (Diode mask#1)	PR coating, exposure, develop
3	Jan. 20	No lecture (MLK Holiday)	Lab#2: SiO ₂ (BOE)	Jan. 20 (holiday)
4	Jan. 27	Doping, diffusion	Lab#3: Spin-on-glass (SOG)/Diffusion	Thermal treatment, strip off SOG
5	Feb. 3	Oxidation; PN diodes	Lab#4: Oxidation/passivation	Oxide thickness measurement
6	Feb. 10	Dry/wet etching; CMOS Intro	Lab#5: Photolithography (Diode mask#2) + BOE	TAs do Photolithography of Diode mask#3
7	Feb. 17	Deposition -PVD, CVD; Metallization	Lab#6: Sputtering aluminum, Liftoff	
8	Feb. 24	MEMS Intro; MEMS microactuator design	Mask layout design	
9	Mar. 2	No lecture (Spring Break)	No Lab (Spring Break)	
10	Mar. 9	PN diodes characterization	Lab#7: Diodes Characterization	MEMS layout design due
11	Mar. 16	MEMS surface micromachining	Lab#8: Photo (MEMS mask#1); sputter Ti/Ni; Liftoff	Si wafers w/oxide
12	Mar. 23	MEMS bulk micromachining; DRIE	Lab#9: Photo (MEMS mask#2); BOE	
13	Mar. 30	Actuator characterization	Lab#10: DRIE	
14	Apr. 6	Lab presentation (optional)	Lab#11: MEMS testing	
15	Apr. 13	Project Presentation (group#1-4)	Lab#12: MEMS testing	
16	Apr. 20	Project Presentation (group#5-8)	No lab	

Attendance Policy, Class Expectations, and Make-Up Policy

- Cell phones and other electronic devices are to be silenced. No text messaging during class, lab, and exams.
- Requirements for class attendance and make-up exams, assignments, and other work are consistent with university policies that can be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>
- Excused absences must be in compliance with university policies in the Graduate Catalog (<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>) and require appropriate documentation.
- Dress Code: Protective eyewear and protective gloves will be available and must be worn at all times while in the laboratory. Long pants and close-toed shoe must be worn in the laboratory (no sandals). Those who do not follow the dress code will not be allowed in the laboratory. No food and drinks of any kind (including chewing gum) are allowed in the laboratory.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Attendance	100	10%
Pre-lab	100 each	10%
In-lab performance	100 each	20%
Lab report	100 each	30%
Lab final presentation	100	10%
Project	100	20%
Total		100%

- Pre-Lab Assignment and Lab Report Submission: The deadline for the individual pre-lab assignment submission is the beginning of each experiment, and the deadline for the group lab report submission is to be announced by your TA. Please work ahead to ensure that your pre-labs and all lab reports are finished on time.
- Pre-Lab Late Policy: Pre-Labs must be turned in on time. You can participate in the lab that week, but you will not get any credit for the pre-lab for that week.
- Lab Report Late Policy: -20% within 24 hours of deadline; No credit after 24 hours past the due date

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 - 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 - 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluer.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.ua.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of

behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: [https://www.dso.ufl.edu/documents/UF Complaints policy.pdf](https://www.dso.ufl.edu/documents/UF%20Complaints%20policy.pdf).

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.