

## Semiconductor Device Fabrication Laboratory

EEE 5354L Section 0001

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

**Lecture Location:** NANO 115 (Spring 2022); **Lab Location:** NRF Teaching Lab

**Academic Term:** Fall 2022

### **Instructor:**

Name: Yong-Kyu “YK” Yoon

Email Address: [ykyoon@ece.ufl.edu](mailto:ykyoon@ece.ufl.edu) or [yongkyu.yoon@ufl.edu](mailto:yongkyu.yoon@ufl.edu)

Office Phone Number: (352) 392-5985

Office Hours: Tue and Fri 1 – 2 pm, Larsen Hall 225 (or Zoom: [ufl.zoom.us/j/3523925985](https://ufl.zoom.us/j/3523925985))

### **Teaching Assistant/Peer Mentor/Supervised Teaching Student:**

Please contact through the Canvas website

- Woosol Lee, [leewoosol@ufl.edu](mailto:leewoosol@ufl.edu), BEN 200, TBD
- Sunghyun Hwang, [sunghyun.hwang@ufl.edu](mailto:sunghyun.hwang@ufl.edu), BEN 200, TBD
- James Overmeyer, [jovermeyer@ufl.edu](mailto:jovermeyer@ufl.edu), BEN 200, TBD
- Hanna Jang, [hannajang@ufl.edu](mailto:hannajang@ufl.edu), BEN 200, TBD
- SM Emanuel Hoque Yousuf, [syousuf@ufl.edu](mailto:syousuf@ufl.edu), NEB 200, TBD

### **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, 2nd 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	Aug. 29	Syllabus/Lab Safety/Photolithography	No lab	Grouping/Lab tour
2	Sep. 5	No Lecture	Lab#1: Photolithography (Diode mask#1)	PR coating, exposure, develop
3	Sep. 12	Wet Etching	Lab#2: SiO <sub>2</sub> (BOE)	Thermal treatment, strip off SOG
4	Sep. 19	Doping, diffusion	Lab#3: Spin-on-glass (SOG)/Diffusion	Thermal treatment, strip off SOG
5	Sep. 26	Oxidation; PN diodes	Lab#4: Photolithography (Diode mask#2) + BOE	Modified process is applied
6	Oct. 3	Dry etching; CMOS Intro (optional)	Lab#5: Drive-in + Photolithography (Diode mask #3)	TAs continue Photolithography of Diode mask#3
7	Oct. 10	Deposition -PVD, CVD; Metallization; Klayout Intro	Lab#6: Descum + Remove Natural Oxide + Sputtering aluminum, Lift-off	Rapid Thermal Annealing (TRA) is applied
8	Oct. 17	MEMS Intro; MEMS micro actuator design	Mask layout design	
9	Oct. 24	PN diodes characterization	Lab#7: Diodes Characterization	
10	Oct. 31	MEMS surface micromachining	Lab#8: Photo (MEMS mask#1); sputter Ti/Ni; Liftoff	MEMS layout design due
11	Nov. 7	MEMS bulk micromachining; DRIE	Lab#9: Photo (MEMS mask#2); BOE	Si wafers w/oxide
12	Nov. 14	Actuator characterization	Lab#10: DRIE	
13	Nov. 28	Make up	Lab#11: MEMS Test	
14	Dec. 5	Project Presentation	No Lab	

## Attendance Policy, Class Expectations, and Make-Up Policy

Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://catalog.ufl.edu/graduate/regulations/>

## Evaluation of Grades

**\*\*Assessment Guidance from the ECE Graduate Committee:** Course evaluation components should include:

1. At least one component that individually evaluates each student's understanding of course material and ability to apply concepts.
2. At least one evaluation activity that takes place in class.
3. When a project is involved, evaluation rubrics should be explicitly stated.
4. When team work is expected, individual student contribution verification method should be explicitly stated.

*If an in-class exam is administered then 1 and 2 are fulfilled. In the case of a project, a project report that is graded per the stated evaluation rubrics and states which work was done by each student in the project team will address both 3 and 4.*

Students are expected to attend class lectures and arrive on time. Please turn off cell-phones, pagers, and other electronic devices during the class unless you are asked to use them.

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 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 who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, 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/>.

## **In-Class Recording**

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

## **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 Conduct Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. 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
- Jennifer Nappo, Director of Human Resources, 352-392-0904, [jpennacc@ufl.edu](mailto:jpennacc@ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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>

### ***Campus Resources:***

#### ***Health and Wellness***

##### **Covid-19 Protocols:**

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

##### **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](mailto: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:** <https://counseling.ufl.edu>, 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](mailto: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](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**Career Connections Center**, Reitz Union, 392-1601. Career assistance and counseling; <https://career.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://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>;<https://care.dso.ufl.edu>.

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