

ECH 4905/ECH 6937 Semiconductor Device Fabrication and Material Characterization

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2. Office hours: make appointments with email

Grader and tutor office hour: Mon 11:00 AM to 12:00 PM

<https://ufl.zoom.us/j/4151280750?pwd=UnNxdFNwVFZ6a2lMcVNuWjNlaEE2dz09>

3. Catalog Description – (3 credits) The overall goal is to provide students with knowledge in semiconductor material characterization and device fabrication techniques.
4. Pre-requisites and Co-requisites: None
5. Course Objectives -
 - a. Students will gain knowledge in semiconductor based processes, units, and corresponding equipment.
 - b. Students will gain knowledge in to design and fabricate the devices.
 - c. Students will be able to use the scientific method and problem solving strategies, as well as statistical methods, to design and carry out experiments in order to solve engineering problems.
 - d. Students will demonstrate familiarity and experience with the capabilities and limitations of semiconductor process equipment.
 - e. Students will understand and practice safe laboratory and chemicals-handling principles.
 - f. Students will be able to integrate topics from various semiconductor processing steps to solve realistic problems in the areas of material and device characterization.
 - g. Students will exhibit critical and creative thinking skills for analysis and evaluation of problems and cause-effect relationships.
 - h. Students will be able to obtain and evaluate appropriate informational/data from databases, handbooks, correlations, experiments, literature, etc.
 - i. Students will be able to rationalize units, make order of magnitude estimates, assess reasonableness of solutions, and select appropriate levels of solution sophistication.
 - j. Students will demonstrate effective reading of technical material.
 - k. Students will demonstrate effective interpretation of graphical data.

- l. Students will practice good teamwork principles.
 - m. Students will gain general concepts of estimating mass-transfer coefficients and use them to determine mass-transfer rates across phase boundaries during oxide growth.
 - n. Students will demonstrate knowledge of photolithographic chemistry.
 - o. Students will understand fundamentals of vacuum deposition including thermal evaporation and sputtering deposition systems.
6. Materials and Supply fees: N/A
7. Required Textbook and Software
No textbook required
Software Required – SRIM and Layout Editor

- (a) Download the SRIM-2013 (Professional) software from <http://www.srim.org/SRIM/SRIMLEGL.htm>. Download the file and follow the procedures indicated on the website but when you rename the file “SRIM-2013-Pro.e” use the name ZIP.exe to avoid confusions later. **Please make sure your windows language and version are English.**

After extracting the file open the “SRIM-Setup” folder. Right click on the “_SRIM-Setup (Right-Click).bat” and select “Run as administrator”. Follow indicated procedures.

Go back to the uncompressed folder and open the “SRIM.exe” file (this is the software link). Be sure you can access the Stopping/Range table and also the TRIM Calculation window and they appear complete on the screen.

- (b) Download “layout editor” from the link below from <https://layouteditor.org/> and install it.

8. Recommended Reading -

Stephen A. Campbell, The Science and Engineering of Microelectronic Fabrication, Second Edition ed.: Oxford University Press, 2001.

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.

9. Course Schedule

Wk	Date	Topic	HW
1	8/23	Semiconductor I	
	8/25	Semiconductor II	
	8/27	Semiconductor III	
2	8/30	Field Effect Transistor and Bipolar Transistor	
	9/1	Field Effect Transistor and Bipolar Transistor	
	9/3	Four point measurement, transmission line method,	
3	9/6	Holiday	
	9/8	Schottky diode characterization, Hall Measurement	HW Semiconductor
	9/10	Oxide Growth	
4	9/13	Oxidation I	HW Measurement
	9/15	Oxidation II	
	9/17	Ion Implantation I	
5	9/20	SRIM (please load SRIM software before this class)	HW Oxidation
	9/22	Ion Implantation II	
	9/24	Exam I (Semiconductor/Oxidation)	
6	9/27	Chemical Vapor Deposition (CVD) and Molecular Beam Epitaxy	
	9/29	Plasma Enhanced Vapor Deposition (PECVD)	HW Implantation
	10/1	Sputtering	
7	10/4	Evaporation	HW CVD
	10/6	Diffusion in Solid I	
	10/8	No Class	
8	10/11	Diffusion II	HW Sputtering and Evaporation
	10/13	Photolithography	
	10/15	Photo Resist I	HW Diffusion
9	10/18	Photo Resist II	
	10/20	Photo Resist III	
	10/22	Mask Design I	
10	10/25	Mask Design II	HW Photolithography
	10/27	Exam II (Ion Implantation, CVD, Metal Deposition and Diffusion)	
	10/29	Vacuum Gauge and Vacuum Pump I	
11	11/1	Vacuum Gauge and Vacuum Pump II	
	11/3	Wet and plasma etching I	HW Mask design
	11/5	Wet and plasma etching II	
12	11/8	Surface Analysis (SEM)	HW Vacuum Pump
	11/10	XPS/Auger	
	11/12	Auger/SIMS/RBS	HW Etching
13	11/15	Crystal I	
	11/17	Exam III (Photolithography, Vacuum Pump and Etching)	
	11/19	Crystal II	
14	11/22	x-ray	HW Surface Analysis
	11/24	Holiday	
	11/26	Holiday	
15	11/29	Defects	
	12/1	Presentation	HW Crystal and x-ray

	12/3	Presentation	
16	12/6	Presentation	
	12/8	Exam 4 (Crystal/Surface Analysis)	

10. Grading – methods of evaluation: 30% for exams (3 highest scores out of 4 exams), 60% for homework (one homework with the lowest score will be dropped. Students must submit all the homework assignments and received at least 60 points. **The grades for homework for mask design and ion implantation simulation can be dropped.** Any assignment with a score less than 60 will be counted toward the final grade.), 10% for presentation). **No late homework will be accepted.**

Grading Scale

<i>Percent</i>	<i>Grade</i>	<i>Grade Points</i>
90.0 - 100.0	A	4.00
87.0 - 89.99	A-	3.67
84.0 - 86.99	B+	3.33
81.0 - 83.99	B	3.00
78.0 - 80.99	B-	2.67
75.0 - 79.99	C+	2.33
72.0 - 74.99	C	2.00
69.0 - 71.99	C-	1.67
66.0 - 68.99	D+	1.33
63.0 - 65.99	D	1.00
60.0 - 62.99	D-	0.67
0 - 59.99	E	0.00

More information on UF grading policy may be found at:

[UF Graduate Catalog](#)
[Grades and Grading Policies](#)

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the [Disability Resource Center](#). 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 feedback on the quality of instruction in this course by completing [online evaluations](#). Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students on the [Gator Evals page](#).

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](#) 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.

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 the [Notification to Students of FERPA Rights](#).

Health and Wellness

You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated. Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

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) to be evaluated for testing and to receive further instructions about returning to campus. 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.

Campus Resources:

Health and Wellness

U Matter, We Care:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

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

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or 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, Various ways to receive assistance with respect to using the libraries or finding resources. <http://cms.uflib.ufl.edu/ask>.

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://care.dso.ufl.edu>

[On-Line Students Complaints](#)