

# ADVANCED ELECTRONIC MATERIALS PROCESSING

EMA 6616/ 4614

**Class Periods:** MWF, 8.30-9.20 AM

**Location:** EDGE Studios, NEB 201

**Academic Term:** Fall 2017

## **Instructor:**

Instructor: S.J. Pearton  
343 Nuclear Science Building  
Phone: 352/846-1086  
E-mail: [spear@mse.ufl.edu](mailto:spear@mse.ufl.edu)  
<http://pearton.mse.ufl.edu>  
Office Hours: 9.30-10.30 pm Monday & Wednesday

## **Teaching Assistants:**

There are usually none for this course

## **Course Description**

This is a 3 credit graduate class. The goal is to give an overview of the properties of semiconductor and related material for particular applications, and some detail of individual processing steps such as lithography, etching, deposition, implantation, annealing and oxidation. Some basic electronic and photonic devices such as bipolar transistors, metal-semiconductor field effect transistors, metal-oxide semiconductor field effect transistors, diode lasers and light-emitting diodes will be discussed. Examples of current individual and integrated processes will also be covered.

## **Course Pre-Requisites / Co-Requisites**

None, but some knowledge of semiconductor physics is assumed.

## **Course Objectives**

To provide the student with an up-to-date picture of how modern semiconductor chips are fabricated; comparison of Si versus compound semiconductors; processing modules such as diffusion, ion implantation, wet and dry etching and metal deposition; materials selection requirements; yield and reliability requirements; basics of component devices such as MOSFETs, bipolar transistors, LEDs and laser diodes.

## **Materials and Supply Fees**

None

## **Professional Component (ABET):**

This course addresses the following MSE Program outcomes:

(a) To apply mathematics, science, engineering basics and the fundamentals of materials science to envision solutions to and to solve engineering problems. (High coverage)

This course builds on fundamental concepts learned in previous courses and applies them to materials processing. Students are assigned homework and exam problems in which they must describe appropriate applications of the various processing techniques.

There is also some discussion of economic impact of the semiconductor industry (Low coverage) and trends in this technology (contemporary issues, low coverage)

## **Relation to Program Outcomes (ABET):**

Outcome	Coverage*
a. Apply knowledge	High
B1. Conduct experiments	

B2. Statistical design of experiments	
c. Design	
d. Function on teams	
e. Solve programs	
f. Professional and ethical responsibility	
g. Communicate	
H1. Economic impact	Low
H2. Global, societal, and environmental impact	
i. Lifelong learning	
j. Contemporary issues	Low
k. Techniques, skills, and tools for degree program	

\*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not part of the course.

### ***Required Textbooks and Software***

None

### ***Recommended Materials***

- Title Text: Fabrication Engineering at the Micro- and Nanoscale, Stephen A. Campbell, third edition, Oxford University Press, 2008, ISBN 978-0-19-532017-6 (available in the University Bookstore in paperback edition).
- There is a E-Learning System page for the course containing additional relevant material, including lecture notes, solution sets from the text book and semiconductor videos <http://elearning.ufl.edu/>

### ***Course Schedule***

Lecture	Day/Date	Topic	Assigned Problems
1	Monday, 8/21	General Introduction/Electronics video	
2	Wednesday, 8/23	Properties of Semiconductors	
3	Friday, 8/25	Video (Microchip)	
4	Monday, 8/28	Properties of Semiconductors	1-3
5	Wednesday, 8/30	Bulk Growth	
6	Friday, 9/1	Epitaxial Growth	
-	Monday, 9/4	Labor Day-no class	
7	Wednesday, 9/6	Epitaxial Growth	
8	Friday, 9/8	Growth and characterization	
9	Monday, 9/11	Characterization	
10	Wednesday, 9/13	Lithography	
11	Friday, 9/15	Lithography /(Video Lithography)	
12	Monday, 9/18	Lithography	
13	Wednesday, 9/20	Wet Etching	
14	Friday, 9/22	Dry Etching	
15	Monday, 9/25	Video (Si Run I)	
16	Wednesday, 9/27	Dry Etching (Video Etch)	
17	Friday, 9/29	Quiz #1	****
18	Monday, 10/02	Deposition(Video Deposition)	
19	Wednesday, 10/04	Video (Si Run II)	4-6

-	Friday, 10/06	Homecoming	
20	Monday, 10/09	Implantation	To be distributed
21	Wednesday, 10/1	Implantation (Video Implantation)	
22	Friday, 10/13	Quiz #2	****
23	Monday, 10/16	Diffusion	
24	Wednesday, 10/18	Video (Transistorized)	
25	Friday, 10/20	Annealing	
26	Monday, 10/23	RTA	
27	Wednesday 10/25	First Exam	****
28	Friday, 10/27	Contacts	
29	Monday, 10/30	Contacts	
30	Wednesday, 11/1	Process Integration/MOSFET	
31	Friday, 11/3	Gate Dielectrics	
32	Monday, 11/6	Video (Semiconductor Devices)	
33	Wednesday, 11/8	MESFETs	
-	Friday, 11/10	Veteran's Day (no class)	
34	Monday, 11/13	MESFETs/HEMTs	
35	Wednesday, 11/15	HBTs	
36	Friday, 11/17	LEDs	
-	Monday, 11/22	Thanksgiving (no class)	
-	Wednesday, 11/22	Thanksgiving (no class)	
-	Friday, 11/24	Thanksgiving (no class)	
37	Monday, 11/27	Lasers	
38	Wednesday, 11/29	Detectors	
39	Friday, 12/1	Detectors	
40	Monday, 12/4	Review of class	
41	Wednesday, 12/6	Second Exam (optional date)***	*****

\*\*\* to be decided by consultation with students. Individuals may schedule taking the exam at other times.

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

Attendance at the lectures is not required, but experience has shown it is more beneficial to the student's understanding of the course materials. If you attend the lectures, be prompt in your arrival as a courtesy to the other students. Cell phones must be turned off during lectures. Excused absences are consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

### ***Evaluation of Grades***

<b>Assignment</b>	<b>Total Points</b>	<b>Percentage of Final Grade</b>
Quizzes (2)	15 each	30%
Midterm Exam	30	30%
Final Exam	40	40%
		100%

**Homework:** Optional, but any serious student will do it.

**Make-up Exam Policy:** Reasonable excuses will be entertained for absences from exams or quizzes and the student will be expected to take the exam as soon as possible after it was originally scheduled.

<b>Grade Scale:</b>	90-100%	A	85-89%	B <sup>+</sup>
	80-84%	B	75-79%	C <sup>+</sup>
	65-74%	C	61-64%	D <sup>+</sup>
	56-60%	D	0-55%	F

Grades are absolute and are not curved

For EMA 4614 students-A “C-“ will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

For EMA 6616 students-In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better). Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: <http://gradschool.ufl.edu/catalog/current-catalog/catalog-general-regulations.html#grades>  
More information on UF grading policy may be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

### ***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 feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. 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 at <https://evaluations.ufl.edu/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://www.dso.ufl.edu/sccr/process/student-conduct-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: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

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

#### **Health and Wellness**

##### **U Matter, We Care:**

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

**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 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 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_Complaints_policy.pdf).

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