

ABET Course Syllabus
EMA 4414L Electronic Materials Laboratory
Fall 2017

1. Catalog Description (1 credits): This course provides hands-on experience for students specializing in electronic materials. Laboratory topics include characterization of optical and electronic properties of semiconductor materials, electronic devices characterization, and semiconductor processing.
2. Pre-requisites and Co-requisites:
Pre-req: EMA 4614
3. Course Objectives: The course emphasizes the identification and testing of electronic devices, and fabrication and testing of electronic materials. The influence of material and interface properties on device performance will also be stressed.
4. Contribution of course to meeting the professional component: This is a 1 credit course.
5. Relationship of course to program outcomes: This course addresses the following MSE Program outcomes (note: Numbers refer to the list of MSE Program outcomes):
 1. Ability to apply knowledge of mathematics, science, and engineering to materials systems. This course requires for the students to assess and calculate material parameters from data obtained experimentally. Device structures that are produced in the laboratories will be tested to see if certain device performance requirements are satisfied. (HIGH)
 2. Ability to conduct experiments, analyze and interpret data. For this course, the students will have to follow instructions, set-up experiments, collect data and interpret data, and discover any sources of error. (HIGH)
 3. Ability to conduct and analyze design of experiments (DOE). The students will be exposed to a simple experiment, identify the control variables, the uncontrolled variables and asked to expose sources of error and solutions to those sources. Also, the students will run a simple computer circuit model, identify key components in the model and comment on the component's impact to the construction of the circuit. (LOW)
 4. Ability to apply and integrate knowledge of structure, properties, processing, and performance to solve materials selection and design problems within realistic constraints. The students will be asked to compare the published material property values with the experimentally obtained values and give reason for any discrepancies. (MEDIUM)
 6. Ability to identify, formulate, and solve engineering problems. The students will be asked to provide realistic solutions to issues associated with the material processing and material testing to improve the experimental data sets. (MEDIUM)
 7. Understanding of professional and ethical responsibility. The students will be placed into laboratory groups and will be asked to grade their peer's performance within the group. (Low)
 8. Ability to communicate effectively in both oral and written form. The students will have to submit a written laboratory report for each laboratory. These will be graded on both technical content and clarity. (HIGH)
 13. Ability to use the techniques, skills, and tools needed for practice as a materials engineer. The course provides students with hands on laboratory experience in the field of electronic materials testing and processing. This knowledge will be applicable in either the academic arena or the industrial arena. (HIGH)

6. Instructor: Dr. Nancy Ruzycki
 a. Office location: RHN 135
 b. Telephone: 352.846.2991
 c. E-mail address: nruzycki@mse.ufl.edu
 d. Office hours: Tuesdays 4th period, or by appointment
7. Teaching Assistant: none
8. Meeting Times: Tuesday 10th -11th periods, or Wednesday 10th-11th periods
9. Class/laboratory schedule: lab 2 hours, each week
10. Meeting Location:
 Lab – NRF facilities unless notified by instructor.
11. Materials and Supply Fees: Fees listed on Canvas for the course
12. Textbooks and Software Required: No required text. All exams and projects will be based on material presented in class as well as handouts.
13. Recommended Reading:
 a) Hummel, R. E. (2011). *Electronic properties of materials*. Springer.
 b) Kasap, S. O. (2006). *Principles of electronic materials and devices* (Vol. 81). New York, NY: McGraw-Hill.
 c) Books to be put on reserve desk at Library for this course.
14. Course Outline - Below is the tentative schedule of topics, activities, reading assignments, exams, and homework. See Canvas Unit Objectives, Learning Outcomes, assignments, and rubrics. This outline is subject to change.

There may be changes/substitutions to the laboratories listed below, depending upon available equipment.

Session	Topic	Labs and Activities
1	Lab Safety,	Lab Quiz on Safety
2	Semiconductor device background, Hall Effect Measurements	Pre-Lab on Hall Effect Pre-Lab Quiz Hall Effect Hall Effect Laboratory Hall Effect Post-Lab Hall Effect Skills Outcomes
3	Ion Implantation	Ion Implantation simulation Pre-lab Ion Implantation simulation Lab Ion Implantation post-lab Ion Implantation Skills Outcome Lab notebook due
4	Wet and Dry Etching	Pre-Lab Wet and Dry Etching Pre-Lab Quiz Wet and Dry Etching Wet and Dry Etching Laboratory Wet and Dry Etching Post-Lab Wet and Dry Etching Skills Outcomes
5	Oxide Growth	Pre-Lab Oxide Growth
6		Pre-Lab Oxide Growth Oxide Growth Laboratory Oxide Growth Post-Lab Oxide Growth Skills Outcomes Lab Notebook Due

7	Sputtering	Sputtering experiment
8		Pre-Lab Sputtering experiment Pre-Lab Quiz Sputtering experiment Sputtering experiment Laboratory Sputtering experiment Post-Lab Sputtering experiment Skills Outcomes
9	Photolithography	Pre-Lab Photolithography experiment
10		Pre-Lab Quiz Photolithography experiment Photolithography experiment Laboratory Photolithography experiment Post-Lab Photolithography experiment Skills Outcomes Lab Notebook Due
11	Thermal Evaporation	Pre-Lab Thermal Evaporation experiment
12		Pre-Lab Quiz Thermal Evaporation experiment Thermal Evaporation experiment Laboratory Thermal Evaporation experiment Post-Lab Thermal Evaporation experiment Skills Outcomes
13	Characterization	Characterization of contacts
14		Characterization of MOS device (all pre-Lab, pre-Lab quiz, lab, post lab, outcomes) Final Report Lab Notebook Due

15. Attendance and Expectations - Attendance is **strongly** suggested since significant amount of participative as well as individual and collaborative work will be performed during the class sessions and labs are not made up in this course. **Students are expected to comply with all laboratory guidelines, protocols, and procedures. Students who do not comply with these requirements or who behave disorderly or disrespectfully WILL be asked to leave. Leaving your cell phone on, leaving early or arriving late can be VERY distracting, you should avoid it. All electronic devices (laptops, cell-phones, etc.) should be turned off or in silent mode.** Students may not bring phones or devices into the clean room lab areas, unless they are in their pockets. Phones may not be touched while wearing gloves, students must leave the room and remove gloves before touching phones.

Students will be graded according to the following:

Student daily notebook	60 % of final grade
Pre-Lab Quizzes	5 % of final grade
Wafer Progress Progression outcome points	5 % of final grade
Device Characterization points	15 % of final grade
Final Report on wafer processing	15 % of final grade

17. Grading Scale - Grades will not be curved and there is no extra credit.

Grade	Earned percentiles total
A	93
A-	88
B+	84

B	80
B-	76
C+	72
C	68
C-	65
D+	62
D	59
D-	56
E	50

This statement must be included in every grade scale for undergraduate level 1000-5000 syllabi:

“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>

18. Make-up Exam Policy – Make up exams will be provided only with the **prior approval of the instructor in accordance with university policies**. In general, acceptable reasons for excused absence include illness, serious family emergencies, special curricular requirements, military obligation, court-imposed legal obligations, and religious holidays. In all cases you will be required to provide written documentation, and obtain prior instructor approval. You will not be excused from any exam without following the policy above, with no exceptions. Students not in attendance for the scheduled exam will receive a score of zero. To be clear, Make-up exams will only be allowed in exceptional cases, with prior instructor approval, sufficient documentation, and in accordance of university policies. Make-up exams for excused absences as well as exam conflicts must occur within 1 week of the missed exam, and may occur before the missed exam.

19. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. UF Counseling Services –Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

22. Software Use – All faculty, staff and student 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.

23. Students are expected to provide feedback on the quality of instruction in this course based on 10 criteria. These evaluations are conducted online at <https://evaluations.ufl.edu>. 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>.

23. Diversity and Inclusion: This course supports diversity and inclusion for all students .Effective engineering practice relies on the ability to recognize and embrace diversity in all its forms, including viewpoints.