

**Laser Theory and Design**  
EEL 4446/5447 Section TBA  
**Class Periods:** Tuesday 2 & 3, Thursday 3  
**Location:** Black Hall, Room 415  
**Academic Term:** Fall 2018

**Instructor:** Prof. Henry Zmuda  
**email:** zmuda@ece.ufl.edu  
**Phone:** (352) 392 – 0990  
**Mobile** (850) 225 – 9200 (emergencies only please)  
Office Hours: TBA

**Teaching Assistants:** none

**Course Description**

Credits: 3; Studies the field of semiconductor optoelectronics and the physics of optoelectronic devices including the interaction of photons with electrons and holes in a semiconductor leading to the realization of optoelectronic devices such as photon amplifiers, LEDs, diode lasers, electro-absorption modulators, and detectors, including their design and application-specific characteristics.

**Course Pre-Requisite:** Physics of Electrical Engineering.

**Course Objectives:** The student will learn how to design, construct, and test (in principle, no actual construction is performed) a variety of optoelectronic devices to meet specifications with regard to emission/detection wavelength, power level, and size.

**Materials and Supply Fees:** None

**Required Textbooks and Software**

None – Extensive course notes developed by the instructor are provided.

**Recommended Textbooks**

Laser Diodes and Photonic Integrated Circuits  
Larry Coldren, Scott Corzine, and Milan L. Mashanovitch  
Wiley, 2012, 2<sup>nd</sup> Edition  
978-0470484128

**Course Schedule**

Week 1: Introduction, Energy bands in solids, the E-k diagram  
Week 2: Density of states, Occupation probability  
Week 3: Fermi level and quasi Fermi levels, p-n junctions  
Week 4: Schottky junction and Ohmic contacts  
Week 5: Semiconductor optoelectronic materials  
Week 6: Bandgap modification, Heterostructures and Quantum Wells

Week 7: Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier

**Exam 1**

Week 8: Electroluminescence. The LED: Device structure, materials and characteristics

Week 9: The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation

Week 10: Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL)

Week 11: Semiconductor optical amplifiers (SOA), SOA characteristics and some applications

Week 12: Quantum-confined Stark Effect and Electro-Absorption Modulators

### Exam 2

Week 13: Relation to atomic systems and Solid State Lasers

Week 14: Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection

Week 15: Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance. Photo-transistors, solar cells

### Final Exam

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

While attendance is not strictly required class participation is a component of the overall grade, so the student must be present for the majority of the lectures. Name cards will be given to each student to place at his or her desk so that attendance and participation can be monitored. There are no penalties for absence or tardiness though students are expected to be present and arrive on time.

Quizzes, generally five minutes in duration, are given at the beginning of class and are not announced in advance. Students who arrive late will not be granted extra time. In general, there are no make-ups for quizzes. Students with excused absences should notify the instructor as soon as possible to see if special arrangements can be made.

Cell phone use during class is not permitted. Laptops/tablets may be open and used, but ONLY for lecture-related material.

Late homework policy: 1 day late, 25% reduction in grade; 2 days later, 50% reduction in grade; 3 or more days late, 75% reduction in grade.

For legitimate excused absences (sickness, unavoidable university-related travel, personal emergencies) must be documented. Arrangements for make up exams for excused absences will be scheduled between the student and instructor.

Excused absences are consistent with university policies in the undergraduate catalog (<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>) and require appropriate documentation.

## Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Class Participation	-	5%
Homework Sets (10)	10 each	5%
Quizzes (up to 10) None dropped	10 each	15%
Exam 1	100	15%
Exam 2	100	15%
Final Exam	100	25%
Design Project	100	20%
Total		100%

Note: This course is co-listed with the graduate class. Students in the graduate section will complete a design project. Homework and exam questions for the graduate section will in general contain additional questions.

## 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 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>.