



UNIVERSITY OF  
CENTRAL FLORIDA

# OSE 5414 - FUNDAMENTALS OPTOELECT DEVICES

Section: 0001

*Optics and Photonics*

## Course Information

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**Term:** Fall 2024

**Class Meeting Days:** TR

**Class Meeting Time:** 09:00 - 10:15

**Class Meeting Location:** CROL A214

**Modality:** P

**Credit Hours:** 3.00

## Instructor Information

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Pieter Kik

**Office Location:** CREOL A220

**Office Hours:**

T/R 10:30am-11:30am

**Phone:** 407-8234622

**Email:** kik@creol.ucf.edu

## Course Description

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OSE 5414 OPT-OPT 3(3,0)Fundamentals of Optoelectronic Devices: PR: Graduate standing or C.I. Operation, methods of fabrication, applications, and limitations of various optoelectronic devices including quantum well semiconductor devices. Even Fall.

This course aims at covering the physics and engineering issues that define basic semiconductor optoelectronics devices. The course contains a mix of the electrical properties and optical properties of semiconductors and the interplay between photons and electrons in semiconductors.

We start off by learning about the material properties of bulk crystals and define the concept of energy bands for the electrons and holes in semiconductors using fundamental quantum mechanics; next we relate the energy of the free electrons to the materials' electrical and optical properties. The behavior of p-n junctions and other potential barriers in semiconductor structures are analyzed, and their effect on semiconductor device performance will be discussed.

In the second half of the course we will discuss semiconductor optoelectronic devices such as the LED, the laser diode, solar cells, semiconductor modulators, and various types of photodetectors.

**List of topics covered:**

- Crystal Structure of Solids
- Introduction to Quantum Mechanics
- Introduction to the Quantum Theory of Solids
- The Semiconductor in Equilibrium
- Carrier Transport Phenomena
- Semiconductor Optical Absorption and Emission
- Nonequilibrium Excess Carriers in Semiconductors
- The PN Junction
- The PN Junction Diode
- Metal-Semiconductor and Semiconductor Heterojunctions
- Optical Devices
  - Solar Cells
  - Photodetectors

- Light Emitting Diodes; Laser Diodes
- Optical modulators

## **Student Learning Outcomes**

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After successful completion of this course, students will have a basic understanding of solid state physics as applied to semiconductor optical devices, and a thorough understanding of the characteristics, operation, and limitation of these devices. The students will be able to use the knowledge gained in this course to further their research and to take more advanced classes in optoelectronics and integrated semiconductor devices.

## **Course Materials and Resources**

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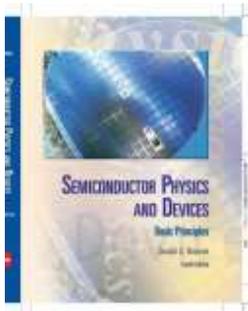
### **OSE5414 Slides**

**Authors:** P. G. Kik

**Online Access:** [Webcourses > Files > Slides](#)

## **Recommended Course Materials**

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**Title:** Semiconductor Physics And Devices

**ISBN:** 9780077418847

**Authors:** Donald Neamen

**Publisher:** McGraw-Hill Higher Education

**Publication Date:** 2011-01-01

**Edition:** 4th Ed.

## **Course Assessment and Grading Procedure**

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Assignments must be submitted on Webcourses as a PDF attachment by the submission deadline. The annotated graded homework PDF will be uploaded as an attachment to the homework submission.

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Assessment	Percent of Final Grade
Homework	20%
Midterm	30%
Final Exam	50%
	100%

## Grading Scale

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Letter Grade	Percentage
A	94-100%
A-	90-93%
B+	87-89%
B	84-86%
B-	80-83%
C+	77-79%
C	74-76%
C-	70-73%
D+	67-69%
D	64-66%
D-	61-63%
F	0-60%

## Policies for Course Grade

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### Missed/Late Assignments

Missed or Late assignments without prior consent from the instructor will not receive credit. An extension of the submission deadline may be granted at the discretion of the instructor if the following criteria are met:

- The extension request was sent before the original submission deadline.
- The student provided a plausible excuse for the delayed submission.
- The student provided a reasonable updated submission deadline.

### Makeup Work Policy

If an emergency arises and a student cannot take an exam on the scheduled date, the student **must** give notification to the instructor **no less than 24 hours before** the scheduled time. The instructor will specify a new date for taking the exam. Any illness will be considered a medical emergency only if an official Doctor's note confirming the illness is submitted to the CREOL Graduate Office.

## Grade Objections

All objections to grades should be made **in writing within one week** of the work in question. Objections made after this period has elapsed will **not** be considered – NO EXCEPTIONS.

## Course Accessibility

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The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need access to course content due to course design limitations should contact the professor as soon as possible. Students should also connect with [Student Accessibility Services \(SAS\)](#) (Ferrell Commons 185, [sas@ucf.edu](mailto:sas@ucf.edu), phone 407-823-2371). For students connected with SAS, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential course access and accommodations that might be necessary and reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SAS, faculty and the student may be warranted to ensure an accessible course experience.

## Academic Integrity

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Students should familiarize themselves with UCF's Code of Conduct at [Student Conduct and Integrity Office](#). According to Section 1, "Academic Misconduct," students are prohibited from engaging in:

- a. Academic misconduct is defined as any submitted work or behavior that obstructs the instructor of record's ability to accurately assess the student's understanding or completion of the course materials or degree requirements (e.g., assignment, quiz,

and/or exam). Examples of academic misconduct include but are not limited to: plagiarism, unauthorized assistance to complete an academic exercise; unauthorized communication with others during an examination, course assignment, or project; falsifying or misrepresenting academic work; providing misleading information to create a personal advantage to complete course/degree requirements; or multiple submission(s) of academic work without permission of the instructor of record.

- b. Any student who knowingly helps another violate academic behavior standards is also in violation of the standards.
- c. Commercial Use of Academic Material. Selling of course material to another person and/or uploading course material to a third-party vendor without authorization or without the express written permission of the University and the instructor of record. Course materials include but are not limited to class notes, the instructor of record's slide deck, tests, quizzes, labs, instruction sheets, homework, study guides, and handouts.
- d. Soliciting assistance with academic coursework and/or degree requirements. The solicitation of assistance with an assignment, lab, quiz, test, paper, etc., without authorization of the instructor of record or designee is prohibited. This includes but is not limited to asking for answers to a quiz, trading answers, or offering to pay another to complete an assignment. It is considered Academic Misconduct to solicit assistance with academic coursework and/or degree requirements, even if the solicitation did not yield actual assistance (for example, if there was no response to the solicitation).

### **Responses to Academic Dishonesty, Plagiarism, or Cheating**

Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, [The Golden Rule](#). UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and respond to academic misconduct when necessary. Penalties for violating rules, policies, and instructions within this course can range from a zero on the exercise to an "F" letter grade in the course. In addition, an Academic Misconduct report could be filed with the Office of Student Conduct and Academic Integrity, which could lead to disciplinary warning, disciplinary probation, or deferred

suspension or separation from the University through suspension, dismissal, or expulsion with the addition of a “Z” designation on one’s transcript.

Being found in violation of academic conduct standards could result in a student having to disclose such behavior on a graduate school application, being removed from a leadership position within a student organization, the recipient of scholarships, participation in University activities such as study abroad, internships, etc.

Let’s avoid all of this by demonstrating values of honesty, trust, and integrity. No grade is worth compromising your integrity and moving your moral compass. Stay true to doing the right thing: take the zero, not a shortcut.

## **Reporting an Incident or Issue**

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If you believe you have experienced abusive or discriminatory behavior by any faculty or staff member, contact the Office of Institutional Equity [online](#) or at 407-823-1336. You can also choose to report using the UCF Integrity Line and can report anonymously or as yourself at 1-855-877-6049 or using the [online form](#). UCF cares about you and takes every report seriously. For more information see the [Reporting an Incident or Issue Webpage](#).

## **Title IX**

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Title IX prohibits sex discrimination, including sexual misconduct, sexual violence, sexual harassment, and retaliation. If you or someone you know has been harassed or assaulted, you can find resources available to support the victim, including confidential resources and information concerning reporting options at [Let's Be Clear](#) and [UCF Cares](#).

For more information on diversity and inclusion, Title IX, accessibility, or UCF’s complaint processes contact:

- Title IX – OIE – [Office of Institutional Equity](#) & [askanadvocate@ucf.edu](mailto:askanadvocate@ucf.edu)
- Disability Accommodation – Student Accessibility Services – [Student Accessibility Services](#) & [sas@ucf.edu](mailto:sas@ucf.edu)
- [Access and Community Engagement](#) (including the Ginsberg Center for Inclusion and Community Engagement, Military and Veteran Student Success, and HSI)

Initiatives)

- UCF Compliance and Ethics Office – [Compliance, Ethics, and Risk Office](#) & [complianceandethics@ucf.edu](mailto:complianceandethics@ucf.edu)
- The [Ombuds Office](#) is a safe place to discuss concerns.

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## Deployed Active-Duty Military Students

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Students who are deployed active duty military and/or National Guard personnel and require accommodation should contact their instructors as soon as possible after the semester begins and/or after they receive notification of deployment to make related arrangements.

## Campus Safety

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At UCF Public Safety and Police, safety is the top priority. Emergencies on campus are rare, but if one should arise, it's important to be familiar with some basic safety and security concepts.

- In an emergency, always dial 911.
- Every UCF classroom has an **Emergency Procedure Guide** posted on a wall near the door, which will show you how to respond to a variety of situations. This guide can also be found online [here](#).
- In the event of an active threat, remember **AVOID, DENY, DEFEND**. Choose the best course of action and act immediately. Watch the video [here](#) to learn more.

- **AVOID.** Pay attention to your surroundings and have an exit plan. Get as much distance and as many barriers between you and the threat as quickly as possible.
- **DENY.** When avoiding is difficult or impossible, deny the threat access to you and your space. Lockdown by creating barriers, turning the lights off and remaining quiet and out of sight. Make sure your cell phone is silenced, but do not turn it off.
- **DEFEND.** When you are unable to put distance between yourself and the threat, be prepared to protect yourself. Commit to your actions, be aggressive and do not fight fairly. Do whatever it takes to survive.
- For emergencies on campus, UCF will utilize the [UCF Alert](#) system. All UCF students, faculty and staff are automatically enrolled to receive these email and text alerts, however, it's a good idea to frequently ensure your [contact information is up to date](#).

## **Financial Aid Accountability**

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All instructors/faculty are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete this activity by the end of the first week of classes or as soon as possible after adding the course. Failure to do so may result in a delay in the disbursement of your financial aid.

## **Class Schedule**

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**Preliminary schedule.** Check slide 1 of the most recent lecture for an up-to-date schedule.

Class	Day	Date	Subjects covered
1	T	8/20	Introduction / course overview
2	R	8/22	Semiconductor physical structure
3	T	8/27	Introduction to quantum mechanics, potential wells, atoms
4	R	8/29	Band structure, Kronig-Penney model, band gaps, Bloch waves
5	T	9/3	Effective mass, conduction mechanisms, 3D band structure

6	R	9/5	Density of states, thermal distribution functions, free carriers
7	T	9/10	Optical absorption of homogeneous semiconductors
8	R	9/12	Doped semiconductors
9	T	9/17	Carrier transport
10	R	9/19	Non-equilibrium carriers and diffusion current; the photoconductor
11	T	9/24	The p-n junction - unbiased
12	R	9/26	The p-n junction - reverse bias
13	T	10/1	The p-n photodetector - basic principle of operation
	R	10/3	Recap / discussion / practice exam (zoom only)
	<b>T</b>	<b>10/8</b>	<b>Midterm Exam</b>
14	R	10/10	Midterm discussion, start of p-n junction in forward bias
15	T	10/15	The p-n diode - current-voltage relationship
16	R	10/17	The p-n photodetector
17	T	10/22	Schottky barrier intro, Schottky diode detector, MSM detector
18	R	10/24	Solar cells 1 - basic concepts; load optimization; bandgap choice
19	T	10/29	Solar cells 2 - contacts; ideal junction location; carrier recombination
20	R	10/31	Solar cells 3 - concentrator cells, heterojunction cells, amorphous Si
21	T	11/5	Electroluminescence, light emitting diodes
22	R	11/7	Laser diodes I - General concepts
23	T	11/12	Laser diodes II - Gain spectrum, threshold current
24	R	11/14	Laser diodes III - Advanced semiconductor lasers
25	T	11/19	Optical response of extrinsic carriers
26	R	11/21	Modulators; electroabsorption, quantum confined Stark effect
	T	11/26	Recap / discussion / practice exam
	R	11/28	No class - Thanksgiving
	<b>R</b>	<b>12/5</b>	<b>FINAL EXAM (7am-9:50am, A214)</b>