



# CREOL, The College of Optics and Photonics

**OSE 6474: Fundamentals of Optical Fiber Communications**  
CREOL, The College of Optics and Photonics  
**Credit Hours: 3**  
**Term: Spring 2024**

## Syllabus

**Time:** Mon-Wed., 3:00-4:15 PM, Spring 2024  
**Location:** CREOL ROOM A214  
**Prerequisites:** Graduate Standing; OSE6111 "Optical Wave Propagation"  
**Course Description:** Introduces key principles and analysis of optical communication systems. Emphasis on developing the ability to analyze and design digital, analog fiber-based systems and networks  
**Instructor:** Dr. Pawel Jung  
**Email/Contact Info:** [Pawel.jung@ucf.edu](mailto:Pawel.jung@ucf.edu)  
**Office Hours and Location:** Monday-Wednesday 2:00-3:00  
CREOL ROOM 214  
**Course Modality:** P, V  
**GTAs:** N/A  
**Class Website/ Webcourse:** N/A

### Course Materials:

Fiber Optic Communication Systems, 3rd Edition, G. P. Agrawal, John Wiley and Sons, 2002.

#### Supplementary (Optional) Texts and Materials

- Optical Fiber Communications: Principles and Practice, 3rd Edition, John M. Senior, Prentice Hall, 2009.
- Fundamentals of Optical Waveguides, 2nd Edition, K. Okamoto, Academic Press, 2006.
- Optical Networks, 2nd Edition, R. Ramaswami and K. Sivarajan, Morgan Kaufmann, Elsevier, 2010.

### Course Grading and Requirements for Success:

Specify details on how work will be graded, with percentages of each category in the table below.

Criteria	Grade Weighting
Homework	25%
Midterm Exam 1	25%
Midterm Exam 2	25%
Final Exam	25%

Total	100%
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**Participation:** Students are expected to attend the lectures, no points for the

**Final Exam:** CREOL UCF ROOM A204, April 24 2023, 3:00-4:15 PM

**Make Up Policy:** If an emergency arises and a student cannot submit assigned work on or before the scheduled due date or cannot take an exam on the scheduled date, the student **must** give notification to the instructor **no less than 24 hours before** the scheduled date and **no more than 48 hours after the** scheduled date.

**Attendance Policy:** Students are expected to attend the lectures.

**Assignment Submission:**

Homework will be assigned approximately bi-weekly and collected one week from the day they are handed out.

Offsite students may choose to scan their work and email to the grader. Late returns will not be graded. You may use calculators, mathcad or matlab or mathematica to solve the homework problems but do not turn in a printout of these. You need to show your work step by step as if you were taking a test or exam. Mathcad or other similar software printouts will not be graded.

**Financial Aid and Attendance:** As of Fall 2014, all faculty members are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete the following academic activity by the end of the first week of classes, or as soon as possible after adding the course, but no later than January 13 2023. Failure to do so will result in a delay in the disbursement of your financial aid.

Grading scale (%)	
94-100	A
90-93	A-
87-89	B+
84-86	B
80-83	B-
74-79	C+
65-73	C
60-64	C-
55-59	D+
53-54	D
50-52	D-
0-49	F

**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.

**Deadlines, Holidays, and Significant Semester Events:**

First Day of Class	Jan. 8, 2024
Last Day to Drop Classes:	Jan. 12, 2024
Last Day to Add Classes:	Jan. 12, 2024
Final Exam:	April 24, 2024

Please refer to the [UCF Academic Calendar](#) and the [UCF Exam Schedule](#) for more information such as Exam Dates, Add/Drop, Withdrawal, and Grade Forgiveness Deadlines.

### **Extra Credit**

N/A

### **Grade Dissemination**

Homework, graded mid-term tests will be returned to the students. The final exam can be discussed with the student upon request.

### **Policy Statements**

#### **Academic Integrity**

Students should familiarize themselves with UCF's Rules of Conduct at <https://scai.sdes.ucf.edu/student-rules-of-conduct/>. According to Section 1, "Academic Misconduct," students are prohibited from engaging in

1. Unauthorized assistance: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
4. Falsifying or misrepresenting the student's own academic work.
5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor.
7. Helping another violate academic behavior standards.
8. Soliciting assistance with academic coursework and/or degree requirements.

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

Students should familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule* <https://goldenrule.sdes.ucf.edu/>. 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, 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.

### **Unauthorized Use of Websites and Internet Resources**

There are many websites claiming to offer study aids to students, but in using such websites, students could find themselves in violation of academic conduct guidelines. These websites include (but are not limited to) Quizlet, Course Hero, Chegg Study, and Clutch Prep. UCF does not endorse the use of these products in an unethical manner, which could lead to a violation of our University’s Rules of Conduct.

They encourage students to upload course materials, such as test questions, individual assignments, and examples of graded material. Such materials are the intellectual property of instructors, the university, or publishers and may not be distributed without prior authorization. Students who engage in such activity could be found in violation of academic conduct standards and could face course and/or University penalties. Please let me know if you are uncertain about the use of a website so I can determine its legitimacy.

### **Unauthorized Distribution of Class Notes**

Third parties may attempt to connect with you to sell your notes and other course information from this class. Distributing course materials to a third party without the my authorization is a violation of our University’s Rules of Conduct. Please be aware that such class materials that may have already been given to such third parties may contain errors, which could affect your performance or grade.

Recommendations for success in this course include coming to class on a routine basis, visiting me during my office hours, connecting with the Teaching Assistant (TA), and making use of the Student Academic Resource Center (SARC), the University Writing Center (UWC), the Math Lab, etc. If a third party should contact you regarding such an offer, I would appreciate your bringing this to my attention. We all play a part in creating a course climate of integrity.

### **In-Class Recording**

Students may, without prior notice, record video or audio of a class lecture for a class in which the student is enrolled for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach enrolled students about a particular subject.

Recording class activities other than class lectures, including but not limited to lab sessions, student presentations (whether individually or part of a group), class discussion (except when incidental to and incorporated within a class lecture), clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, private conversations between students in the class or between a student and the faculty member, and invited guest speakers is prohibited.

Recordings may not be used as a substitute for class participation and class attendance and may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct as described in the Golden Rule.

### **Course Accessibility Statement**

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) <http://sas.sdes.ucf.edu/> (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.

### **Deployed Active Duty Military Students**

If you are a deployed active duty military student and feel that you may need a special accommodation due to that unique status, please contact your instructor to discuss your circumstances.

### **Campus Safety Statement**

Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Students should make a note of the guide's physical location and review the online version at <https://centralflorida-prod.modolabs.net/student/safety/index>.
- Students should know the evacuation routes from each of their classrooms and have a plan for finding safety in case of an emergency.
- If there is a medical emergency during class, students may need to access a first-aid kit or AED (Automated External Defibrillator). To learn where those are located, see <https://ehs.ucf.edu/automated-external-defibrillator-aed-locations>.
- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <https://my.ucf.edu> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address,

cell phone number, and cell phone provider, click “Apply” to save the changes, and then click “OK.”

- Students with special needs related to emergency situations should speak with their instructors outside of class.
- To learn about how to manage an active-shooter situation on campus or elsewhere, consider viewing this video <https://youtu.be/NIKYajEx4pk>.

## **Detailed Course Outline**

### ***Course Overview***

The course will cover the physical layer associated with fiber optic networks. Topics include optical fibers, detectors/receivers and noise characteristics, optical sources like semiconductor lasers and LEDs as well as optical amplifiers and other fiber-based components.

### ***Course Objectives***

This course will aim at elucidating the key principles underlying the analysis of optical communication systems based on their fiber- and optoelectronic-based components. The emphasis will be on engineering aspects and the students should be able to comprehend, analyze and design digital and analog fiber-based systems and networks.

In order to analyze and design fiber-optic systems, it is necessary to study the components that constitute it, the principles that underlie their operation, and their functional characteristics from the perspective of a system design engineer. To this extent, the course will develop tools to understand:

- Propagation of signals and their impairments in optical fibers
- Operational characteristics of optical transmitters and receivers
- Link analysis of digital and analog optical systems
- Dispersion management techniques

### ***Topics to be covered during this course***

1. Overview of fiber optic communication systems
2. Propagation of signals in fibers
  - Multimode fiber: ray analysis, graded-index fibers, bandwidth, modal noise
  - Single-mode fibers: pulse propagation, group velocity dispersion, polarization-mode dispersion (PMD), optical dispersion compensation techniques.
  - Fiber fabrication techniques
  - Nonlinear effects in fibers
  - Planar slab waveguides
  - Waveguide modes, field distribution, and group velocity
3. System performance of telecom lasers
  - Operation principles, modulation, chirp, linewidth enhancement factor, phase and intensity noise characteristics
4. Optical receivers
  - Noise (Shot and thermal noise sources and PIN vs. APD)
  - Sensitivity (Bit-error rate, minimum received power, quantum limit of detection)
  - Sensitivity degradation (extinction ratio, intensity noise, timing jitter)
5. Optical modulators
  - Electro-optic modulators
  - Electro-absorption modulators
  - Acousto-optic modulators

## 6. Optical amplifiers

- Erbium doped fiber amplifiers (EDFAs): gain spectrum and bandwidth, gain saturation and amplifier noise
- Semiconductor optical amplifiers(SOAs): basic design and characteristics

## 7. Optical communication systems

- Loss- and dispersion-limited systems
- Power and rise time budget
- System architectures (point-to-point, distributed and local area networks)
- Long-haul digital link design (sources of power penalty: modal noise, dispersive pulse broadening, mode partition noise, frequency chirping and reflection feedback)
- WDM systems
- Dispersion management
- Dispersion-compensating fibers
- Fiber Bragg gratings

## 8. Coherent optical systems

- Homodyne and heterodyne detectors
- Modulation formats (ASK, PSK and FSK)