UNIVERSITY OF CENTRAL FLORIDA

OSE 6111 - OPTICAL WAVE PROPAGATION

Section: 0001

Optics and Photonics

Course Information

Term: Fall 2025
Class Meeting Days: MW
Class Meeting Time: 10:30AM - 11:45AM
Class Meeting Location: CROL 0102
Modality: P
Credit Hours: 3.00

Combined Course Details

This syllabus applies to OSE 6111 0001, OSE 6111 0V02.

Instructor Information

Name: Miguel A. Bandres
Office Location: A222
Office Hours
Wed 2:00-4:00pm, we can arrange a meeting on demand.
Email: bandres@creol.ucf.edu

Course Description

OSE 6111 OPT-OPT 3(3,0)Optical Wave Propagation: PR: Graduate standing or C.I. Optical propagation of light waves as applied to isotropic, anisotropic, and inhomogeneous media, guided waves and Gaussian beams. Fall, Spring.

Course Overview

The course will provide an introduction to fundamentals of computational methods for photonic waveguide optics and integrated photonic devices. See the list full of the topics at the end. For class you should bring a laptop with MATLAB or any other programing language (Python, Julia, etc.). If there any problem with that we can arrange something.

Student Learning Outcomes

After successful completion of this course, students will be able to understand the fundamentals of wave propagation and their applications.

Required Course Materials and Resources

No textbook requires. Notes and references will be provided for relevant topic.

Course Assessment and Grading Procedure

Lecture Notes, References and Videos will be provide for each topic.

Homework Policy: The following guidelines are intended to make sure everyone is clear and comfortable regarding what is expected of them for coursework in this class. You can talk to anyone you wish, and read anything you wish (but not previous HW solutions). I encourage you to discuss the course material and the homework problems with your classmates. However, before you discuss a homework problem with a classmate or look for related information in some other reference, you must

first make a solid effort at it on your own. After you discuss a homework problem with a classmate or read related information in some other reference, I expect you to write up the solution on your own, starting from something close to a blank sheet of paper and relevant references like class notes and books.

Grading Scale

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Letter Grade	Percentage
A	95-100%
A-	90-94%
B+	85-89%
B	80-84%
B-	70-79%
C	65-69%
C-	55-64%
D	50-55%
F	<49%

Policies for Course Grade

Late Work Policy:

Homework turned in late will be assessed a penalty: 7% will be deduced for each day late, and will not be accepted if overdue by more than 3 days.

Attendance: For in class section attendance is required.

Artificial Intelligence (AI) Use Policy

AI is **not allowed** on homework, midterms, or exams. You may use AI tools to learn the material and for practice.

Disability Access & Accommodations

The University of Central Florida is committed to providing equal access to all students with disabilities (ADHD, learning disabilities, Autism, chronic medical conditions, physical disabilities, etc.). To receive consideration for reasonable disability-related course accommodations, disabled students must contact Student Accessibility Services (SAS) and complete the steps required for SAS to review accommodation requests. More information can be found on the UCF Student Accessibility Services website under the Start Here tab or by contacting SAS directly (Ferrell Commons 185; sas@ucf.edu; Phone - 407-823-2371).

Approved accommodations are shared with course instructors via the SAS Course Accessibility Letter. Implementing certain accommodations may require discussion about specific considerations of the course design, course learning objectives, and the individual academic and course challenges experienced by the student. While students with disabilities or chronic health needs are also encouraged to discuss any course concerns with professors in addition to contacting SAS, professors are not required to facilitate disability-related adjustments to the course unless the professor has received a Course Accessibility Letter from SAS that outlines approved accommodations.

Academic Integrity

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:

1. 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 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.

2. Any student who knowingly helps another violate academic behavior standards is also in violation of the standards.
3. 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 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.
4. 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.

Title IX

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 access and community engagement, Title IX, accessibility, or UCF's complaint processes contact:

- Title IX – ONAC – Office of Nondiscrimination & Accommodations Compliance & askanadvocate@ucf.edu
- Disability Accommodation – Student Accessibility Services – Student Accessibility Services & 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
- The Ombuds Office is a safe place to discuss concerns.

Reporting an Incident or Issue

If you believe you have experienced discrimination by any faculty or staff member, contact the Office of Nondiscrimination & Accommodations Compliance via the ONAC website or at 407-823-1336. You can also choose to report using the UCF Integrity Line either anonymously or as yourself at 1-855-877-6049 or by using the online form. UCF

cares about you and takes every report seriously. For more information see the Reporting an Incident or Issue Webpage.

Deployed Active-Duty Military Students

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 arrangements.

Campus Safety

At UCF's 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 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

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

Course Schedule

Week	Topic
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
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16	

List of Topics

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- **MATLAB,** quick introduction and important concepts as code vectorization and indexing
- **Review of Electromagnetic Theory**
  - Time-domain Maxwell's equations and the wave equation
  - Time harmonic Maxwell's equation and Helmholtz equations
  - The paraxial wave equation
  - Symmetries of the Maxwell's equations
- **Fourier Theory**
  - Fourier transform and its properties
  - Discrete Fourier Transform
  - Fast Fourier Transform Algorithm
  - Sampling theorem, Aliasing and Spectral leakage
  - Phase retrieval
- **FFT Beam Propagation Methods**
  - Free space beam propagation
    1. Gaussian beams
    2. Non-diffractive beams
    3. Accelerating beams
  - Beam Propagation in ABCD optical systems
  - Propagation in non-homogeneous medium
    1. Photonic waveguide lattices
  - Pulse propagation in fibers
  - Absorbing Boundary Conditions
- **Numerical Differentiation**
  - Forward and central differences
  - Higher-order methods
  - Higher-order derivatives
- **Finite Difference Beam Propagation Method**
  - Explicit Forward-time central-space

    - Implicit Backward-time central-space
    - Crank-Nicolson
    - Absorbing boundary conditions
    - Transparent boundary conditions
    - Pade approximation
- **Periodic Structures**
    - Dispersion Relation
- **2D Alternating-Direction Implicit Finite Difference Method**
- **Semi-Vectorial Finite Difference Beam propagation**
    - High-index contrast waveguides
    - Quasi-TE and Quasi-TM modes
    - Altenating-direction implicit finite difference method
    - Vectorial beam propagation in slab waveguides TE and TM modes
    - TE-TM mode splitter
- **Coupled Mode Theory**
    - Mode Splitter
    - Directional Couplers
- **Non-paraxial (wide-angle) beam propagation**
- **Eigenmodes and propagation constants of Optical devices**
    - Iterative methods for computing eigenvalues
    - Matrix methods for eigenvalue problems
    - Numerov Method
    - Spectral Method for eigenvalue problems
    - 2D Spectral Methods using functions
    - Multimode waveguides
    - Bounded and radiating modes
- **Numerical Errors**

    - Round off error
    - Truncation error
- **Wave propagation in z-dependent structures**
    - Waveguide mode converter using corrugated waveguides
- **Wave propagation in Non-linear media**
    - Solitons
- **Multi-layer slab waveguides**
    - TE and TM modes
- **Three-dimensional Finite difference propagation in high-index contrast medium**
    - Channel waveguide and effective index technique
- **Finite-Difference Time-Domain Method**
    - Basic concepts and ideas
- **Periodic Structures**
    - Plane wave decomposition
    - Propagation in periodic media
    - Band Structure