CREOL OSE 6125: Computational Photonics

College of Optics and Photonics, Spring 2021
University of Central Florida

COURSE SYLLABUS

Instructor:	Dr. Miguel A. Bandres	Term:	SPRING 2021
Office:	CREOL A222	Class Meeting Days:	Monday/Wednesday
		Class Meeting Hours:	4:30pm-5:45pm
E-Mail:	bandres@creol.ucf.edu	Class Location:	Section 1: CROL 102
			Section 2: Zoom
Office Hours:	Thursday 2:30pm-3:30pm	Lab Location:	No Lab

Additional Note: Office hours are planned for Thursday 2:30pm-3:30pm, but I will be happy to discuss the material with you at any time. Please send me an email if you would like to schedule a meeting.

I. University Course Catalog Description

Computational methods for photonic guided wave structures, periodic structures, and integrated photonic structures and devices.

II. 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.

III. Course Prerequisites

Graduate standing or consent of instructor.

IV. Course Credits

3 Credit hours.

V. Required Texts and Materials

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

VI.   Supplementary (Optional) Texts and Materials

Before each topic I will give a list of specific reference for that topic.

VII.   Basis for Final Grade

Assessment	Percent of Final Grade
Homework (~12 assignments)	80%
Exercises/Class participation	20%
	100%

Homework will be submitted online. Homework is due 1 week after assigned. The lowest graded homework will be dropped. **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 (%)	
95 – 100	A
90 – 94	A –
85 – 89	B +
80 – 84	B
70 – 79	B –
65 – 69	C
55 – 64	C –

VIII.   Grade Dissemination

Graded tests and materials in this course will be returned individually and not posted publicly. You can access your scores at any time using "myUCF Grades" in the portal. Please note that scores returned mid-semester are unofficial grades. If you need help accessing myUCF Grades, see the online tutorial: https://myucfgrades.ucf.edu/help/.

IX.   Course Policies: Grades

Late Work Policy:

There are **no** make-ups for take-home final exam. Homework turned in late will be assessed a penalty: 5% will be deduced for each day late, and will not be accepted if overdue by more than 6 days.

Extra Credit Policy:

The homework (one) with the lowest grade will not count for the final grade.

Grades of "Incomplete":

The current university policy concerning incomplete grades will be followed in this course. Incomplete grades are given only in situations where unexpected emergencies prevent a student from completing the course and the remaining work can be completed the next semester. Your instructor is the final authority on whether you qualify for an incomplete. Incomplete work must be finished by the end of the subsequent semester or the "I" will automatically be recorded as an "F" on your transcript.

X.	**Course Policies: Technology and Media**
	Email: ==Fell free to email me regarding any question== or concern about the class or to request a meeting.
	Classroom Devices: Recording audio or video of the class it is not allow.

XI. **Course Policies: Student Expectations**

Disability Access:

The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. This syllabus is available in alternate formats upon request. Students who need accommodations must be registered with Student Disability Services, Ferrell Commons Room 185, phone (407) 823-2371, TTY/TDD only phone (407) 823-2116, before requesting accommodations from the professor.

Attendance Policy:

Regular class attendance (in person or by Zoom) is required in this course and is necessary for students to understand many of the topics covered. Students must be on time to class. If missed a class, it is the responsibility of the student to find out the materials covered.

Financial Aid and Attendance:

Students' academic activity at the beginning of each course must be documented. In order to document that you began this course, ==students must complete the academic participation verification question== posted on Webcourses no later than a week after the first class. Failure to do so will result in a delay in the disbursement of financial aid.

Academic Conduct Policy:

Academic dishonesty in any form will not be tolerated. If you are uncertain as to what constitutes academic dishonesty, please consult The Golden Rule, the University of Central Florida's Student Handbook (http://www.goldenrule.sdes.ucf.edu/) for further details. As in all University courses, The Golden Rule Rules of Conduct will be applied. Violations of these rules will result in a record of the infraction being placed in your file and receiving a zero on the work in question AT A MINIMUM. At the instructor's discretion, you may also receive a failing grade for the course. Confirmation of such incidents can also result in expulsion from the University

XII. **Important Dates to Remember**

All the dates and assignments are tentative, and can be changed at the discretion of the professor.

Drop/Swap Deadline:	Fri, January 15th 2021
Grade Forgiveness Deadline:	Mo, April 26th 2021
Withdrawal Deadline:	Fri, March 36th 2021

Calendar:

January (8)		February (8)		March (9)		April (6)	
11	13	1	3	1	3	5	7
18	20	8	10	8	10	11-18 Spring Break	
25 MLK Day	27	15	17	15	17	19	21
	16	22	24	22	24		
				29			

XIII. List of Topics

1. **MATLAB,** quick introduction and important concepts as code vectorization and indexing

2. **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.

3. **Fourier Theory**
   - Fourier transform and its properties
   - Discrete Fourier Transform
   - Fast Fourier Transform Algorithm
   - Sampling theorem, Aliasing and Spectral leakage
   - Phase retrieval

4. **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

5. **Numerical Differentiation**
   - Forward and central differences
   - Higher-order methods
   - Higher-order derivatives

6. **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

7. **Periodic Structures**
   - Dispersion Relation

8. **2D Alternating-Direction Implicit Finite Difference Method**

9. **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

10. **Coupled Mode Theory**
    - Mode Splitter
    - Directional Couplers

11. **Non-paraxial (wide-angle) beam propagation**

12. **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

13. **Numerical Errors**
    - Round off error
    - Truncation error

14. **Wave propagation in z-dependent structures**
    - Waveguide mode converter using corrugated waveguides

15. **Wave propagation in Non-linear media**
    - Solitons

16. **Multi-layer slab waveguides**
    - TE and TM modes

17. **Three-dimensional Finite difference propagation in high-index contrast medium**
    - Channel waveguide and effective index technique

18. **Finite-Difference Time-Domain Method**
    - Basic concepts and ideas
19. **Periodic Structures**
    - Plane wave decomposition
    - Propagation in periodic media
    - Band Structure
20. **Rigorous Coupled-Wave Analysis (RCWA)**
    - Effective medium theory

Religious Observances

Students are expected to notify their instructor in advance if they intend to miss class to observe a holy day of their religious faith. For a current schedule of major religious holidays, see the Faculty Center's main web page under "Calendars," and for additional information, contact the Office of Diversity Initiatives at 407-823-6479.

Regarding COVID-19
University-Wide Face Covering Policy for Common Spaces and Face-to-Face Classes

To protect members of our community, everyone is required to wear a facial covering inside all common spaces including classrooms (https://policies.ucf.edu/documents/PolicyEmergencyCOVIDReturnPolicy.pdf). Students who choose not to wear facial coverings will be asked to leave the classroom by the instructor. If they refuse to leave the classroom or put on a facial covering, they may be considered disruptive (please see the Golden Rule for student behavior expectations). Faculty have the right to cancel class if the safety and well-being of class members are in jeopardy. Students will be responsible for the material that would have been covered in class as provided by the instructor.

Notifications in Case of Changes to Course Modality

Depending on the course of the pandemic during the semester, the university may make changes to the way classes are offered. If that happens, please look for announcements or messages in Webcourses@UCF or Knights email about changes specific to this course.

COVID-19 and Illness Notification

Students who believe they may have a COVID-19 diagnosis should contact UCF Student Health Services (407-823-2509) so proper contact tracing procedures can take place.

Students should not come to campus if they are ill, are experiencing any symptoms of COVID-19, have tested positive for COVID, or if anyone living in their residence has tested positive or is sick with COVID-19 symptoms. CDC guidance for COVID-19 symptoms is located here: (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html)

Students should contact their instructor(s) as soon as possible if they miss class for any illness reason to discuss reasonable adjustments that might need to be made. When possible, students should contact their instructor(s) before missing class.

In Case of Faculty Illness

If the instructor falls ill during the semester, there may be changes to this course, including having a backup instructor take over the course. Please look for announcements or mail in Webcourses@UCF or Knights email for any alterations to this course.

Course Accessibility and Disability COVID-19 Supplemental Statement

Accommodations may need to be added or adjusted should this course shift from an on-campus to a remote format. Students with disabilities should speak with their instructor and should contact sas@ucf.edu to discuss specific accommodations for this or other courses.