College of Optics & Photonics

Spring 2017

OSE-6125 Computational Photonics

Time: Tuesday and Thursday 10:00 AM - 11:45 AM
January 10, 2017 –April 27, 2017

Location CREOL-A-214

Credit Hours: **3 hours**

Prerequisite: OSE6111 or consent of instructor

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

Objective The course will provide an introduction to fundamentals of computational methods for photonic waveguide optics and integrated photonic devices.

Instructor: Dr. Jim Moharam, Professor
Office CREOL 274
E-mail: moharam@creol.ucf.edu

Office Hours: Tuesday and Thursday 1:30-2:30 PM or drop by.

Course Materials: Class materials, notes, and projects are posted on:
https://webcourses.ucf.edu

Reference Materials:

- Class notes and selected journal papers.
- "Optical Waveguide Analysis," K. Kawano and T. Kitoh, Wiley
- "Any good "Mathematical Methods" textbook.

Grading Policy:

- Six projects 100%
- Late submission is not accepted.
- Plus and minus grades will be used.

Make up Work/Exam Policy:

If an emergency arises and a student cannot submit assigned work by the due date or cannot take an exam on the scheduled date, the student must notify the instructor no less than 24 hours before and no more than 48 hours after the scheduled date.

General Information:

- Students are required to attend the class in person.
- The e-mail of record at UCF will be used for communication.
- My preferred method of communication (other than in person) is e-mail.
- If you have questions out of office hours, email me.

Calendar:

January (7)		February (8)		March (7)		April (6)	
			2		2		
10	12	7	9	7	9	4	6
17	19	14	16	**14(SB)**	**16(SB)**	11	13
24	26	21	23	21	23	18	20
31		28		28	30		

- **Withdrawal deadline** March 22, 2017
- **Spring Break – no classes** March 13-19, 2017

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, student must complete the ***academic participation verification question*** *posted on* ***Webcourses*** no later than week after the first class. Failure to do so will result in a delay in the disbursement of financial aid.

Class Attendance:

- Regular class attendance is necessary for students to fully grasp the course concepts. If you miss a class session, it will be your responsibility to find out the materials that were covered.

Professionalism:

- Per university policy and plain classroom etiquette, mobile phones, etc. must be silenced during all classroom lectures unless you are specifically asked to make use of such devices for certain activities. You should be present in class before the lecture begins.

Ethics:

- As in all university courses, "The Golden Rule of Conduct" will be applied. If you are uncertain as to what constitutes academic dishonesty, please consult "The Golden Rule" in the UCF Student Handbook (www.goldenrule.sdes.ucf.edu) for further details. Violation of these rules will result in a record of the infraction being placed in your file and additional sanctions may be applied.

Students with Special Testing/Learning Needs:

- Students with documented special needs and requiring special accommodations must be registered with UCF Student Disability Services (www.sds.sdes.ucf.edu) or at (407) 823-2371 prior to receiving those accommodations. Students must inform the instructor of their special needs as early as possible in the first week of classes.

Course Outline:

Review of Electromagnetic Theory and Maxwell's Equations

- Time–domain differential Maxwell's equations and the wave equation
- Time harmonic Maxwell's equation and Helmholtz equations

Optical Waveguides

- Slab waveguides
- Multi-layer slab waveguides
- Numerical computations of the modes and field distribution
- Channel waveguide and the effective index technique
- Directional couplers and coupler mode Theory

Periodic Structures

- Propagation in periodic media
- Periodic layered media and Bragg reflection
- First order coupled mode theory
- Volume Bragg gratings
- Diffraction of Finite beams – Plane wave decomposition
- Surface-relief grating structures
- Modal Approach
- Rigorous Coupled-Wave Analysis (RCWA)
- S-matrix approach in stacked periodic structures

The RCWA in Integrated Photonics

- Effective medium theory
- Guide-mode resonant (GMR) devices
- Artificial periodic structures
- Perfect matching layers and absorbing boundaries
- Application to integrated waveguide output grating coupler

Finite Difference Analysis

- Finite difference approximations
- Taylor expansions for deriving mathematical operators
- Absorbing boundary conditions, perfectly matched layers
- Eigenmode formulation
- Scattering matrices for discontinuities

Finite-Difference Time-Domain Method

- Discretization of the electromagnetic fields
- Yee grid
- Absorbing boundary condition
- Stability conditions, rate of conference, resolution, numerical artifacts

Beam Propagation Methods

- FFT Beam Propagation Method (FFT-BPM)
- Finite Difference Beam Propagation Method (FD-BPM)
- TE and TM Formulations – equidistant discretization – stability condition
- Transparent boundary condition