College of Optics & Photonics

OSE-6111 Optical Wave Propagation
Spring 2020

Time: Tuesday, 5:00 PM – 7:45 PM
January 7, 2020 – April 21, 2020

Location: LMMFC Campus

Credit Hours: 3 hours

Prerequisite: Graduate standing or consent of instructor

Description: Optical propagation of light waves as applied to isotropic, anisotropic, inhomogeneous media, planar waveguide, and periodic structures.

Instructor: Dr. Jim Moharam, Professor
- **Office:** CREOL–A234
- **Email:** moharam@creol.ucf.edu

Office Hours: Tuesdays - before and after class or by appointment

Class Website: Course materials (syllabus, notes, problem sets, solutions, and old exams) will be available on https://webcourses.**ucf**.edu/.

Reference Materials: Class notes.
A Yariv and P. Yeh, "Photonics: Optical Electronics in Modern Communications," Oxford University Press, 6th edition, 2006. (useful but not required)

Course Requirements and Grading Policy:

- **Problem sets: 10%**
  - Problem sets are to be submitted before the beginning of the class on the due date in person (preferred) or by e-mail (moharam@creol.ucf.edu).
  - Late homework is not accepted.
  - You may work with others but the submission must be all yours.
- **Midterm Exam I:** **25%** February 25, 2020 (Tentative)
- **Midterm Exam II:** **25%** March 24, 2020 (Tentative)
- **Final Exam:** **40%** (April 21, 2020)

Exams are comprehensive and are closed book and notes.
All exams are held at LMMFC Campus.

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:

- UCF e-mail of record will be used for communication.
- My preferred method of communication (other than in person) is e-mail.
- If you have questions, E-mail me. and I will get back to you within a reasonable time.

Grading Scale (%) Interpretation:

Plus and minus grades will be used.

(%)	Rubric Description
$A \geq 90$	Excellent, has a strong understanding of all concepts and is able to apply the concepts. Has full mastery of the content of the course.
$90 > B \geq 70$	Good, has a strong understanding of most or all of the concepts and is able to apply them to stated and defined situations.
$70 > C \geq 60$	Average, has a basic understanding of the major concepts of the course and is able to apply to basic situations.
$60 > D \geq 50$	Below average, has a basic understanding of only the simple concepts and is able to apply to only a limited number of the most basic situations.
$F < 50$	Demonstrates no understanding of the course content

Calendar:

January	February	March	April
7	4	3	7
14	11	**Spring Break**	14
21	18	17	**21 (Final)**
28	**25 (MT1)**	24 **(MT2)**	
		31	

- Withdrawal deadline — Friday, March 20, 2020
- Spring Break – No classes — March 9-14, 2020

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 may result in a delay in the disbursement of financial aid.

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:

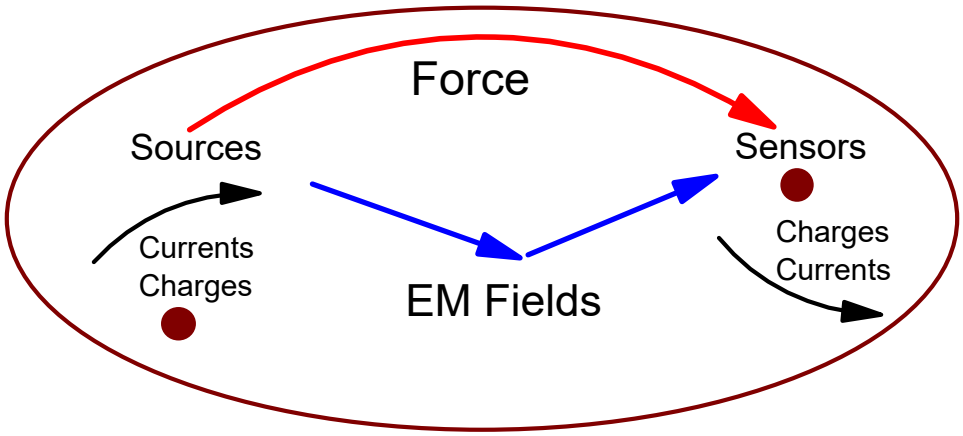
- As in all university courses, "The Golden Rule of Conduct" will be applied. If you are uncertain as to what constitutes academic dishonesty, please consult "The Golden Rule" in the UCF Student Handbook (www.goldenrule.sdes.ucf.edu) for further details. Violation of these rules will result in a record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

Electromagnetic Theory

The electromagnetic theory describes the interaction between static and time varying charges and currents.



- The concept of fields is introduced to formulate the governing equations.
- The source charges and currents produce “electromagnetic fields”.
- These fields exert forces on the sensor charges and currents.

Course Outline:

Review of Vector Analysis (3 hours)

- Vector representation and vector coordinate transformations
- Vector operations
- Differential vector operations and Gauss’ and Stokes’ theorems
- Fourier analysis in linear systems

Electromagnetic Field Theory (3 hours)

- Electromagnetic fields
- Dielectric, conducting, and magnetic materials
- Conduction and displacement currents
- Constitutive relationships and permittivity, permeability, and conductivity
- Lorentz force equation

Maxwell’s Equations (4.5 hours)

- Integral and differential time varying Maxwell’s equations
- Power and energy and the Poynting’s theorem
- Complex time harmonic Maxwell’s equations
- Boundary conditions and field matching at interfaces.

Electromagnetic Propagation in Linear Isotropic Homogenous Media (4.5 hours)

- The wave equation and Helmholtz equation
- Plane wave propagation
- Power flow density
- Electromagnetic field polarization: linear, circular, and elliptical

Reflection and Refraction at Planar Interfaces (9 hours)

- Field matching at planar interfaces
- Propagating, surface, and evanescent waves
- TE and TM polarizations
- Reflection and transmission coefficients,
- Brewster angle, critical angle, total internal reflection
- Reflection and refraction in multi-layered structures
- Quarter-wave stack and applications in thin film coatings

Electromagnetic Propagation in Anisotropic Media (9 hours)

- Dielectric tensor classification of anisotropic media
- Dispersion relation and light propagation in uniaxial and biaxial media
- Power flow in anisotropic media
- Refraction and reflection at anisotropic interface
- Jones's calculus and retardation plates
- Index ellipsoid

Optical Propagation in Periodic Media (3 hours)

- Periodic field spatial harmonics
- Generalized phased matching condition and the grating equation
- Planar, conical, and spherical diffraction
- Propagation and evanescent diffracted orders

Metallic Waveguides (3 hours)

- Parallel plate metallic waveguides
- Dispersion relations for TEM, TE, and TM modes
- Cut-off conditions and single mode operation
- Field distribution and power flow in metallic waveguides

Dielectric Waveguides (6 hours)

- Dielectric planar asymmetric waveguides
- Dispersion relations for TE and TM modes
- Cut-off conditions and single mode waveguide
- Field distribution and power flow in planar waveguides
- Mode orthogonally and mode excitation