Course Syllabus (Aug. 19, 2020 draft)

EEL 4440 Optical Engineering, Fall 2020

M, W 3:00-4:15; HPA I ROOM 207

Instructor: Dr. MJ SOILEAU (SWALLOW)

- **University-Wide Face Covering Policy for Common Spaces and Face-to-Face Classes (Aug 19, 2020 update)**
  - 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.

Financial Aid and Attendance:

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 and submit the first homework assignment by the due date of August 26, 5 pm. Failure to do so will result in a delay in the disbursement of your financial aid. This will be submitted via the EEL 4440 Webcourses portal.

Office: Room A219 CREOL Building, mj@ucf.edu, 407-443-3808

Web site: **Materials available on UCF Webcourses system**

Office Hours: **M W at 4;30-5-PM (after class)**
(This time may be rearranged to best meet the needs of students time. – Will be discussed in class.)

I will be in my office at these times, but of course I will be happy to discuss the material with you anytime. Often, I get questions via e-mail that can be quickly answered.

Course Description:

Detailed course description and learning outcomes:

Introduction:
Some of the main growth areas in the "high-tech" sector are centered on the branch of optics known as "Photonics", examples are; displays, data storage, telecommunication systems. This is not a temporary phenomenon. Continued growth of optics and photonics based industries means that there will be a growing and permanent need for engineers and scientists with some training in optics. According to the American Academies of Science and Engineering, 15% of the USA, and world economy is ***ENABLED*** by optics. Other areas of optics, such as bio-photonics, laser machining, laser marking, infrared imaging, etc. are growing strongly also. These topics are covered in the other courses in the Photonic Science and Engineering degree program. This course provides students with the strong foundation in optics that will be needed for the subsequent courses or subsequent independent study of optics. We will frequently make reference to applications as we go.

Content:
This course introduces the basic descriptions of light as rays (geometrical optics), waves (physical optics), and photons. This course will emprise the fundamental nature of light as electromagnetic radiation and as such is rigorously described my **Maxwell's Equations** for electromagnetics. We will derive the WAVE EQUATION which in turn describes the preparation of light. Reflection and refraction of light rays and waves from planar and curved surfaces are described in the context to MAXWELL'S EQUAIONS with appropriate boundary condition. The course introduces, together with applications to basic optical systems, such as single-lens imaging, microscopes, telescopes, etc). Total internal reflection of rays is used to describe light propagation through optical fibers. Interference of optical waves is described along with interferometers and their applications to optical metrology and sensing. Diffraction of optical waves propagating through apertures is examined and the effects on the resolution of imaging systems and the spreading and focusing of optical beams are covered. Diffraction gratings and grating spectrometers. Polarization and polarization devices. Regarding light as photons, a brief introduction to absorption, emission, and luminescence phenomena is followed by a brief description of light emitting diodes, lasers and optical detectors.

Learning outcomes:
Upon completion of this course, students should understand the basic principles of modern geometrical and physical optics and photonics. They should be able to read the specifications of commercial optical instruments such as a scanner for a laser printer, a telescope, or a spectrometer, and determine how these specifications impact the intended application. They should also be able to solve analysis and design problems for basic optical systems such as the following examples:

- Design an imaging system with prescribed magnification using a given lens, and determine the spatial resolution.
- Determine the critical angle for a given optical fiber and the angle of the cones of the incident and transmitted rays at the input and output of the fiber.
- Determine the changes in the Young's double-slit interference pattern that result from bringing the slits closer by some factor.
- Determine the changes in the Michelson interferogram that result from moving one of the mirrors or inserting a thin glass slab in one of the arms.

- Design an optical modulator by use of two polarizers and a wave retarder with variable retardation.
- Design an optical communication link.

Topics:
- Geometrical optics: Optical rays. Refractive index. Fermat's principle. Reflection and refraction from planar mirrors and boundaries between media of different refractive indexes. Total internal reflection. *Applications: single-lens imaging, microscopes, telescopes, prism scanning systems, concentrators, optical fibers.*
- Physical optics: Wave propagation. Planar and spherical waves. Reflection and refraction from planar mirrors and planar boundaries between media of different refractive indexes. Comparison between geometrical and wave optics.
- Interference of light and optical interferometers. *Applications: optical sensing and metrology.*
- Diffraction of light. *Applications: resolution of imaging systems. Angular spreading and focusing of optical beams.*
- Diffraction gratings and grating spectrometers.
- Polarization and polarization devices (polarizers, retarders, rotators).
- Light as Photons. Brief introduction to absorption, emission, and luminescence.
- Optical devices: detectors, LEDs, and lasers.

Textbook:
Introduction to Optics, 3rd ed., F. L. Pedrotti, L.S. Pedrotti and L. M. Pedrotti, Prentice-Hall, 2009. Chapters covered: 1 through 11; 13; 15.

Recommended Reference:
Schaum's Outline of Theory and Problems of Optics, Eugene Hecht, McGraw Hill, 1975. Chapters covered: 1; 3; 4; 6; 7.

Other Reference books:
Optics, 4th ed., E. Hecht, Addison-Wesley.
Fundamentals of Photonics, B. Saleh and M. Teich, 2nd ed., Wiley, 2007.

Class Web site:
Materials used for classes will be available on UCF Webcourses. If you want a hard copy of the slides, print them. These are only printed for you for the first class.

You are required to read or view materials prior to class. If you do not, you will not be able to do well in this class. See below.

Teaching vs. Learning
Most people learn things for themselves. As a teacher, my job is to help students to learn the material. In order to help you learn in depth, I plan to use a significant amount of class time for detailed discussion of concepts, and problem-solving. Credit will be given for these activities. These types of activities require that students actually carry out reading assignments prior to class. I will occasionally set in-class quizzes to ensure that students come to class prepared.

Professionalism and Ethics

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.

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 the student 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.

Students with Special Testing/Learning Needs
Students with special needs and require special accommodations must be registered with UCF Student Disability Services prior to receiving those accommodations. Students must have documented disabilities requiring the special accommodations and must meet with the instructor to discuss the special needs as early as possible in the first week of classes. UCF Student Disability Services can be contacted at http://www.sds.sdes.ucf.edu/, or at (407)823-2371.

Final Exam: Wednesday, December 9, 2020 Time: 1:00PM -3:50PM

COVID considerations. All classes will be recorded via either Webcourses of Zoom. All materials will be distributed and collected via the web. If required to achieve the UCF and CDC guidelines, then half the class will meet live (in person) on Mondays and the other half on Wednesdays. Date for live class attendance will be determined strictly alphabetically. There will be no in person classes after Thanksgiving, and the final exam will be administered online. ALL quizzes, and homework will be submitted online via Webcourses. Procedures for Midterm Exams will be determined as the term progresses.

According to UCF rules, masking is required for live classroom attendance. Students feeling ill are encouraged to view the lectures via Webcourses.

Expect at least one quiz per week. These will focus on the most recent material (although all past topics are fair game!), previous homework, and assigned reading (even if that reading has not be covered in class.)

Relationship of Course to ABET Criteria

ABET Criteria	Level of Emphasis During Course (Low, Medium, High)
(a) An ability to apply knowledge of mathematics, science, and engineering.	H
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.	L

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	L
(d) An ability to function on multidisciplinary teams.	L
(e) An ability to identify, formulate, and solve engineering problems.	H
(f) An understanding of professional and ethical responsibility.	L
(g) An ability to communicate effectively.	M
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	L
(i) A recognition of the need for, and an ability to engage in life-long learning.	L
(j) A knowledge of contemporary issues.	M
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	H

Grading: (Grading based on 100% but 5% extra credit is possible.)

Activity	Grade weighting
Homework	15%
Quizzes	15%
In class participation,	5 %
Extra Credit opportunities	+5%
Two mid-terms, each worth 20% of total grade,	40%
Final exam	25%
TOTAL	**100% + 5%**

Grading Scale (%)					Rubric Description (Plus and minus letter grades will be awarded as per policy.)
100	≥	A	>	90	Excellent, has a strong understanding of all concepts and is able to apply the concepts in all and novel situations. Has full mastery of the content of the course.
90>		B	≥	80	Good, has a strong understanding of most or all of the concepts and is able to apply them to stated and defined situations.
80>		C	≥	70	Average, has a basic understanding of the major concepts of the course and is able to apply to basic situations.
70>		D	≥	60	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.
60 >		F	≥	0	Demonstrates no understanding of the course content.

Grade Objections: All objections to grades should be made **in writing within one week** of the grade being posted for the work in question.