Syllabus for ECEN 5645
Introduction to Optoelectronics
Fall 2015

Purpose
Optoelectronic systems are ubiquitous here in the 21st century. Although the semiconductor lasers, silica glass fibers and pin diodes of the internet are generally unseen, this optoelectronic application has arguably wrought more changes on society than any technical development of the last half century. A more visible and possibly even more widespread application of optoelectronics is the cell phone camera. Both optical communication systems and and electronic imaging systems convert modulated light streams to electronic information streams at their output. The optoelectronics of the communication systems are a bit richer as such systems also impress the target electronic information stream on a light stream and transport that light stream to the distant receiver. This course focuses on basic principles of light and electronic materials that allow for production, transmission and reception of optical signals. Emphasis is placed on propagation, waveguide transmission and detection.

Particulars
Instructor: Alan Mickelson
Office: ECEE 130
Office Hours: M 1:00 - 1:50 p.m. and Th 2:00 p.m. - 2:50 p.m.
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Grader Keyon Janani
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Office Hours: M 1:00 p.m. - 2:50 p.m. and W 2:00 - 2:50 p.m.
Lecture: TTH 12:30 -1:45 p.m. in ECCE 1B14

Homework: There will be weekly homework assignments. Solutions will be discussed in class at a rate of two problems per day. Students will be assigned (beforehand, by email communication) to lead the in-class discussions. Each assigned student will submit and subsequently present one or two slides to elucidate their approach to their assigned problem. Homework solutions will be distributed to students who specifically ask the instructor for solution sets by email request.

Exams: Three will be 3 in-class midterm exams (9/24/15, 10/29/15 and 12/03/15).

Project: There will be a term project. The project will involve a project proposal, a project progress report with completion schedule, a written report (minimally 10 pages single-spaced with 5 figures and 10 references) and an in-class presentation.

Website: The website will be [http://ecee.colorado.edu/~ecn5645/](http://ecee.colorado.edu/~ecn5645/).

Text: The primary text will be:

S. O. Kasap
Optoelectronics and Photonics: Principles and Practices

The text is well written, clear and recent. The text is expensive (circa $150) but there are really no alternatives of comparable quality, no less at more competitive price. I recommend your buying the text as the explanations and examples can prove to be a real asset to learning. Further, most of the problems to be assigned will come from the problems at the end of the various chapters of the book. The text is long, 545 pages. This is too much for a one semester course. The plan will be to cover the majority of chapters 1 (Wave Nature of Light), 2, (Dielectric Waveguides and Optical Fibers) and 5 (Photodetectors and Image Sensors). The choice to skip chapters 3 and 4 is to great degree predicated on that material (light sources) being covered elsewhere in the University of Colorado optics curriculum.

Objectives

The overall objective of the course is to prepare the student in the analysis, use and design of information bearing optoelectronic systems. A hope is that some students will apply the knowledge learned in the course to conceive, invent and innovate improved optical communication and/or electronic imaging systems. A specific set of objectives for this course may be enumerated to be:

1. to employ wave concepts to analyze guided wave optical systems,
2. to conceptualize the flow of information in communication systems,
3. to determine the salient characteristics of electrical signals that have been converted from information streams on optical carriers.
Grading

There will be weekly homework, three exams and a project. Each of the exams and project will have equal weight. The final grade will be based on a total of 40% homework grades and 60% exam plus project grade.

Schedule

Topical Overview

1. Wave Nature of Light (5 weeks) Chapter 1 in text
2. Dielectric Waveguides and Optical Fibers (5 weeks) Chapter 2 in text
3. Photodetectors (4 weeks) Chapter 5 in text
4. Projects presentations (1 week)

Week 1 (Light and Index): August 25 and August 27

1. Plane and diverging waves - section 1.1.
2. Refractive index and wave velocity - sections 1.2 and 1.3

Week 2 (Energy flow at interfaces): September 1 and September 3

1. Poynting vector and total internal reflection - sections 1.4 and 1.5 (Problem set 1 due)
2. Fresnel’s relations - section 1.6

Week 3 (Optical coatings and absorption): September 8 and September 10

1. Anti-reflection coatings - section 1.7 (Problem set 2 due)
2. Absorption and index - section 1.8

Week 4 (Coherence and interference): September 15 and September 17

1. Temporal and spatial coherence - section 1.9 (Problem set 3 due)
2. Superposition and interference of waves - section 1.10
Week 5 (Interferometers and exam 1): September 22 and September 24

1. Interferometers - section 1.11 (Problem set 4 due)
2. in class Exam 1

Week 6 (Waveguides and dispersion): September 29 and October 1

1. Slab waveguides - section 2.1 (Project proposal due)
2. Waveguide dispersion - section 2.2

Week 7 (Step index fiber): October 6 and October 8

1. Step index fiber - section 2.3 (Problem set 5 due)
2. Examples for step index fiber - sections 2.3 and 2.4

Week 8 (Fiber dispersion): October 13 and October 15

1. Fiber dispersion - section 2.5 (Problem set 6 due)
2. Examples of fiber dispersion - sections 2.5 and 2.6

Week 9 (Transmitting information in a fiber): October 20 and October 22

1. Electrical and optical bandwidth - section 2.7 (Problem set 7 due)
2. Graded index fiber - section 2.8

Week 10 (Fiber attenuation and second exam): October 27 and October 29

1. Fiber attenuation - section 2.9 (Problem set 8 due)
2. In class exam 2

Week 11 (Optical photodetection): November 3 and November 5

1. PN junction detectors - section 5.1 and 5.2 (Project progress report and completion schedule due)
2. Photodetector materials - section 5.3
Week 12 (PiN detectors and responsivity): November 10 and November 12
   1. Responsivity -section 5.4 (Problem set 9 due)
   2. PiN detectors -section 5.5

Week 13 (Other detector types): November 17 and 19
   1. Avalanche, heterojunction, Schottkeys, and phototransistors - section 5.6 - 5.10 (Problem set 10 due)
   2. Photodetector circuits and noise - sections 5.11 and 5.12

Week 14 (Fall Break): November 24 and November 26
   1. no class
   2. no class

Week 15 (Image sensors and exam 3): December 1 and December 3
   1. Image sensors - 5.13 (Problem set 11 due)
   2. In class exam 3

Week 16 (Project presentations): December 8 and December 10
   1. Project presentations
   2. Project presentations

No Final Exam during exam period

Disability

If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs may be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, and http://www.colorado.edu/disabilityservices/
Religious Observance

Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, students with religious obligations that may cause conflicts with the course proceeding are requested to talk to the instructor within the first two weeks of the semester. See full details at http://www.colorado.edu/policies/fac_relig.html

Classroom Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to such behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat all students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which they and their students express opinions. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender variance, and nationalities. Class rosters are provided to the instructor with the student’s legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at http://www.colorado.edu/policies/classbehavior.html and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

Honor Code

All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at http://www.colorado.edu/policies/honor.html

Discrimination & Sexual Harrassment

The University of Colorado at Boulder policy on Discrimination Harassment (http://www.colorado.edu/odh), the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships applies to all students, staff and faculty.
Any student, staff or faculty member who believes she/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at [http://www.colorado.edu/odh](http://www.colorado.edu/odh).