OPTI 510R: Photonics Syllabus

Instructor:
Professor Stanley Pau, College of Optical Sciences, Rm 427, spau@optics.arizona.edu
Professor Robert A. Norwood, College of Optical Sciences, Rm 533, rnorwood@optics.arizona.edu
Office Hours: Drop-in or by appointment

Lecture Schedule:
Lecture, Monday and Wednesday 9:00am to 10:15am, Rm 305

Teaching Assistant:
Tsung-Han Wu, thwu@optics.arizona.edu

Course Objectives:
This course has been designed to give an introduction to photonics at the graduate level. From the Photonics Dictionary at photonics.com, Photonics is defined as

The technology of generating and harnessing light and other forms of radiant energy whose quantum unit is the photon. The science includes light emission, transmission, deflection, amplification and detection by optical components and instruments, lasers and other light sources, fiber optics, electro-optical instrumentation, related hardware and electronics, and sophisticated systems. The range of applications of photonics extends from energy generation to detection to communications and information processing.

Both instructors have extensive industrial experience in photonics devices and their applications; as a consequence, this course is designed to be device oriented, with many practical examples of photonics components. The students will learn how the devices are made, designed and operated. The course can be broadly divided into two parts. The first part covers fundamentals such as theories of dispersion, absorption and birefringence. Thorough understanding of these concepts is required for the rest of the course. This review will be followed immediately by studies of passive components such as gratings, Fabry Perot filters and Bragg mirrors. We then move to wave propagation in planar geometries, specifically different kinds of integrated optics devices. There will be a midterm exam, which will provide students with enough feedback on their performance in order to drop the class if they are doing poorly. The second part of the class covers wave propagation in optical fiber with applications to optical networks, telecommunications, and optical interconnects. Different type of fiber based devices are examined. We will study various types of fiber amplifiers, specialty fiber and nonlinear effects in fibers that impact optical network performance. Many practical aspects of fiber-based devices will be covered including their design, fabrication and packaging; relevant reliability standards will also be introduced. Finally, we will examine different kinds of active lightwave devices including optical interconnects, LEDs, laser diodes and photodetectors.

Grading Policy:
Two Exams 60%
Homework Assignments 40%
TOTAL 100%
**Exams:**
We plan to have two exams during the semester. The exams will be based on the lectures, homework assignments, and materials in the textbook. Each exam includes materials in the different parts of the class. The first exam will cover the first half of the course, while the second exam covers the second half of the course.

**Homework Assignments**
There will be a homework problem set assigned approximately every two weeks. The problem set is due in class. The due date will be listed in the problem set handouts. *Late homework will be accepted up to a week after it was due, and will be graded at 50% off. All materials that are over a week late will receive zero credit.* For distance learning students, you can email scanned/electronics copies of your homework to the TA before the deadline. Recording of class lectures will be available online to distance learning students only. Please contact Cindy Robertson (cindyr@optics.arizona.edu).

**Textbook:**
We have one required textbook for the class:


There will be handouts given during class to supplement the materials not in the textbook. Supplements and additional materials are available on the class website, which will be updated periodically during the semester: [http://d2l.arizona.edu](http://d2l.arizona.edu) (use your NetID to login).

**Course Policies:**
It is **very important** to attend all lectures. If you must be absent, it is your responsibility to obtain and review the information you missed. The students are encouraged to ask questions during the lecture. Attendance is not mandatory. If you miss an exam, it may not be made up unless you have a documented medical or family emergency.

If you need to leave the room during lecture, please do so discreetly, so that you won’t disturb the professor and the students.

You are encouraged to work with each other as a team. You should not, however, copy each others homework.

**Additional Information**

**Academic Integrity**
According to the Arizona Code of Academic Integrity ([http://dos.web.arizona.edu/uapolicies/cai2.html](http://dos.web.arizona.edu/uapolicies/cai2.html)), “Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student’s submitted work must be the student’s own.” Unless otherwise noted by the instructor, work for all assignments in this course must be conducted independently by each student. **CO-AUTHORED WORK OF ANY KIND IS UNACCEPTABLE.** Misappropriation of exams before or after they are given
will be considered academics misconduct.

Misconduct of any kind will be prosecuted and may result in any or all of the following:
* Reduction of grade
* Failing grade
* Referral to the Dean of Students for consideration of additional penalty, i.e. notation on a student’s transcript re. academic integrity violation, etc.

Students with a Learning Disability
If a student is registered with the Disability Resource Center, he/she must submit appropriate documentation to the instructor if he/she is requesting reasonable accommodations. (http://drc.arizona.edu/instructor/syllabus-statement.shtml).

References
[1] Class notes are taken partially from those prepared by Alan Kost and Seppo Honkanen
This is a tentative schedule for the class and is subject to change. Additional updates and information will be given during the semester.

**Week 1:**
1/11 Lecture 1: Maxwell Equations, Wave Equations, Dielectric Media, Constitutive Relations, Anisotropic Media, 5.1, 5.2

**Week 2:**
1/16 Holiday, Dr. Martin Luther King, Jr. Day
1/18 Lecture 2: Electromagnetic Waves, Absorption and Dispersion, 5.3, 5.4, 5.5

**Week 3:**
1/23 Lecture 3: Resonant Medium, Pulse Propagation, 5.5, 5.6, 5.7
1/25 Lecture 4: Optics of Anisotropic Media, Optical Activity and Magneto-Optics, Beam Splitter, Waveplates, Optical Isolator, 6.3, 6.4, 6.6

**Week 4:**
1/30 Lecture 5: Dispersion, Grating and Wavelength Separation, Wavelength Switches p. 56-57 and handouts
2/1 Lecture 6: Fabry Perot Filters and Bragg Mirrors, 7.1

**Week 5:**
2/6 Lecture 7: Mirror and Dielectric Waveguides, 8.1, 8.2
2/8 Lecture 8: 2D Waveguides & Optical Coupling in Waveguides, 8.3, 8.4, 8.5

**Week 6:**
2/13 Lecture 9: Mode Dispersion, Phase & Group Velocity, and Waveguide Loss (handouts)
2/15 Lecture 10: Waveguide Materials & Fabrication (handouts)

**Week 7:**
2/20 Lecture 11: Arrayed Waveguide Gratings (handouts)
2/22 Lecture 12: Compact Photonics: Microring Resonators & Photonic Bandgap Devices (handouts)

**Week 8:**
2/29 Lecture 14: Exam 1

**Week 9:**
7 March - LAST DAY TO DROP COURSE WITH A "W" (if passing)
3/5 Lecture 15: Fiber: Rays and Waves, 9.1, 9.2
3/7 Lecture 16: Field Distribution, Modes, Polarization, and V number, 9.2 + handouts
**Week 10:**
No lecture: Spring recess, Mar. 10 to Mar. 18

**Week 11:**
3/19 Lecture 17: Attenuation and Dispersion, 9.3, 9.4

**Week 12:**
3/26 Lecture 19: Practical Aspects of Fiber: Manufacturing, Coupling, Splicing, Connectorizing, Testing, & Telcordia Standards (handouts)
3/28 Lecture 20: Nonlinear Effects in Optical Fiber and Their Effects on Optical Networks (handouts)

**Week 13:**
4/2 Lecture 21: EDFA, SOA and Raman Amplifiers, 14.1-14.5 + handouts

**Week 14:**
4/9 Lecture 23: Optical Interconnects, OEO vs. OOO, Wavelength Switches, Time Domain Switches, 24.3, 23.1
4/11 Lecture 24: LEDs, pn Junctions, 17.1

**Week 15:**
4/16 Lecture 25: Laser Diodes, 17.3, 17.4
4/18 Lecture 26: More Laser Diodes, VCSEL, Applications, 17.4 and handouts

**Week 16:**
4/23 Lecture 27: Photodetectors and Photoconductors, 18.1, 18.2
4/25 Lecture 28: Photodiodes and Avalanche Photodiodes, 18.3, 18.4

**Week 17:**
4/30 Lecture 29: Course Summary and Exam Review
5/2 Lecture 30: Exam 2

**Last day of class, Wed., May, 2**

S. Pau, 15 lectures 1-6, 22-30
R. Norwood, 15 lectures 7-14, 15-21