INTEGRATED PHOTONICS
(OSE6421, 3 CREDIT HOURS)

INSTRUCTOR: SASAN FATHPOUR

SPRING 2016; CLASS DAY AND TIME: TUES. & THURS. 1:30-2:45 PM; ROOM: CROL 102
OFFICE HOURS: THURSDAYS, 3:00-4:00 PM, RM A212

CATALOG DESCRIPTION
The course reviews working principle, system functionality and design and fabrication issues of semiconductor integrated photonic devices and circuits for optical telecommunication and interconnect applications.

COURSE GOALS
The course complements the OSE courses on ‘fundamentals of optoelectronic devices’, ‘computational photonics’ and ‘optical communication systems’ to deepen students’ education in photonic engineering. The course’s goal is elucidating the key principles underlying the analysis and design of integrated photonic devices, with an emphasis on the engineering and practical aspects of them. The students should be able to understand and design integrated photonic devices and circuits at the end of the course. The course also introduces selected advanced research topics currently pursued in the field.

COURSE APPROACH
In order to analyze and design integrated photonic devices and circuits, it is necessary to study the components that constitute it, the principles that underlie their operation, and their functional characteristics from the perspective of a device engineer. To this extent, the course will begin with very briefly reviewing optoelectronic device principles as well as optical waveguide design. It will then quickly get into discussions on advanced integrated devices and circuits such as optical switches, optical transceivers, wavelength converters, arrayed waveguide gratings, etc. The course will end with more state-of-the-art topics such as silicon photonics.

PREREQUISITE:
- Graduate standing
- Basic knowledge of photonics, semiconductors and optoelectronics at the graduate level is assumed. Although not mandatory, knowledge of optoelectronics at the level of OSE5414 Fundamentals of Optoelectronics is helpful.

REQUIRED READINGS:
Course Website:
https://webcourses.ucf.edu/courses/1173451

SUGGESTED TEXTBOOKS:
- K. Okamoto, *Fundamentals of Optical Waveguides*, 2nd Ed., Academic Press, 2006.
- W. S. Chang, *Fundamentals of Guided-Wave Optoelectronic Devices*, Cambridge University Press, 2010.
- S. L. Chuang, *Physics of Photonic Devices*, 2nd Ed., Wiley, 2009.
- L. A. Coldren, S. W. Corzine and M. L. Masanovic, *Diode Lasers and Photonic Integrated Circuits*, John Wiley and Sons, 2nd Edition, 2012.

- R. G. Hunsperger, *Integrated Optics: Theory and Applications*, 5th Edition, Springer-Verlag, Berlin Germany, 2002.
- J. M. Liu, *Photonic Devices*, Cambridge 2005.

COURSE OUTLINE:

1. Introduction: Why Integrated Photonics?
2. Integrated Optical Waveguides
    a. Overview of basic waveguide mode analysis
    b. Waveguide platforms on various materials and their fabrication techniques
3. Fundamental Analysis Tools and Devices for Integrated Photonics
    a. Coupled-mode theory
        - Applied to waveguide directional couplers, Mach-Zehnder interferometers/modulators and grating waveguides
    b. Super-mode analysis
        - Applied to tapered waveguides and *Y*-junction splitter/combiners and Mach-Zehnder interferometers/modulators
    c. Input and output waveguide couplers
        - Optical mode converters, prism and grating couplers
    d. Energy loss in optical waveguides
        - Sources of optical loss and their measurement techniques
4. Advanced Passive Photonic Devices
    a. Wavelength-division multiplexing components
        - Mulitplexers, Demultiplexers
        - Multimode interferometers
        - Arrayed waveguide gratings
    b. Integrated photonic filters and delay lines
        - Integrated Fabry-Perot filters
        - Bragg grating filters
        - Microring resonators
5. Overview of Semiconductor Lasers
6. Advanced Topics in Semiconductor Lasers
    a. DBR and DFB lasers
    b. VCSELs
    c. Dynamic effects: Rate equations, Large signal analysis, Relative intensity noise and linewidth
7. III-V Optoelectronic Integrated Circuits
    - Multisection lasers
    - Integrated transmitters and receivers
8. Silicon Photonics
    a. Introduction: why silicon photonics?
    b. Passive devices: waveguides, couplers, resonators, etc.
    c. Active devices: Modulators and detectors
9. Application of Integrated Photonic Systems
    a. Optical transceivers and interconnects
    b. Challenges and opportunities

GRADING:

Homework Assignments: 30%
Midterm Exam: 40% (Date: March 17, 2015)
Final Project: 30%

University Rules on 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.

Academic Ethics Specific to This Lab Course
It is the nature of a laboratory course that you will be working in groups. Obviously, those of you who are lab partners will be using the same raw data. You are encouraged to discuss your observations and insights with your lab partners; however, each of you has to write your own ORIGINAL lab reports.

Cheating and plagiarism are serious breaches of the UCF Code of Honor as described in the UCF Golden Rule and the UCF Creed, and will not be tolerated in this course. All cases will be reported to the Office of Student Conduct (OSC).

Definitions
Cheating: any unauthorized assistance in graded, for-credit assignments.
Plagiarism: appropriating the work of others and claiming, implicitly or explicitly, intentionally or unintentionally, that it is your own.

With increased use of the internet, digital plagiarism is becoming more of a problem on campuses everywhere. You are encouraged to use the internet; however, electronic copying and pasting of material directly into reports and papers without proper reference of the source is blatant plagiarism. **Always reference the sources of information.**

Providing a fellow student with experimental data from an experiment in which he/she did not participate is also forbidden. All parties that are involved in such practice will be reported to UCF Office of Student Conduct (OSC).

If there is any question concerning acceptable practice in this laboratory course, do not hesitate to ask the instructor.