INTEGRATED PHOTONICS
(OSE6938S, 3 CREDIT HOURS)

INSTRUCTOR: SASAN FATHPOUR

SPRING 2015; CLASS DAY AND TIME: TUES. & THURS. 1:30-2:45 PM; ROOM: CROL 102
OFFICE HOURS: TUESDAYS, 3:00-4:00 PM

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
There exist courses on 'optoelectronic devices' and the numerical aspects of 'integrated optics' in CREOL's curriculum. However, there is no available course on bridging between these device-oriented courses and the more system- and network-oriented courses offered on optical communications and fiber optics. This new course aims at filling this gap. 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 will also introduce 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:
  OSE6432 Fundamentals of Photonics (assumed)
  OSE5414 Fundamentals of Optoelectronics (helpful)

REQUIRED READINGS:
Course Website:
https://webcourses.ucf.edu/courses/1082799

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.

- 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. Review of basic waveguide theories
    b. Fabrication techniques
3. Advanced Passive Devices
    a. Coupled-mode theory
        - Applied to waveguide couplers and grating waveguides
    b. Super-mode analysis
        - Applied to tapered waveguides and Y-junction splitter/combiners
    c. Wavelength division multiplexing components
        - Multimode interferometers, Arrayed waveguide gratings, ring resonators, filters, etc.
    d. Input and Output Couplers
        - Mode converters and grating couplers
    e. Waveguide losses
        - Absorption mechanism and propagation loss measurement techniques
4. Review of Active Photonic Devices: Lasers, Modulators & Detectors
5. Advanced Topics on Semiconductor Lasers
    a. DFB lasers and VCSELs
    b. Dynamic Effects: Rate equations, Large signal analysis, Relative intensity noise and linewidth
6. III-V Optoelectronic Integrated Circuits:
        - Multisection lasers
        - Integrated transmitters and receivers
7. Silicon photonics
    a. Introduction
    b. Passive devices
    c. Active devices
        - Modulators and detectors
8. Examples of integrated systems
    a. Optical transceivers
    b. Optical interconnects

GRADING:

Homework Assignments: 30%
Midterm Exam: 35% (Date: March 26, 2015)
Final Project: 35%