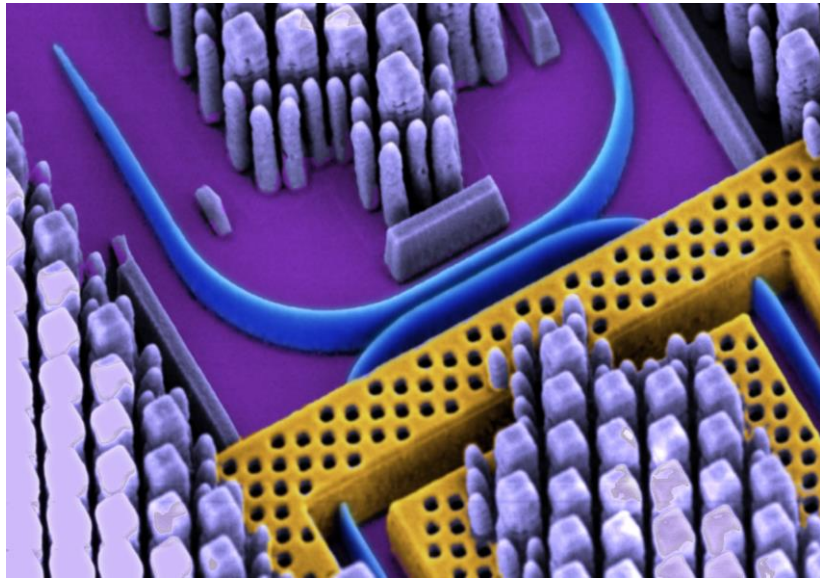


NEW course (up to 4 credit hours)!

Pre-requisite: ECE350

ECE 442: Silicon Photonics



Silicon photonics is a rapidly growing multi-\$B industry as well as an active area of advanced research. This course will focus on practical applications of Electro-Magnetic concepts to **photonic integrated circuits**.

1. **Passive** devices : filters, converters, polarizers.
2. **Active** devices: modulators, switches, photodetectors.
3. **Optical communications** using silicon photonics.
4. **Applications** in biosensing, quantum, and neuromorphic computing.

Optional 4 credit hours: independent project on design, testing, and analysis of your own silicon circuit.

<https://courses.engr.illinois.edu/ece442/fa2021/>

Catalog description: Electromagnetic waves, optical waveguides, waveguide couplers, waveguide filters, electro-optical devices, modulators, photodetectors, optical communications.

Information for undergraduate students:

I taught this class ECE498YV for several years now and it can be either taken in a sequence to ECE452 or as a stand-alone class. The only pre-requisite is ECE350 or analogous class on basic EM concepts. Over last several years that I taught it about third of each class were undergraduates that perform as good, or in a number of cases even better, than many graduates.

Undergraduate credit hours: 3

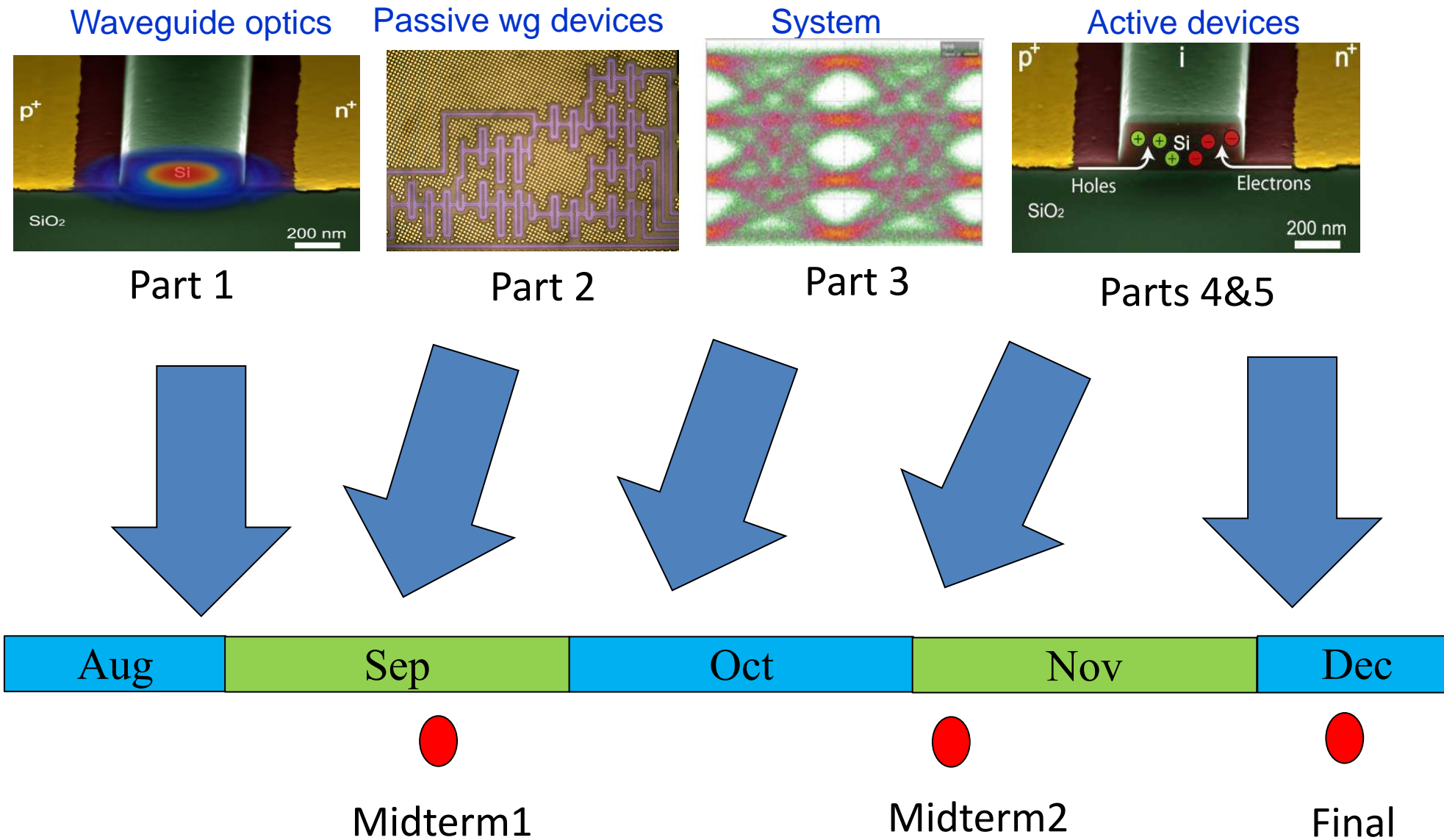
Graduate credit hours: 4

This additional credit hour is given to graduate students to participate in design and testing of your own photonic integrated circuits. Report is required at the end of the course.

Students notes:

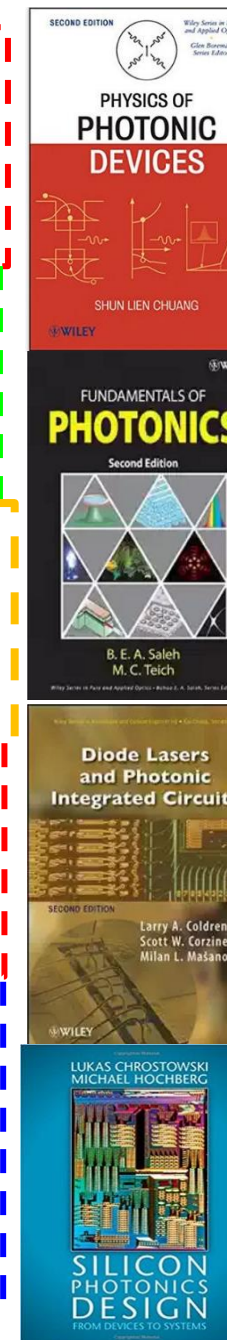
- Fantastic course! Enjoyable class. Learned a lot
- Learning physical theory behind device operation is very very useful
- Interesting mix of qualitative and physics description w practical apps
- Unique perspective. Provides great insight to industry “why tech matters”
- Very passionate, knowledgeable, caring, and helpful. Fair grading
- Topics are well presented and relevant
- Really helpful homework's add a lot to understanding

Course Timeline and Structure



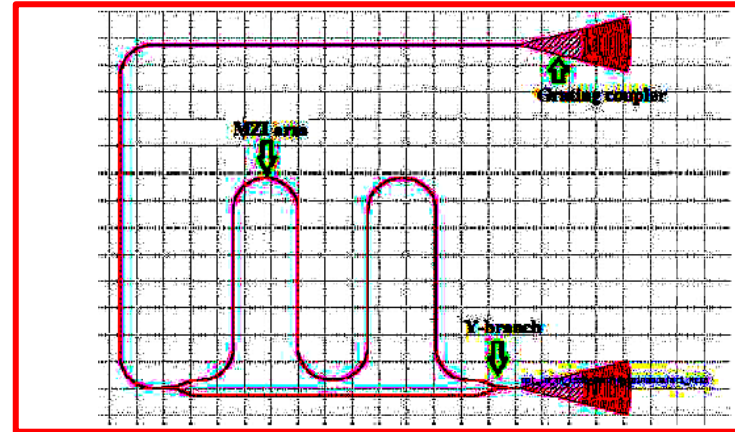
Course topics

- 1. Waveguide optics:** planar and rectangular waveguides. Passive waveguide devices: optical coupling, coupled-mode theory, coupled waveguides, directional couplers.
- 2. Passive devices:** Mach-Zehnder interferometer. WDM optical filters. Optical ring resonators. Add-drop multiplexers. Waveguide Bragg gratings. Polarization splitters and rotators.
- 3. Communications systems:** Attenuation and dispersion. Signal distortion in optical waveguides, group delay. Optical data communications basics: modulation formats, optical link budget, BER and penalties.
- 4. TX active devices:** Si modulators. Electro-optical effects in silicon, amplitude and phase modulators. Traveling wave modulator in reverse-biased electro-optic
- 5. RX active devices:** Ge photodetector. Shottky and PIN diodes. Fabrication approaches. RX figures of merit.
- 6. Emerging applications** of Si photonics in quantum computing, neuromorphic computing, and biological sensing.



Independent design project

4 graduate credit hours

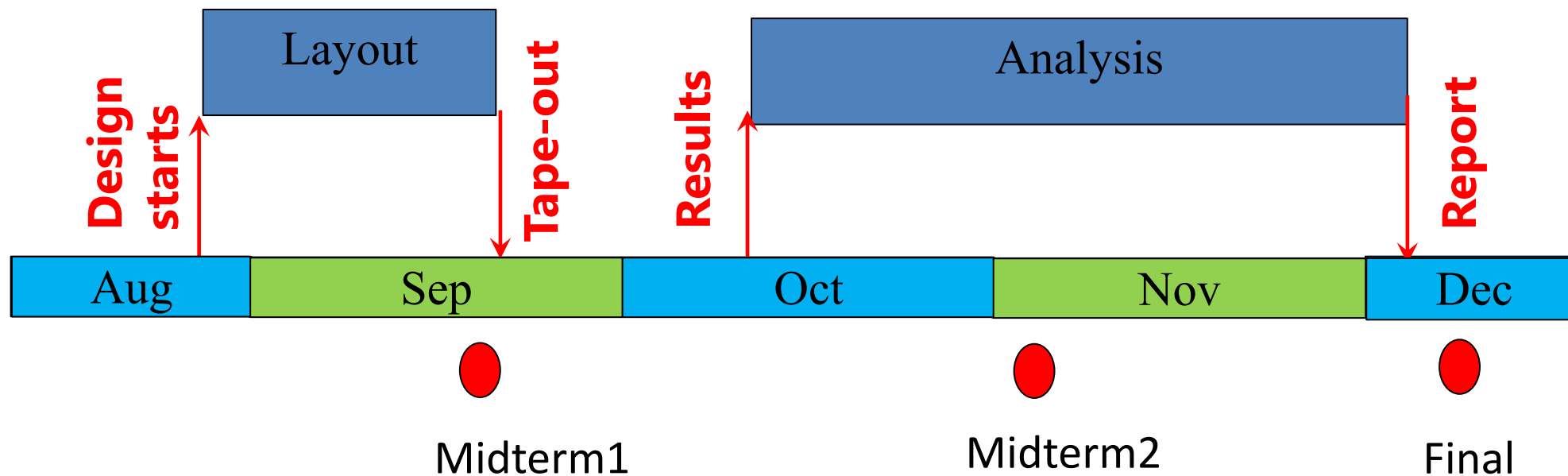


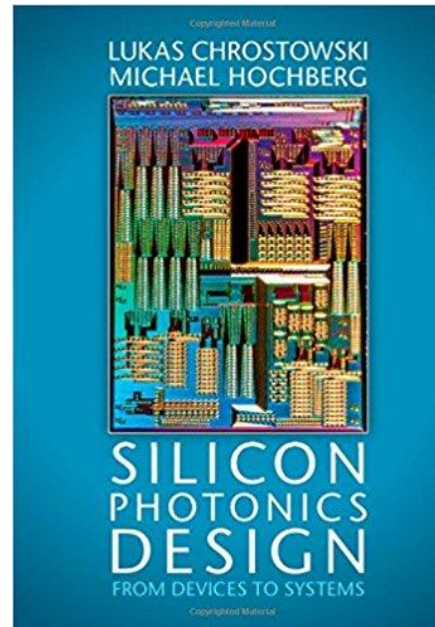
Taking this option, you will:

- **Model** the optical waveguide using a mode solver to determine the wavelength-dependent effective index and propagation constant. Model a silicon photonic optical circuit using a compact model approach.
- **Design** photonic components and circuits, e.g., interferometer. Identify design parameter variations.
- **Create and submit a layout** for fabrication. Learn the fabrication design rules, automated testing constraints, and design submission details.
- **Receive measurement** data from fabricated devices. Analyze the data to extract parameters from the measurements and compare with models.
- **Report** on your design results.

Timeline (subject to change)

- Aug 21 software licenses & intro videos available
- Aug 29 starting with photonic component modelling
- Sep 21 Tape-out**
- Oct 11 Chips & Measurements done
- Dec 01 Report due**





Textbook:

- Lukas Chrostowski, Michael Hochberg, "Silicon Photonics Design", Cambridge University Press, 2015.
- UIUC have a subscription to this book, [offering free PDF downloads.](#)
- <https://www.cambridge.org/core/books/silicon-photonics-design/BF3CF13E8542BCE67FD2BBC7104ECEAB>

As a **first-time designer**, you will design a Mach-Zehnder Interferometer, consisting of fiber grating couplers, two splitters, and optical waveguides.

