**EEE 538: Optoelectronic Devices**

**Course Description**

This course is designed to provide junior and senior graduate students with detailed theory and practical knowledge of semiconductors materials and optoelectronic devices such as light emitting diodes, lasers, photodetectors, and solar cells. The applications of these devices will also be discussed. This course will offer not only classroom lectures but also demonstration of real world experiments in state-of-the-art laboratories at ASU.

**Enrollment Requirements**

Prerequisite(s): Fulton Electrical, Computer and Energy Engineering (ECEE) graduate student or CIDSE, SBHSE, SEMTE or SSEBE graduate student.

**Course Overview**

The course will cover the following areas in great details.

1. **Semiconductors and their electronic properties** (semiconductor statistics, effective mass theory, carrier generation and recombination, excitonic effect, basics of many body effects, spontaneous and stimulated emission, etc.)
2. **Advanced junction theory** (PN junctions, tunnel junctions, Schottky barriers, and ohmic contacts, and heterojunctions)
3. **Light emitting diodes** (electroluminescence processes, photon recycling effect, light extraction, possible luminescence refrigeration in LEDs, and device characterization)
4. **Laser diodes** (theory of material optical gain in semiconductors, detailed optical mode theory for semiconductor region waveguides, carrier and optical confinements in double-heterostructure lasers, edge emitting lasers, surface emitting lasers, distributed feedback lasers, QW lasers, nanolasers, direct modulation of laser diodes, etc.)
5. **Photodetectors** (semiconductor photoconductors, photodiodes, avalanche photodiodes, noise in photodetectors, and detection limits, novel IR detectors)
6. **Solar cells** (thermodynamic limits, the detailed balance model, and a semi-analytical model for practical single and multi-junction solar cells, comparison between solar cells and photodetectors and LEDs)
7. **Applications** (Optical communication, photovoltaics, IR imaging systems, chemical and biomedical sensing, etc.)

**Course Itinerary**

1. Semiconductors and their electronic properties (semiconductor statistics, effective mass theory, carrier generation and recombination, excitonic effect, basics of many body effects, spontaneous and stimulated emission, etc.) -- 6 lectures

2. Advanced junction theory (PN junctions, tunnel junctions, Schottky barriers, and ohmic contacts, and heterojunctions) -- 2 lectures

3. Light emitting diodes (electroluminescence processes, photon recycling effect, light extraction, possible luminescence refrigeration in LEDs, and device characterization) -- 4 lectures

4. Laser diodes (theory of material optical gain in semiconductors, detailed optical mode theory for semiconductor region waveguides, carrier and optical confinements in double-heterostructure lasers, QW lasers, direct modulation of laser diodes, etc.) -- 6 lectures

5. Photodetectors (semiconductor photoconductors, photodiodes, avalanche photodiodes, noise in photodetectors, and detection limits, novel IR detectors using type-II superlattice) -- 2 lectures

6. Solar cells (thermodynamic limits, the detailed balance the model, and a semi-analytical model for practical single and multi-junction solar cells, detailed comparison between solar cells and photodetectors and LEDs) -- 3 lectures

7. Applications (Optical communication, photovoltaics, IR imaging systems, chemical and biomedical sensing, etc.) -- 2 lectures