Syllabus

EEE 598— Optical Spectroscopy of Semiconductor Materials and Heterostructures
(Spring 2016)

Introduction and Goals:

This course is one in a series of new optoelectronic courses being developed to teach *hands-on experimental skills* to junior graduate students, preferably PhD students, in engineering and related disciplines so that they can be better prepared for their thesis research and future career.

This course is designed to provide systematic basic training in the area of optical spectroscopy of semiconductor materials and heterostructures, including quantum dots, nanowires, quantum wells, and superlattices. The topics encompassed, cover the basic experimental and communication skills required for graduate research and future careers in science and engineering.

Prerequisites or co-requisites: Graduate students from Ira Fulton Schools of Engineering and Physics.

Enrollment: Due to limited lab space, the enrollment will be limited to **12 students**.

Coordinator: Professor Y.-H. Zhang, School of Electrical, Computer and Energy Engineering.

Text book: Lecture notes and published literature

Reference book: Wolfgang Demtröder, *Laser spectroscopy: basic concepts and instrumentation*, Springer, 2003.

Prerequisites by topics:

1. Electromagnetic waves, quantum mechanics, and basic solid state physics
2. Basic concepts underlying semiconductor materials and devices

Topics:

1) Review of the basic optical processes in semiconductor materials and heterostructures
2) Basic spectroscopy components and instrumentation
   a) Optical components (lens, mirrors, filters, beam splitters, etc.)
   b) Light sources (lamps, gas lasers, solid-state lasers, laser diodes, LEDs, blackbody IR source)
   c) Dispersion devices (prisms, gratings, interferometers)
   d) Detectors (PMT, photodetectors, thermal power sensors, pyroelectric sensors)
3) Related optics and application to spectroscopy
   a) Laser and Gaussian Beam Propagation and Transformation
   b) Light collection and aperture matching (optical throughput)
4) Weak signal detection techniques
   a) lock-in amplifier
   b) boxcar average
   c) photon counting
5) Spectroscopy systems
   a) Monochromators
   b) FTIR (step scan and double modulation)
   c) Interferometers
6) Basic spectroscopy techniques
   a) CW and time-resolved photoluminescence

    b) Transmission measurements
    c) Modulated reflectance
    d) Raman scattering
    e) Spectroscopic ellipsometry
7) Practical experimental know how and data analysis
    a) Optical alignment
    b) System calibration
    c) Error analysis
    d) Fitting and modeling experimental data
8) How to give technical presentations
9) How to write technical reports, proposals, and journal publications

(The covered topics of each semester may vary depending on the needs of enrolled students.)

Exams: Term projects and a final project. All the exams will be open book. Students are expected to give a few presentations and write reports.

Labs: There will be several lab projects for students to choose from. It is anticipated that the students need to spend *substantial amount of time* in carrying out experiments in various labs to learn hands-on experience.