Nanophotonics

**Instructor:** Dr. C. Z. Ning, Professor of Electrical Engineering, cning@asu.edu

3 hours per week

**Description**
Have you ever thought about the following questions?

1) How you might be able to make a laser that has a diameter one thousandth of your hair’s thickness?
2) Can you squeeze a light beam through a hole or a slit that is much smaller than the wavelength?

These and other fascinating questions will be addressed during our graduate course on “Nanophotonics”. Nanophotonics is a new and still emerging field of study that deals with generation (emission), propagation, manipulation, and detection of photons in structures of nanometers in size. This course intends to introduce graduate students into this exciting field of study by starting at a very elementary level. Students will be gradually guided to the very frontier of current research in nanophotonics. In addition, you will learn practical methods in growing, fabricating, and calculating, simulating some of the nanophotonic structures and devices. In the process, you will learn to appreciate how “nano” makes the difference in “photronics” and how what you learn might impact your own research.

**Contents**

1. Introduction and overview (zoo of nanostructures, what is nanophotonics)
2. Preparation and Review (Maxwell Equations, Quantum Mechanics, Optics)
3. Light generation by nanostructures (semiconductor quantum wells, wires, dots, nanocrystals, nanowires)
4. Light propagation in nanostructures (nanowires, nano-waveguides)
5. Combining emission and propagation: Nanolasers (laser basics, nanowire lasers)
6. Photonic crystals (Maxwell equations and dielectric periodic structures)
7. Surface plasmas (propagation at metal-dielectric interfaces, transmission through subwavelength hole, subwavelength waveguides)
8. Near-field optics
9. Overview of other topics in nanophotonics and outlook
10. Lab tour: growth and characterization of photonic nanostructures
11. Student presentations

**Recommended background:** Not absolute necessary but following preparations would be very helpful: Electromagnetism or Electrodynamics, Classical Optics, Quantum Mechanics, Solid State or Semiconductor Physics.

**Who should attend:** Graduate students of EE, Physics, Chemistry, Material Sciences or Engineering

**Course grading:** Mid-term (35%), final project (35%), homework (30%) which may involve presentations by students on materials they are assigned to study.

**Reference Books:**

1) Principles of Nano-Optics, by Lukas Novotny and Bert Hecht
2) Nanophotonics, by Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande, Juan Ariel Levenson
3) Surface Plasmon Nanophotonics, by Mark L. Brongersma, Pieter G. Kik
4) Nanophotonics, by P.N. Prasad
5) Photonic Crystals, by John D. Joannopoulos, Robert D. Meade, Joshua N. Winn