ECE 4223: Nanophotonics

Credits and contact hours: 3 Credits

Instructor: Eric Donkor

Textbook: Optical Metamaterials, Wenshan Cai and Vladimir Shalaev, Springer
Plasmonics: Fundamentals and Applications; Stephan A. Maier, Springer

a. *Other supplemental materials*: Instructor's web-based notes

***Specific course information*:**

a. *Catalog Description*: Principles and applications of nanophotonics with focus on optical metamaterials, plasmonics, and photonic bandgap crystals. Topics covered include electric plasma, magnetic plasma, optical magnetism, negative index metamaterials, localized and non-localized surface plasmon polaritons, photonic bandgap structures, superlens, optical cloaking.

b. *Prerequisite*: ECE 3223, open only to students in the school of engineering

c. *Required, elective, or selected elective:* Elective

***Specific goals for the course*:**

a. *Specific outcomes of instruction*: Students will be able to:

- apply principles of physical optics to analyze light propagation in optical metamaterials, plasmonic structures, and photonic crystals.

- Employ analytical models such as Maxwell-Garnett Theory, Bruggemann Effective Medium Method, to determine the effective permittivity and effective permeability of nanoscale dielectric-metal, and dielectric-dielectric composite materials.

- Analyze the optical characteristic of electric metamaterials, magnetic metamaterials, negative-index metamaterials, plasmonics structures, and photonic crystals

- Describe the principles underlying nanophotonics applications such as optical cloaking, plasmonic sensors, photonic crystal fibers.

b. *ABET Criterion 3: Student Outcomes addressed by the course*:

1. **an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics**
   Design and open-ended problems in nanophotonic applications requires students to be able to formulate and solve problems using analytical or simulation tools.

2. **an ability to apply engineering design to produce solutions that meet specified needs with considerations of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors**
   n/a

3. **an ability to communicate effectively with a range of audience**
   Students learn to communicate through in-class oral presentation and technical report on an assigned topic in nanophotonics

4. **An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts**
   n/a

5. **an ability to function effectively on a team whose members together provide leaderships, create a collaborative and inclusive environment, establish goals, plan task, and meet objectives**
   n/a
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6. **an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusion**
   n/a

7. **an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.**
   Students research and write a technical report on topics focusing on emerging trends in nanophotonics, by referencing published technical reports and archival journals in nanophotonics.

Topics covered:

- Optical properties of metal-dielectric composites
- Electric metamaterials
- Magnetic metamaterials
- Negative-index metamaterials
- Surface plasmon polaritons
- Propagating and localized surface plasmon waves
- Optical cloaking
- Optical nanoantennas
- Surface plasmon sensors
- Photonic Crystal fibers