Nanophotonics and Metamaterials*

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ECE695S

*) This course was prepared with M. Brongersma and S. Fan from Stanford. Their help is highly appreciated.
Nanophotonics and Metamaterials

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Course Web page
http://cobweb.ecn.purdue.edu/~shalaev/teaching.html - to download lectures

Recommended Textbook:
1. Photonic Crystals: Molding the flow of light.

Grading 30% homework, 30% midterm exam, 40% final (presentation and report)
Overview of the Course

Part I: Introduction to light interaction with matter
   Derivation Wave Equation in matter from Maxwell’s equations
   Dielectric properties of insulators, semiconductors and metals (bulk)
   Light interaction with nanostructures and microstructures (compared with $\lambda$)

Part II: Photonic Crystals
   Electromagnetic effects in periodic media
   Media with periodicity in 1, 2, and 3-dimensions
   Applications: Omni-directional reflection, sharp waveguide bends,
   Light localization, Superprism effects, Photonic crystal fibers

Part III: Metal optics (plasmonics) and nanophotonics
   Light interaction with 0, 1, and 2 dimensional metallic nanostructures
   Guiding and focusing light to nanoscale (below the diffraction limit)
   Photonic, plasmonic and hybrid nanocircuits
   Near-field optics
   Nanolasers
   Plasmonic nano-sensors
Overview of the Course

Part IV: Metamaterials and hot topics in quantum nanophotonics

- Metamaterials: artificial magnetism and negative refractive index
- Metamaterials: superlens and hyperlens
- Transformation optics and cloaking
- Tunable and active plasmonic materials
- Refractory plasmonics
- Plasmonics for energy conversion, data storage and biomed applications
- Metasurfaces
- Nanolasers
- Tunable and active plasmonic materials
- Refractory plasmonics
- Plasmonics for energy conversion, data storage and biomed applications
- Silicon photonics
- Diamond photonics
- Graphene photonics
- Intro to quantum photonics
- Topological Quantum Computer
- Photonic Neuromorphic Computing
- Photonic Topological Insulators
- Parity-Time Symmetry in Optics and Photonics
- Random Lasers
- Coherent Perfect Absorber or ‘Anti-Laser’
- Orbital Angular Momentum of Light and its control with metamaterials/metasurfaces
- Epsilon-Near-Zero (ENZ) and Mu-Near-Zero (MNZ) metamaterials
- All-Dielectric Metasurfaces
- Control of Heat Radiation with Metamaterials
- Phase-Change Materials for Photonics
- Optical Nano-tweezers to manipulate and control nano-objects