**ECE782: Nanophotonics (나노광자학)** Spring 2016

***Instructor:*** Prof. Jongwon Lee

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***Class Hours:*** Mon/Wed 10:30 – 11:45 AM

***Class Room:*** EB2 311

***Office Hours:*** Mon/Wed 1:30 – 2:30 PM

***Text Book:*** No text required.

***Additional References:***

1. Sergey V. Gaponenko, *Introduction to Nanophotonics*, Cambridge, University Press (2010)
2. John D. Joannopoulos, Steven G. Johnson, Joshua N. Winn, and Robert D. Meade, *Photonic Crystals: Molding the Flow of Light*, 2nd Ed., Princeton University Press (2008)
3. Lukas Novotny and Bert Hecht, *Principles of Nano-Optics*, Cambridge University Press (2006)
4. Stefan A. Maier, *Plasmonics – Fundamentals and Applications*, Springer (2007)

***Course Description:***

This course intends to provide and discuss advanced knowledge of nanophotonics. We will discuss light propagation, emission, absorption and scattering in complex structures and emphasize the advantages of confining light waves to match the length scale of electron waves. This course is designed to familiarize you with the new concepts and technology in the developing field of nanophotonics. The topics include: light-matter interaction, surface-plasmon polaritons, plasmonic waveguides, photonic crystals, and metamaterials.

***Topics***

1. **Introduction to light-matter interaction**

* Maxwell equations and derivation of wave equation
* Dielectric properties of optical materials: insulator, semiconductor and metals (bulk)
* Density of states, group velocity and phase velocity
* Material dispersion

1. **Evanescent waves and plasmonics**

* Potential barrier and evanescent waves
* Surface plasmons and localized surface plasmons
* Light scattering by metal nanoparticles and hot spots
* Guiding and focusing light to nanoscale (below the diffraction limit)
* Applications: SPP based sensors, SPP based spectroscopy, Nanolasers

1. **Periodic structures and photonics crystals**

* Bloch waves, reciprocal space, and Brillouin zones
* Electronic and photonic band structures
* Bandgaps and band structures of 1D, 2D, and 3D photonic crystals
* Photonic crystal defects and confinement of light
* Applications: Omni-directional reflection, Superprism effect, Photonic crystal fibers

1. **Metamaterials and Metasurfaces**

* Metamaterials: artificial magnetism and negative refractive index
* Metamaterials: superlens and hyperlens
* Tunable and active plasmonic metamaterials
* Metasurfaces – anomalous reflection and refraction
* Nonlinear metasurface
* Graphene photonics

***Grading:***

Homework (30%) / Mid-term Exam (40%) / Final Presentation and report (30%)

**Homework:** Submit homework after class on the due date. Late submission is not allowed and regarded as not submitted.

**Exams:** One midterm exam (open note)

**Honor Code Statement:** You are expected to do homework and exams by yourself, and any plagiarism is strictly prohibited and will be appropriately punished. When preparing homework you are allowed to discuss with other peer students, but all material submitted must be original.

***Course Schedule***

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| Week | Contents | note |
| 1  Mar 2 | 1. Course overview & Introduction |  |
| 2  Mar 7/9 | 2. Review of Maxwell’s Equations  3. Dispersion in Materials |  |
| 3  Mar 14/16 | 4. Optical Properties of Bulk and Nano  5. Optical Properties of Metals |  |
| 4  Mar 21/23 | 6. SPP dispersion  7. SPP excitation |  |
| 5  Mar 28/30 | 8. SPP propagation, Chip-scale SPR  9. Dielectric particles, Metallic particles |  |
| 6  Apr 4/6 | 10. Intro to Photonic Crystals, Band diagram  11. 1D PC, Transfer Matrix |  |
| 7  Apr 11/13 | 12. Applications of PC  No class on Wed. (April 13th) – 국회의원 선거 |  |
| 8  Apr 18/20 | Midterm Exam |  |
| 9  Apr 25/27 | 13. Si Photonics  14. Metamaterial Super lens |  |
| 10  May 2/4 | 15. Negative index metamaterials  16. Hyperbolic Metamaterials |  |
| 11  May 9/11 | 17. Metamaterial cloaking  18. Active metamaterials |  |
| 12  May 16/18 | 19. Metasurfaces  20. Nonlinear metasurfaces |  |
| 13  May 23/25 | 21. Graphene photonics  22. TBD |  |
| 14  May 30 | Student Presentation  No class on Wed. (June 1st ) – Conference attendance |  |
| 15  June 6/8 | No class on Mon. (June 6th) – 현충일  Student Presentation |  |
| 16 | No class |  |