OPTI 567: Nanophotonics
Effective Fall 2026

Course Description:

This course will cover the interaction of light with nano-scale features on objects. The course will include mathematical foundations, including those of plasmonics and metamaterials, as well as a review of applications of nanophotonics and recently-published progress in the field. Ways to focus light and image objects beyond the diffraction limit will be presented.

Pre-requisites:

OPTI 501: Electromagnetic waves **or** ECE 381A: Introductory Electromagnetics **or** PHYS 332
Please contact the instructor if you do not meet one of the pre-requisites but would still like to take the class.

Number of Units/ component:

3 units / lecture

Locations and Times:

Tuesdays & Thursdays 9:30-10:45am, Meinel 422.

Instructor Information:

Instructor name: Euan McLeod
Office: Meinel 623
Email: euanmc@optics.arizona.edu
Office hours: Immediately following class or as arranged.

Expected Learning Outcomes:

- Understand how scattering from small particles depends on particle size, shape, and composition.
- Be familiar with ways to numerically model light at the nano-scale.
- Explain how both localized surface plasmons and surface plasmon polaritons can be used to concentrate light into nanoscale volumes.
- Describe how photonic crystals can be used to reflect, guide, or confine light.
- Conceptually explain and mathematically derive the diffraction limit of light.
- Explain what optical metamaterials are and how they can be used to image objects with sub-diffraction-limit resolution.
- Learn schemes to perform imaging with resolution beyond the diffraction limit.

Recommended Texts:
Primary textbook (required, but should be available online):

- L. Novotny and B. Hecht, *Principles of Nano-Optics*, 2nd edition, Cambridge University Press (2012)
- Access via the D2L site for this course → Content → Online Textbook and Lecture Notes
- Note that there are some significant differences between the 1st and 2nd editions of this book.

The following books are recommended as references, but are not required.

- J. D. Joannopoulos, S. G. Johnson, J. N. Winn, and R. D. Meade, *Photonic Crystals: Molding the Flow of Light*, 2nd edition, Princeton University Press (2008).
- J. Goodman, *Fourier Optics*, Roberts & Company (2005).
- D. J. Griffiths, *Introduction to Quantum Mechanics*, Prentice Hall (1995).
- C. F. Bohren and D. R. Huffman, *Absorption and Scattering of Light by Small Particles*, Wiley (1998).

List of Topics:

- What is nanophotonics?
- Review of electromagnetism fundamentals
- Finite difference time domain modeling method
- Interaction of light with dipolar nanoparticles
- Radiation reaction correction for particle polarizability
- Lorentzian and Fano lineshapes
- Relationship between classical and quantum mechanical dipoles
- Interaction of light with wavelength-scale particles
- Coupled (discrete) dipole approximation modeling method
- Mie scattering
- Quadrupole approximations
- Optical tweezers / optical manipulation of nanoparticles
- Photonic crystals
- Interaction of light with plasmonic metals
- Surface plasmon polaritons
- Localized surface plasmons
- Optical antennas
- Purcell effect
- Transmission through nanoscale apertures
- Near-field scanning optical microscopy
- Physical and mathematical foundations of the diffraction limit
- Metamaterials, including double-negative media, hyperbolic metamaterials, transformation optics, and metasurfaces
- Super-resolution microscopy, including multiphoton, STED, structured illumination, synthetic aperture, fluorescent localization (PALM/STORM), and confocal

Number of Exams and Papers:

There will be one final exam. It will be in-class during the last course of the semester. It will be open-book and open-notes. The only resources that cannot be used are those where there is another human or an AI agent (Claude, Chat-GPT, Gemini, etc.) responding in real time (e.g., email, text-messages, posting to message boards, forums, etc.).

Short quizzes will occur periodically, run through D2L. There will be one project, due toward the middle of the semester. Project details will be explained during the course.

Assignment Schedule:

Assignment	Date assigned	Date due
Homework #1	9/8/26	9/22/26
Homework #2	9/22/26	10/6/26
Homework #3	10/6/26	10/20/26
Project	8/27/26	10/27/26
Homework #4	10/27/26	11/10/26
Homework #5	11/10/26	11/24/26
Homework #6	11/24/26	12/3/26
Final Exam	12/8/26	12/8/26

Course Policies:

Grading Policy

Homework	25%
Quizzes	15%
Project	25%
Final Exam	35%
Total	100%

The grading scale is A: 90-100, B:80-89, C: 70-79, D: 60-69, E: <60. The thresholds between grades may be lowered by the instructor depending upon the final distributions of grades, but will not be raised.

Late homework: A 24-hr grace period will be given for homework turned in after the deadline. After 24 hours, late homework will lose 20% of its earned points, and will lose another 20% of its earned points for each additional week it is late thereafter. Depending on the circumstances, extensions may be granted, however they *must* be arranged with the instructor before the deadline. Late projects will lose points in the same fashion as homework. Any projects or homework turned in after the last day of lecture will receive zero credit.

Distance Learning

The class will be offered via distance learning provided sufficient enrollment.

Academic Integrity (http://web.arizona.edu/~studpubs/policies/cacaint.htm)

According to the Arizona Code of Academic Integrity, “Integrity is expected of every student in all academic work. The guiding principle of academic integrity is that a student’s submitted work must be the student’s own.” Unless otherwise noted by the instructor, work for all assignments in this course must be conducted independently by each student. Co-authored work of any kind is unacceptable. Misappropriation of exams before or after they are given will be considered academics misconduct.

Misconduct of any kind will be prosecuted and may result in any or all of the following:

- Reduction of grade
- Failing grade
- Referral to the Dean of Students for consideration of additional penalty, i.e. notation on a student’s transcript re. academic integrity violation, etc.

AI Policy

For this course, feel free to use AI for study assistance. When approaching homework problems, you will learn the most if you try to solve the problem on your own before turning to AI (or another student who already has the solution). If you use AI to help with homework assignments, it is not permitted to simply electronically copy and paste the AI output and turn that in. Analytical derivations should be written and turned in freehand.

Class Recording

Students should be mindful that instructor course content is subject to intellectual property protections, and that fellow students have privacy rights and expectations as part of class activities. Some students may have an approved accommodation from the Disability Resource Center, which automatically notifies instructors through the DRC Instructor portal. Students who do not have a DRC accommodation must notify the instructor if they wish to record (audio and/or video) or photograph any class activity. When course activities are recorded, they should be used for a student’s own personal educational use only.

Attendance Policy

It is important to attend all classes, as what is discussed in class is pertinent to adequate performance on assignments and exams. If you must be absent, it is your responsibility to obtain and review the information you missed. This is especially important in this course where a substantial amount of course material will emerge through class discussion.

"All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion. Absences pre-approved by the UA Dean of Students (or Dean's designee) will be honored."

Classroom Behavior

The Arizona Board of Regents' Student Code of Conduct, ABOR Policy 5-308, prohibits threats of physical harm to any member of the University community, including to one's self. See: http://policy.web.arizona.edu/threatening-behavior-students.

Accessibility and Accommodations

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu) to establish reasonable accommodations.

The information contained in this syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.