Course Description:

This course will cover the interaction of light with nano-scale features on objects. Ways to focus light and image objects beyond the diffraction limit will be presented. 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.

Pre-requisites:

OPTI 501: Electromagnetic waves.
Please contact the instructor if you do not meet the pre-requisites but would still like to take the class.

Number of Units/ component:

3 units / lecture

Locations and Times:

Meinel 305, Tu/Th 2:00 pm – 3:15 pm.

Instructor Information:

Instructor name: Euan McLeod
Office: Meinel 623
Email: euanmc@optics.arizona.edu
Office hours: TBD

Expected Learning Outcomes:

- Conceptually explain and mathematically derive the diffraction limit of light.
- Understand how scattering from small particles depends on particle size and composition.
- Learn schemes to perform fluorescence imaging with resolution beyond the diffraction limit.
- Learn ways to generate light using nanoscale particles.
- Describe how near-field scanning optical microscopes work and their various imaging modalities.
- Explain how both localized surface plasmons and surface plasmon polaritons can be used to concentrate light into nanoscale volumes.
- Explain what optical metamaterials are and how they can be used to image objects with sub-diffraction-limit resolution.
- Be familiar with ways to numerically model light at the nano-scale.
Recommended Texts:

The following books are recommended as references, but are not required. If you were to choose one book that best covered the course material, it would be *Principles of Nano-Optics*. Note that as this is a rapidly-evolving field, there are some significant differences between the 1st and 2nd editions of this book.


Tentative List of Topics:

- What is nanophotonics?
- Resolution, sensitivity, and localization
- Physical and mathematical foundations of the diffraction limit
- Evanescent fields
- Scattering of light by nanoparticles
- Optical manipulation of nanoparticles
- Fluorescent imaging of nanoparticles, including STED / PALM / STORM
- Nanoscale waveguides
- Optical microresonators for nano-sensing, including photonic crystals
- Light-generating nanostructures (quantum dots, etc.)
- Transmission of light though nanoscale holes
- Near-field scanning optical microscopy
- Localized surface plasmons
- Surface plasmon polaritons
- Optical metamaterials for superlenses
- Metasurfaces
- Numerical simulation approaches

Number of Exams and Papers:

There will be one midterm exam and one final exam. Short quizzes will occur periodically, most likely run through the web to accommodate distance learning students. There will be one project, due toward the end of the semester, but before the start of Finals. Project details will be explained during the course. Homeworks will be assigned approximately every two weeks. The quiz and homework periods are tentative and may be changed before or during the course, but ample advance warning will be given.
Course Policies:

Grading Policy

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Homework</td>
<td>15%</td>
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<tr>
<td>Quizzes</td>
<td>10%</td>
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<tr>
<td>Project</td>
<td>15%</td>
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<tr>
<td>Midterm</td>
<td>30%</td>
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<tr>
<td>Final Exam</td>
<td>30%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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The final grade will be determined according to a curve, with breaks between letter grades determined at the instructor’s discretion, and grades will not necessarily align with the traditional percentages for A, B, C, etc.

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.

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.
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.

Students with Disabilities

If a student is registered with the Disability Resource Center, he/she must submit appropriate documentation to the instructor if he/she is requesting reasonable accommodations. (http://drc.arizona.edu/instructor/syllabus-statement.shtml).

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.