UNIVERSITY OF CENTRAL FLORIDA

OSE 6650 - Optical Properties of Nanostructured Materials

Section: 0001

Optics and Photonics

Course Information

Term: Spring 2025
Class Meeting Days: TR
Class Meeting Time: 10:30AM - 11:45AM
Class Meeting Location: CROL A214
Modality: P
Credit Hours: 3.00

Combined Section Information

This syllabus applies to sections OSE 6650 0001, OSE 6650 0V02.

Instructor Information

Pieter Kik
Office Location: CREOL A220
Office Hours:
T/R 12pm-1pm
Email: kik@ucf.edu

Course Description

OSE 6650 OPT-OPT 3(3,0)Optical Properties of Nanostructured Materials:PR: Graduate standing OSE 6111, OSE 5312, or C.I. Theory and application of nanostructured optical

materials: Effective medium theory, nanostructured surfaces, plasmon waveguides, nanophotonic circuits, metallic near-field lenses, collective modes in nanoparticle arrays, metamaterials. Spring.

This course covers topics dealing with the optical properties of nanostructured materials. In the first part of the course we will discuss effective medium theory, including the Maxwell-Garnett description of the refractive index of inhomogeneous materials. We will cover applications of nanostructured dielectrics, including metasurfaces and metalenses based on propagation phase and geometric phase. The second part of the course deals with the optical properties of nanostructured metallo-dielectric materials. We will introduce the concept of localized surface plasmons (LSPs) on metal nanoparticles, and discuss spectral control of the plasmon resonance frequency by tuning shape, size, and dielectric environment. This is followed by applications of LSPs, including surface enhanced Raman scattering (SERS) and index-based biosensing. The third part of the course covers electromagnetic surface waves known as surface plasmon polaritons (SPPs), and discusses the use of surface plasmon resonance (SPR) for biodetection. Finally, we briefly discuss the concept of metamaterials: composite materials that have been nanostructured to obtain a specific dielectric response. We will discuss how this can give rise to negative refraction, and we will discuss an early experimental realization of this concept.

The course concludes with a substantial hands-on simulation component with industrial level electromagnetics design software. Students choose a nanophotonic structure related to one of the topics covered in class, and investigate its optical response numerically. This allows direct visualization of several concepts covered early in the course.

Student Learning Outcomes

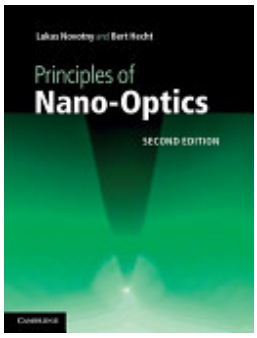
After successful completion of this course, students will have a basic understanding of plasmonics, nanophotonics, and metamaterials. The students will be able to use the knowledge gained in this course to numerically simulate nanophotonic elements, which will enable them to further their research and enhance existing technologies.

Course Materials and Resources

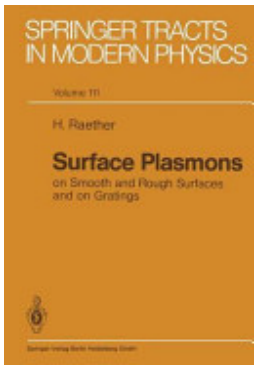
OSE6650 Slides
Authors: P. G. Kik
Online Access: Webcourses > Files > Slides

Recommended Course Materials

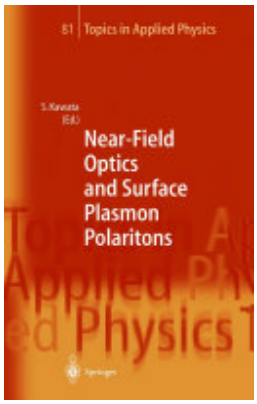
Title: Plasmonics: Fundamentals and Applications
ISBN: 9780387378251
Authors: Stefan Alexander Maier
Publisher: Springer Science & Business Media
Publication Date: 2007-05-16



Title: Principles of Nano-Optics
ISBN: 9781139560450
Authors: Lukas Novotny, Bert Hecht
Publisher: Cambridge University Press
Publication Date: 2012-09-06



Title: Surface Plasmons on Smooth and Rough Surfaces and on Gratings
ISBN: 9783662151242
Authors: Heinz Raether
Publisher: Springer
Publication Date: 2013-10-03



Title: Near-Field Optics and Surface Plasmon Polaritons
ISBN: 9783540445524
Authors: Satoshi Kawata
Publisher: Springer Science & Business Media
Publication Date: 2003-07-01

Course Assessment and Grading Procedure

Students will carry out weekly simulations in CST Studio, based on provided templates or structure descriptions. Students will be asked to describe various observations made in the simulations. At the end of the semester, students will be sufficiently familiar with the simulation software to design and evaluate their own nanophotonic element / system. The results of this individual project will be submitted in the form of a final report, which takes the place of the final exam.

After about three months each student will choose a nanophotonics-related recent scientific publication to present in a short (12 minute) PowerPoint presentation to demonstrate understanding of the core concepts. The presentation grade will depend on effort, understanding, clarity, enthusiasm, critical thinking, and timing.

Simulation assignments and the final project report must be submitted on Webcourses as a PDF attachment by the submission deadline. The annotated graded homework PDF will be uploaded as an attachment to the homework submission.

Grading Scale

Letter Grade	Cutoff
A	94%
A-	90%
B+	87%
B	84%
B-	80%

Letter Grade	Cutoff
C+	77%
C	74%
C-	70%
D+	67%
D	64%
D-	61%
F	0%

Policies for Course Grade

Makeup Work Policy

If an emergency arises and a student cannot take an exam on the scheduled date, the student must give notification to the instructor no less than 24 hours before the scheduled time. The instructor will specify a new date for taking the exam. Any illness will be considered a medical
emergency only if an official Doctor’s note confirming the illness is submitted to the CREOL Graduate Office.

Missed/Late Assignments

Missed or Late assignments without prior consent from the instructor will not receive credit. An extension of the submission deadline may be granted at the discretion of the instructor if the following criteria are met:
- The extension request was sent before the original submission deadline.
- The student provided a plausible excuse for the delayed submission.
- The student provided a reasonable updated submission deadline.

Grade Objections

All objections to grades should be made in writing within one week of the work in question. Objections made after this period has elapsed will not be considered.

Course Accessibility

The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need access to course content due to course design limitations should contact the professor as soon as possible. Students should also connect with Student Accessibility Services (SAS) (Ferrell Commons 185, sas@ucf.edu, phone 407-823-2371). For students connected with SAS, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential course access and accommodations that might be necessary and reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SAS, faculty and the student may be warranted to ensure an accessible course experience.

Academic Integrity

Students should familiarize themselves with UCF's Code of Conduct at Student Conduct and Integrity Office. According to Section 1, "Academic Misconduct," students are prohibited from engaging in:

a. Academic misconduct is defined as any submitted work or behavior that obstructs the instructor of record's ability to accurately assess the student's understanding or completion of the course materials or degree requirements (e.g., assignment, quiz, and/or exam). Examples of academic misconduct include but are not limited to: plagiarism, unauthorized assistance to complete an academic exercise; unauthorized communication with others during an examination, course assignment, or project; falsifying or misrepresenting academic work; providing misleading information to create a personal advantage to complete course/degree requirements; or multiple submission(s) of academic work without permission of the instructor of record.

b. Any student who knowingly helps another violate academic behavior standards is also in violation of the standards.

c. Commercial Use of Academic Material. Selling of course material to another person and/or uploading course material to a third-party vendor without authorization or without the express written permission of the University and the instructor of record. Course materials include but are not limited to class notes, the instructor of record's

slide deck, tests, quizzes, labs, instruction sheets, homework, study guides, and handouts.

d. Soliciting assistance with academic coursework and/or degree requirements. The solicitation of assistance with an assignment, lab, quiz, test, paper, etc., without authorization of the instructor of record or designee is prohibited. This includes but is not limited to asking for answers to a quiz, trading answers, or offering to pay another to complete an assignment. It is considered Academic Misconduct to solicit assistance with academic coursework and/or degree requirements, even if the solicitation did not yield actual assistance (for example, if there was no response to the solicitation).

Responses to Academic Dishonesty, Plagiarism, or Cheating

Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule*. UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and respond to academic misconduct when necessary. Penalties for violating rules, policies, and instructions within this course can range from a zero on the exercise to an "F" letter grade in the course. In addition, an Academic Misconduct report could be filed with the Office of Student Conduct and Academic Integrity, which could lead to disciplinary warning, disciplinary probation, or deferred suspension or separation from the University through suspension, dismissal, or expulsion with the addition of a "Z" designation on one's transcript.

Being found in violation of academic conduct standards could result in a student having to disclose such behavior on a graduate school application, being removed from a leadership position within a student organization, the recipient of scholarships, participation in University activities such as study abroad, internships, etc.

Let's avoid all of this by demonstrating values of honesty, trust, and integrity. No grade is worth compromising your integrity and moving your moral compass. Stay true to doing the right thing: take the zero, not a shortcut.

Title IX

Title IX prohibits sex discrimination, including sexual misconduct, sexual violence, sexual harassment, and retaliation. If you or someone you know has been harassed or

assaulted, you can find resources available to support the victim, including confidential resources and information concerning reporting options at Let's Be Clear and UCF Cares.

For more information on diversity and inclusion, Title IX, accessibility, or UCF's complaint processes contact:

- Title IX – OIE – Office of Institutional Equity & askanadvocate@ucf.edu
- Disability Accommodation – Student Accessibility Services – Student Accessibility Services & sas@ucf.edu
- Access and Community Engagement (including the Ginsberg Center for Inclusion and Community Engagement, Military and Veteran Student Success, and HSI Initiatives)
- UCF Compliance and Ethics Office – Compliance, Ethics, and Risk Office & complianceandethics@ucf.edu
- The Ombuds Office is a safe place to discuss concerns.

Reporting an Incident or Issue

If you believe you have experienced abusive or discriminatory behavior by any faculty or staff member, contact the Office of Institutional Equity online or at 407-823-1336. You can also choose to report using the UCF Integrity Line and can report anonymously or as yourself at 1-855-877-6049 or using the online form. UCF cares about you and takes every report seriously. For more information see the Reporting an Incident or Issue Webpage.

Deployed Active-Duty Military Students

Students who are deployed active duty military and/or National Guard personnel and require accommodation should contact their instructors as soon as possible after the semester begins and/or after they receive notification of deployment to make related arrangements.

Campus Safety

At UCF Public Safety and Police, safety is the top priority. Emergencies on campus are rare, but if one should arise, it's important to be familiar with some basic safety and security concepts.

- In an emergency, always dial 911.
- Every UCF classroom has an **Emergency Procedure Guide** posted on a wall near the door, which will show you how to respond to a variety of situations. This guide can also be found online here.
- In the event of an active threat, remember **AVOID, DENY, DEFEND**. Choose the best course of action and act immediately. Watch the video here to learn more.
    - **AVOID**. Pay attention to your surroundings and have an exit plan. Get as much distance and as many barriers between you and the threat as quickly as possible.
    - **DENY.** When avoiding is difficult or impossible, deny the threat access to you and your space. Lockdown by creating barriers, turning the lights off and remaining quiet and out of sight. Make sure your cell phone is silenced, but do not turn it off.
    - **DEFEND.** When you are unable to put distance between yourself and the threat, be prepared to protect yourself. Commit to your actions, be aggressive and do not fight fairly. Do whatever it takes to survive.
- For emergencies on campus, UCF will utilize the UCF Alert system. All UCF students, faculty and staff are automatically enrolled to receive these email and text alerts, however, it's a good idea to frequently ensure your contact information is up to date.

Financial Aid Accountability

All instructors/faculty are required to document students' academic activity at the beginning of each course. In order to document that you began this course, please complete this activity by the end of the first week of classes or as soon as possible after adding the course. Failure to do so may result in a delay in the disbursement of your financial aid.

Class Schedule

Topic No.	Topic
1	Effective medium theory
2	Metasurfaces and metalenses
3	Metasurfaces optics using geometric phase
4	Near-fields and Near-field Microscopy
5	Localized surface plasmon resonances on metallic nanospheres
6	LSP resonances - effect of particle size and host index
7	Effect of radial composition - biodetection using selective binding
8	SPPs on planar metal films - dispersion + prism coupling
9	Near-field and grating based SPP excitation
10	SPPs beyond single planar interfaces
11	Surface Enhanced Raman Scattering (SERS)
12	Negative index materials
13	Photonic bandgap materials