ECE 564 Modern Light Microscopy (Syllabus)

Instructor: Prof. Yun-Sheng Chen
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Instructor Office Hours: Thursday, 11:00 am – 12:00 pm or by personal appointment
Lecture: Tuesdays & Thursdays, 9:30 – 10:50 am, 3015 ECEB
Credit: 4 hours
Pre-Requisites: One of ECE 460, MSE 405, PHYS 402
Course Website: https://courses.engr.illinois.edu/ece564
https://yschenlab.web.illinois.edu/?page_id=583
Course Objective: To introduce current research topics in modern light microscopy: optics principles (statistical optics, Gaussian optics, elastic light scattering, dynamic light scattering); traditional microscopy (bright field, dark field, DIC, phase contrast, confocal, epi-fluorescence, confocal fluorescence); current research topics (multiphoton, CARS, STED, FRET, FIONA, STORM, PALM, quantitative phase).

Instructor Teaching & Learning Philosophy:
I believe and teach that technology is becoming increasingly interdisciplinary, particularly between engineering, medicine, and biology. Your ability to learn and integrate ideas and concepts from multiple disciplines will enable you to investigate and solve many of the new engineering problems we will face in the future. I value three things in students and colleagues: hard work, productivity, and creativity. To be successful in my course and in life, you must demonstrate that you possess one or more of these three values.

Course materials:
Course slides and reading material will be distributed weekly.
Classroom lectures will emphasize the main points in the material and allow for discussion. I expect you to read the assigned chapters from the reading materials but focus on the concepts presented in the lecture. Homework and exams will be structured with the assumption that you have read all of the assigned text and handout material.

Recommended Textbooks:
- "Introduction to optical microscopy" by J. Mertz (Roberts and Company, 2010)
- "Quantitative phase imaging of cells and tissues" by G. Popescu (McGraw-Hill, 2011)

Other Suggested References:
- "The Fourier integral and its applications" by A. Papoulis (McGraw-Hill, New York, 1962).
- "The Fourier transform and its applications" by R. N. Bracewell (McGraw Hill, Boston, 2000).
- "Introduction to Fourier optics" by J. W. Goodman (McGraw-Hill, New York, 1996).
- "Principles of optics: electromagnetic theory of propagation, interference and diffraction of light" by M. Born and E. Wolf (Cambridge University Press, Cambridge; New York, 1999).
- "Light Scattering by Small Particles" by H. C. van de Hulst (Dover Publications New York, 1981).
- "Electromagnetic wave propagation, radiation, and scattering" by A. Ishimaru (Prentice Hall, Englewood Cliffs, N.J., 1991).
- "Dynamic Light Scattering : With Applications to Chemistry, Biology, and Phys." by B. J. Berne and R. Pecora (Dover Publications; Unabridged edition (August 14, 2000) 2000).
- "Optical waves in crystals" by Yariv, Amnon, and Pochi Yeh. (Vol. 5. New York: Wiley, 1984.)

- "Nonlinear optics; a lecture note and reprint volume" by N. Bloembergen (W.A. Benjamin, New York,, 1965).
- "Nonlinear optics" by R. W. Boyd (Academic Press, Amsterdam ; Boston, 2008).
- "The principles of nonlinear optics" by Y. R. Shen (J. Wiley, New York, 1984).
- "Handbook of biomedical nonlinear optical microscopy" by B. R. Masters and P. T. C. So (Oxford University Press, New York, 2008).

Exams:
One midterm will be given in class. You will be allowed to have one equation sheet (front and back) for the exam.

An excuse from the Dean's office is the only acceptable excuse for missing an exam.

Homework:
There will be two graded homework sets for this course. Homework assignments will be distributed approximately 1 week before they are due. Solutions will be posted on the course website. Late homework will be accepted, but 10% will be deducted for each day it is late.

Problem-Based Learning Report:
A Problem-Based Learning Report will be due on the final class day. This report should provide a detailed overview and resolution to questions related to light microscopy. Students are encouraged to consult with Prof. Chen in advance regarding their chosen questions and modalities. They should then utilize their acquired knowledge to propose technically sound solutions that further microscopy advancements. Additionally, one class session has been designated for workshops to assist in crafting these reports.

Journal Article Review:
Each student is expected to present a journal article relating to the course topics, aligned with the lecture sequence throughout the semester. Articles must be pre-approved by Prof. Chen to ensure they focus on key topic areas. Before each presentation, the chosen article will be shared with the class. All students are required to read and be prepared to engage in the subsequent discussion. Presentation format and duration will be discussed in class. Additionally, one session will be dedicated to honing critical reading skills and mastering techniques for scientific presentations. Grading will consider the quality of the presentation, comprehension of the material, and the presenter's ability to facilitate class discussion.

Grading:
Your final grade in this course will be based on your total score on all the components of the course. The total score is broken down into the following components:

Midterm	30%
Final report	25%
Final presentation	15%
Homework	20%
Participation	10%
Total	**100%**

Class Calendar:
See course website

Absences and Excused Grades:

There is no way to make up a missed semester exam. An unexcused absence from a semester exam will be assigned a zero grade. An excused absence requires a letter from the Dean's office. An excused absence from a semester exam will receive an EX grade. At the end of the semester, the EX grade will be replaced with the average of your grades on the other exams and the final.

Grade Disputes:
Grade disputes on homework will be settled at the discretion of the TA. Grade disputes on the semester exams will be settled at the discretion of Prof. Chen. In both cases, the problem in question will be RE-GRADED, making it possible for you to receive a lower score. To dispute an exam grade, you must explain your dispute IN WRITING and staple this to the front of your exam. Prof. Chen will then re-grade your exam.