

BME333 Modern Optical Microscopy and Imaging – Fall 2024

Time: Tuesday & Thursday 9:30-10:50 AM
Room: Tech LG62

Instructor: Dr. Hao F. Zhang
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Office hours: Tuesday & Thursday, 11:00 AM -12:00 PM or by appointment

Co-instructor: Biological Imaging Facility Director, Dr. Tong Zhang
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Office hours: By appointment

Textbook: *Fundamentals of Light Microscopy and Electronic Imaging*, Douglas B. Murphy, Wiley-Liss, ISBN: 0-471-25391-X

References: *Biomedical Optics: Principles and Imaging*, Lihong V. Wang and Hsin-i Wu, Wiley Interscience, 1st Edition, ISBN: 0471743046
Biomedical Photonics Handbook, Tuan Vo-Dinh, CRC Press, ISBN: 0849311160
Tissue Optics, Valery Tuchin, SPIE Press, 2nd Edition, ISBN: 0819464333
Optics, Eugene Hecht, Addison-Wesley, 4th Edition, ISBN: 0805385665
Handbook of Biological Confocal Microscopy, James B. Pawley, 3rd Edition, Springer, ISBN: 0-387-25921-X

Prerequisite: Physics, Calculus, Statistics, and Differential Equations (PHYSICS 135-2; GEN_ENG 205-4, BMD_ENG 220 or IEMS 303.)

Course Objectives: Bio-optical imaging has played a critical role in almost all significant breakthroughs in recent biomedical research. Knowledge of current bio-optical imaging technologies is essential for students planning future careers or graduate studies in biomedicine-related fields. This course provides students with (1) a fundamental background in tissue optics; (2) an understanding of physics, strengths, and limitations of various existing bio-optical imaging technologies; (3) knowledge of emerging bio-optical imaging technologies for anatomic and functional studies; (4) problem-solving skill when facing a specific biomedical challenge; (5) Python program practice for scientific computation.

Topics

Introduction to optics, optical properties of tissue, and photon-tissue interactions
Monte Carlo simulation (Multistage research project)
Sensing of optical properties and spectroscopy
Ballistic imaging

Wide-field and dark-field microscopy (Lab at BIF, Evanston)

Polarization, phase contrast, and differential interference contrast microscopy (Lab at BIF, Evanston)

Fluorescence microscopy (Demo/lab at BIF, Evanston)

Confocal microscopy

Two-photon microscopy

Optical coherence tomography

Super-resolution imaging (Demo/lab at Nikon Imaging Center, Chicago)

Special note related to COVID: BME 333 has significant and exciting (fun) lab components. Some students may be unable to attend some lectures and/or labs, so please work with Prof. Zhang to find an optimal solution.

Grading

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|-----------------------------|------|
| Midterm/Monte Carlo Project | 30% |
| Homework | 30% |
| Lab | 30% |
| Final presentation/report | 10% |
| Total | 100% |

Note: Homework is due one week after the initial assignment (may be extended for a second week depending on the performance of most of the class or specified otherwise). There will be a penalty for missing classes without prior permission. Research project requirements will be discussed in class.

It is difficult to find a single textbook covering all the course topics. Accordingly, as needed, we will draw upon other references (book chapters, research articles, etc.) and internet resources.

The current schedule is subject to minor revisions as the quarter proceeds.

The skill of searching and retrieving scientific literature from databases, such as PubMed, is required.

Homework and research projects involve Python programming.

If unanticipated conflicts arise, the student should contact the instructor at least two weeks in advance to discuss arrangements for make-up examinations or turning in project/homework late.

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability –and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class.

Any student requesting accommodations related to a disability or other condition is required to register with ANU (accessiblenu@northwestern.edu; 847-467-5530) and provide professors with an accommodation notification from AccessibleNU, preferably within the first two weeks of class. All information will remain confidential.

Zero tolerance for academic plagiarism and dishonesty