

BE773/EC773: ADVANCED OPTICAL MICROSCOPY

Spring 2008

T-Th 4-6pm

Room: TBA

Prof. Jerome Mertz (jmertz@bu.edu)
Room 202, 24 Cummington St.

Office hours: M4-5pm, or by appointment

Required textbook: "Introduction to Optical Microscopy" by Jerome Mertz
Recommended textbook: "Introduction to Fourier Optics" by Joseph Goodman

The following is an approximate course syllabus:

- Lecture 1: Introduction**
(ray tracing)
- Lecture 2: Monochromatic field propagation**
(Rayleigh-Sommerfeld, Fresnel, Fraunhofer)
- Lecture 3: Field propagation through lens**
(coherent spread function, bandwidth, resolution)
- Lecture 4: Intensity and coherence propagation**
(Zernike-van Cittert, point spread function)
- Lecture 5: 3D imaging**
(defocus, 3D optical transfer function, optical sectioning)
- Lecture 6: Detector noise**
(shot noise, thermal noise, electron gain)
- Lecture 7: Scattering and absorption**
(Born approximation, Rayleigh-Debye)
- Lecture 8: Homework review**
- Lecture 9: Phase contrast I**
(Zernike PC, oblique field)
- Lecture 10: Phase contrast II**
(differential interference contrast)
- Lecture 11: Digital holography**
(phase stepping, off-axis, numerical focusing)
- Lecture 12: Optical coherence tomography I**
(time domain, Doppler)
- Lecture 13: Optical coherence tomography II**
(frequency domain)
- Lecture 14: Fluorescence I**
(lifetime imaging)
- Lecture 15: Fluorescence II**
(fluorescence correlation spectroscopy)
- Lecture 16: Homework review**
- Lecture 17: Confocal microscopy**
(fluorescence; optical sectioning)
- Lecture 18: Two photon microscopy**
(probe volume, tissue imaging)

- Lecture 19: Coherent nonlinear microscopy I**
(second harmonic generation)
- Lecture 20: Coherent nonlinear microscopy II**
(THG, CARS)
- Lecture 21: Structured illumination microscopy**
(coherent, incoherent)
- Lecture 22: Superresolution I**
(synthetic aperture, nonlinear)
- Lecture 23: Superresolution II**
(STED, PALM)
- Lecture 24: Homework review**

Remaining lectures reserved for student reports.

As part of the requirements for this course, every student will be asked to provide lecture notes for at least two lectures. These will be made available to the class at most 3 days after the lectures. Instead of a final exam, every student will be asked to present a report on a recent publication (chosen by the student), both written and oral. Homework is due one week after it is assigned. Late homework will incur a 10% grade deduction per day late. Homework more than one week late will not be accepted. There will be no midterm exam.

Grading will be based on homework (50%), the final report (25%), class participation (15%), and lecture notes (10%).