BE773/EC773: ADVANCED OPTICAL MICROSCOPY

Fall 2014  M-W 4-6pm  Room: TBA

Prof. Jerome Mertz (jmertz@bu.edu)  Office hours: Tues 4-5pm, or by appointment
Room 202, 24 Cummington St.

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:  Propagation through lens
(coherent spread function, point spread function, resolution)
Lecture 4:  3D imaging
(defocus, 3D optical transfer function, optical sectioning)
Lecture 5:  Detector noise
(shot noise, thermal noise, electron gain)
Lecture 6:  Scattering and absorption
(Born approximation, Rayleigh-Debye)
Lecture 7:  Homework review
Lecture 8:  Phase contrast I
(Zernike PC, oblique field)
Lecture 9:  Phase contrast II
(differential interference contrast)
Lecture 10:  Digital holography
(phase stepping, off-axis, numerical focusing)
Lecture 11:  Optical coherence tomography I
(time domain, Doppler)
Lecture 12:  Optical coherence tomography II
(frequency domain)
Lecture 13:  Fluorescence I
(lifetime imaging)
Lecture 14:  Fluorescence II
(flourescence correlation spectroscopy)
Lecture 15:  Homework review
Lecture 16:  Confocal microscopy
(flourescence; optical sectioning)
Lecture 17:  Two photon microscopy
(probe volume, tissue imaging)
Lecture 18:  Coherent nonlinear microscopy I
(second harmonic generation)
Lecture 19: Coherent nonlinear microscopy II  
(THG, CARS)

Lecture 20: Structured illumination microscopy  
(coherent, incoherent)

Lecture 21: Superresolution I  
(synthetic aperture, nonlinear)

Lecture 22: Superresolution II  
(STED, PALM)

Lecture 23: Homework review

Remaining lectures: Projects

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 2 days after the lectures. Instead of a final exam, every student will be asked to provide an oral presentation on a recent publication (chosen by the student). Homework is assigned on Wednesdays and due the following Mondays. Late homework will incur a 5% 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 (60%), the final report (20%), class participation (10%), and lecture notes (10%).