

Optics and Imaging in Modern Microscopy

#

Course at glance

There have recently been great advances in instruments and techniques for microscopy, especially for biological and medical research and diagnostics. The course reviews the basic optical and imaging principles that form the basis of modern microscopy. Different microscopy modalities are introduced, including those based on fluorescence, and also label-free methods based on phase, polarization or non-linear optical properties.

#

Instructor

Colin Sheppard colin.sheppard@iit.it

Tel: +39 010 71 781 804

Nanophysics, Istituto Italiano di Tecnologia

#

Credits: 3

#

Synopsis

This course introduces the optics necessary to investigate the common properties of imaging systems, including the physical principles, hardware and algorithms. Applications in the biomedical area are stressed, but other applications range from remote sensing, geophysical imaging, nondestructive testing and machine vision.

#

Syllabus

The Course develops in about 9/10 hours in the classroom.

Diffraction and focusing; effects of numerical aperture, polarization and Fresnel number. Microscopy concepts. Coherent and incoherent imaging; transfer functions, Abbe imaging theory, illumination system, imaging performance, microscope objectives, partially-coherent imaging. The generalized microscope. Phase contrast; defocus, dark field, Zernike phase contrast, differential phase contrast. Polarization imaging. Confocal microscopy and imaging; principles and instruments. surface profiling. image formation in the confocal microscope. Fluorescence microscopy; detectors, signal, signal-to-noise ratio, comparative performance of imaging systems. Superresolution in microscopy. Advances in pupil filters. Three-D imaging; 3D transfer functions, holography and tomography. Three-dimensional imaging techniques; interference microscopy and OCT, multiphoton imaging, fringe projection. Image modeling and reconstruction; tomography, Born and Kirchhoff approximations.

#

The examination consists in a journal club based on a selected list of papers provided to the students

#

Reading list

Please refer to the Educational Program Section of the NIC@IIT - <http://www.nic.iit.it/education-program-training/>
Notes by Colin Sheppard will be available at the Course

Specific textbooks for this Course are:

- E. Hecht, Optics, Addison Wesley (2002)
- A. Diaspro (ed.), Confocal and Two-Photon Microscopy: Foundations, Applications and Advances, Wiley (2001)
- J. Pawley (ed.) Handbook of Confocal Microscopy, Springer (2006)
- C.J.R. Sheppard and D. Shotton, Confocal Laser Scanning Microscopy, Garland Science (1997)

Venue

IIT - Via Morego, 30 16163 Genova

Course date

March 2015