Summary
Introduction to the different contrast enhancing methods in optical microscopy. Basic hands-on experience with optical microscopes at EPFL's BioImaging and Optics Facility. How to investigate biological samples? How to obtain high quality images?

Content
The course combines theory with hands-on experience to teach the basic principles of commonly used optical microscopy techniques including bright-field, dark-field, phase-contrast, DIC, polarization, fluorescence as well as introduce advanced techniques such as confocal, multi-photon, and super-resolution microscopy. The course also provides hands-on experience with wide field and confocal microscopes.

Keywords
Optical microscopy and tomography, fluorescence spectroscopy, aberrations.

Learning Prerequisites
Required courses
Advanced optics (MT) or Biomicroscopy I (SV).

Recommended courses
Analysis IV, Linear algebra, General physics III/IV.

Important concepts to start the course
Basic matrix calculations, Fourier transformation, electromagnetic waves, wide field and confocal microscopy.

Learning Outcomes
By the end of the course, the student must be able to:
• Choose an appropriate imaging method for investigating the biological sample of interest.
• Estimate the performance and limitations of optical microscopes.
• Sketch the essential elements of optical microscopes.
• Operate wide field and confocal microscopes.
• Assess / Evaluate the operation principles of commonly used microscopy methods

Transversal skills
• Use a work methodology appropriate to the task.
• Communicate effectively with professionals from other disciplines.
• Continue to work through difficulties or initial failure to find optimal solutions.

Teaching methods
Lecturing with exercises (50%) and practice in the microscopy facility (50%).

Expected student activities
Following the lecturing and solving the exercises regularly is necessary for mastering the course contents. The solutions of the exercises are distributed at the next lecture. The student is invited to find his/her own solutions and to discuss them with the assistants. An active participation in the laboratory leads to the mastering of different microscopes.

Assessment methods
20% Homework, individual
• In the second half of the semester: 3 homeworks on computer (2 weeks)

80% End-term exam, individual
• written exam with handwritten notes during the exam period

Supervision
Office hours No
Assistants Yes
Forum Yes
Others Possible to take dates.

Resources
Bibliography
• Geometrical and matrix optics: José-Philippe Pérez, Optique: fondements et applications (2004).
• Eugene Hecht, Optics (2002).
• Miles V. Klein and Thomas E. Furtak, Optics (1986).
• Confocal microscopy: Min Gu, Principles of three-dimensional imaging in confocal microscopes (1996).


Notes/Handbook
The course slides are published on Moodle.

Websites
- https://micro.magnet.fsu.edu/primer/
- https://microscopyfocus.com/
- https://focalplane.biologists.com/network/

Moodle Link
- https://go.epfl.ch/MICRO-562