



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Microscopia Ottica

2021-1-F1701Q127

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#### Aims

To offer an introduction to optics applied to the development of optical devices for the research and development in Biophysics, Biotechnology, Medicine and Biophotonics.

#### Contents

Geometrical Optics: lenses, mirrors and compositions of lenses and stops.

Physical Optics: Fresnel Theorem and its applications.

Aberrations of optical devices

Scanning Optical Microscopies.

#### Detailed program

- Electromagnetic energy, intensity with lasers in continuous and pulsed emission mode.
- Fresnel coefficients for reflection and refraction: phenomenology; the retarder plates.
- Introduction to "Fresnel Coefficients and Maxwell equations".

- Law of the prism in minimal deviation (geometrical and physical optics treatment), relation with the thin lens.
- The law of focal lengths for thin lenses. Composition of thin lenses.
- The matrix method for lenses and mirrors and its applications to optical instruments.
- Thick lens. Principal planes and the focal length. Magnification of an optical system.
- Principal aberrations of lens systems: phenomenology and Seidel treatment.
- Aberration correction.
- Introduction to Physical Optics, Huygens-Fresnel principle and Fresnel Integral.
- Applications of the Fresnel integral: Fresnel zones, Gaussian beam propagation.
- Applications of the Fresnel theorem: Fourier optics and spatial filtering.
- Optical fibers: geometric and physical optics treatment.
- Optical resolution
- Optical Microscopy techniques (Confocal Microscopy, Multi-photon Microscopy, Second Harmonic Generation Microscopy, Brighfield and darkfield, Coherent Anti-Stokes Raman Microscopy).

## **Prerequisites**

Knowledge of electromagnetic waves and of the mathematical treatment of the wave equation.

Knowledge of the fundamentals of the light-matter interactions modes.

Skills: solution of partial derivatives equations; trigonometry.

## **Teaching form**

Lectures with slides in power point, Java simulations for ray-tracing and computation of the optical response

Discussion of problems.

Assignment of home exercises

Reading and discussion of research papers.

During the Covid-19 emergency period, the course will be held only online by means of synchronous video-taped lessons. Virtual meetings will be held weekly to answer possible questions from the students.

## **Textbook and teaching resource**

Copy of the slides discussed during the lectures loaded on the e-learning platform.

Indication of the web sites with information on specific applications and Java simulations.

Books:

- "Optics". Klein
- "Optics". Hecht
  
- "Introduction to optical microscopy". Mertz
- "Introduction to Fourier Optics". Goodman

## **Semester**

Second semester of the Master Degree

## **Assessment method**

Oral exam on:

1. basic principles of the construction of an optical device and its discussion based on the matrix method;
2. basic principles of Fourier Optics;
3. resolution of an optical device in wide field and in scanning modes;
4. discussion of a preassigned research paper.

During the Covid-19 emergency period, oral exams will be held only online. They will be carried out using the WebEx or Google Meet platforms and a public link will be published on the course e-learning page for virtual access to the examination of interested students.

### **Office hours**

Usually the teacher is always available for reception, however the presence is guaranteed only if previously arranged, either in classroom or by e-mail.

During the Covid-19 emergency period, an online reception slot will be determined, after previous arrangements with the teacher by e-mail.

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