UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Optical Microscopy

2223-1-F1701Q127

Aims

To offer an introduction to optics applied to the development of optical devices for the research and development in Biophysics, Biotechnology, Mdicine 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 (geometical 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 excercises

Reading and discussion of research papers.

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 princpiles of Fourier Optics;

3. resolution of an optical device in wide field and in scanning modes;

4. discussion of a research paper (with an optional slide presentation), related to topics not covered during frontal lessons.

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.

Sustainable Development Goals

QUALITY EDUCATION | GENDER EQUALITY | DECENT WORK AND ECONOMIC GROWTH | INDUSTRY, INNOVATION AND INFRASTRUCTURE | PARTNERSHIPS FOR THE GOALS