MICRO-421 **Computational optical imaging**

Psaltis Demetri

Cursus	Sem.	Type
Electrical and Electronical Engineering	MA2, MA4	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Mechanical engineering	MA2, MA4	Opt.
Microengineering minor	E	Opt.
Microtechnics	MA2, MA4	Opt.
Minor in Imaging	E	Opt.
Photonics minor	E	Opt.
Photonics		Opt.

Language of teaching	English
Credits	4
Withdrawal	Unauthorized
Session	Summer
Semester	Spring
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	3 weekly
Exercises	1 weekly
Number of positions	

Il n'est pas autorisé de se retirer de cette matière après le délai d'inscription.

Summary

Modern imaging systems combine traditional optical devices (lenses, endoscopes, cameras, laser scanners, etc) with digital computers. In this course we learn how to use computational tools to simulate the optical system and combine them with neural networks that process the optical images

Content

1. Optical wave propagation

- **mIngenierie Optique or any Bachelor level optics course**Free space propagation
- Beam propagation method
- Thin transparencies-Lenses and gratings
- Imaging
- Digital Holography
- Computer Generated Holograms

2. Multi-layer networks
3. Microscopy

- DNN - Unet superresolution
- DNN - Unet digital staining
- DNN - Phase from Intensity

4. Scattering media

- Phase conjugation
- Matrix method
- DNN for focusing and imaging through MMFs
- Ptychography

5. Inverse scattering

- Optical diffraction tomography
- Inverst scattering-MaxwellNet

Keywords

Optical imaging, optical instruments, optical design, performance analyis, aberrations, resolution and contrast, microscopy

Learning Prerequisites

Required courses

"MICRO-321 Ingenierie Optique" or any Bachelor level optics course

Recommended courses

"MICRO-321 Ingenierie Optique" or any Bachelor level optics course

Important concepts to start the course

Matrix calculations, Fourier transformation, Electromagnetic waves, refraction and reflection, polarization, signal filtering, basics of geometrical optics

Learning Outcomes

By the end of the course, the student must be able to:

- Sketch optical systems
- Estimate performance of optical systems
- Analyze imaging systems and the image quality
- Compute Digital twin

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Communicate effectively with professionals from other disciplines.
- Continue to work through difficulties or initial failure to find optimal solutions.

Teaching methods

Lecturing with exercises

Expected student activities

Assessment methods

During semester evaluation with weekly graded in class esxercise and also a final written exam in the last day of class.

Supervision

Office hours	No
Assistant.e.s	Yes
Forum	Yes
Others	Possible to take dates

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

B.A. Saleh and M.C. Teich, Fundamental of photonics (2007)
J.W. Goodman, Introduction to Fourier optics (1996)

Ressources en bibliothèque

- Find the references at the Library

Notes/Handbook

Course material and slides covering geometrical and matrix optics, Fourier optics, microscopy are published on Moodle

Moodle Link

- https://go.epfl.ch/MICRO-421