PHYS-438

# Fundamentals of biomedical imaging

Gruetter Rolf

| Cursus | Sem. | Type |
|---|---|---|
| Bioingénierie | MA2, MA4 | Opt. |
| Génie électrique | | Obl. |
| Ing.-phys | MA2, MA4 | Opt. |
| Mineur en Neuroprosthétiques | E | Opt. |
| Mineur en Neurosciences computationnelles | E | Opt. |
| Mineur en Technologies biomédicales | E | Opt. |
| Photonique | | Obl. |
| Physicien | MA2 | Opt. |
| Sciences du vivant | MA2, MA4 | Opt. |

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|---|---|
| Language | English |
| Credits | 4 |
| Session | Summer |
| Semester | Spring |
| Exam | Written |
| Workload | 120h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Lecture | 2 weekly |
| Exercises | 2 weekly |

## Summary

The goal of this course is to illustrate how modern principles of basic science approaches are integrated into the major biomedical imaging modalities of importance to biology and medicine, with an emphasis on those of interest to in vivo.

## Content

1. Introduction to the course, importance and essential elements of bioimaging - lab visit of CIBM
2. Ultrasound imaging; ionizing radiation and its generation
3. X-ray imaging - when the photon bumps into living tissue, radioprotection primer
4. Computed tomography - From projection to image
5. Emission tomography - what are tracers and how to "trace" them in your body, x-ray detection, scintillation principle
6. Positron emission tomography (PET) - imaging anti-matter annihilation
7. Tracer kinetics - modeling of imaging data
8. Introduction to biological magnetic resonance (MR) - Boltzmann distribution, from spins to magnetization
9. Excitation of spins, Relaxation, the Basis of MR contrast (The Bloch Equations)
10. MR spectroscopy: In vivo Biochemistry, without chemistry ...
11. From Fourier to image: Principles of MR image formation, k-space - echo formation
12. Basic MRI contrast mechanisms, BOLD fMRI, contrast agents
13. Spin gymnastics: Imaging Einstein's random walk - fiber tracking. Overview of imaging modalities treated in this course

## Keywords

Ultrasound
MRI
PET
SPECT
CT
Radioprotection

## Learning Prerequisites

### Recommended courses

General Physics I-III

### Important concepts to start the course

Fourier transformation

## Learning Outcomes

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

- Deduce which imaging technique is appropriate for a given situation.
- Describe their fundamental promises and limitations
- Differentiate the imaging modalities covered in the course.

## Transversal skills

- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Manage priorities.

## Teaching methods

Ex cathedra with experimental demos.

## Expected student activities

strong participation in course and exercices.

## Assessment methods

a written exam

## Supervision

| | |
|---|---|
| Office hours | Yes |
| Assistants | Yes |

## Resources

### Bibliography

"Introduction to biomedical imaging / Andrew Webb". Année:2003. ISBN:0-471-23766-3

### Ressources en bibliothèque

- Introduction to Biomedical Imaging / Webb

### Websites

- http://lifmet.epfl.ch

### Moodle Link

- http://moodle.epfl.ch/course/view.php?id=250

### Videos

- https://www.youtube.com/playlist?list=PLTCZivgYYpFpVnxdGrxcuL5YOvPwespXy