

PHYS-438

**Fundamentals of biomedical imaging**

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Cursus	Sem.	Type
Auditeurs en ligne	E	Opt.
Biomedical technologies minor	E	Opt.
Electrical Engineering		Opt.
Electrical and Electronical Engineering	MA2, MA4	Opt.
Ing.-phys	MA2, MA4	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Minor in Imaging	E	Opt.
Neuro-X minor	E	Opt.
Neuro-X	MA2, MA4	Opt.
Photonics		Opt.
Physicien	MA2, MA4	Opt.
Physics of living systems minor	E	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Lecture	2 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**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.
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- Describe their fundamental promises and limitations
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### 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 exercises

### 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  
Also available as e-book at EPFL library

#### Ressources en bibliothèque

- [Introduction to biomedical imaging / Webb](#)

#### Websites

- <http://lifmet.epfl.ch/>

#### Moodle Link

- <https://go.epfl.ch/PHYS-438>

#### Videos

- [http://provided on moodle](#)