EPFL

PHYS-719

Advanced biomedical imaging methods and instrumentation

Hyacinthe Jean-Noël, Invited lecturers (see below), Just Nathalie

Cursus	Sem.	Type
Electrical Engineering		Opt.
Neuroscience		Opt.
Photonics		Opt.
Physics		Opt.

Language of teaching	English
Credits	4
Session	
Exam	Term paper
Workload	120h
Hours	**55**
Courses	27
Exercises	28
Number of positions	

Frequency

Every year

Remark

Next time: Fall

Summary

The main goal of this course is to give the student a solid introduction into approaches, methods, and instrumentation used in biomedical research. A major focus is on Magnetic Resonance Imaging (MRI) and related methods, but other imaging modalities will be increasingly covered.

Content

The course will cover the following topics by experts of each field:

Introduction (Bloch equations; Components of an MRI systems; Peamplifier, ADC;Longitudinal interference)
MRI basics (Spin-warp imaging, slice selection, EPI;Fourier image reconstruction, zero-filling apodization; -space imaging strategies - what defines contrast;Gibbs ringing and other artefacts)
Hardware of imaging (Gradient coils - eddy currents; Shimming: Theory of coil design, spherical harmonics; field mapping and shim methods)
Localization methods for MRS (ISIS, PRESS, STEAM;Chemical shift displacement error;Water suppression methods, fat suppression methods, dynamic range)
Multinuclear MRS in an inhomogeneous RF field (Localization methods (PT, DEPT, HH);Decoupling, WALTZ, adiabatic decoupling;Adiabatic RF pulses;Absolute quantification (water, external, internal))
Moving magnetization (Artifact recognition - bases of artifacts; 2nd moment nulling, PC flow imaging, TOF; Triggering and synchronization)
Diffusion MR(Stejskal-tanner, b value, Einstein-stokes relationship; Restricted vs. hindered diffusion; q-space imaging; DTI and fiber tracking)
Perfusion imaging(Pulsed arterial spin labeling, FAIR, EPISTAR;Continuous arterial spin labeling)
Magnetization transfer(MTC imaging, Solomon equations;Saturation transfer experiments)
Rf coils(Theory of matching;Coil design surface coil TEM coil;Diel effects, coil loading and efficiency)
Imaging sequences (STEAM, SE, FSE (CPMG), FLASH, SSFP)
fMRI(BOLD effect, SE vs GE imaging;Pharmacological MRI;Biophysical basis)
Modeling (Tracer kinetics;Uptake curves)

Dr. Vladimír Mlynárik - 2h
Prof. Ileana Jelescu - 2h
Dr. Daniel Wenz - 2h
Dr. Yohan van de Looij - 2h
Dr. Ruud van Heeswijk - 2h
Prof. Jessica Bastiaansen - 2h
Dr. Hikari Yoshihara - 2h

Prof. Joao Duarte - 2h
Dr- Lijing Xin - 2h
Dr. Jean-Noël Hyacinthe 2h
Dr. Antoine Lutti 2h

Note

Above program is preliminary and for the current year only. May change to include other modalities as well in future years. 80% presence in class is mandatory.

Keywords

spin physics, MRI, RF engineering

Learning Prerequisites

Required courses

Course(s) attended, equivalent to the teaching of "fundamentals of biomedical imaging" or practical exposure to the topics covered in this course as part of the PhD for at least 6 months. In other words, the student should be familiar with the basics of the imaging methodologies covered.

Learning Outcomes

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

- have a solid introduction into approaches, methods, and instrumentation used in biomedical research. A major focus is on Magnetic Resonance Imaging (MRI) and related methods, but other imaging modalities will be increasingly covered