PHYS-719

Advanced biomedical imaging methods and instrumentation

Gruetter Rolf

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

Language of teaching	English
Credits	4
Session	
Exam	Term paper
Workload	120h
Hours	**56**
Courses	28
Exercises	28
Number of positions	

Frequency

Every year

Remark

Every year / 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

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;Gbbs 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, STEAMl;Chemical shift displacement error;Water suppression methods, fat suppression methods, dynamic range)
Multinuclear MRS in an inhomogenous 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)

Note

Above program is preliminary and for the first year only. May change to include other modalities as well in future years

Keywords

spin physics, MRI, RF engineering