

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	56
Courses	28
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

Introduction (Bloch equations; Components of an MRI systems; Pre-amplifier, 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; Dielectric 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)

Keywords

spin physics, MRI, RF engineering