Advanced biomedical imaging methods and instrumentation

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;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 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 (CMG), FLASH, SSFP)
fMRI (BOLD effect, SE vs GE imaging; Pharmacological MRI; Biophysical basis)
Modeling (Tracer kinetics; Uptake curves)

Keywords
spin physics, MRI, RF engineering