Advanced biomedical imaging methods and instrumentation

Gruetter Rolf

**Cursus**

- Génie électrique
- Neurosciences
- Photonique
- Physique

<table>
<thead>
<tr>
<th>Sem.</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opt.</td>
<td></td>
</tr>
<tr>
<td>Opt.</td>
<td></td>
</tr>
<tr>
<td>Obl.</td>
<td></td>
</tr>
<tr>
<td>Obl.</td>
<td></td>
</tr>
</tbody>
</table>

**Language**

- English

**Credits**

- 4

**Session**

- Term paper

**Workload**

- 120h

**Hours**

- 56

- Lecture: 28
- Exercises: 28

**Number of positions**

- Every year

**Frequency**

- Every year

**Remarque**

- 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;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, STEAMI; 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