Syllabus for Medical Physics 710 / BME 710, 3 credits
Advances in Medical Magnetic Resonance

Fall 2018
Instructor: Oliver Wieben, Ph.D.
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Class: Tuesdays & Thursdays; 2:30-3:45 pm
Location: WIMR 1022

Office Hours: by request

Important Note: The schedule, topics covered, and timing of assignments are all tentative and may slightly change over the course of the semester.

Student responsibilities: It is the student's responsibility to attend class, check the course webpage, and stay abreast of changes in scheduling. In addition to lectures and the text, students will also be assigned readings from scientific literature and homework. Students are responsible for meeting all course requirements and observing all deadlines.

Class Overview:
This course is designed to further provide the technical foundation of magnetic resonance imaging (MRI) physics for students performing research in this or related fields. Both fundamental and state-of-the art theory and methods will be covered. Advanced MR image acquisition, reconstruction and analysis methods and applications will be emphasized in the lectures. The concepts will be further reinforced using homework and a class project. Discussions of journal articles will be used to provide exposure to latest technical developments as well as reviews of state of the art in MRI topics of special interest.

Attendance policy: Learning is a proactive experience. As such, students are encouraged to attend every lecture. More than 3 absences must be discussed with the instructor. If any of the mandatory class requirements fall on a day of religious observance of a student, make‐up dates can be scheduled before or after the regularly scheduled requirement. In such a case, the student must notify the instructor within the first two weeks of class of the specific days or dates on which they request relief.
While in class, turn off your cell phones and do not use any electronic devices unless you are using them to take notes. If student laptop use becomes distracting to other students (e.g. because of internet surfing unrelated to class, checking e-mail, etc.), the instructors reserve the right to ask students to shut-down their laptops or to leave the classroom.

Reading Materials
A textbook is not required for this class.
Reading materials from articles and textbooks as well as lecture slides will be provided in form of pdfs by the instructor. Textbooks with relevance to the covered topics are also available at the instructor's office and can be checked out by students. Some of the books are available (but not for checkout) at the Medical Physics library.
Reference books of interest are:

- Bernstein MA et al. Handbook of MRI Pulse Sequences. Elsevier Academic Press 1st edition, 2004 (ISBN-13: 978-0120928613).
- Haacke EM et al. Magnetic Resonance Imaging: Physical Principles and Sequence Design. Wiley Liss 2nd edition (ISBN-13: 978-0471720850). This book is available for download by the publisher: http://onlinelibrary.wiley.com/book/10.1002/9781118633953

- Liang ZP, Lauterbur PC. Principles of Magnetic Resonance Imaging: A Signal Processing Perspective. Wiley IEEE Press, 1st edition 1999 (ISBN-13: 978-0780347236)
- Oppelt, A. (editor). Imaging Systems for Medical Diagnostics. Publicis 2nd edition (in English) 2006 (ISBN-13: 978-3895782268).

Grading:

45%: Homework - Eight assignments consisting of hand-written problems (a few) and (mostly) MATLAB based exercises including simulations and reconstruction tasks with acquired MRI data. The last homework will be a written critique of a project report in the style of a journal reviewer (see below).

20%: Journal discussion - Each student will present 1 peer reviewed journal article. The presentation should be around 10 min with a subsequent discussion period. Scores are given for the quality of the presentation (10%), participation in journal discussions throughout the semester (5%), and performance in quizzes on the reading materials (5%).

35%: Semester Project - (15% for quality of the project, 10% for written report, 10% for oral presentation). See below for more information.

Journal Discussion:

We will discuss a set of journal articles related to different areas of MRI. Articles will be selected by the instructor to be complimentary to material covered in lectures. You will be responsible for reading all papers and one student will be assigned to introduce the paper and lead the discussion of its contents. The papers may either cover recent advances or reviews in a certain area discussed in the course, or areas that were not covered in the lectures.

Semester Projects:

You will conduct and report on an independent MR focused research project. This need not to be novel, but should emphasize some aspect of MR physics. It could be scanner-related experiments, computer simulations, image reconstruction, hardware design, or a combination thereof. Some examples of suitable projects include writing simulation software, develop software for regridding and/or comparing non-Cartesian k-space sampling schemes, either develop or learn to use software for generating RF pulses, fMRI, or DTI analysis (or similar), develop an algorithm for parallel imaging reconstruction or the generation of MR elastography maps, design and construct an RF coil, or others. MR data sets can be provided by the instructor per request for simulation, image reconstruction, or data analysis projects. **Do not simply pursue a project that is already a direct component of your previous, ongoing or thesis-related MRI work**.

The project scope will be proposed in written format to the instructor by October 24th. The results will be presented in class in a conference style format following the International Society for Magnetic Resonance in Medicine (ISMRM) at the end of the semester. Written reports should follow the style guides of the technical note format of either the Journal of Magnetic Resonance Imaging (JMRI) or IEEE Engineering in Medicine and Biology Society (IEEE EMBS). More details on the oral presentation and the final report format will be provided.

The last assignment in class will be to write a critique of another student's project report. This exercise will put you in the shoes and thought process of a reviewer. Guidelines and tips for this task will be provided by the instructor. The review process will be anonymous to the author. In other words, nobody but the instructor will know who reviewed whose report.