Information Sheet

Instructor: Douglas C. Noll
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Lectures: Tues/Thurs: 4:30-6:30, 2nd half of winter term, EECS 3427

Office Hours: Tues/Thurs: 2:30-4, GG Brown 3412

Prerequisites: Integral calculus, trigonometry, physics (EM theory)
Some exposure to Fourier transforms is useful, but not necessary

Text: None. Readings will given through handouts and most course notes will be available on the web.

Course Web Site: **http://www.bme.umich.edu/~dnoll/BME483/** -or-
http://www.eecs.umich.edu/~dnoll/BME483/

Course Announcements: In class and by e-mail - all registered students must send me their e-mail addresses.

Course Description: Introduction to the physics, techniques and applications of magnetic resonance imaging (MRI). Basics of nuclear magnetic resonance physics, spectral analysis and Fourier transforms, techniques for spatial localization, MRI hardware. Applications of MRI including magnetic resonance properties of biological tissues and contrast agents, imaging of anatomy and function.

Grading: 30% Homework, 30% Midterm Exam, 40% Final Exam

References:

Understanding Magnetic Resonance Imaging
RC Smith and RC Lange (1998, CRC Press)
NMR in Medicine: The Instrumentation and Clinical Applications
SR Thomas and RL Dixon (1986, Amer. Inst. of Physics)
Magnetic Resonance Imaging
MT Vlaardingerbroek and JA den Boer (1996, Springer)
Magnetic Resonance Imaging
EM Haacke, et al. (1999, Wiley-Liss)

Tentative Syllabus

(Each class below represents 2 hours of lectures.)

NMR Physics

1. 3/6 Introduction, Policies, Overview of medical imaging modalities, Concept of nuclear spin, Magnetic moment, Precession of a top, Precession of the moment
2. 3/8 Field dependence, Two-state energy systems, Rotating frame of reference, Excitation
3. 3/13 RF fields and coils, Relaxation (T1 and T2), Free Induction Decay (FID), Spin-echoes

Biological Tissues and Contrast

4. 3/15 NMR Properties of Biological Tissues, Contrast Agents, Optimizing Contrast

Spectral Analysis

5. 3/20 Fourier Transforms, Basic Theory, Properties and Relationships
6. 3/22 Time-frequency vs. space-spatial frequency, 2D Transforms

Localization

7. 3/27 Fourier Transforms of the FID, Magnetic field distributions, susceptibility, chemical shift, review for midterm exam
8. 3/29 Midterm exam (1 hr.), Gradient fields and coils, 1D localization
9. 4/3 2D localization, Projection imaging, Spin-warp imaging and reconstruction
10. 4/5 Slice Selection, Putting it all together, Overall system architecture

Applications – Functional MRI and Clinical Uses of MRI

11. 4/10 Tour and demonstrations, Functional MRI Laboratory, BIRB 1089.
12. 4/12 Major clinical applications: neuro, body, musculo-skeletal, cardiac, oncology; imaging methods and image interpretation, physiology of brain activation, MRI observable phenomena
13. 4/17 Blood oxygenation contrast, imaging considerations, rapid imaging techniques, statistical analysis, single-event imaging

14. 4/19 Final exam (2 hrs) – time to be determined.