Course Syllabus, spring 2014

Course #
Title: Quantitative Nuclear Magnetic Resonance in Biomedical Engineering
Credit hour: Time:
Location:

Professor: Dr. Daniel Coman
Room: Phone: 203-785-6170
Email: daniel.coman@yale.edu

Description of the course:
The objective of this course is to teach the students basic concepts of Magnetic Resonance Spectroscopy (MRS) and Magnetic Resonance Imaging (MRI). The students will learn first the basics of NMR, which includes classical description of MR, longitudinal ($T_1$) and transverse ($T_2$) relaxation processes and preparation of sample for MR experiments. Magnetic Resonance Imaging technology and methods of obtaining contrast images in MRI will be discussed. Radio Frequency (RF) pulses and magnetic field gradients will be described, and their importance for MR will be presented. The principles of Spectroscopic Imaging and its applications for Molecular Imaging will be explained. Examples of MR technological developments and their interconnection with the field of Biomedical Engineering will be given at various points during the course.

Course Content and Schedule:

Section 1 – Basic Principles of Magnetic Resonance (6 Weeks)
- Classical description of Magnetic Resonance
- Fourier Transformation in MR
- Time-domain filtering
- Longitudinal ($T_1$) relaxation process
- Transverse ($T_2$) relaxation process
- Preparation and Acquisition of an Magnetic Resonance experiment

Section 2 – Magnetic Resonance Imaging (3 Weeks)
- Principles of Magnetic Resonance Imaging (MRI)
- Contrast MRI Imaging

Section 3 – Radio Frequency Pulses (3 Weeks)
- The effect of a square RF pulse on magnetization
- Selective and adiabatic pulses, decoupling
- Pulse calibration and specific absorption rate

Section 4 – Molecular Imaging using Bioengineered Agents (3 Weeks)
- Principles of Spectroscopic Imaging (SI)
- Examples of agents used in research or medicine
**Homework:** There will be weekly homework assignments which will be handed out at the end of each class and they are due at the start of next class. Late homeworks will be accepted only under special circumstances and requires approval before the deadline by Dr. Coman.

**Examinations:** There will be four quizzes at the end of each section and a final exam at the end of the semester. You can use your textbook, supplemental materials provided in class, and your course notes as references while taking the quizzes and the final exam. No other materials or sources are permitted.

**Grading:**
- Homework = 30%
- Quizzes = 4 x 10% = 40%
- Final exam = 30%

Any student with a document disability seeking academic adjustments or accommodations is requested to speak with Dr. Coman during the first two weeks of class. All discussions will remain as confidential as possible. Students with disabilities will need to also contact Disability Support Center at the University.

**Cheating is absolutely unaccepted in any form.** If you will be caught cheating, you will be warned once, with zero for that assessment. The second offense will result in an “F” for the course. Cheating is defined as using the work of others as your own. Copying homework, letting others copy your work, using papers from the internet as is, any talking or looking around during exams, and allowing others to look at our exam papers are examples of cheating.

**Textbooks and References:**