M229: Advanced Topics in Magnetic Resonance Imaging

Spring 2025: 4 Units
Lectures: Tue/Thu 10:00 AM – 11:50 AM
Bauer Auditorium, CHS BH-173
https://mrrl.ucla.edu/pages/m229

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Course Description: This course will explore recent MRI developments that 1) have had high impact on the field, 2) involve novel pulse sequence design or image reconstruction, and/or 3) enable imaging of anatomy or function in a way that surpasses what is currently possible with any other modality. Simulations and programming exercises in MATLAB will provide hands-on experience for students. Students will propose and carry out a final project along current directions of advanced MRI research.

Prerequisites: This course is a follow-up to M219 (Principles and Applications of MRI) and is meant for students interested in pursuing research related to the development or translation of new MRI techniques.

Course Schedule:

1. April 1, Tue **Introduction** – Advanced MRI Techniques and Applications
2. April 3, Thu **Pulse Sequences** – Rapid GRE
3. April 8, Tue **Pulse Sequences** – RARE / Bloch Simulation MATLAB demo
4. April 10, Thu **Pulse Sequences** – Extended Phase Graphs (EPG) / MATLAB demo
5. April 15, Tue **RF Pulse Design** – Adiabatic Pulses
6. April 17, Thu **RF Pulse Design** – Excitation k-space / MATLAB Demo
7. April 22, Tue **Image Reconstruction** – Partial k-space (by Dr. Kyung Sung)
8. April 24, Thu **Image Reconstruction** – Parallel Imaging (by Dr. Kyung Sung)
9. April 29, Tue **Image Reconstruction** – Compressed Sensing (by Dr. Shu-Fu Shih)
10. May 1, Thu **Project Discussion**
11. May 6, Tue **Fast Imaging** – Non-Cartesian Sampling I
12. May 8, Thu **Fast Imaging** – Non-Cartesian Sampling II

[ISMRM: May 10 – May 15]

13. May 20, Tue **Fast Imaging** – EPI, PROPELLER
14. May 22, Thu **Image Reconstruction** – Deep Learning (by Dr. Shu-Fu Shih)
15. May 27, Tue **Fat-Water MRI** (by Dr. Xiaodong Zhong)
16. May 29, Thu **Susceptibility MRI** (by Dr. Jingwen Yao)
17. June 3, Tue **Motion in MRI** (by Dr. Anthony Christodoulou)
18. June 5, Thu **Advanced Applications of MRI - TBD** (by Dr. Jason Chiang)
19. June 10 or 12, **Final Project Presentations**

Course Assignments:

- Reading book chapters and research papers
- Programming assignments x2 (MATLAB)
- Final project presentation (1-page abstract and 10+10 min oral presentation)

Grading Structure:

- Participation (10%), Homework (30%), Final Project (60%), Extra Points.

Reading List:

- Handbook of MRI Pulse Sequences. M. A. Bernstein, K. F. King, and X. J. Zhou. Elsevier Academic Press, 2004. ISBN-13: **978-0120928613**.
    - *Note: A free digital copy is available to UCLA students via the UCLA library*
- Research papers as assigned