

BMDE-660: Advanced Magnetic Resonance Imaging and Spectroscopy of the Brain

Department of Biomedical Engineering
McGill University

Winter 2023



Instructors

Prof. Christine Tardif

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Prof. David Rudko

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Guest lecturers

Prof. Jamie Near, University of Toronto

Dr. Jennifer Campbell, McGill University and University of Calgary

Prof. Claudine Gauthier, Concordia University

Dr. Christopher Rowley, McGill University

Course schedule

Tuesdays and Thursdays, 1:05pm to 2:25pm in Duff #321.

Detailed lecture schedule available on *MyCourses*.

Learning outcomes

By the end of this course, students will:

1. Know a variety of MRI/S data acquisition and reconstruction techniques.
2. Understand MRI/S contrast mechanisms and how they related to brain structure, function, connectivity and chemistry.
3. Understand the trade-offs between different MRI/S techniques in terms of data quality, acquisition efficiency and biological specificity.
4. Be able to evaluate data quality and identify sources of artifacts.
5. Be able to optimize an MRI/S protocol for a given study.
6. Be able to critically evaluate new imaging and spectroscopy techniques.

Course material

- Classes will mainly consist of powerpoint presentations. The white board will also be used, so be prepared to take notes.
- PDFs of lecture slides will be available via *MyCourses*.
- Additional material may be recommended during class (eg. a journal article or website).

Questions:

Don't hesitate to interrupt us and ask questions during class!

Please ask questions regarding the assignments via the discussion board on *MyCourses*.

Zoom lectures (if we are required to work from home)

- Zoom lectures will be recorded and uploaded to *MyCourses* (in addition to pdfs).
- You are expected to attend the lectures. If you have a scheduling conflict (eg, you are currently in a different time zone), please contact us asap.
- Please turn your video on, and mute yourself unless you would like to ask a question or make a comment.
- Please enter your name correctly.
- Please make sure your internet connection is good and consistent, in particular when you will be giving presentations.

Evaluations

Assignment #1	20%
Assignment #2	20%
Assignment #3	15%
Image artifact presentation	10%
Final project	
Oral presentation	15%
Written report	20%

Due dates are in the lecture schedule

Course materials

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BMDE-660: Advanced Magnetic Resonance Imaging and Spectroscopy
Lecture schedule, Winter 2023
 (updated Jan 10, 2023)

#	Date	Key Content	Lecturer
1	Jan 10	Course Introduction Classical and quantum description of NMR	Prof. Tardif
2	Jan 12	Excitation, relaxation and detection	Prof. Rudko
3	Jan 17	MRI/S equipment and safety, including magnets, gradients, and radio-frequency coils	Prof. Tardif
4	Jan 19	Fourier transform, spatial encoding, k-space	Prof. Rudko
5	Jan 24	Basic Sequences: gradient echo and spin-echo based approaches Confirm topics for group image artefact presentations	Prof. Tardif
6	Jan 26	Introduction to coil design	Prof. Rudko
7	Jan 31	Advanced coil design	Prof. Rudko
8	Feb 2	Radiofrequency excitation pulse design Assignment #1 due	Prof. Rudko
9	Feb 7	Parallel transmit RF pulse design	Prof. Tardif
10	Feb 9	Fast image acquisition & reconstruction I: turbo and multiple echo imaging, steady state imaging, non-cartesian trajectories	Prof. Tardif
11	Feb 14	Fast image acquisition & reconstruction II: parallel imaging	Prof. Rudko
12	Feb 16	Fast image acquisition & reconstruction III: NUFFT/gridding, compressed sensing, forward reconstruction model	Prof. Tardif
13	Feb 21	MR Spectroscopy	Prof. Near
14	Feb 23	Student Artefact presentations	

SPRING BREAK			
15	Mar 07	Diffusion imaging - part 1 Assignment #2 due	Dr. Campbell
17	Mar 09	Diffusion imaging - part 2	Dr. Campbell
18	Mar 14	Quantitative MRI: proton density, T1 relaxometry and B1 mapping	Prof. Tardif
19	Mar 16	Magnetization transfer imaging and multi-modal MRI	Prof. Tardif
19	Mar 21	Quantitative MRI : T2(*) relaxometry, quantitative susceptibility mapping	Prof. Rudko
20	Mar 23	Quantitative MRI at ultra-high field	Prof. Rudko
21	Mar 28	MRI of brain physiology Assignment #3 due	Prof. Gauthier
22	Mar 30	Student Project Presentations	
23	Apr 04	Student Project Presentations	
24	Apr 06	Student Project Presentations	
25	Apr 11	Student Project Presentations	