



**The University of Western Ontario Schulich School of
Medicine and Dentistry Department of Medical
Biophysics**

BIOPHYS 9650 – Concepts of MRI

Fall Semester 2023 (*half-course*)

Course Objective:

The purpose of this course is to provide students with an understanding of the conceptual underpinnings of Magnetic Resonance Imaging. This course will focus on the concepts needed to interpret MR images and design MRI experiments. It is intended for graduate students that will be using MR images in their thesis work, as opposed to students needing an in-depth knowledge of MR physics. Those students should consider BIOPHYS 9662/9663 instead.

At the end of this course, students should be able to:

1. Describe the origins of image contrast
2. Describe the trade-offs involved in adjusting basic imaging parameters
3. Identify the appropriate sequence to use to achieve a desired image contrast
4. Identify common sources of image artifact and strategies to minimize them
5. Describe the essential steps in MRI data acquisition
6. Read and interpret a pulse sequence diagram
7. Understand the use of the Fourier Transform in MRI
8. Describe the process of spatial encoding in MRI
9. Describe the purpose of the basic hardware elements in an MRI system
10. Identify the most important safety concerns in MRI
11. Understand and adjust basic MRI pulse sequence parameters to optimize an MR image
12. Identify commonly used pulse sequences on a pulse sequence diagram. Understand the major components unique to each sequence
13. (a) Understand the basic methods behind common post-processing techniques and (b) propose the most appropriate techniques for a given application

Prerequisites:

Permission of Course coordinator (check with Medical Biophysics office).

Note: Unless you have either the requisites for this course or written special

permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees if you are dropped from a course for failing to have the necessary prerequisites.

Course Time and Location:

The course material will be presented as asynchronous online videos. However, the class will meet once per week (Thursday 8:30 – 9:20 am) for a brief review and/or to answer student questions. Student presentations will be delivered synchronously online during the last week of November and into December if required. The presentations will take place Tuesday, Wednesday and Thursday from 8:30 am to 9:20 am. (Please ensure that you are available during these time slots.)

Room: TBA

NOTE: In the event of a COVID-19 resurgence during the course that necessitates moving away from face-to-face interaction, the Thursday class will be delivered entirely online. The grading scheme will not change. Any remaining assessments will also be conducted online at the discretion of the instructor.

Class Web Site

<https://owl.uwo.ca/portal>

Instructor, Office hours:

Instructor office hours vary. Please contact the appropriate instructor by email to schedule an appointment.

Textbook:

This course will use the following textbook to support the lectures:
“MRI From Picture to Proton, 2nd Ed.” Donald W. McRobbie, Elizabeth A. Moore, Martin J. Graves and Martin R. Prince. Cambridge University Press, 2007.

Or

“MRI From Picture to Proton, 3rd Ed.” Donald W. McRobbie, Elizabeth A. Moore, Martin J. Graves and Martin R. Prince. Cambridge University Press, 2017.

The online material will follow the textbook and students will be expected to read the assigned sections of the text (See outline) before coming to the weekly class. Supplementary materials will be provided as necessary.

Reference Textbooks:

The following textbooks provide more in depth coverage of the physics of MRI and are used in Biophysics 9662/9663:

“Handbook of MRI Pulse Sequences.” Matt Bernstein, Kevin King, Xiaohong Joe Zhou. Elsevier Academic Press. 2004.

“Magnetic Resonance Imaging: Physical Principles and Sequence Design.” E. Mark Haacke, Robert W. Brown, Michael R. Thompson, Ramesh Venkatesan. John Wiley & Sons. 1999

Evaluation:

The final mark in the course will be distributed as follows:

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|--------------------------|-----|------------------------------------|
| 1. Take Home Assignments | 50% | (equal weight for each assignment) |
| 2. Final Presentation | 25% | (Nov 28 – Dec 8) |
| 3. Final exam | 25% | (During Exam period (Dec 11 – 22)) |

Assignment grades will be posted regularly on the class OWL site. Any errors, or appeals to your scores, must be reported to your instructor within two weeks of their initial posting.

Assignments:

Assignments will be posted on OWL and will normally be due back the following week. (See the course outline for exact due dates.) Students are encouraged to work together on the assignments, although each student must hand in their own work.

Final Presentation:

In the last two weeks of class, students will be asked to prepare and present a short (15 minute) presentation in class that discusses a pulse sequence of their choosing. The presentation will be followed by a short (10 min) question period. Details of what is expected in the presentation and how it will be evaluated can be found on the class OWL website.

Final Exam:

There will be one Final exam. The Final exam will be given as an online test available through OWL and will be scheduled during exam week.

Accommodations for Religious Holidays

When scheduling unavoidably conflicts with religious holidays which a) require an absence from the University or b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate department chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

A student who, for either of the situations outlined in paragraph one above (a or b), is unable to write examinations and term tests on a Sabbath or Holy Day in a particular term shall give notice of this fact in writing to his or her Dean as early as possible, but not later than November 15 for mid-year examinations and March 1 for final examinations, i.e., approximately two weeks after the posting of the mid-year and final examination schedule respectively. In the case of mid-term tests, such notification is to be given in writing to the instructor within 48 hours of the announcement of the date of the mid-term test. If a Special Examination is offered as an alternative means to satisfy the academic requirements, the instructor(s) in the case of mid-term tests and the dean in the case of mid-year and Spring final examinations will arrange for special examination(s) to be written at another time. In the case of mid-year and Spring final examinations, the accommodation must occur no later than one month after the end of the examination period involved. It is mandatory that students seeking accommodations under this policy give notification before the deadlines and that the Faculty accommodate these requests.

For purposes of this policy the University has approved a list of dates which are recognized religious holidays which require members of those religions to be absent from the University; this list is updated annually and is available at Departmental, Deans' and Faculty advising offices.

Make-up Policy

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Academic Counselling office of their home faculty.

For UWO Policy on Accommodation for Medical Illness, see:

http://www.uwo.ca/univsec/handbook/appeals/accommodation_medi.f

A student requiring academic accommodation due to illness should use the Student Medical Certificate [see: <https://studentservices.uwo.ca/> under the Medical Documentation heading for a downloadable SMC] when visiting an off-campus medical facility, or request a Records Release Form (available in the Academic Counselling office) for visits to Student Health Services.

Students seeking academic accommodation on medical grounds for any missed tests, exams, participation components and/or assignments worth 10% or more of their final grade must apply to the Academic Counselling office of their home Faculty and provide documentation. Academic accommodation cannot be granted by the instructor or department.

Mental Health Services

Students who are in emotional/mental distress should refer to Mental Health@Western <http://www.uwo.ca/uwocom/mentalhealth/> for a complete list of options about how to obtain help.”

Final Examination

In accordance with Senate Policy, a Special Examination will be held within thirty days of the regular final examination for students who are unable to write the regular examination for medical or other documented reasons. Requests for such a Special Examination must be made to the Associate Dean, Schulich School of Medicine and Dentistry.

Note that if you fail to write a scheduled Special Examination, permission to write another Special Examination will be granted only with the permission of the Academic Counselling Office in exceptional circumstances and with appropriate supporting documents. In such a case, the date of this Special Examination normally will be the scheduled date for the final exam the next time the course is offered.

Accessibility

Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you.

You may also wish to contact Services for Students with Disabilities (SSD) at 661- 2111 x 82147 for any specific question regarding an accommodation.

Academic Offenses

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

“Computer-marked multiple-choice tests and/or exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating.

Classroom Conduct

Disruptive behaviour will not be tolerated in class. Please respect the rights of your classmates to benefit from the lecture by limiting your conversations to those essential to the class. Students who persist in loud or rude behaviour will be asked to leave.

Complaints and Suggestions

If you have a concern about something, please let us know. We rely on your feedback. Please contact initially the person most directly concerned; this will usually be your instructor. If that is not satisfactory, or if there is something more general bothering you, talk it over with the Medical Biophysics Department Chair or the Chair of Graduate Studies (for contact information see <http://www.uwo.ca/biophysics/>).

Contacting Us

The simplest way to contact the instructors outside of lectures is via your UWO e- mail account. Please allow 2–3 working days for a response.

Course Outline & Class Schedule:

Week #	Date of In-person class	Topics: Please review Videos for the specific week prior to class	Textbook reference	Assignments Due Dates
1	Sept 7	Course Overview Introduction to MRI	Ch. 1, Ch. 2	
2	Sept 14	Introduction to Contrast in MRI	2 nd ed: Ch 3 3 rd ed: Ch 3	
3	Sept 21	Digital Image Basics	2 nd ed: Ch 4 3 rd ed: Ch 5	Sept 22: #1 covers weeks 1 and 2
4	Sept 28	Imaging Parameter Selection	2 nd ed: Ch 5 3 rd ed: Ch 6	Sept 29: #2 covers week 3
5	Oct 5	Artefacts	2 nd ed: Ch 6 3 rd ed: Ch 7	
6	Oct 12	No class		Oct 13: #3 covers weeks 4 and 5
7	Oct 19	Resonance and Relaxation	2 nd ed: Ch 8 3 rd ed: Ch 9	
8	Oct 26	Making an Image	2 nd ed: Ch 7 3 rd ed: Ch 8	Oct 27: #4 covers week 7
9	Nov 2	MRI sequences	2 nd ed: Ch 12 3 rd ed: Ch 12 & 13	Nov 3: #5 covers week 8
10	Nov 9	Safety	2 nd ed: Ch 10 3 rd ed: Ch 20	
11	Nov 16	Post Processing		Nov 17: #6 covers week 9
12	Nov 23	Hardware	2 nd ed: 9.1 – 9.4 3 rd ed: 10.1–10.5	

Presentations:

Draft Presentation Due Nov 13
 Tuesday Nov 28, Wed Nov 29, Thurs Nov 30
 If required: Tuesday Dec 5, Wed Dec 6, Thurs Dec 7

Final Exam On-line – During Undergraduate exam period (Dec 11 – 22)