Instructor
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- Should include 'BIOM 5200' in the subject of the email.
- All email correspondence should be from your Carleton email account. Email from accounts other than your Carleton email account may not receive any response.

Office hours: To be posted on the course webpage (cuLearn).

Calendar Description
Mathematical models of image formation based on the image modality and tissue properties. Linear models of image degradation and reconstruction. Inverse problems, regularization for image reconstruction. Image formation in radiology, computed tomography, MRI, nuclear medicine, ultrasound, positron emission tomography, electrical impedance tomography.

Prerequisite(s): OCIECE/OCIBME graduate students, or permission of the instructor.

Course Objectives
The objective of the course is to learn how to “process” signals to obtain medical images for each imaging modality, based on its physics, mathematical modeling and instrumentation.
* Note that this course is not for digital image processing/analysis of medical images.

Learning Outcomes
- Understand physics of image formation.
- Understand mathematical models of image formation.
- Understand instrumentations of imaging modalities.
- Understand image reconstruction.
- Understand limitations and challenges of imaging modalities.
- Explain image formation of imaging modalities.
- Explain basic operations of imaging modalities.
- Explain mechanism of image contrast based on tissue properties.
- Explain image artifacts (image errors) in medical images.
- Demonstrate knowledge enough to develop an advanced medical imaging technique.

Course Website
Course materials and announcements will be placed on cuLearn, so students are responsible for checking the website frequently.

Textbooks
*Medical Imaging Signals and Systems*
Evaluation and Grading Scheme
To pass the course, a student must: (1) pass the final examination test (50% or better), and (2) obtain an overall passing average. For students who pass the final exam, the final grade will be calculated as follows:

<table>
<thead>
<tr>
<th>Work</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Quiz</td>
<td>15%</td>
</tr>
<tr>
<td>Project</td>
<td>35%</td>
</tr>
<tr>
<td>- Abstract</td>
<td>5%</td>
</tr>
<tr>
<td>- Final proposal</td>
<td>30%</td>
</tr>
<tr>
<td>Final exam</td>
<td>50%</td>
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</tbody>
</table>

Breakdown of Course Requirements
• Quiz:
There will be five in-class quizzes. Class attendance is required and each quiz has a weight of 3% in total mark for your final grade. If a quiz is missed for circumstances beyond your control, you should submit appropriate documentations (e.g. medical certificate in case of illness) within three (3.0) working days for consideration.

• Project:
Objectives of the project are: getting familiar with advanced technology, current limitation and challenges of medical imaging, and training for writing a research proposal and/or introduction of thesis. Students select a topic in the area of medical imaging, review 10-15 literatures (including the latest ones) of the topic, and propose possible research subjects. Students are encourage to select a topic of interest or relevant to their studies in the area of medical imaging. The project report is for evaluation purposes only and will not be returned to students.

<table>
<thead>
<tr>
<th>Work</th>
<th>Description</th>
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<tbody>
<tr>
<td>Abstract of proposal</td>
<td>Abstract is 1-2 pages (double spaced). Include a title, brief introduction of technology, background, problem descriptions (such as limitations, issues, challenges, future improvement, etc.), proposed techniques or methods if you already have such ideas, and (at least 5) references.</td>
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<tr>
<td>Final proposal</td>
<td>Final proposal is 10–15 pages (double spaced). Marks are based on the technical content, consistency of discussion and clarity of its presentation for review of current techniques (introduction, background, techniques, state of the art, etc.), analysis of problems (limitations, issues, challenges, future improvement, etc.), and proposed research subjects (justification, needs, impact, approach, method, originality, novelty, uniqueness, advantage, etc.).</td>
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• Examination:
The final examination will be held during the University's formal examination period. The final examination is for evaluation purposes only and will not be returned to students. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available.
Week-by-Week breakdown

<table>
<thead>
<tr>
<th>Week</th>
<th>Subject</th>
<th>Textbook Chapter</th>
</tr>
</thead>
</table>
| 1    | Course overview  
     Introduction of medical imaging | Ch 1 |
| 2    | Signals and system  
     Imaging quality | Ch 2  
     Ch 3 |
| 3, 4, 5 | Physics of radiography  
 Planar tomography (CT) | Ch 4  
 Ch 5  
 Ch 6 |
| 6, 7 | Physics of nuclear medicine  
 Planar scintigraphy  
 Emission computed tomography (SPECT, PET) | Ch 7  
 Ch 8  
 Ch 9 |
| 8, 9 | Physics of ultrasound  
 Ultrasonic imaging systems | Ch 10  
 Ch 11 |
| 10, 11 | Physics of magnetic resonance  
 Magnetic resonance imaging (MRI) | Ch 12  
 Ch 13 |
| 12   | Advanced imaging modality | |

General Regulations

**Student Responsibility:** It is the student's responsibility to remain informed of all rules, regulations and procedures required by their program and by the Faculty of Graduate and Postdoctoral Affairs. Ignorance of regulations will not be accepted as a justification for waiving such regulations and procedures.

**Academic Integrity:** Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: [https://carleton.ca/registrar/academic-integrity/](https://carleton.ca/registrar/academic-integrity/). This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

**Plagiarism:** Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.

**Deferred Term Work:** Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current Graduate Calendar, Academic Regulations of the University, Section 9.3.

**Academic Accommodation:** You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at [http://www.carleton.ca/equity/](http://www.carleton.ca/equity/) For an accommodation request, the processes are as follows:
- **Pregnancy obligation**: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see [https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

- **Religious obligation**: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see [https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

- **Academic Accommodations for Students with Disabilities**: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult [https://carleton.ca/pmc/students/dates-and-deadlines/](https://carleton.ca/pmc/students/dates-and-deadlines/) for the deadline to request accommodations for the formally-scheduled exam (if applicable).

- **Survivors of Sexual Violence**: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton’s Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: [https://carleton.ca/sexual-violence-support/](https://carleton.ca/sexual-violence-support/).

- **Accommodation for Student Activities**: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see [https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf](https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf)

**Copyright on Course Materials**: The materials created for this course (including the course outline and any slides, posted notes, labs, project, assignments, quizzes, exams and solutions) are intended for personal use and may not be reproduced or redistributed or posted on any web site without prior written permission from the author(s).

**Health and Safety**: Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: [http://sce.carleton.ca/courses/health-and-safety.pdf](http://sce.carleton.ca/courses/health-and-safety.pdf)

**Students from the University of Ottawa**: You can request to have access to cuLearn: please see [http://gradstudents.carleton.ca/forms-policies/](http://gradstudents.carleton.ca/forms-policies/)