Carleton University
Department of Systems and Computer Engineering

BIOM 5200/ SYSC 5304/ BMG 5105/ ELG 5127
Medical Imaging Modalities
Winter 2022

Course Outline

Instructor Information

Prof. Yuu Ono,
Email: yuuono@sce.carleton.ca

- 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 Brightspace

Calendar Information

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. http://calendar.carleton.ca/grad

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 Brightspace, so students are responsible for checking the website frequently.

Textbooks

Medical Imaging Signals and Systems

J.L. Prince and J.M. Links, Pearson Prentice Hall, 1st edition, 2006 (or 2nd edition, 2015).

Evaluation and Grading Scheme

To pass the final exam, a student must obtain at least 50% of the final examination mark. For students who pass the final exam, the final grade will be calculated as follows:

Work	**Weight**
Assignment	15%
Project - Abstract - Final proposal	35% - 5% - 30%
Final exam	50%

Breakdown of course requirements

- Assignment:

There are **five** assignments. However, only one out of five assignments chosen by the instructor will be marked and counted in your final grade. The marked assignment has a weight of 15% in total mark for your final grade. To obtain the assignment mark, all the five assignments **MUST** be submitted by the deadline posted on Brightspace. If one or more assignments are missed, zero mark is given for the assignment mark. If an assignment 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 encouraged 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.

Work	Description
Abstract of proposal	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.

Final proposal	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.).

- Final examination**:**

The final examination is for evaluation purposes only and will not be returned to students. Students who miss the final exam may be granted permission to write a deferred examination (see the Graduate Calendar for regulations on deferred exams).

e-Proctoring: Following the departmental policy, please note that tests and examinations in this course will use a remote proctoring service provided by Scheduling and Examination Services. You can find more information at https://carleton.ca/ses/e-proctoring/.

Week-by-Week breakdown

Week	Subject	Textbook Chapter
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 Projection radiography Computed tomography (CT)	Ch 4 Ch 5 Ch 6
6, 7, 8	Physics of nuclear medicine Planar scintigraphy Emission computed tomography (SPECT, PET)	Ch 7 Ch 8 Ch 9
9, 10	Physics of ultrasound Ultrasonic imaging systems	Ch 10 Ch 11
11, 12	Physics of magnetic resonance Magnetic resonance imaging (MRI)	Ch 12 Ch 13
13	Review	

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/. 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/ For an accommodation request, the processes are as follows:

- **Pregnancy or Religious obligation**: 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/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*). **Requests made within two weeks will be reviewed on a case-by-case basis**. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) 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/.
- **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

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

Students from the University of Ottawa: You can request to have access to Brightspace: please see http://gradstudents.carleton.ca/forms-policies/