

Physics of Medical Imaging

Lectures: 11:30 am - 1pm Wednesday and Friday

Location: HP 3349 (SunRay lab)

Lecturers: Tong Xu E-mail: txu@physics.carleton.ca
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 Office Hours: By appointment

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Prerequisites: PHYS 4203/5313 Physical Applications of Fourier Analysis, or equivalent,
 and
 PHYS 5203 Medical Radiation Physics, or equivalent.

References:

Most useful:

- IAEA , Diagnostic Radiology Physics: a handbook for teachers and students, (Free ebook from IAEA website).

Other references:

- Handouts given in lectures
- J. Beutel, H.L. Kundel, & R.L. Van Metter, editors, Handbook of Medical Imaging, vol.1: Physics and Psychophysics, SPIE Press, 2000 (ISBN: 0-8194-3621-6). Available on-line from books.google.com.
- J.L. Prince and J.M. Links, Medical Imaging Signals and Systems, Pearson Prentice Hall, 2006 ISBN 0-13-065353-5H.E. Johns & J.R. Cunningham, The Physics of Radiology, 4th edition, 1983.
- R.N. Bracewell, The Fourier Transform and its Applications, 2nd edition (revised), McGraw-Hill, 1986.
- S. Webb (editor), The Physics of Medical Imaging, Institute of Physics, 1988.
- S.Cherry, J. Sorenson, & M. Phelps, Physics in Nuclear Medicine, 3rd edition, Saunders, 2003.
- M.J. Bronskill & P. Sprawls, 1992 Proceedings from the AAPM Summer School on MRI, AAPM, 1992.
- M. Haacke, R. Brown, M. Thompson, & R. Venkatesan, Magnetic Resonance Imaging: Physical Principles and Sequence Design, Wiley, 1999 (ISBN: 0-471-35128-8)
- Z.-P. Liang & P. C. Lauterbur, Principles of Magnetic Resonance Imaging: A Signal Processing Perspective, SPIE Press, 2000. (ISBN: 0-8194-3516-3)
- W.K. Pratt, Digital Image Processing, 2nd edition, Wiley, 1991.

Course Content:

Conventional planar X-ray imaging – formation and systems
 Imaging system evaluation and linear system theory

Digital x-ray imaging
Computed Tomography
Nuclear Medicine
Positron Emission Tomography
Ultrasound Imaging
Magnetic Resonance Imaging

Assignments & Project: about 6 problem sets. Late assignments only be accepted in exceptional case. Grading will in part be on clarity, rigour, and organization of solutions. In addition, there will be one project on a specific area of medical imaging, requiring a written report and presentation.

Exam: There will be a 3-hour closed-book in-person final exam. A formula sheet will be allowed (details to be announced)

<u>Grading Scheme:</u>	Assignments	=	60%
	Project	=	20%
	Final Exam	=	20%

Important Dates:

January 9, 2023: Winter term begins. First Day of Class.
February 20, 2023: Statutory holiday. University closed.
February 20-24, 2023: Winter break, no classes.
March 15, 2023 : Last day for academic withdrawal from winter courses.
April 7, 2023: Statutory holiday. University closed.
April 12, 2023: Last Day of Class. Classes follow a Friday schedule.
April 12, 2023: Winter term ends.
April 15-27, 2023: Final examinations in full winter, late winter, and fall/winter courses will be held. Examinations are normally held all seven days of the week.

Academic-Accommodation

You may need special arrangements to meet your academic obligations during the term. 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 accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form [click here](#).

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 [click here](#).

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 the [PMC website](#) 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/equity/sexual-assault-support-services>

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 will be provided to students who compete or perform at the national or international level. 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: <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

UNIVERSITY POLICY

In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100 B+ = 77-79 C+ = 67-69 D+ = 57-59

A = 85-89 B = 73-76 C = 63-66 D = 53-56

A- = 80-84 B- = 70-72 C- = 60-62 D- = 50-52

F = <50

Academic- Integrity

Academic misconduct undermines the values of honesty, trust, respect, fairness, and responsibility that we expect in this class. Carleton University provides supports such as academic integrity workshops to ensure, as far as possible, that all students understand the norms and standards of academic integrity that we expect you to uphold. Your teaching team has a responsibility to ensure that their application of the Academic Integrity Policy upholds the university's collective commitments to fairness, equity, and integrity. (adapted from Carleton University's Academic Integrity Policy, 2021).

Examples of actions that do not adhere to Carleton's Academic Integrity Policy include: • Plagiarism • Accessing unauthorized sites for assignments or tests • Unauthorized collaboration on assignment and exam

Sanctions for not abiding by Carleton's Academic Integrity Policy

A student who has not adhered to Carleton's Academic Integrity Policy may be subject to one of several sanctions:

1. If you take full responsibility for your actions, and it is the first time you have violated the policy, you will receive zero on the assessment. If you are found to have violated the policy but do not take responsibility, an additional grade deduction will be applied (e.g. an A- will become a B+)
2. Subsequent violations of the policy may result in more severe sanctions such as failing the course, suspension from all studies and/or expulsion.

Process of an Academic Misconduct Investigation

Step 1: The instructor believes misconduct has occurred and submits documentation to the Dean of the Faculty of Science.

Step 2: The Dean reviews documentation and can proceed with or dismiss the allegation.

Step 3: If sufficient evidence, the student receives an allegation statement by email. Ombuds services is copied on the email.

Step 4: The student provides a written response to the evidence provided.

Step 5: Either party may request a meeting between student, dean, and the ombudsperson.

Step 6: Dean informs the student of the decision.
Appeal: Student has the right to appeal the decision.

Additional details about this process can be found on the Faculty of Science Academic Integrity website. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students.

Plagiarism

Plagiarism is the passing off of someone else's work as your own and is a serious academic offence. For the details of what constitutes plagiarism, refer the Faculty of Science Academic Integrity website. To further understand Academic Integrity, consider attending the Learning and Support Academic Integrity Workshop. Summer 2022 14

What are the Penalties for Plagiarism? A student found to have plagiarized an assignment may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from fulltime studies; and/or a reprimand; a refusal of permission to continue or to register in a specific degree program; academic probation; award of an FNS, Fail, or an ABS.

What are the Procedures?

3. All allegations of plagiarism are reported to the Dean of Faculty of Science. Documentation is prepared by instructors and/or departmental chairs.
4. The Dean writes to the student and the University Ombudsperson about the alleged plagiarism.
5. The Dean reviews the allegation. If it is not resolved at this level then it is referred to a tribunal appointed by the Senate.

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<https://carleton.ca/registrar/academic-integrity/>

Assistance for Students

Academic and Career Development Services: <https://students.carleton.ca/departments/career-services/>

Writing Services: <http://www.carleton.ca/csas/writing-services/>

Peer Assisted Study Sessions (PASS): <https://carleton.ca/csas/group-support/pass/>

Math Tutorial Centre: <https://carleton.ca/math/math-tutorial-centre/>

Science Student Success Centre: <https://sssc.carleton.ca/>

Special Information for Pandemic Measures

Carleton will continue to follow all public health guidelines as the COVID-19 pandemic continues. Instructors may find it helpful to review the [guidelines for in-class teaching](#) and [labs](#). Both guideline documents are available on the [COVID-19 website](#).

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are [a number of actions you can take](#) to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

Feeling sick? Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's [symptom reporting protocols](#).

Masks: Carleton has paused the [COVID-19 Mask Policy](#), but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

Vaccines: Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of

vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in [cuScreen](#) as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the [University's COVID-19 website](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.

Important Dates for 2022-23

A [full list of important dates](#) is available on the Calendar website. Please note that the academic withdrawal dates have changed recently. Consult the Calendar website for the most updated information: <https://calendar.carleton.ca/academicyear>