



# ENGG\*4040 Medical Imaging Modalities

Fall 2018

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 1.00 - September 05, 2018

---

## 1 Course Details

### 1.1 Calendar Description

The course will cover the basic knowledge of medical imaging systems, how they operate and to what uses they can be applied. Systems covered will include x-ray radiography, computed tomography, magnetic resonance imaging, positron emission tomography, gamma cameras, and ultrasound imaging. Emphasis will be on the underlying physics and computation, highlighting factors affecting image quality, patient safety, and clinical use.

**Pre-Requisite(s):** MATH\*1210, PHYS\*1130

**Restriction(s):** Restricted to students in BENG, BSCH.BMPH

### 1.2 Course Description

MATH\*1210, PHYS\*1130

### 1.3 Timetable

The timetable is subject to change. Please see WebAdvisor/CourseLink for the latest information.

#### Lectures

Tuesday	All Sections	MINS-106	10:00AM-11:20AM
---------	--------------	----------	-----------------

#### Lectures/Tutorials

Thursday	All Sections	MINS-106	10:00AM-11:20AM
----------	--------------	----------	-----------------

#### Labs

Tuesday	Sec 0101	THRN-2307	12:30PM-02:20PM
---------	----------	-----------	-----------------

Monday	Sec 0102	THRN-2307	02:30PM-04:20PM
--------	----------	-----------	-----------------

Monday	Sec 0103	THRN-2307	12:30PM-02:20PM
--------	----------	-----------	-----------------

##Some labs may take place at other locations. Look on CourseLink for updates.

### 1.4 Final Exam

Exam: December 5, 2018

Time: 11.30 am to 1.30 pm

Exam time and location is subject to change. Please see WebAdvisor/CourseLink for the latest information.

---

## 2 Instructional Support

### 2.1 Instructor(s)

**Eran Ukwatta PhD, PEng**

**Email:** eukwatta@uoguelph.ca

**Telephone:** 519-824-4120 x53404

**Office:** Richards 1507

**Office Hours:** Tuesday from 11.30 am to 12.30 pm

\*\*Communication by email, CourseLink or in-person is much preferred to communication by phone.

### 2.2 Instructional Support Team

**Lab Technician:** Ahmed Mezil

**Email:** amezil@uoguelph.ca

**Telephone:** +1-519-824-4120 x53729

**Office:** THRN 2308

### 2.3 Teaching Assistant(s)

**Teaching Assistant:** Amit Tah

**Email:** atah@uoguelph.ca

**Telephone:** +1-519-824-4120 x54841

**Office:** SC1 4407-8

**Office Hours:** TBA

---

## 3 Learning Resources

### 3.1 Required Resource(s)

**Course Website (Website)**

<http://courselink.uoguelph.ca>

Course material, news, announcements, and grades will be regularly posted to the ENGG\*4040

CourseLink site. You are responsible for checking the site regularly.

**J. L. Prince & J. M. Links, Medical Imaging Signals and Systems (2nd Edition), Pearson Prentice Hall, 2014. ISBN: 0-13-214518-9. (Textbook)**

In my opinion, there is no single book which covers all the material for this course in its entirety.

Therefore supplementary material will be suggested to students as the course proceeds.

### 3.2 Reference Book

## 3.2 Lecture Information

All the lecture notes are posted on the web page usually a day before the lecture (week #1-#13).

## 3.2 Lab Information

Labs will take place every other week for each group of students. Students are expected to acquire the required data to complete the lab during the lab session. The handouts and/or supplementary data for all the lab sessions are within the lab section of the website. Lab questions will be due in two weeks after the completion of the lab and should be submitted using CourseLink.

The TA will be available during the off weeks to respond to your lab and project questions.

## 3.2 Assignments

Assignments are due according to the schedule given in this outline. Any updates on deadlines will be posted on the course website.

## 3.2 Exams

All the exams in this course (i.e, quiz, midterm, and final exam) are open book. You are allowed to have your course notes, the course textbook (Medical Imaging Signals and Systems) and calculator. Any other material, cell phones, computers, and the Internet are not allowed.

## 3.2 Miscellaneous Information

Any other relevant information will also be posted on the web page in CourseLink.

---

# 4 Learning Outcomes

This course aims to familiarize students with existing imaging modalities from both an engineering and clinical/practical perspective. Students are exposed to the underlying physics and engineering to understand their implications in the clinical settings. Numerous applications of the various imaging modalities will be explored.

## 4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Describe the physics and engineering design of various medical imaging modalities (ultrasound, x-ray, CT, PET, SPECT, MRI & NMR, digital histopathology)
2. Apply knowledge of fundamental engineering principles in implementing concepts of medical imaging systems and solving problems
3. Examine artifacts and defects in imaging systems and challenges in in-vivo imaging of humans
4. Operate several model hardware to acquire imaging data
5. Write programming code in Matlab to process medical imaging data
6. Design analysis methods and models to extract clinically relevant information from medical images

7. Compare the technical strengths and limitations of imaging modalities for a given clinical application

## 4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome Set Name	Course Learning Outcome
1	Knowledge Base	1, 2
1.3	Recall, describe and apply fundamental engineering principles and concepts	1
1.4	Recall, describe and apply program-specific engineering principles and concepts	2
3	Investigation	3, 4, 6, 7
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	6
3.3	Analyze and interpret experimental data	4
3.4	Assess validity of conclusions within limitations of data and methodologies	3, 6, 7
4	Design	5
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	5
5	Use of Engineering Tools	7
5.2	Demonstrate proficiency in the application of selected engineering tools	7

## 5 Teaching and Learning Activities

The following is a tentative list of topics covered in the class. As the course progress, the order in which the topics are covered is subject to change.

### 5.1 Lecture

**Topic(s):** Introduction of The Course

**Topic(s):** Overview of Medical Imaging Modalities & Signal Processing

**Topic(s):** Signals and Systems

- Topic(s):** Image Quality
- Topic(s):** Physics of Ultrasound Imaging
- Topic(s):** Ultrasound Imaging Systems and Applications
- Topic(s):** Projection Radiography
- Topic(s):** Computed Tomography
- Topic(s):** Nuclear Medicine: PET and SPECT
- Topic(s):** Magnetic Resonance Imaging (MRI)
- Topic(s):** Other Types of Imaging: Digital histopathology, Optical Imaging, Optical Coherence Tomography
- Topic(s):** Postprocessing of Medical Images
- Topic(s):** Applications of Medical Imaging Modalities

## **5.2 Lab**

**Sept 24-25**

**Topic(s):** Image Quality

**Oct 15-16**

**Topic(s):** CT & PET Reconstruction

**Oct 29-30**

**Topic(s):** Nuclear Magnetic Resonance

**Nov 12-13**

**Topic(s):** Postprocessing of Imaging Data

## **5.3 Other Important Dates**

**Monday, October 8, 2018:** Thanksgiving Day, No Classes

**Tuesday, October 9, 2018:** Study Day, No Classes

**Friday, November 2, 2018:** 40<sup>th</sup> Class Day - Last day to drop classes

**Thursday, November 29, 2018:** Make up for Study Day (Tuesday Schedule)

**Friday, November 30, 2018:** Make up for Thanksgiving Day (Monday Schedule)

---

## 6 Assessments

### 6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Assignment #1	6
Assignment #2	6
Group Project	18
Lab attendance & Reports	12
Quiz	8
Midterm	20
Final Exam	30
Total	100

### 6.2 Assessment Details

#### **Assignment #1 (6%)**

**Due:** Thu, Oct 4

This assignment will be released on September 20th.

#### **Assignment #2 (6%)**

**Due:** Thu, Nov 8

The Assignment will be released on October 18th.

#### **Lab Reports (12%)**

Each lab is weighted equally.

A report must be submitted for each lab where it is due in **two weeks** after the lab date. The lab report should be brief and must contain information on acquired data and relevant comments along with answers to the corresponding lab questions. Labs are to be completed in groups of 1-3. You are responsible to ensure that you/or your group submit the report.

#### **Group Project (18%)**

**Due:** Wed, Nov 28

The group project will consist of some analytical questions and Matlab experiments related to the lecture material of the course. The final report and associated files are to be submitted

electronically on CourseLink. Please follow the naming convention for files provided in the project question sheet.

**Quiz (8%)**

**Date:** Tue, Oct 2, MINS, Room 106

**Midterm Test (20%)**

**Date:** Thu, Oct 18, MINS, Room 106

Midterm will be held during the regular class.

**Final Exam (30%)**

**Date:** Wed, Dec 5, TBA

---

## 7 Course Statements

### 7.1 Course Grading Policies

**Missed Assessments:** If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

**Accommodation of Religious Obligations:** If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

**Passing grade:** In order to pass the course, you must pass the overall course and exam portions (midterm and final exam). Students must obtain a grade of 50% or higher on the combined exam and midterm portions (with above weights, i.e.  $[0.30 \times \text{Exam Mark (in \%)} + 0.20 \times \text{Midterm Mark (in \%)}] > 25.0\%$ ) of the course in order to pass the course.

**Missed midterm tests:** If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of the missed test will be added to the final exam.

**Lab Work:** You must attend all laboratories. If you miss a laboratory, arrangements must be made with the instructor.

**Late Assignments & Projects:** Late submissions of assignments will be subject to a penalty (usually 10%/day). Assignments and projects more than 2 days late will not be accepted.

---

## 8 School of Engineering Statements

## 8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

## 8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

## 8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

---

# 9 University Statements

## 9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

## 9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The regulations and procedures for [Academic Consideration](#) are detailed in the Undergraduate Calendar.

## 9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for [Dropping Courses](#) are available in the Undergraduate Calendar.

## 9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

## 9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their



academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: [www.uoguelph.ca/sas](http://www.uoguelph.ca/sas)

## 9.6 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The [Academic Misconduct Policy](#) is detailed in the Undergraduate Calendar.

## 9.7 Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

## 9.8 Resources

The [Academic Calendars](#) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

---