ENGG*4040 Medical Imaging Modalities
Fall 2013

School of Engineering

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1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor: Aravinthan Jegatheesan
Office: THRN 2401, ext. 58973**
Email: jegathea@uoguelph.ca
Office hours: TBA
**Communication by email, CourseLink or in-person is much preferred to communication by phone.

1.2 Lab Technician

Technician: Carly Fennell
Office: THRN 1102, ext. 56676
Email: gennc@uoguelph.ca

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2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4040 Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

1. J. L. Prince & J. M. Links, *Medical Imaging Signals and Systems,* Pearson Prentice Hall, 2006. ISBN: 0-13-065353-5.

   In my opinion there is no single book with covers all the material for this course in its entirety. Therefore supplementary material will be suggested to students as the course proceeds.

2.3 Additional Resources

1. M. A. Bernstein, K. F. King & X. J. Zhou*, Handbook of MRI Pulse Sequences*, Elsevier Academic Press, 2004. ISBN: 0-12-092861-2.
2. R. A. de Graaf*, in vivo NMR Spectroscopy*, John Wiley & Sons Ltd., 2007. ISBN: 978-0470-026700.
3. A. Oppelt*, Imaging Systems for Medical Diagnostics*, Publicis Corporate Publishing, 2005. ISBN: 3-89578-226-2.
4. Z-P Liang & P. C. Lauterbur. *Principles of Magnetic Resonance Imaging.* Wiley-IEEE Press, 1999. ISBN: 0-78-034723-4

These books are only recommended if you intend to pursue work or study in this area of engineering.

2.4 Additional Resources

Lecture Information: All the lecture notes are posted on the web page usually a day before the lecture (week #1-#12). Each 3 hour session is structured with 2 hours of lecture and 1 hour of tutorial/practical information.

Lab Information: The handouts and data from all the lab sessions are within the lab section of the website. All types of resources regarding tutorials, links to web pages can be found in this section.

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

Exams: Both the midterm and the final are open book exams. You are allowed your course notes, books and calculator. No other material is allowed.

Miscellaneous Information: Other information which may be beneficial will also posted on the web page.

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3 ASSESSMENT

3.1 Dates and Distribution

Assignments: 20% (2 assignments x 10% each)

Assignment #1: Due Friday, October 4, 2013

Assignment #2: Due Friday, October 18, 2013

Assignment reports and associated files are to be submitted electronically on CourseLink. Please follow the naming convention for files provided in the assignment sheet.

Lab Project: 20%

Final Report: Due Friday, November 22, 2013

The lab work will consist of a running project with sections and data from labs released through the course. All students are required to consult with the instructor midway (weeks 7-9) through the course to show progress the lab project.

Final report and associated files are to be submitted electronically on CourseLink. Please follow the naming convention for files provided in the assignment sheet.

Midterm Test: 20%

Wednesday, October 23, 2013. 18:30-20:30, Room TBA on Courselink

Final Exam: 40%

Friday, December 6, 2013 Room TBA on WebAdvisor

3.2 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. Students must obtain a grade of 50% or higher on the combined exam and midterm portions (with above weights) 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. There will be no makeup midterm tests.

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/projects more than 3 days late will generally not be accepted.

4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 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, gama cameras, and ultrasound imaging. Emphasis will be on the underlying physics and computation, highlighting factors affecting image quality, patient safety, and clinical use. (First offering - Fall 2013)

Prerequisite(s): MATH*1210, PHYS*1130

4.2 Course Aims

This course aims to familiarize students with current imaging modalities, from both a physics and engineering prospective through to a practical & clinical view. Students are exposed to the underlying physics and engineering to understand their implications in the clinical settings. Comparative applications of the various imaging modalities will be examined.

4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Understand the general concepts and history of medical imaging. Know the benefits and limitations of various modalities.
2. Understand the physics and engineering design of various medical imaging modalities (x-ray, CT, PET, SPECT, ultrasound, MRI & NMR) and the associated equipment and how they contribute to clinical use.
3. In-vivo imaging and challenges.
4. Identify medical image types and associated artifacts and defects.
5. Apply knowledge of underlying physics to postulate modalities for clinical needs and identify errors in imaging systems.
6. Design analysis methods and models to extract clinically relevant information from medical images.
7. Evaluate imaging modalities and postulate methods to improve system design.
8. Concisely and articulately communicate the physics and design of various medical imaging modalities.

4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

Graduate Attribute	Learning Objectives	Assessment
1. Knowledge Base for Engineering	1,2,3	Assignments, Exams
2. Problem Analysis	1,4,5	Assignments, Exams, Project
3. Investigation	6	Labs, Project
4. Design	6	Assignment, Project
5. Use of Engineering Tools	2	Labs, Project
6. Communication	8	Project, Exams
7. Individual and Teamwork	6	Labs
8. Professionalism	-	-
9. Impact of Engineering on Society and the Environment	2	Project
10. Ethics and Equity	-	-
11. Environment, Society, Business, & Project Management	-	-
12. Life-Long Learning	1	-

4.5 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. 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 project.

4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. 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.

4.7 Relationships with other Courses & Labs

Previous Courses:

ENGG*1500: Solving systems of linear equations, matrix algebra, complex numbers.

PHYS*1130: Electrical current and circuit design. Resonance. Doppler effect.

MATH*1200 & MATH*1210: Partial differential equations to solve various image transformation problems. Limits, differentiation, integration, series expansion

Follow-on Courses:

ENGG*4660: Medical imaging from a signals and analysis perspective.

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5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Tuesday	7:00 – 9:50	ROZH 105

Laboratory:

Tuesday	9:30 - 11:20	TBA

5.2 Lecture Schedule

Lectures	Lecture Topics	References	Learning Objectives
1	Overview of Medical Imaging	Chapter 1	1
2	Analyzing Quality	Chapter 2,3	1,2,3,6,7
3	X-Ray & Intro to CT Imaging	Chapter 4,5,6	1,2,3
4	CT and Nuclear Imaging	Chapter 6,7,9	1,2,3,5
5	Ultrasound Imaging	Chapter 10,11	1,2,3,5
6	Introduction to MRI	Chapter 12	1,2,3
7	Clinical Imaging	---	1,2,3,5
8	RF and Gradients in MRI	Chapter 12,13	1,2,
9	Chemical Shift Imaging & Spectroscopy	---	1,2,3
10	Perfusion and Diffusion	---	1,2,3,5
11	Functional MRI	---	1,2,3
12	Advanced MRI Imaging	---	1,2,3

5.3 Lab Schedule

TBA – Always check Courselink. The room for labs may change throughout the semester.

6 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.

7 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.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:

http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:

http://www.academicintegrity.uoguelph.ca/

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:

http://www.uoguelph.ca/engineering/undergrad-counselling-ethics