ENGG*4660 Medical Imaging
Winter 2016

UNIVERSITY *of* GUELPH
School of Engineering

(Revision 0: January 4, 2016)

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1 INSTRUCTIONAL SUPPORT

1.1 Instructor

Instructor:	Bob Dony, Ph.D., P.Eng.
Office:	THRN 2341, ext. 53458
Email:	rdony@uoguelph.ca
Office hours:	TBA on Courselink or by appointment

1.2 Lab Technician

None.

1.3 Teaching Assistants

GTA	Email	Office Hours
Jesse Knight	jknigh04@uoguelph.ca	TBA

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2 LEARNING RESOURCES

2.1 Course Website

Course material, news, announcements, and grades will be regularly posted to the ENGG*4460 Courselink site. You are responsible for checking the site regularly.

2.2 Required Resources

None.

2.3 Additional Resources

- Gonzalez, Woods, Eddins, *Digital Image Processing using MATLAB*, Pearson Prentice Hall, 2004

- Gonzalez, Woods, *Digital Image Processing*, Addison-Wesley, 1992

- Castleman, *Digital Image Processing*, Prenice Hall, 1996

- Prince, Links, *Medical Imaging: Signals and Systems*, Pearson Prentice Hall, 2006

- Suetens, *Fundamentals of Medical Imaging*, Cambridge, 2002

2.4 Communication and Email Policy

Please use lectures and lab help sessions as your main opportunity to ask questions about the course. Major announcements will be posted to the course website. It is your responsibility to check the course website regularly. As per university regulations, all students are required to check their ¡mail.uoguelph.ca¿ e-mail account regularly: e-mail is the official route of communication between the University and its students.

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3 ASSESSMENT

3.1 Dates and Distribution

Computer Labs/Assignments: 40%
See section 5.3 below for dates

Midterm 25%
Thu Mar 3, In Class

Final Exam: 35%
Fri Apr 22, 11:30-13:30, 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 as attached in Appendix A

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 Consideration of Religious Obligations as attached in Appendix A

Passing grade: As per University policy, the minimum passing grade is 50%.

Missed midterm tests: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of any missed test will be added to the final exam weight. There will be no makeup midterm tests.

Late Assignments: Late submission of assignments will not be accepted.

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4 AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

4.1 Calendar Description

This course covers the fundamentals of medical image processing. Image processing topics covered include: fundamentals of resolution and quantization; linear systems as applied to multi-dimensional continuous and discrete systems including the relationship between the point spread functions and modulation transfer function; point operations such as contrast enhancement, histogram equalization, and H and D curves, geometric operations for distortion correction, including interpolation methods; linear filtering in both the spatial and spatial-frequency domains; and image restoration and inverse filtering; image segmentation and pattern recognition; and multimodal processing such as image registration. Emphasis will be placed on applications for medical imaging.[1]
Prerequisite(s): ENGG*3390

4.2 Course Aims

Medical imaging is a rapidly developing field within biomedical engineering. There is a demand both within the research community and in clinical support for people with knowledge of the imaging process for the various modalities and the digital image processing techniques for enhancing, restoring and manipulating digital images.

Note: Previous offerings of ENGG*4660 also included material that dealt with the various imaging modalities such as x-ray radiography, CT, MRI, ultrasound, etc., covering the basic physics of image formation with emphasis on the parameters which affect image quality. With the first offering of ENGG*4040 Medical Imaging Modalities in Fall 2013, this material has now been moved from ENGG*4660 to ENGG*4040.

4.3 Learning Objectives

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

1. Relate the point spread function to image resolution both in terms of spatial and spatial-frequency measurements.

2. Perform filtering operations in both the spatial and spatial-frequency domains.

3. Explain the effects and uses of the various image processing techniques on digital images.

4. Given a corrupted image, justify a choice of image processing operators to restore or enhance the image, design and implement the operators, and evaluate both qualitatively and quantitatively the results.

5. Describe the components of pattern recognition and explain their limitations.

6. Justify the choice of segmentation technique given an end-use application.

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[1]Revised Calendar description pending

7. Implement various segmentation techniques as appropriate.

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

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/D2L 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*3390: Provides a background in linear systems theory and signal processing.

5 TEACHING AND LEARNING ACTIVITIES

5.1 Timetable

Lectures:

Tuesday		10:00-11:20	MACN 118
Thursday		10:00-11:20	MACN 118

Laboratory:

Monday	Sec 01	14:30 - 16:20	THRN 2336
Friday	Sec 02	13:30 - 15:20	THRN 2336

5.2 Lecture Schedule

Day	Lecture Topics	Learning Objectives
Jan 12	2D Signals	1,2
Jan 14	2D Systems	1,2
Jan 19	Fourier	1,2
Jan 21	Human Visual System	1,3
Jan 26	Vision and Resolution	1,3
Jan 28	MATLAB Image Processing	-
Feb 2	Point Operations and the Histogram	3
Feb 4	Histogram Equalization	3
	Algebraic Operations	
Feb 9	Geometric Operations	3
Feb 11	Image Registration	3
Reading Week		
Feb 23	Filtering	2-4
Feb 25	Optimal Filtering	2-4
Mar 1	Optimal Filtering	2-4
Mar 3	**Midterm**	
Mar 8	Wavelets	2-4
Mar 10	Wavelets	2-4
Mar 15	Segmentation	5-7
Mar 17	Thresholding and Edge Detection	5-7
Mar 22	Pattern Classification	5-7
Mar 24	Multi-Dimensional Pattern Recognition	5-7
Mar 29	Supervised Learning Systems	5-7
Mar 31	Unsupervised Learning	5-7
Apr 5	Neural Networks	5-7
Apr 7	Non-linear filtering	
	3D Modelling and Visualization	

5.3 Lab Schedule

Week	Topic	Due
2	Introduction to MATLAB	-
3-5	Point and Geometric Operations	Feb 11
5	Image Registration	Feb 25
6-7	Filtering	Mar 10
8-7	Optimal Filtering	Mar 24
9-12	Segmentation	Apr 7

5.4 Other Important Dates

Monday, January 11 2016: First day of class

Monday, February 15 - Friday, February 19 2016: Winter Break

Friday, March 11 2016: drop date - 40th class

Friday, April 8 2016: last day of class

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6 LAB SAFETY

N/A.

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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.

Please see the Academic Misconduct Policy as detailed in the Undergraduate Calendar as attached in Appendix A.

7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar as attached in Appendix A.

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

8 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact Student Accessibility Services as soon as possible

For more information, contact SAS at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

9 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, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

10 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:
http://www.uoguelph.ca/registrar/calendars/index.cfm?index