BIOM9027

Medical Imaging

Term 3, 2021

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Robert Nordon	r.nordon@unsw.edu.au			+61938505 58

Lecturers

Name	Email	Availability	Location	Phone
Mitra Safavi-Naeini	m.safavi-naeini@unsw.edu.au		ANSTO	+61 2 9717 3143
Claudia Hillenbrand	claudia.hillenbrand@unsw.edu.au		Level 1, Building 3, Prince of Wales Hospital, Randwick, NSW, 2031	

School Contact Information

Student Services can be contacted via unsw.to/webforms.

Course Details

Units of Credit 6

Summary of the Course

Medical imaging technology has played a pivotal role in the development of modern medicine. Medical imaging was born with the discovery of X-rays by Röntgen in 1895. During the early part of the 20th century, the development of modern physics led to both harmful and beneficial applications that have had profound influences on society. This interplay between physics, engineering and medicine led to development of X-ray imaging, nuclear isotope imaging, magnetic resonance imaging and ultrasound. More recently, advances in computational power and algorithms for image analysis is playing a more central role in automated analysis of medical images and computer-assisted diagnostics.

Course Aims

This course will provide fundamental theory and applications of medical imaging technologies, enabling graduates to work in the biomedical imaging industry in a R&D or management role and to communicate with expert practitioners related to this field. The learning outcomes listed above relate most strongly to the following UNSW graduate capabilities

- The skills involved in scholarly enquiry
- An in-depth engagement with the relevant disciplinary knowledge in its inter-disciplinary context
- The capacity for analytical and critical thinking and for creative problem solving.
- A capacity to contribute to and work within the international community.
- Information literacy - the skills to appropriately locate, evaluate and use relevant information.
- The ability to engage in independent and reflective learning.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Demonstrate an understanding of the physical basis of medical imaging	PE1.1
2. Apply mathematical and computational tools for image formation	PE1.2
3. Provide technical explanations for imaging artifacts	PE1.3
4. Critically evaluate medical imaging technologies from a technical and safety perspective	PE1.5, PE1.6, PE3.1
5. Communicate effectively with medical professions working in the field of medical imaging	PE3.2, PE3.4

Teaching Strategies

Suggested approach to learning	All of the course content will be delivered online using Moodle for content and assignments. Microsoft Teams will be used for the delivery of live tutorials and group work. The tutorial will be web-based delivered using the Microsoft Teams platform. This will provide students the opportunity to work on set problems, directly with their colleages and the lecturer
Lectures	Each week there will be a lecture of approximately one to three hours depending on the modality. Lecture will be held online via Microsoft Teams. Magnetic Resonance Imaging and Nuclear Medical Imaging will have 3-hour lectures, while X-ray imaging image processing will have a 1-hour lecture followed by an online computer lab
Tutorials	The tutorials will be Matlab based computer labs intended to teach the principles of imaging reconstruction, restoration and enhancement. Tutorials will be face-to-face and optionally online.
Online activities	Computer vision tutorials will be delivered as online activities.
Assessments	Assignments (50%) There will be four assignments, one for each modality (x-ray, nuclear medical imaging, magnetic resonance imaging) and image analysis. Final examination (50%) The final exam consists of four sections, one for each imaging modality and image analysis. These are short answer questions that require some calculation and have a very similar format to the assignment questions. The online exam will be open book.

Additional Course Information

This course is an introduction to medical imaging by x-ray, nuclear isotype and magnetic resonance imaging as well as image processing. The course is interdisciplinary drawing from physics, mathematics and computer science. Whilst it is not necessary to have taken an undergraduate course in physics and computer science, a background in signal analysis (BIOM9621) or related subject is a highly desirable. Please contact us to determine if your educational background is appropriate for this course.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. X ray imaging assignment	13%	05/10/2021 12:00 AM	1, 2, 3
2. Image analysis assignment	13%	06/10/2021 12:00 AM	2
3. Magnetic resonance imaging	13%	26/10/2021 12:00 AM	1, 2, 3, 4, 5
4. Nuclear medicine imaging	13%	10/11/2021 12:00 AM	1, 2
5. Final Exam	50%	Not Applicable	1, 2, 3, 4, 5

Assessment 1: X ray imaging assignment

Assessment length: N/A
Submission notes: See moodle
Due date: 05/10/2021 12:00 AM

Will cover x-ray production, interaction with tissues, and imaging including CT reconstruction

Assessment 2: Image analysis assignment

Due date: 06/10/2021 12:00 AM

A MATLAB programmatic exercise which applies methods such as image restoration, enhancement, registration and segmentation

Assessment 3: Magnetic resonance imaging

Due date: 26/10/2021 12:00 AM

Will cover the physical principles of nuclear magnetic resonance, excitation and RF signal analysis and image formation

Assessment 4: Nuclear medicine imaging

Due date: 10/11/2021 12:00 AM

Will cover the physics interaction of high energy radiation with tissues, radiopharmaceuticals and detectors, as well a digital imaging and data processing.

Assessment 5: Final Exam

The final exam will cover x-ray, magnetic resonance, imaging analysis and nuclear medical imaging. The exam is online (moodle) and open book.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

Contact hours	3 hours per week	
Lecture	Wednesday, 3:00 – 4:00 pm	online
Tutorial/Laboratory		
Face-to-face with social distancing or online	Wednesday, 4:00 – 6:00 pm	**Mathews 103** (or online if lockdown still inforced)
or		
Web based	TBA	Microsoft Teams

View class timetable

Timetable

Date	Type	Content
Week 1: 13 September - 17 September	Online Activity	Introduction medical imaging, X-ray production and interaction with tissues, Radon transform. Lecturer: Robert Nordon
	Online Activity	Image Enhancement and Registration (online lecture and tutorial). Lecturer: Robert Nordon
Week 2: 20 September - 24 September	Online Activity	X-ray imaging, Fourier transform, Line integrals and Central Slice Theorem. Lecturer: Robert Nordon
	Online Activity	Image Segmentation (online lecture and tutorial). Lecturer: Robert Nordon
Week 3: 27 September - 1 October	Online Activity	CT image reconstruction, inverse radon transforms, sampling errors. Lecturer: Robert Nordon
	Online Activity	Feature Classification (online lecture and tutorial). Lecturer: Robert Nordon
Week 4: 4 October - 8 October	Online Activity	Principles of magnetic resonance imaging 1. Lecturer: Dr Claudia Hillenbrand
Week 5: 11 October - 15 October	Online Activity	Principles of magnetic resonance imaging 2. Lecturer: Dr Claudia Hillenbrand
Flexi-Week: 18 October - 22 October	Fieldwork	Tour of Research Imaging (NSW) Randwick Precinct (may be virtual, depending on Lockdown restrictions)

Week 7: 25 October - 29 October	Online Activity	MRI Hardware and special imaging methods. Lecturer: Dr Claudia Hillenbrand
Week 8: 1 November - 5 November	Online Activity	Nuclear medicine: physics, radiopharmaceuticals, detectors. Lecturer: Dr Mitra Safavi-Naeini
Week 9: 8 November - 12 November	Online Activity	Nuclear medicine: digital imaging and data processing. Lecturer: Dr Mitra Safavi-Naeini
Week 10: 15 November - 19 November	Online Activity	Nuclear medicine: SPECT and PET / Revision. Lecturer: Mitra Safavi-Naeini

Resources

Prescribed Resources

All material will be provided via Moodle and Teams. Online activities including lectures and tutorials will utilise the Teams platform.

Recommended Resources

DATES TO NOTE

Refer to MyUNSW for **Important Dates**.

PLAGIARISM

Beware! An assignment that includes plagiarised material will receive a 0% Fail, and students who plagiarise may fail the course. Students who plagiarise will have their names entered on plagiarism register and will be liable to disciplinary action, including exclusion from enrolment.

It is expected that all students must at all times submit their own work for assessment. Submitting the work or ideas of someone else without clearly acknowledging the source of borrowed material or ideas, is plagiarism.

All assessments which you hand in **must** have a **Non Plagiarism Declaration Cover Sheet**. This is for both individual and group work. Attach it to your assignment before submitting it to the Course Coordinator or at the School Office.

Plagiarism is the use of another person's work or ideas as if they were your own. When it is necessary or desirable to use other people's material you should adequately acknowledge whose words or ideas they are and where you found them (giving the complete reference details, including page number(s)). The Learning Centre provides further information on what constitutes Plagiarism at:

https://student.unsw.edu.au/plagiarism

ACADEMIC ADVICE

- Contract cheating and 'sharing' of assignment answers are very serious breaches of academic conduct. Please read the **student conduct policy** and the **academic misconduct procedure**. It is expected that students attend all lectures and tutorial sessions.
- Assignments submitted after the due date without prior notification and permission will be subject to a deduction in marks.
- UNSW has a wide range of student support services. The resources listed below should be used by students needing assistance related to aspects of their overall University experience. Specific help regarding this course can be sought from the course coordinator.

http://www.student.unsw.edu.au/

https://my.unsw.edu.au/student/howdoi/HowDoI_MainPage.html

http://www.counselling.unsw.edu.au/

- Students with a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator before, or at the commencement of, their course, and should contact the **Equitable Learning Service.** Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam or assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.
- If you believe that your performance in an assessable component of the course has been affected by illness or another unexpected circumstance, you should make an application for special consideration as soon as possible after the event by visiting UNSW Student Central. Please talk to the course coordinator as well and note that considerations are not granted automatically.
- UNSW has strict policies and expectations relating to Occupational Health and Safety (OHS) accessed at **http://www.ohs.unsw.edu.au/**

Course Evaluation and Development

Student feedback has helped to shape and develop this course, including feedback obtained from on-line evaluations as part of UNSW's Course and Teaching Evaluation and Improvement process (**MyExperience**).

Submission of Assessment Tasks

Laboratory reports and major assignments will require a Non Plagiarism Declaration Cover Sheet.

Late submissions will be penalised 10% of the mark for each calendar day late. If you foresee a problem in meeting the nominated submission date please contact the Course Convenor to make an appointment to discuss your situation as soon as possible.

Academic Honesty and Plagiarism

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Academic Information

COURSE EVALUATION AND DEVELOPMENT
Student feedback has helped to shape and develop this course, including feedback obtained from on-line evaluations as part of UNSW's as part of UNSW's myExperience process. You are highly encouraged to complete such an on-line evaluation toward the end of Term. Feedback and suggestions provided will be important in improving the course for future students.

DATES TO NOTE
Refer to MyUNSW for Important Dates, available at:
https://my.unsw.edu.au/student/resources/KeyDates.html

ACADEMIC ADVICE
For information about:

- Notes on assessments and plagiarism,
- Special Considerations,
- School Student Ethics Officer, and
- BESS

refer to the School website available at
http://www.engineering.unsw.edu.au/biomedical-engineering/

Supplementary Examinations:

Supplementary Examinations for Term 3 2021 will be held on Monday 10th January – Friday 14th January (inclusive) should you be required to sit one.

Image Credit

Wilhelm Conrad Roentgen, discovered x-rays in 1895. This is the first x-ray of a human (Roentgen's wife's hand).

Online Radiography Continuing Education for Radiologic X ray Technologist. Biological Effects of Irradiation (ceessentials.net)

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	✓
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	
PE2.2 Fluent application of engineering techniques, tools and resources	
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	✓
PE3.2 Effective oral and written communication in professional and lay domains	✓
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	✓
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	