ELEC316

Medical Imaging Systems

S1 Day 2019

School of Engineering

Contents

General Information

Unit convenor and teaching staff
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Credit points
3

Prerequisites
ELEC215 and MATH235 and (ELEC270 or PHYS201)

Corequisites

Co-badged status

Unit description
The aim of this unit is to provide a basic understanding of various medical imaging systems such as X-ray, CT, Ultrasound, PET, SPECT and MRI. The unit consists of five modules. Each module covers the basic working principles, underlying physics, system hardware and image reconstruction principles, for each specific imaging modality. In the first module, an overview of X-ray and CT imaging systems will be provided. This will be followed by a second module on nuclear medicine which consists of PET and SPECT systems. Module three will include ultrasound system explaining about systems based on Pulse Echo and Doppler Effect. Module four will explain about MRI where basic MR physics, imaging principles, and image reconstruction algorithms will be explained followed by introduction of system designs at various magnetic fields. In module five, various other imaging systems such as bio-luminescence and MSOT will be introduced. The theory of medical imaging systems will be tested in practice through tutorials and practical sessions which involve the modelling and simulation exercises on multi-physics design aspects of medical imaging systems. These exercises will be done using a commercial software COMSOL Multiphysics 5.3 and MATLAB. Besides, there will be some hands on experimentation exercises for MRI sub-parts, and optical CT.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).

Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.

Be able to understand the safety aspects and applications of various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI and why their design needs rigorous approvals from government agencies.

Be able to understand the significance of "modeling and simulation" at the design stages of medical imaging systems. Demonstrate their skills in "modeling and simulation" using a commercial software COMSOL Multiphysics 5.4 and understand its capabilities: (a) to perform analysis of sub-parts of medical imaging systems, and (b) to understand the underlying physics of the imaging system and their interaction with human body.

General Assessment Information

Notifications

Formal notification of assessment tasks, grading rubrics and due dates will be posted on iLearn. Although all reasonable measures to ensure the information is accurate, the University reserves the right to make changes without notice. Each student is responsible for checking iLearn for changes and updates.

Weekly Plan

A weekly plan of lectures, assignments, tests, laboratory and workshop sessions will be posted on iLearn. Students are expected to be aware of possible minor variations.

Assignment Tasks

Assignment questions will be posted on iLearn. Assignment solutions will be posted within one to five days after the submission date. Submissions will not be accepted once the solution is

posted.

All assignments must be submitted electronically through iLearn (in pdf format). Submissions are expected to be typed in a logical layout and sequence. Markers WILL NOT grade poorly organized or illegible scans or drafts. Illegible scans or drafts are assignments that are handwritten or digital photographed with for example a smartphone. The expected workload includes preparation of final copies and clear diagrams. Resubmissions will be permitted up to due date.

All assignments should be prepared individually. It is expected that students consult tutors, lecturers or other students while learning the concepts, but copying assignments from others is not accepted. Students are expected to have read and understood the academic honesty policy.

Absences

Late notices or absences from tests, workshops and laboratories will be considered under extenuating circumstances upon lodgement and approval of a formal notice of disruption of studies.

Grading

To obtain a passing grade (P/CR/D/HD) a total mark of 50% or more is required AND a mark of 50% or more is required for the final examination. The final exam is a hurdle requirement because it is the only reliable assessment of individual performance for this unit. A passing grade of 50% or more in the final examination is a condition of passing this unit. Students who make a serious attempt but fail to meet the hurdle requirement will be given one further opportunity to pass. A serious attempt is defined as achievement of a mark of 40% or greater.

Assessment Tasks

Name	Weighting	Hurdle	Due
Laboratory and Tutorials	15%	No	Weekly (starts in week 2)
CT Image Reconstruction	10%	No	Week 7
COMSOL Project 1	15%	No	Week 9
COMSOL Project 2	15%	No	Week 12
Exam	45%	Yes	Week 14-16

Laboratory and Tutorials

Due: **Weekly (starts in week 2)**
Weighting: **15%**

Laboratory and Problem-solving assignments

Practical sessions start in week 2 and are comprised of laboratory or problem-solving workshop

sessions linked to the learning outcomes. Practical sessions are compulsory for all students. Students are expected to arrive on time and use the laboratory time efficiently. Students should enroll in one practical class at the beginning of the semester. Laboratory or workshop worksheets, required data and other necessary items will be posted on iLearn prior to the weekly sessions and it is compulsory for students to complete the preparatory work before coming to the session. It is strongly advisable to rehearse the lecture material before each practical session.

Practicals will be largely assessed in class but there may be some "take-home" assignments for the laboratory sections. More information will be available on iLearn.

In laboratory sessions, students learn: (a) how to acquire data from an optical CT scanner and Nuclear Magnetic Resonance (NMR) system, and (b) use MATLAB based programs for image reconstruction and data processing in CT and MRI, and (c) use COMSOL Multiphysics 5.4 for "modeling and simulation" tasks to understand the working principles and design of various sub-parts of medical imaging systems. Students do not need to bring their personal laptop to the laboratory sessions. Computers with the required software (such as MATLAB and COMSOL Multiphysics 5.4) will be provided.

This Assessment Task relates to the following Learning Outcomes:

- Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).
- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.
- Be able to understand the safety aspects and applications of various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI and why their design needs rigorous approvals from government agencies.
- Be able to understand the significance of "modeling and simulation" at the design stages of medical imaging systems. Demonstrate their skills in "modeling and simulation" using a commercial software COMSOL Multiphysics 5.4 and understand its capabilities: (a) to perform analysis of sub-parts of medical imaging systems, and (b) to understand the underlying physics of the imaging system and their interaction with human body.

On successful completion you will be able to:

- Demonstrate an understanding of the differences between various medical imaging

systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).

- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.
- Be able to understand the safety aspects and applications of various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI and why their design needs rigorous approvals from government agencies.

CT Image Reconstruction

Due: **Week 7**
Weighting: **10%**

Assignment Title: CT image reconstruction from raw data

Assignment Task: You will acquire raw data from an optical CT scanner and you have to use an algorithm you learnt in class and practical sessions, to write a program in MATLAB to reconstruct CT image from this raw data. You must also write a report on this assignment.

This Assessment Task relates to the following Learning Outcomes:

Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.

On successful completion you will be able to:

- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.

COMSOL Project 1

Due: **Week 9**
Weighting: **15%**

Project Title: Design and Analysis of a Sub-part of a Medical Imaging System

Project Task: Choose any medical imaging system from X-ray, CT, PET, SPECT. Review

various sub-parts of your chosen system and propose a design analysis or design modification of any sub-part of your chosen system. You must make a report for this assignment where you must write following sections: (a) **Introduction** of your sub-part chosen and what problem you are trying to analyze (b) **Methods** you are using to solve your problem including mathematical equations used (c) **Results** of your analysis with figures (d) **Discussion** of your results where you must write reasons and critical analysis for why you think you obtained those results (e) **Conclusion** where you must write if you could achieve the goal you set for this problem.

This Assessment Task relates to the following Learning Outcomes:

Be able to understand the significance of "modeling and simulation" at the design stages of medical imaging systems. Demonstrate their skills in "modeling and simulation" using a commercial software COMSOL Multiphysics 5.4 and understand its capabilities: (a) to perform analysis of sub-parts of medical imaging systems, and (b) to understand the underlying physics of the imaging system and their interaction with human body.

On successful completion you will be able to:

- Be able to understand the significance of "modeling and simulation" at the design stages of medical imaging systems. Demonstrate their skills in "modeling and simulation" using a commercial software COMSOL Multiphysics 5.4 and understand its capabilities: (a) to perform analysis of sub-parts of medical imaging systems, and (b) to understand the underlying physics of the imaging system and their interaction with human body.

COMSOL Project 2

Due: **Week 12**
Weighting: **15%**

Project Title: Focused Ultrasound Induced Heating in Tissue Phantom

Background: When an ultrasound beam passes through a volume of tissue, some of the energy of the primary acoustic field is absorbed locally by the tissue and turned into heat. This results in a temperature increase whose magnitude is a function of the physical properties of the medium (acoustic absorption coefficient, density, and specific heat), the properties of the ultrasound device (beam geometry), and the frequency and time-averaged acoustic intensity of the acoustic field.

Project Task: Research some material related to the above background statement and create a model geometry in COMSOL for a phantom and ultrasound probe of your choice. Propose a heat analysis problem and find its solution using COMSOL. You must make a report for this assignment where you must write following sections: (a) **Introduction** of your chosen geometry for ultrasound probe and phantom, and what problem you are trying to analyze (b) **Methods** you are using to solve your problem including mathematical equations used (c) **Results** of your analysis with figures (d) **Discussion** of your results where you must write reasons and critical analysis for why you think you obtained those results (e) **Conclusion** where you must write if you could achieve the goal you set for this problem.

This Assessment Task relates to the following Learning Outcomes:

Be able to understand the significance of "modeling and simulation" at the design stages of medical imaging systems. Demonstrate their skills in "modeling and simulation" using a commercial software COMSOL Multiphysics 5.4 and understand its capabilities: (a) to perform analysis of sub-parts of medical imaging systems, and (b) to understand the underlying physics of the imaging system and their interaction with human body.

On successful completion you will be able to:

- Be able to understand the significance of "modeling and simulation" at the design stages of medical imaging systems. Demonstrate their skills in "modeling and simulation" using a commercial software COMSOL Multiphysics 5.4 and understand its capabilities: (a) to perform analysis of sub-parts of medical imaging systems, and (b) to understand the underlying physics of the imaging system and their interaction with human body.

Exam

Due: **Week 14-16**
Weighting: **45%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Invigilated test of the learning outcomes.

This Assessment Task relates to the following Learning Outcomes:

- Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).
- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.
- Be able to understand the safety aspects and applications of various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI and why their design needs rigorous approvals from government agencies.

On successful completion you will be able to:

- Demonstrate an understanding of the differences between various medical imaging

systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).

- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.
- Be able to understand the safety aspects and applications of various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI and why their design needs rigorous approvals from government agencies.

Delivery and Resources

Delivery of this course is through a series of 13 theoretical lectures of 2 hours each and a series of practical sessions / tutorials.

The theoretical lecture series consist of 5 modules:

1. Radiographic Imaging: Physics of radiography, X-ray imaging, CT imaging

2. Nuclear Medicine Imaging: PET, SPECT

3. Ultrasound: Physics of ultrasound, Pulse Echo, Doppler

4. Magnetic Resonance Imaging: Physics of MRI, MRI hardware and software components, image reconstruction

5. Other Imaging Modalities: Bio-luminescence, optical

The practical sessions and tutorials involve hands-on programming and "modeling and simulation" assignments. Tutorial sessions will be provided to teach how to process signals and images in MATLAB, write MATLAB scripts and functions, and how to use COMSOL Multiphysics 5.4.

Technology used and required

- Word processing (MS Word, Latex, ...)
- MATLAB (can be downloaded from the university depositories)
- COMSOL Multiphysics 5.4 (it is a licensed software which can only be accessed from Lab Room No 237 during practical sessions and the data required to complete COMSOL Project 1 and 2 must be completed only at Lab No 237 during practical sessions)
- Powerpoint (or alternative presentation software (e.g. SliTex))
- Library and Internet search engines

Textbooks

The provided lecture material should be sufficient to obtain a profound understanding of the covered topics but some helpful textbooks are as follows:

1. The Essential Physics in Medical Imaging. Third Edition, Wolters Kluwer Health (by Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone).

2. Medical Imaging Signals and Systems. Second Edition, Pearson (by Jerry L. Prince, Jonathan M. Links)

Other learning material for further reading will be recommended on iLearn and/or in the lecture notes

Unit Schedule

Week	Lecture	Practical / Tutorial
Radiographic Imaging		
1	Physics of radiography	-
2	Interaction of x-ray with matter	X-ray attenuation and multiple other short problems in physics of radiography
3	X-ray - system and imaging equations	Introduction to COMSOL Multiphysics Modeling - practice session with x-ray
4	CT - system and imaging equations	Optical CT (acquire data and image reconstruction)
Nuclear Medicine Imaging		
5	Nuclear Imaging - the scintillation camera	Optical CT (acquire data and image reconstruction)
6	Nuclear Imaging - SPECT system and imaging equations	SPECT reconstruction tutorial and MATLAB programming
7	Nuclear Imaging - PET system and imaging equations	PET reconstruction tutorial and MATLAB programming
Ultrasound		
8	Ultrasound - physics and interaction with matter	Multiple short problems in physics of ultrasound
9	Ultrasound - system and imaging equations	Modeling of acoustic waves in ultrasound using COMSOL Multiphysics
Magnetic Resonance Imaging		
10	MRI - basic physics	Focused Ultrasound induced heating in tissue phantom using COMSOL Multiphysics
11	MRI - system and imaging equations	Multiple short problems in physics of MRI
12	MRI - data acquisition	NMR demo in laboratory
Other Imaging Modalities		
13	Bio-luminescence, optical imaging	T1/T2 relaxometry

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).
- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system,

mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.

- Be able to understand the significance of "modeling and simulation" at the design stages of medical imaging systems. Demonstrate their skills in "modeling and simulation" using a commercial software COMSOL Multiphysics 5.4 and understand its capabilities: (a) to perform analysis of sub-parts of medical imaging systems, and (b) to understand the underlying physics of the imaging system and their interaction with human body.

Assessment tasks

- Laboratory and Tutorials
- COMSOL Project 1
- COMSOL Project 2

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).
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underlying physics of the imaging system and their interaction with human body.

Assessment tasks

- Laboratory and Tutorials
- COMSOL Project 1
- COMSOL Project 2
- Exam

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).
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Assessment tasks

- Laboratory and Tutorials
- CT Image Reconstruction

- COMSOL Project 1
- COMSOL Project 2
- Exam

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).
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Assessment tasks

- Laboratory and Tutorials
- CT Image Reconstruction
- COMSOL Project 1
- COMSOL Project 2

- Exam

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).
- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.
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Assessment tasks

- Laboratory and Tutorials
- CT Image Reconstruction
- COMSOL Project 1
- COMSOL Project 2
- Exam

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing

data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an understanding of the differences between various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).
- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.
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Assessment tasks

- Laboratory and Tutorials
- CT Image Reconstruction
- COMSOL Project 1
- COMSOL Project 2
- Exam

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an understanding of the differences between various medical imaging

systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: underlying physics, working principle, hardware system, software system (including image reconstruction principle).

- Demonstrate an understanding of the differences in the image reconstruction algorithms of various medical imaging modalities including X-ray, CT, PET, SPECT, Ultrasound, and MRI in following aspects: mathematical model of raw data from system, mathematical model of reconstructed data, and programming of image reconstruction algorithm in MATLAB.
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Assessment tasks

- Laboratory and Tutorials
- CT Image Reconstruction
- COMSOL Project 1
- COMSOL Project 2
- Exam

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcome

- Be able to understand the safety aspects and applications of various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI and why their design needs rigorous approvals from government agencies.

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcome

- Be able to understand the safety aspects and applications of various medical imaging systems including X-ray, CT, PET, SPECT, Ultrasound, and MRI and why their design needs rigorous approvals from government agencies.

Assessment task

- Laboratory and Tutorials