COURSE DETAILS

Units of Credit 6

Contact hours 3 hours per week

Lecture Wednesday, 9:00 – 10:00 am online

Tutorial/Laboratory

Face-to-face with social distancing Wednesday, 10:00 – 12:00 pm Tyree Energy Technology G16 Room G16

or

Web based TBA Microsoft Teams

Course Coordinator Robert Nordon

email: r.nordon@unsw.edu.au

office: 515c

phone: 93850559

Lecturers

Dr Robert Nordon (r.nordon@unsw.edu.au)
Dr Andre Bongers (andre.bongers@unsw.edu.au)
Dr Mitra Safavi-Naeini (mitras@ansto.gov.au)
### INFORMATION ABOUT THE COURSE

**Presumed knowledge and skills**

Biological Signal Analysis (BIOM9621) or equivalent

Fourier Transform and Sampling Theory

**How BIOM9027 relates to other courses**

This course is an introduction to medical imaging by x-ray, nuclear isotope 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.

### COURSE DESCRIPTION

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 20\textsuperscript{th} 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.

### OBJECTIVES

To develop an understanding of the principles of medical imaging technologies from an engineering perspective.

**Graduate attributes**

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 interdisciplinary 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.
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. A face-to-face tutorial has been scheduled for Sydney based students, as well as a Web-based tutorial for Overseas or Interstate students. The Web-based tutorial will be delivered using the Microsoft Teams platform. |
| 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. |

EXPECTED LEARNING OUTCOMES

On completion of this subject, students should be able to:

a) demonstrate an understanding of the physical basis of medical imaging

b) apply mathematical and computational tools for image formation

c) provide technical explanations for imaging artifacts

d) critically evaluate medical imaging technologies from a technical and safety perspective

e) communicate effectively with medical professions working in the field of medical imaging
## ASSESSMENT

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Contribution</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>X ray imaging assignment</td>
<td>12.5%</td>
<td>Will cover x-ray production, interaction with tissues, and imaging including CT reconstruction</td>
</tr>
<tr>
<td>Nuclear Medical Imaging assignment</td>
<td>12.5%</td>
<td>Will cover the physics interaction of high energy radiation with tissues, radiopharmaceuticals and detectors, as well a digital imaging and data processing</td>
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<tr>
<td>Magnetic resonance imaging assignment</td>
<td>12.5%</td>
<td>Will cover the physical principles of nuclear magnetic resonance, excitation and RF signal analysis and image formation</td>
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<tr>
<td>Image analysis assignment</td>
<td>12.5%</td>
<td>A MATLAB™ programmatic exercise which applies methods such as image restoration, enhancement, registration and segmentation</td>
</tr>
<tr>
<td>Final examination</td>
<td>50%</td>
<td>The final exam will cover x-ray, magnetic resonance and nuclear medical imaging. There will also be questions on image analysis.</td>
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## ASSIGNMENTS

1. Xray imaging issued by 23 September, due on 6 October
2. Image analysis issued by 7 October, due on 27 October
3. Magnetic resonance issued by 27 October, due on 10 November
4. Nuclear medicine issued by 11 November, due on 27 November

*Penalties for late submissions will be at the rate of 2% per day after the due time and date have expired.*
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lecturers</th>
<th>Subjects covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16 September</td>
<td>Dr R Nordon</td>
<td>Introduction medical imaging, X-ray production and interaction with tissues, Radon transform Image Enhancement and Registration (online lecture and tutorial)</td>
</tr>
<tr>
<td>2</td>
<td>23 September</td>
<td>Dr R Nordon</td>
<td>X-ray imaging, Fourier transform, Line integrals and Central Slice Theorem Image Segmentation (online lecture and tutorial)</td>
</tr>
<tr>
<td>3</td>
<td>30 September</td>
<td>Dr R Nordon</td>
<td>CT image reconstruction, inverse radon transforms, sampling errors Feature Classification (online lecture and tutorial)</td>
</tr>
<tr>
<td>4</td>
<td>7 October</td>
<td>Dr A Bongers</td>
<td>Principles of magnetic resonance imaging 1</td>
</tr>
<tr>
<td>5</td>
<td>14 October</td>
<td>Dr A Bongers</td>
<td>Principles of magnetic resonance imaging 2</td>
</tr>
<tr>
<td>6</td>
<td>21 October</td>
<td>Professor Daniel Moses</td>
<td>Clinical Radiology</td>
</tr>
<tr>
<td>7</td>
<td>28 October</td>
<td>Dr A Bongers</td>
<td>MRI Hardware and special imaging methods</td>
</tr>
<tr>
<td>8</td>
<td>4 November</td>
<td>Dr M Safavi-Naeini</td>
<td>Nuclear medicine: physics, radiopharmaceuticals, detectors</td>
</tr>
<tr>
<td>9</td>
<td>11 November</td>
<td>Dr M Safavi-Naeini</td>
<td>Nuclear medicine: digital imaging and data processing</td>
</tr>
<tr>
<td>10</td>
<td>18 November</td>
<td>Dr M Safavi-Naeini</td>
<td>Nuclear medicine: SPECT and PET / Revision</td>
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RELEVANT RESOURCES
All material will be provided via Moodle

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).

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
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/