COURSE DETAILS

Units of Credit 6
Contact hours 3 hours per week
Lecture Tuesday, 6:00 – 9:00 pm Mathews 102 (Active Learning Space)

Tutorial/Laboratory Tuesday, 7:00 – 9:00 pm Mathews 102 (Active Learning Space)

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 Stefan Eberl (stefan@cs.usyd.edu.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 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.

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 learning material will be posted onto Moodle prior to lectures. We strongly advise that students attend all lectures as lecture material is incomplete and will require a significant level of interaction with the lecturers. Most of the students comment that their understanding was significantly enhanced by the assignments. It is important to master the skills developed by these assignments and work independently rather than groups. Any evidence of collusion between students or sharing assignment answers will be recorded against your academic record, with penalties for repeat offenders. Furthermore, 50% of the assessment so it is in your interests to develop your own problem solving skills.

Students will receive marked assignments and the answers and can communicate with lecturers via moodle or during class. Students will not be expected to memorize formulae for the final exam; these will be provided on the exam paper. The formulae list will not provide symbol definitions, so the student will require a sound understanding of how to apply formulae to solve medical imaging problems. Always check your units when solving problems! We also recommend that you prepare your own list of formulae for revision.

Lectures

Each week there will be a lecture of approximately one to three hours depending on the modality. 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 computer lab.

Tutorials

The tutorials will be Matlab based computer labs intended to teach the principles of imaging reconstruction, restoration and enhancement.

Assessments

Assignments (50%)
There will be four assignments, one for each modality (x-ray, nuclear medical imaging, magnetic resonance imaging) and image analysis. The students will have 2 weeks to complete each assignment, and they should receive their marked assignment before the last lecture for that modality (see timetable).

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. Only University approved calculators are allowed into exams.

Generally all complicated formulae and physical constants will be provided on the exam paper, though the definitions of symbols will not be provided. You should also check with each lecturer which formulae they would like you to memorize!

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>
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<tr>
<td>Final examination</td>
<td>50%</td>
<td>The final exam will cover xray, magnetic resonance and nuclear medical imaging. There will also be questions on image analysis.</td>
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## ASSIGNMENTS

1. Xray imaging                       | issued on: 8\textsuperscript{th} August due on: 22\textsuperscript{nd} August |
2. Nuclear medicine                   | issued on: 29\textsuperscript{th} August due on: 12\textsuperscript{th} September |
3. Magnetic resonance                 | issued on: 19\textsuperscript{th} September due on: 1\textsuperscript{st} October |
4. Image analysis                     | issued on: 10\textsuperscript{th} October due on: 24\textsuperscript{th} October |

*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>
<th>Assignment release date</th>
<th>Assignment due date</th>
<th>Marked assignment returned to students</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>26 July</td>
<td>Dr R Nordon</td>
<td>Introduction medical imaging, X ray production and interaction with tissues, Radon transform</td>
<td>8 August</td>
<td>22 August</td>
<td>29 August</td>
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<tr>
<td>2</td>
<td>2 August</td>
<td>Dr R Nordon</td>
<td>X ray imaging, Fourier transform, Line integrals and Central Slice Theorem</td>
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<td>3</td>
<td>9 August</td>
<td>Dr R Nordon</td>
<td>CT image reconstruction, inverse radon transform, sampling errors</td>
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<tr>
<td>4</td>
<td>16 August</td>
<td>Dr S Eberl</td>
<td>Nuclear medicine: physics, radiopharmaceuticals, detectors</td>
<td>29 August</td>
<td>12 September</td>
<td>26 September</td>
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<td>5</td>
<td>23 August</td>
<td>Dr S Eberl</td>
<td>Nuclear medicine: digital imaging and data processing</td>
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<td>6</td>
<td>30 August</td>
<td>Dr S Eberl</td>
<td>Nuclear medicine: SPECT and PET / Revision</td>
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<td>7</td>
<td>6 September</td>
<td>Dr A Bongers</td>
<td>Principles of magnetic resonance imaging 1</td>
<td>19 September</td>
<td>3 October</td>
<td>17 October</td>
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<tr>
<td>8</td>
<td>13 September</td>
<td>Dr A Bongers</td>
<td>Principles of magnetic resonance imaging 2</td>
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<td>9</td>
<td>20 September</td>
<td>Dr A Bongers</td>
<td>MRI Hardware and special imaging methods</td>
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<td>Mid Semester Break</td>
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<tr>
<td>10</td>
<td>4 October</td>
<td>Dr R Nordon</td>
<td>Image enhancement and registration</td>
<td>10 October</td>
<td>24 October</td>
<td>31 October</td>
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<tr>
<td>11</td>
<td>11 October</td>
<td>Dr R Nordon</td>
<td>Image Segmentation</td>
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<tr>
<td>12</td>
<td>18 October</td>
<td>Dr R Nordon</td>
<td>Feature Classification</td>
<td></td>
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<tr>
<td>13</td>
<td>25 October</td>
<td>Prof L Bilston</td>
<td>Applications of imaging: from diagnostics to biomechanics</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 (CATEI) process.

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

- Last year we had problems with contract cheating and ‘sharing’ of assignment answers which 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
Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and 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/