UNSW Course Outline

BIOM9660 Bionics and Neuromodulation - 2024

Published on the 12 May 2024

General Course Information

Course Code : BIOM9660
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : Graduate School of Biomedical Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate, Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

A person who was born deaf or lost their hearing later in life can now hear because of a **Cochlear Implant**. A person with Parkinson's disease who lost the ability to control their muscles or someone with epilepsy whose brain suddenly goes into an overdrive state, can regain normal

function because of **Deep Brain Stimulation**. A person who has lost sight from a progressive disease can see again because of a **Bionic Eye**. A person with constant pain in their body, so much that their lives are literally controlled by it can lead a normal life because of **Spinal Cord Stimulation**. These are technologies that exist today because of engineers such as yourselves.

Welcome to “Bionics and Neuromodulation”. This course will provide you with the appropriate background theory and knowledge of therapeutic bionic devices used to treat a range of disorders such as the ones mentioned above. This course will also provide you with the knowledge of how these devices interact with the human nervous system to induce a therapeutic effect through a process called neuromodulation. By the end of the course you should have a fundamental understanding of the important factors that dictate the success or failure of such devices as well as the important factors surrounding their design. You should also be qualified to advise on the choices available for a given therapeutic application and the advantages and disadvantages of each alternative. Finally, you should also learn how the “biology” i.e. our own bodies interact with these artificial devices and challenges on how to make devices safe and effective. A key element of this course is that you will get to learn first-hand from lecturers who are involved in the research and development of these devices both at UNSW and in the industry sector from two of Australia’s leading companies, Cochlear Limited and Saluda Medical. You will also get to hear views from the end users of some of these devices.

Course Aims

The aims of this course are to:

- introduce students to the fundamentals of bionic devices, their relation to understanding therapeutic sensory and functional neural stimulation as well as their ability to modulate the activity of neurons;
- understand the principles which govern the application of electrical neural stimulation and the design of instruments to be used for this purpose;
- understand various applications of therapeutic electrical neural stimulation including the underlying biological process that dictate the success or failure of such devices

This course is for all engineers from various backgrounds and disciplines – as long as you want to design something to help humans. It is natural for engineers from different disciplines to migrate to their 'comfort zone' when approaching the design of a medical implant. For instance, the electrical engineer will tend to concentrate on implant circuitry, the materials engineer is more likely to have an interest in implant packaging or electrode materials, the software engineer will really keep the end users in mind when designing the human machine interface and the chemical engineer will worry about the chemical reactions that occur as a result of electrical

stimulation. However, an important objective of the course is to also gain working knowledge of, and confidence to operate in, a broad range of topics within the field of bionics, as well as to highlight the opportunities of working in this field when the 'comfort zones' are broadened. Therefore, you will also experience learning concepts that may be out of your immediate engineering discipline.

Relationship to Other Courses

This course is part of the Bionics, Biomechanics, and Biomechatronics theme within the Graduate School of Biomedical Engineering. It best aligns with **BIOM9640 Biomedical Instrumentation** and **BIOM9650 Biosensors and Transducers**. In addition, it has connections to **BIOM9551 Biomechanics of Physical Rehabilitation** as well as **BIOM9910 Health Technology Innovation: Clinical Immersion**. While not a prerequisite, courses related to basic anatomy, physiology, electrical engineering and programming can enhance understanding and accelerate assessment completion for this course.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the scope of various implantable and non-implantable bionic devices in terms of their applications in medicine
CLO2 : Explain the fundamental factors that drive the safety and efficacy of neuromodulation using electrical stimulation
CLO3 : Identify the complexities and specific challenges (surgical, clinical, electrical, mechanical, chemical, materials and software) related to life-long bionic device design
CLO4 : Review aspects of the literature surrounding bionic devices and assess the knowledge gained to formulate hypotheses, plan and carry out experiments to address these hypotheses
CLO5 : Solve a range of practical problems related to bionic devices in a team
CLO6 : Express findings from the bionics literature and one's own work using oral and written methods

Course Learning Outcomes	Assessment Item
CLO1 : Explain the scope of various implantable and non-implantable bionic devices in terms of their applications in medicine	• Progressive Learning Quizzes and Reading Game • Laboratory Participation and Reports
CLO2 : Explain the fundamental factors that drive the safety and efficacy of neuromodulation using electrical stimulation	• Progressive Learning Quizzes and Reading Game • Laboratory Participation and Reports
CLO3 : Identify the complexities and specific challenges (surgical, clinical, electrical, mechanical, chemical, materials and software) related to life-long bionic device design	• Progressive Learning Quizzes and Reading Game • Laboratory Participation and Reports
CLO4 : Review aspects of the literature surrounding bionic devices and assess the knowledge gained to formulate hypotheses, plan and carry out experiments to address these hypotheses	• Sound Processing Coding Assignment • Group presentation and evaluation • Laboratory Participation and Reports
CLO5 : Solve a range of practical problems related to bionic devices in a team	• Sound Processing Coding Assignment • Group presentation and evaluation • Progressive Learning Quizzes and Reading Game • Laboratory Participation and Reports
CLO6 : Express findings from the bionics literature and one's own work using oral and written methods	• Sound Processing Coding Assignment • Group presentation and evaluation • Progressive Learning Quizzes and Reading Game • Laboratory Participation and Reports

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams

Additional Course Information

From 2024, all laboratory sessions will be 3-hours in duration.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Progressive Learning Quizzes and Reading Game Assessment Format: Individual	35%	
Laboratory Participation and Reports Assessment Format: Individual	40%	
Sound Processing Coding Assignment Assessment Format: Individual	10%	
Group presentation and evaluation Assessment Format: Group	15%	

Assessment Details

Progressive Learning Quizzes and Reading Game

Assessment Overview

Quizzes will be conducted during the term in selected weeks (see course timetable). These will be administered within Moodle promptly at the start of the lecture period. Quizzes must be attempted individually and as a group within the relevant lecture window, unless exceptional circumstances prevent this, which will be dealt with on a case-by-case basis. Students are expected to prepare for each quiz by studying the lecture and laboratory materials from the previous weeks. Short answer or multiple-choice questions will be the norm, and the aim will be to assess the student's understanding of the material as the course progresses (breadth as well as depth). Be advised that once a concept is introduced to the course, it may appear on any assessment event from that point onward. For instance, if a concept is introduced during week 1, a question on that concept could be on a quiz in week 7 (or any other week after week 1).

One of the most effective ways to learn is by asking questions, particularly good questions to your peers
and answering questions that your peers have asked. To facilitate learning of each other, we will also play a

competitive Q&A game throughout the term – all about asking good questions on which you will be
assessed on. Details will be provided in the lecture during week 1.

Course Learning Outcomes

- CLO1 : Explain the scope of various implantable and non-implantable bionic devices in terms of their applications in medicine
- CLO2 : Explain the fundamental factors that drive the safety and efficacy of neuromodulation using electrical stimulation
- CLO3 : Identify the complexities and specific challenges (surgical, clinical, electrical, mechanical, chemical, materials and software) related to life-long bionic device design
- CLO5 : Solve a range of practical problems related to bionic devices in a team
- CLO6 : Express findings from the bionics literature and one's own work using oral and written methods

Laboratory Participation and Reports

Assessment Overview

A series of laboratory sessions will be conducted in weeks 1-5 and 7-9 to perform practical experiments.
These experiments will complement and add to the concepts introduced in the lectures. Each lab topic
will be covered across three consecutive weeks. You will work in groups during the labs. Attendance and
participation in the laboratory sessions will be marked. There will be two lab reports that you will need
to prepare individually, one worth 15% and the other worth 25%.

Course Learning Outcomes

- CLO1 : Explain the scope of various implantable and non-implantable bionic devices in terms of their applications in medicine
- CLO2 : Explain the fundamental factors that drive the safety and efficacy of neuromodulation using electrical stimulation
- CLO3 : Identify the complexities and specific challenges (surgical, clinical, electrical, mechanical, chemical, materials and software) related to life-long bionic device design
- CLO4 : Review aspects of the literature surrounding bionic devices and assess the knowledge gained to formulate hypotheses, plan and carry out experiments to address these hypotheses
- CLO5 : Solve a range of practical problems related to bionic devices in a team
- CLO6 : Express findings from the bionics literature and one's own work using oral and written methods

Sound Processing Coding Assignment

Assessment Overview

Students will need to write code in Matlab relating to sound processing in cochlear implants. The details of this coding assignment will be provided in the first week of the course.

Course Learning Outcomes

- CLO4 : Review aspects of the literature surrounding bionic devices and assess the knowledge gained to formulate hypotheses, plan and carry out experiments to address these hypotheses
- CLO5 : Solve a range of practical problems related to bionic devices in a team
- CLO6 : Express findings from the bionics literature and one's own work using oral and written methods

Group presentation and evaluation

Assessment Overview

A group presentation in the form of a video or live presentation that describes a topic in Bionics. This will be marked by both the course co-ordinator (worth 5%) and by your peers (5%). In addition, students will complete a group evaluation at the end of the term. 2.5% will be weighted for completing the evaluation of your team members as an individual, and 2.5% will be based on the evaluation students receive from other team members.

Course Learning Outcomes

- CLO4 : Review aspects of the literature surrounding bionic devices and assess the knowledge gained to formulate hypotheses, plan and carry out experiments to address these hypotheses
- CLO5 : Solve a range of practical problems related to bionic devices in a team
- CLO6 : Express findings from the bionics literature and one's own work using oral and written methods

General Assessment Information

Grading Basis

Standard

Course Schedule

Attendance Requirements

Both, lectures and labs are expected to be attended in person unless special circumstances apply.

Course Resources

Recommended Resources

Highly Recommended Textbooks:

1) Implantable Neural Prostheses 1 Devices and Applications; Zhou, David; 2009 https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9781493950836

2) Implantable Neural Prostheses 2 Techniques and Engineering Approaches; Zhou, David; 2010 https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9781461424673

3) Neurobionics: The Biomedical Engineering of Neural Prostheses; Shepherd, Robert; 2016 https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9781118814871 4) Neuroprosthetics: Theory And Practice; Kipke, Daryl R; 2017 https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9789813207141

Highly Recommended Journal Papers:

1) Merrill et al. (2005) Electrical stimulation of excitable tissue: design of efficacious and safe protocols. Journal of Neuroscience Methods 141:171-198.

2) Cogan (2008) Neural stimulation and recording electrodes. Annual Reviews in Biomedical Engineering.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Mohit Shivdasani		Room 515A, Level 5, Gordon and Jacqueline Samuels Building	401311423	By appointment	Yes	Yes
Demonstrator	Michael Italiano					No	No
	Wenlu Duan					No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

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 convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. 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.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published.

Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/ Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School Contact Information

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