UNSW Course Outline

BIOM9711 Modelling Organs, Tissues and Devices - 2024

Published on the 06 Feb 2024

General Course Information

Course Code : BIOM9711
Year : 2024
Term : Term 1
Teaching Period : T1
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : Graduate School of Biomedical Engineering
Delivery Mode : Multimodal
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

Computer modelling of complex physiological systems and their interaction with medical devices is becoming increasingly important in modern medical device design. This course provides a practical overview of computational modelling in bioengineering, focusing on a range

of applications including electrical stimulation of neural and cardiac tissue, implantable drug delivery, cancer therapy, biomechanics and blood flow. You will be introduced to the basic principles of modelling and simulation of dynamic physical systems using ordinary and partial differential equations, as well as how to implement and solve models using Matlab and COMSOL Multiphysics numerical software.

Course Aims

This course aims to provide a practical overview of computational modelling in bioengineering, focusing on a range of applications of importance for modelling organs, tissues and devices. It will teach the basic principles of modelling and simulation of dynamic physical systems using ordinary and partial differential equations. Computational modelling is important in understanding the complex interactions between a medical device and the human body, as well as improving overall device design. A good understanding of modelling principles is also useful for many other courses in biomedical engineering, including mass transfer in medicine, dynamics of the cardiovascular system, as well as a range of thesis and design projects.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Solve systems of ordinary and partial differential equations using a range of theoretical and computational techniques.
CLO2 : Model various biomedical systems using ordinary and partial differential equations.
CLO3 : Implement and solve models in Matlab and COMSOL Multiphysics numerical software.
CLO4 : Identify the basic principles underlying electrical stimulation, drug delivery, heat flow, solid mechanics, fluid mechanics, and their interactions in various body tissues and medical devices.
CLO5 : Implement and solve a complex bioengineering model using COMSOL Multiphysics numerical software.

Course Learning Outcomes	Assessment Item
CLO1 : Solve systems of ordinary and partial differential equations using a range of theoretical and computational techniques.	• Major Project • Computer based Final Exam • Weekly quizzes • Assignments
CLO2 : Model various biomedical systems using ordinary and partial differential equations.	• Major Project • Computer based Final Exam • Weekly quizzes • Assignments
CLO3 : Implement and solve models in Matlab and COMSOL Multiphysics numerical software.	• Major Project • Computer based Final Exam • Weekly quizzes • Assignments
CLO4 : Identify the basic principles underlying electrical stimulation, drug delivery, heat flow, solid mechanics, fluid mechanics, and their interactions in various body tissues and medical devices.	• Major Project • Computer based Final Exam • Weekly quizzes • Assignments
CLO5 : Implement and solve a complex bioengineering model using COMSOL Multiphysics numerical software.	• Major Project • Computer based Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System | Blackboard Collaborate | Microsoft Teams

Additional Course Information

Pre-class exercises, group activities and homework assignments

Each week, pre-class exercises will be posted on Moodle to help you prepare for the computer laboratory. You will be required to answer these questions online prior to each week's laboratory class. During the computer laboratory class itself, you will be given an individual test under exam conditions (30 minutes), followed by an opportunity to confer with members of your allotted class group and post a revised answer to the same exercises (another 15 minutes). Your team-based learning mark for that week will consist of the sum of your individual submission and your submission following group discussion. The remainder of the laboratory class will consist of further group submissions and following through with worked problems. This latter class work is not assessable.

Each week, you will also be given a homework assignment (8 assignments in total), each due Tuesday, 12 noon, the following week.

All lectures each week will be pre-recorded: you may watch this lecture at any time of your convenience prior to your scheduled weekly Wednesday laboratory class.

Every week, Monday 10-11 am (i.e. in the latter half of the scheduled weekly lecture slot), there will be a 1 hour online consultancy session where students can ask questions related to lectures, assignments, or other course content.

Major project

You will be required to implement a bioengineering model of your choice using COMSOL Multiphysics numerical software. Your model must first be approved by the course coordinator (via Stage 0, due Monday, Week 4), and will be subdivided into four stages of submission. The final submission (Stage 3) is due 11:55 pm Monday, Week 11.

Recommended learning approaches

The following provides examples of learning approaches highly recommended for this course.

Private Study

- Watch the online lecture each week.
- Read the pre-lecture reading material assigned each week.
- Complete the weekly pre-class exercises and homework assignments.
- Attend the weekly consultancy session if you have any questions related to the course.
- Implement example Matlab/COMSOL models from the lectures and Moodle modules, and make sure you understand these.
- Watch videos on Moodle and read additional material pertaining to Matlab or COMSOL, to

master the use of these.

Laboratories

- Work through the weekly team-based learning activities, both the individual and group-based assessments.
- Follow worked examples.
- Work through set weekly class exercises.
- Ask questions.

Homework Assignments

- Allocate sufficient time to work through the assignment questions and submit them before the due date each week.

Major Project

- Choose a bioengineering model from published literature.
- Reflect on how to implement this model in COMSOL.
- Read about the implementation of this model by others, and ask questions.
- Submit the 4 stages of your project by the due dates.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Major Project Assessment Format: Individual	30%	Due Date: Monday, Week 11
Computer based Final Exam Assessment Format: Individual	30%	Due Date: TBA
Weekly quizzes Assessment Format: Individual	10%	Due Date: During class
Assignments Assessment Format: Individual	30%	Due Date: Tuesday 11:55 PM the following week

Assessment Details

Major Project

Assessment Overview

This assessment consists of a major project submission, in which students are required to implement and solve a biomedical engineering model of their choice using COMSOL Multiphysics software. Along with the model itself, students are also required to submit a six-page report in the form of a journal paper.

The major project will consist of 4 stages of submission:

Stage 0 (0 marks, formative only): Students are required to submit a 100-word major assignment proposal, along with a published research article or text forming the basis of their chosen model.

Stage 1 (worth 1.5 marks out of 30): Students are required to submit a one-page summary of five research articles, reviews, or texts relevant to their chosen model.

Stage 2 (worth 1.5 marks out of 30): Students are to submit a brief one- or two-page submission outlining the geometrical structure and layout of the chosen model, along with the main model equations and boundary conditions to be solved for.

Stage 3 (worth 27 marks out of 30): Final submission of model and report.

Feedback will be provided to students in Moodle around 1 week after the submission of each stage.

Course Learning Outcomes

- CLO1 : Solve systems of ordinary and partial differential equations using a range of theoretical and computational techniques.
- CLO2 : Model various biomedical systems using ordinary and partial differential equations.
- CLO3 : Implement and solve models in Matlab and COMSOL Multiphysics numerical software.
- CLO4 : Identify the basic principles underlying electrical stimulation, drug delivery, heat flow, solid mechanics, fluid mechanics, and their interactions in various body tissues and medical devices.
- CLO5 : Implement and solve a complex bioengineering model using COMSOL Multiphysics numerical software.

Assessment information

You are required to implement a bioengineering model of your choice using COMSOL Multiphysics numerical software. Your model must first be approved by the course coordinator (via Stage 0), and will be subdivided into the following four stages of submission:

Stage 0 (no marks, due 11:55 pm Monday, Week 4): You are required to submit a 100-word major assignment proposal (via Moodle), along with a published research article or text forming the basis of your model design.

Stage 1 (worth 1.5 marks out of 30, due 11:55 pm Monday, Week 6): A one-page summary of five research articles, reviews, or texts relevant to your model. Ideally, these will serve as references in your final submission report. These references can be descriptions of previous computational

models in the field, relevant engineering or physiological principles underlying the model, or general research articles outlining the nature of the problem to be investigated by your model.

Stage 2 (worth 1.5 marks out of 30, due 11:55 pm Monday, Week 8): A brief one- or two-page submission outlining the geometrical structure and layout of your model, along with the main model equations and boundary conditions to be solved for. You must include a description of all terms and parameters used in your equations.

Stage 3 (worth 27 marks out of 30, due 11:55 pm Monday, Week 11): The final submission of your model and report. If necessary, you may modify model details and references from those submitted in stages 0, 1 or 2, as modelling is often an iterative process requiring frequent refinements.

Assignment submission Turnitin type

This is not a Turnitin assignment

Computer based Final Exam

Assessment Overview

The final exam for the course will be open book and online. Students will be required to implement and solve a given computational model using COMSOL Multiphysics software. Feedback will be provided to students in Moodle on completion of marking.

Course Learning Outcomes

- CLO1 : Solve systems of ordinary and partial differential equations using a range of theoretical and computational techniques.
- CLO2 : Model various biomedical systems using ordinary and partial differential equations.
- CLO3 : Implement and solve models in Matlab and COMSOL Multiphysics numerical software.
- CLO4 : Identify the basic principles underlying electrical stimulation, drug delivery, heat flow, solid mechanics, fluid mechanics, and their interactions in various body tissues and medical devices.
- CLO5 : Implement and solve a complex bioengineering model using COMSOL Multiphysics numerical software.

Assignment submission Turnitin type

This is not a Turnitin assignment

Weekly quizzes

Assessment Overview

This assessment consists of a series of quizzes, given during the weekly laboratory class. Each quiz will consist of an individual-based test (known as an individual readiness assurance test, or IRAT) and a team-based test (referred to as a team readiness assurance test, or TRAT). Students will need to prepare by revising the lecture for that week. Feedback will be immediately provided to students in class on completion of the TRAT component.

Course Learning Outcomes

- CLO1 : Solve systems of ordinary and partial differential equations using a range of theoretical and computational techniques.
- CLO2 : Model various biomedical systems using ordinary and partial differential equations.
- CLO3 : Implement and solve models in Matlab and COMSOL Multiphysics numerical software.
- CLO4 : Identify the basic principles underlying electrical stimulation, drug delivery, heat flow, solid mechanics, fluid mechanics, and their interactions in various body tissues and medical devices.

Assignments

Assessment Overview

This assessment consists of weekly submissions in which students are required to solve theoretical and computational modelling problems. There will be a total of eight such submissions. Feedback to students will be provided online around 1 week after each submission.

Course Learning Outcomes

- CLO1 : Solve systems of ordinary and partial differential equations using a range of theoretical and computational techniques.
- CLO2 : Model various biomedical systems using ordinary and partial differential equations.
- CLO3 : Implement and solve models in Matlab and COMSOL Multiphysics numerical software.
- CLO4 : Identify the basic principles underlying electrical stimulation, drug delivery, heat flow, solid mechanics, fluid mechanics, and their interactions in various body tissues and medical devices.

Assignment submission Turnitin type

This is not a Turnitin assignment

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 12 February - 18 February	Lecture	Introduction to Modelling in Bioengineering
Week 2 : 19 February - 25 February	Lecture	Ordinary Differential Equations
Week 3 : 26 February - 3 March	Lecture	Partial Differential Equations
Week 4 : 4 March - 10 March	Lecture	Finite Element Method I
Week 5 : 11 March - 17 March	Lecture	Finite Element Method II
Week 7 : 25 March - 31 March	Lecture	Modelling Electrical Stimulation of Tissue
Week 8 : 1 April - 7 April	Lecture	Models of Diffusion and Heat Transfer
Week 9 : 8 April - 14 April	Lecture	Solid Mechanics
Week 10 : 15 April - 21 April	Lecture	Fluid Mechanics

Attendance Requirements

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

Course Resources

Recommended Resources

Textbook

- Modelling Organs, Tissues, Cells and Devices using Matlab and COMSOL Multiphysics, by S. Dokos (Springer, 2017). Available for download from the library

Online Tutorials

- Online Matlab tutorials and courses from Mathworks, Inc can be accessed from https://au.mathworks.com/academia/tah-portal/university-of-new-south-wales-341489.html
- Online COMSOL Multiphysics tutorials can be accessed from http://www.comsol.com/products/tutorials/
- COMSOL also has a large set of example models in its model library, including complete documentation and model files, which can be accessed within the software itself

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 Session. Feedback

and suggestions provided will be important in improving the course for future students. Changes to the course from previous comments received have included more hands-on model examples in lectures and in the laboratories.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Socrates Dokos		Room 506 Samuels Building (F25)	9385 9406	Mondays 10-11 am (online). Appointments can also be made via e-mail.	No	Yes

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.