COURSE DETAILS

<table>
<thead>
<tr>
<th>Units of Credit</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact hours</td>
<td>4 hours per week</td>
</tr>
<tr>
<td>Lecture</td>
<td>Tuesday, 9:00 – 11:00, Mathews Theatre C (D23)</td>
</tr>
<tr>
<td>Computer</td>
<td>Tuesday, 11:00 – 13:00, Room 518, Level 5, Samuels Bldg (F25)</td>
</tr>
<tr>
<td>Laboratories</td>
<td>Wednesday, 15:00 – 17:00, Room 518, Level 5, Samuels Bldg (F25)</td>
</tr>
<tr>
<td>Course Coordinator</td>
<td>A/Prof Socrates Dokos</td>
</tr>
<tr>
<td></td>
<td>email: <a href="mailto:s.dokos@unsw.edu.au">s.dokos@unsw.edu.au</a></td>
</tr>
<tr>
<td></td>
<td>office: Room 506, Samuels Bldg</td>
</tr>
<tr>
<td></td>
<td>phone: 9385 9406</td>
</tr>
<tr>
<td>Demonstrator</td>
<td>Mr Luke Sy</td>
</tr>
<tr>
<td></td>
<td>email: <a href="mailto:l.sy@unsw.edu.au">l.sy@unsw.edu.au</a></td>
</tr>
</tbody>
</table>

INFORMATION ABOUT THE COURSE

How can you design an effective medical device using only a computer? Such a task requires not only understanding the physics behind device operation, but how it interacts with the complex physiological systems of the human body. Computational modelling is a powerful tool used by the biomedical engineering industry to simulate, understand and optimise medical device function.

Welcome to BIOM9711: Modelling Organs, Tissues and Devices! 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. By the end of this course, you will be able to simulate function of a range of medical devices, including a medical device of your choice as major assignment.

Lecture notes will be available on-line via Moodle, along with weekly on-line quizzes, pre-class exercises and post-class homework assignments, which will all serve as the basis for the computer-based final exam at the end of Term to ascertain your ability to implement and solve a given bioengineering model. Finally, students will also undertake a major modelling project in an area of their choice.

This course is largely a standalone course within GSBmE, serving as a practical introduction to computational modelling in bioengineering. Basic modelling theory and principles are also covered in other GSBmE courses such as BIOM9060 Biomedical Systems Analysis, BIOM9311 Mass Transfer in Medicine, BIOM9701 Dynamics of the Cardiovascular System, BIOM9541 Mechanics of the Human Body and BIOM9621 Biological Signal Analysis.

You will be taught in the GSBmE Green Room (Room 518) using the Windows XP operating system with Matlab and COMSOL Multiphysics mathematical software. The computer laboratories will be accessible using a swipe card system based on your student card (the same system that will give you access to the building and the lifts).

We hope you find this course useful and enjoyable, serving as a stimulus for your own further explorations in the fascinating and boundless field of bioengineering modelling!
HANDBOOK DESCRIPTION
See link to virtual handbook:

OBJECTIVES
This course aims to provide a practical overview of computational modelling in bioengineering, focusing on a range of applications of importance to modelling organs, tissues and devices. The assessment strategy consisting of weekly pre-class exercises and in-class group activities, weekly homework assignments, a major modelling project and a computer-based exam, will help foster the following UNSW Engineering graduate attributes:

• The skills involved in scholarly enquiry (through the major project)
• An in-depth engagement with the relevant disciplinary knowledge in its inter-disciplinary context (through on-line quizzes, pre-class exercises and group activities, homework assignments and the major project)
• Capacity for analytical and critical thinking and for creative problem solving (through on-line quizzes, pre-class exercises, group activities and homework assignments, major project and the computer-based exam)
• Ability to engage independent and reflective learning (through homework assignments and the major project)
• Information literacy (through the major project)
• Skills for effective communication (through the major project report)

TEACHING STRATEGIES
This course will be taught via weekly lectures and computer laboratories. Students will be expected to apply theory covered in lectures weekly to the online quizzes, pre-class exercises, group activities and homework assignments. Assessments and feedback of homework assignments will be regularly provided to the students.

Students learn modelling principles effectively via exposure to a broad range of modelling examples reinforced through computer-based and theory assignments. Hence, a large proportion of this course is dedicated to pre-class exercises and homework assignments. Feedback provided by laboratory demonstrators is important in teaching correct understanding of practical modelling principles. In addition, students will gain extensive modelling experience by implementing a full biomedical model from the literature as a major project.

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

| Private Study | • Read the pre-lecture reading material assigned each week
|              | • Complete the weekly pre-class exercises and homework assignments
|              | • Complete weekly online quizzes (not assessable)
|              | • Implement example Matlab/COMSOL models from the lectures and Moodle modules, and make sure you understand these.
|              | • Watch videos on Moodle pertaining to Matlab or COMSOL, to master the use of these
|              | • Read additional material pertaining to Matlab or COMSOL
|              | • Keep up with notices and find out marks via Moodle
| Lectures     | • Find out what you must learn
|              | • Follow worked examples
|              | • Hear announcements on course changes
|              | • Ask questions
| Tutorials    | • Follow worked examples
|              | • Practice solving set weekly class exercises
|              | • Ask questions
| On-line quizzes and Assignment Submissions | • Learn and be familiar with previous lectures
|              | • Demonstrate higher understanding and problem solving
| Major Project | • Reflect on how to implement a bioengineering model of your choice, read the implementation of others from the literature, and ask questions
|              | • Submit the various parts of your project by the due dates
EXPECTED LEARNING OUTCOMES

By the end of this course, you will have gained a solid understanding of:

- solving systems of ordinary and partial differential equations using a range of theoretical and computational techniques.
- modelling various biomedical systems using ordinary and partial differential equations.
- implementing and solving models using Matlab and COMSOL Multiphysics numerical software.
- basic principles underlying electrical stimulation, drug delivery, heat flow, solid mechanics, fluid mechanics, and their interactions in various body tissues and medical devices.
- Implementing and solving a complex bioengineering model in COMSOL Multiphysics.

For each hour of contact, it is expected that you will put in at least 1.5 hours of private study. You will need to spend substantial time in the computer laboratory or at home implementing computer-based assignments in COMSOL and Matlab, as well as the major project in COMSOL.

ASSESSMENT

The assessment scheme for the course will be:

- Weekly pre-class exercises and group activities (10) 15%
- Homework Assignments (10) 25%
- Major Modelling Project 30%
- Computer-Based Exam 30%

Details of each assessment component are set out below:

PRE-CLASS EXERCISES, GROUP ACTIVITIES, HOMEWORK ASSIGNMENTS AND MAJOR PROJECT

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 lecture. During the computer laboratory class itself, you will be given an opportunity to confer with members of your allotted class group and post a revised answer to the same exercises. Your pre-class exercise mark for that week will consist of the averaged marks between your individual submission and your submission following group discussion. The remainder of the laboratory class will consist of further group submissions as well as following through with worked problems.

Each week, you will also be given a homework assignment (10 assignments in total), each due Monday 9 am the following week.

For the major project, 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 9 am 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 9 am 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 9 am 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 9 am 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.

Note that late submission of weekly assignments will incur a penalty deduction of 20% per day. For the major project, submission of each stage is a requirement for submission of any subsequent stages. Late submission of stages 1, 2 or 3 will incur a penalty deduction of 20% per day.
COURSE PROGRAM

The program of lecture topics is as follows:

TERM 1, 2019

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19-2-2019</td>
<td>Introduction to Modelling in Bioengineering</td>
</tr>
<tr>
<td>2</td>
<td>26-2-2019</td>
<td>Ordinary Differential Equations</td>
</tr>
<tr>
<td>3</td>
<td>5-3-2019</td>
<td>Partial Differential Equations</td>
</tr>
<tr>
<td>4</td>
<td>12-3-2019</td>
<td>Finite-Element Method I</td>
</tr>
<tr>
<td>5</td>
<td>19-3-2019</td>
<td>Finite-Element Method II</td>
</tr>
<tr>
<td>6</td>
<td>26-3-2019</td>
<td>- No Lecture -</td>
</tr>
<tr>
<td>7</td>
<td>2-4-2019</td>
<td>Modelling Electrical Stimulation of Tissue</td>
</tr>
<tr>
<td>8</td>
<td>9-4-2019</td>
<td>Models of Diffusion and Heat Transfer</td>
</tr>
<tr>
<td>9</td>
<td>16-4-2019</td>
<td>Solid Mechanics</td>
</tr>
<tr>
<td>10</td>
<td>23-4-2019</td>
<td>Fluid Mechanics</td>
</tr>
</tbody>
</table>

RELEVANT RESOURCES

- Recommended textbook:

- Recommended on-line software tutorials:
  - a downloadable pdf chapter on solving systems of ordinary differential equations (ODEs) using Matlab, from the text Numerical Computing with Matlab, by Cleve Moler, is at www.mathworks.com/moler/odes.pdf
  - Matlab Introduction (GSBmE) Moodle module
  - 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 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.

DATES TO NOTE

Refer to MyUNSW for Important Dates, available at:
https://my.unsw.edu.au/student/resources/KeyDates.html

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 a 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

For information about:
- Notes on assessments and plagiarism,
- Special Considerations,
- School Student Ethics Officer, and
- BESS

refer to the School website available at
http://www.engineering.unsw.edu.au/biomedical-engineering/