Faculty of Engineering  
Graduate School of Biomedical Engineering

Term 3, 2019  
BIOM9311 Mass Transfer in Medicine

COURSE DETAILS

Units of Credit: 6  
Contact hours: 4 hours per week  
Lecture: Tuesday, 11:00 – 13:00  
Mathews Theatre C (D23)

Computer Laboratories:  
Tuesday, 14:00 – 16:00  
Room 518, Level 5, Samuels Bldg (F25)

Wednesday, 14:00 – 16:00  
Room 518, Level 5, Samuels Bldg (F25)

Thursday, 12:00-14:00  
Room 518, Level 5, Samuels Bldg (F25)

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INFORMATION ABOUT THE COURSE

Welcome to BIOM9311: Mass Transfer in Medicine. This course is an introduction to the understanding and modelling of mass transfer processes of importance in medicine and biology. It includes examples of mass transfer within the body as well as in therapeutic applications. Some topics that will be covered include:

- Mass transfer across synthetic and biological membranes.
- Mass transfer in haemodialysis (artificial kidney)
- Gas exchange in membrane oxygenators (artificial lung)
- Gas exchange in the lungs.
- Transfer of solutes across the capillary endothelium.
- Transfer of drugs or toxins across the skin.
- Slow release of drugs from implants.
- Mass transfer considerations in biosensors.
- Mass transfer considerations in tissue engineering.

Lecture notes will be available on-line via Moodle, along with weekly in-class exercises and post-class homework assignments, which will all serve as the basis for the final exam.

Computer laboratories will be held in the Graduate School of Biomedical Engineering (GSBme)  
Green Room, room 518, using the Windows operating system and COMSOL mathematical software.
The computer laboratory 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 enjoyable, and a catalyst for further learning applications of mass transfer in medicine.

**HANDBOOK DESCRIPTION**


**OBJECTIVES**

The aim of this course is to introduce various mass transfer processes of medical or physiological importance and the methods used to model them. The assessment strategy, consisting of weekly in-class exercises, weekly homework assignments, a laboratory report, a major assignment and a final exam, will help foster the following UNSW Engineering graduate attributes:

- The skills involved in scholarly enquiry (through the in-class exercises, homework assignments and major assignment)
- An in-depth engagement with the relevant disciplinary knowledge in its inter-disciplinary context (through in-class exercises, homework assignments, laboratory report and major assignment)
- Capacity for analytical and critical thinking and for creative problem solving (assessed through in-class exercises, homework assignments, major assignment and the final exam)
- Ability to engage independent and reflective learning (via the in-class exercises, homework assignments and major assignment)

**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 in-class exercises and homework assignments. Assessments and feedback of homework assignments will be regularly provided to the students.

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.

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

<table>
<thead>
<tr>
<th>Private Study</th>
<th>Lectures</th>
<th>Computer Laboratory</th>
<th>Weekly Assignment Submissions, Laboratory Report and Major Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Read the lecture notes and other material each week (Moodle).</td>
<td>• Prepare by reading the lecture notes beforehand.</td>
<td>• Work through set class-exercises and assignment problems.</td>
<td>• Demonstrate higher understanding and problem solving.</td>
</tr>
<tr>
<td>• Make a list of things you do not understand. Ask questions.</td>
<td>• Try to follow the lecture. As you go, make notes of things you don’t understand.</td>
<td>• Ask questions.</td>
<td>• Process, present and interpret experimental data.</td>
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<tr>
<td>• Join/start Moodle discussions of problems</td>
<td>• Ask questions during the lecture, at the following lecture or on the Moodle Help forum.</td>
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<tr>
<td>• Learn COMSOL by working through example problems</td>
<td>• Review the lecture notes as soon as possible after the lecture to reinforce what you learned and to clarify the hard parts.</td>
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</table>
EXPECTED LEARNING OUTCOMES
By the end of this course you will be able to:

- explain the principles of diffusion and diffusive mass transport across synthetic and biological membranes.
- solve various problems in mass transport by analytical and/or numerical means.
- identify the relative importance of convection and diffusion in a given problem.
- formulate and numerically solve models of mass transfer in medical applications such as haemodialysis, drug release, and biosensors.
- recognise the concepts of flow limitation and membrane limitation, distinguishing whether one or the other, or neither, is limiting in a particular medical application.

ASSESSMENT
The assessment tasks for BIOM9311 Mass Transfer in Medicine have been designed to measure your achievement of the learning outcomes. The final grade for this course will normally be based on the sum of the scores from each of the assessment tasks.

Quizzes will consist of multiple choice and short answer questions and are designed to encourage learning throughout the semester and prepare students for the types of questions in the final exam. There will be two quizzes each week, constituting an in-class exercise and a homework assignment. The two quizzes are worth 7.5% each, together total 15% of the course assessment.

The major assignment will be done in groups and is worth 20% of the total course assessment. A substantial problem of some complexity will be defined. The conceptual material required to solve it will have been covered in lectures but applying that material to this problem will not be trivial. It will not be a matter of simply finding the right equation. Clear thinking and working up from the basics will be required. In addition, values of some required material properties will have to be found from the literature. This will not be trivial either. It is expected that the report will clearly detail the method of solution, including all simplifying assumptions.

The laboratory report will be an opportunity for students to take experimental data, analyse it and present their findings in the form of a laboratory report. The laboratory report is worth 20% of the total course assessment.

The Final Exam will be held during the formal exam period and is worth 45% of the total course assessment.

The marks assigned and dates of submission of each assessment task are set out below. Details of each assessment component, the marks assigned to it, the criteria by which marks will be assigned, and the dates of submission are provided in detail on Moodle.

ASSIGNMENTS
The assessment scheme for the course will be:

Weekly in-class exercises (8), due before the end of each tutorial 7.5%
Weekly homework exercises (8), due before the following week’s lecture 7.5%
Laboratory report, due on the 12th November 20%
Major assignment, due on the 26th November 20%
Final Exam (TBA) 45%

The Laboratory report and major assignment will require a Non Plagiarism Declaration Cover Sheet.

Late submissions will be penalised 10% of the mark for each calendar day late. If you foresee a problem in meeting the nominated submission date please contact the Course Convenor to make an appointment to discuss your situation as soon as possible.
COURSE PROGRAM
The program of lecture topics and computer laboratories is as follows:

TERM 3, 2019

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Lecturer</th>
<th>Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17-9-2019</td>
<td>Fundamentals of mass transfer. Introduction to COMSOL</td>
<td>Socrates Dokos</td>
<td>In-class Quiz 1, Homework Quiz 1</td>
</tr>
<tr>
<td>2</td>
<td>24-9-2019</td>
<td>Mass transfer across membranes</td>
<td>Socrates Dokos</td>
<td>In-class Quiz 2, Homework Quiz 2</td>
</tr>
<tr>
<td>3</td>
<td>1-10-2019</td>
<td>Biosensors I</td>
<td>Guozhen Liu</td>
<td>In-class Quiz 3, Homework Quiz 3</td>
</tr>
<tr>
<td>4</td>
<td>8-10-2019</td>
<td>Haemodialysis</td>
<td>Socrates Dokos</td>
<td>In-class Quiz 4, Homework Quiz 4</td>
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<tr>
<td>5</td>
<td>15-10-2019</td>
<td>Drug delivery</td>
<td>Socrates Dokos</td>
<td>In-class Quiz 5, Homework Quiz 5</td>
</tr>
<tr>
<td>6</td>
<td>22-10-2019</td>
<td>(No Lecture)</td>
<td>Guozhen Liu</td>
<td>Lab work (no quiz)</td>
</tr>
<tr>
<td>7</td>
<td>29-10-2019</td>
<td>Biosensors II</td>
<td>Guozhen Liu</td>
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<tr>
<td>8</td>
<td>5-11-2019</td>
<td>Mass transfer in the cardiovascular system</td>
<td>Socrates Dokos</td>
<td>In-class Quiz 6, Homework Quiz 6</td>
</tr>
<tr>
<td>9</td>
<td>12-11-2019</td>
<td>Tissue engineering and bioreactors</td>
<td>Guozhen Liu</td>
<td>In-class Quiz 7, Homework Quiz 7</td>
</tr>
<tr>
<td>10</td>
<td>19-11-2019</td>
<td>Artificial lung and blood gas exchange</td>
<td>Guozhen Liu</td>
<td>In-class Quiz 8, Homework Quiz 8</td>
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RELEVANT RESOURCES
The lecture notes given along with information posted on Moodle will be the primary source of information.

There is no text that suits this course sufficiently well that you are expected to purchase it. The following text comes close. It covers some of the topics in the course quite well. It is written at a fairly serious level.

- Fournier, Ronald AL: Basic Transport Phenomena in Biomedical Engineering, 3Ed, CRC Press 2012. [Library 571.64/3 A, 571.64/3 B, plus one copy of an earlier edition.]

A text which provides useful case studies in biomedical engineering mass transfer phenomena, as well as a useful resource in COMSOL modelling is:


A text which is organised quite differently from the course but which might be helpful on selected topics:


A basic mass transfer reference:


A reference that gives a simple discussion of diffusion as well as the problem of diffusion to a receptor (as on a cell):


A relatively simple reference on fluid flow and dialysis:

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 Term. Feedback and suggestions provided will be important in improving the course for future students.

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/