BIOM9311

Mass Transfer in Medicine

Term Three // 2020

Graduate School of Biomedical Engineering // UNSW Engineering

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Socrates Dokos	s.dokos@unsw.edu.au	By appointment (via e-mail)	Room 506, Samuels Bldg (F25)	9385 9406
Guozhen Liu	guozhen.liu@unsw.edu.au	By appointment (via e-mail)	Room 518, Hilmer Bldg (E10)	9385 0714

Demonstrators

Name	Email	Availability	Location	Phone
Keith Ly	keith.ly@unsw.edu.au	By appointment (via e-mail)		
Mahroo Baharfar	m.baharfar@unsw.edu.au	By appointment (via e-mail)		

School Contact Information

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

Course Details

Credit Points 6

Summary of the Course

This course is an introduction to mass transfer processes in medicine and biology, including the modelling of these. Topics include transfer of solutes across capillaries, mass transfer in haemodialysis, gas exchange in the lungs and in membrane oxygenators, transfer of drugs and toxins across the skin, slow release of drugs from implants, as well as mass transfer considerations in biosensors and in tissue engineering.

Course Aims

The aim of this course is to introduce various mass transfer processes of medical or physiological importance and the methods used to model them.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Explain the principles of diffusion and diffusive mass transport across synthetic and biological membranes.	PE1.1, PE3.2
2. Solve various problems in mass transport by analytical and/or numerical means.	PE1.2
3. Identify the relative importance of convection and diffusion in a given problem.	PE1.3
4. Formulate and numerically solve models of mass transfer in medical applications such as haemodialysis, drug release, and biosensors.	PE2.2, PE2.1
5. Recognise the concepts of flow limitation and membrane limitation, distinguishing whether one or the other, or neither, is limiting in a particular medical application.	PE1.3

Teaching Strategies

This course will be taught via weekly online lectures (pre-recorded) 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 students via Moodle.

Recorded lectures and lecture notes will be available on-line via Moodle, along with weekly in-class exercises and post-class homework assignments. Computer laboratories will be held in the Graduate School of Biomedical Engineering (GSBmE) Computer Laboratory, room 518, using the Windows operating system and COMSOL mathematical software.

Additional Course Information

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 implementing computer-based assignments in COMSOL. The following describes the learning approaches recommended for this course:

Private Study

- Watch the pre-recorded lecture and review the lecture notes each week (Moodle).
- Make a list of things you do not understand. Ask questions.
- Join/start Moodle discussions of problems.
- Learn COMSOL by working through example problems.
- Work through the weekly homework assignment problems.

Computer Laboratory Sessions

- Work through the set class exercises and problems.
- Ask questions.

Laboratory Report and Major Assignment

- Carefully read the detailed laboratory and assignment instructions.
- Process, present and interpret any experimental data.
- Perform any necessary simulations in COMSOL.

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** 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 analyse experimental data and present 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.

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Online Quizzes	15%	In-class quizzes are due during each week's lab class. Homework weekly quizzes are due 5 pm the following Wednesday of each week.	2, 4
Laboratory Report	20%	09/11/2020 05:00 PM	1, 2, 3, 4, 5
Assignment	20%	23/11/2020 05:00 PM	1, 2, 4, 5
Final Exam	45%	Not Applicable	1, 2, 3, 4, 5

Assessment Details

Assessment 1: Online Quizzes

Start date: Weekly lab classes

Details: This assessment consists of a series of online weekly quizzes given during the weekly laboratory classes and online weekly homework quizzes to be completed after each week's class.

Assessment 2: Laboratory Report

Start date: 19/10/2020 09:00 AM

Details:

This assessment involves completion of an online experiment, subsequent analysis of data generated, and presentation of findings in the form of a laboratory report.

Assessment 3: Assignment

Start date: 19/10/2020 09:00 AM

Details:

Students are required to simulate a complex mass transfer system in medicine or biology, submitting a detailed report describing methods, assumptions, results and significance of findings.

Assessment 4: Final Exam

Start date: TBA

Details:

This assessment constitutes the final exam for the course, consisting of a combination of short answers, calculations and essay-type questions.

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 14 September - 18 September	Topic	Fundamentals of Mass Transfer & Introduction to COMSOL
	Assessment	In-class Quiz 1, Homework Quiz 1
Week 2: 21 September - 25 September	Topic	Mass Transfer Across Membranes
	Assessment	In-class Quiz 2, Homework Quiz 2
Week 3: 28 September - 2 October	Topic	Biosensors I
	Assessment	In-class Quiz 3, Homework Quiz 3
Week 4: 5 October - 9 October	Topic	Haemodialysis
	Assessment	In-class Quiz 4, Homework Quiz 4
Week 5: 12 October - 16 October	Topic	Drug Delivery
	Assessment	In-class Quiz 5, Homework Quiz 5
Week 6: 19 October - 23 October	Topic	(No lecture, labs or assessments)
Week 7: 26 October - 30 October	Topic	Biosensors II
	Assessment	No assessments due - lab work only
Week 8: 2 November - 6 November	Topic	Mass Transfer in the Cardiovascular System
	Assessment	In-class Quiz 6, Homework Quiz 6
Week 9: 9 November - 13 November	Topic	Tissue Engineering and Bioreactors
	Assessment	In-class Quiz 7, Homework Quiz 7, Laboratory Report
Week 10: 16 November - 20 November	Topic	Artificial Lung and Blood Gas Exchange
	Assessment	In-class Quiz 8, Homework Quiz 8, Major Assignment (due Monday Week 11)

Resources

Prescribed Resources

- Basic Transport Phenomena in Biomedical Engineering (3rd Edition) by Fournier, Ronald A. L. CRC Press 2012. (Available from the Library: 571.64/3A, 571.64/3B, plus one copy of an earlier edition).

Recommended Resources

The lecture notes given along with information posted on Moodle will be the primary source of information. Additional optional resources are given below:

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

- Datta A, Rakesh V: An Introduction to Modeling of Transport Processes: Applications to Biomedical Systems,Cambridge University Press (2010).

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

- Trusky GA, Yuan Fan, Katz DF: Transport Phenomena in Biological Systems,Pearson Prentice Hall (2004). GSBME library. [Level 7, Main Library (571.64/26)]

A basic mass transfer reference:

- Cussler EL: Diffusion: Mass transfer in fluid systems. Cambridge, Cambridge University Press (1984). [Level 9, Main Library (P 660.28423/23)]

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

- Berg HC: Random walks in Biology. Princeton, Princeton University Press (1993). [Library Level 7 MB 574.01519282/1]

A relatively simple reference on fluid flow and dialysis:

- Keller KH: Fluid mechanics and mass transfer in artificial organs. (1973). A simple introduction to fluid flow and dialysis, but a bit limited.

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

Submission of Assessment Tasks

Laboratory reports and major assignments 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.

Academic Honesty and Plagiarism

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 Information

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

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/

Supplementary Examinations:

Supplementary Examinations for Term 3 2020 will be held on Monday 11th January – Friday 15th January (inclusive) should you be required to sit one.

Image Credit

Synergies in Sound 2016

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	✓
PE2.2 Fluent application of engineering techniques, tools and resources	✓
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in professional and lay domains	✓
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	