BIOM9701

Dynamics of the Cardiovascular System

Term One // 2021

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	Appointments via e-mail	Rm 506, Samuels Building (F25)	9385 9406
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School Contact Information

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

Course Details

Credit Points 6

Summary of the Course

This course provides an overview of the electrical, mechanical and fluid flow principles of the cardiovascular system, aiming to teach how the appropriate equations of physics and engineering can be used to analyse cardiac function and blood flow quantitatively in all the parts of the cardiovascular system. Students will also learn how mathematical modelling can be applied to this biological system to achieve even further insights.

Course Aims

To attain an understanding of the electrical and mechanical principles by which the cardiovascular system functions, and to be able to use the appropriate equations to analyse cardiac function as well as blood flows quantitatively in all the parts of the system. You will also learn how mathematical modelling can be applied to this biological system to achieve further insights.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Students will be able to relate the fundamental principles of cardiac mechanics and electrophysiology to normal and abnormal cardiovascular function.	PE1.1
2. Students will be able to deconstruct the fundamental principles underlying pulsatile blood pressure and flow.	PE1.3
3. Students will be able to explain the physiological function of the microcirculation and the effects of arterial branching on blood flow and pressure.	PE1.3
4. Students will be able to describe the features of venous blood flow and the principles of autonomic and humoral regulation of the cardiovascular system.	PE1.3
5. Students will be able to discover how medical devices are used to measure cardiovascular variables and to treat various cardiovascular pathologies.	PE2.2
6. Students will be able to implement and solve mathematical models of the cardiovascular system numerically using MATLAB software.	PE1.2, PE2.1

Teaching Strategies

This course will be taught via weekly online lectures, team-based learning activities, pre-class activities and homework assignments. Students will be expected to apply theory covered in lectures weekly to the

team-based learning activities and homework assignments. Assessments and feedback will be regularly provided to the students.

Experience suggests that students learn cardiovascular dynamics effectively via participation in class discussions, problem solving exercises and computer modelling. Hence, a large proportion of this course is dedicated to pre-class and team-based learning activities. Feedback provided by laboratory demonstrators is important in teaching correct understanding of theoretical principles.

Additional Course Information

Pre-class exercises, group activities and assignments

Each week, pre-class exercises will be posted on Moodle to help you prepare for the team-based learning activities in 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 30 minutes). Your team-based learning 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 and following through with worked problems. This latter class work is not assessable.

Throughout the course you will also be given various homework assignments (6 assignments in total), due Monday 11:55 pm on either the following week or the week after. Note that late submission of assignments will incur a penalty deduction of 20% per day.

Learning approaches

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

Private Study

- Watch the online lecture
- Implement example Matlab code from the lectures and Moodle modules. Make sure you understand the code, even if you are familiar with Matlab
- Complete the weekly pre-class exercises and arrive prepared to each lab class
- Complete homework assignments

Computer Laboratory

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

Homework Assignments

- Allocate enough time to complete these and submit by the due date

Assessment

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Online Quizzes	20%	Not Applicable	1, 2, 3, 4, 5, 6
Assignments	30%	Not Applicable	1, 2, 3, 4, 5, 6
Final exam	50%	Not Applicable	1, 2, 3, 4

Assessment Details

Assessment 1: Online Quizzes

Start date: Not Applicable

Details:

This assessment consists of a series of online weekly pre-class exercises and in-class quizzes during the weekly laboratory class.

Additional details:

Each week, pre-class exercises will be posted on Moodle to help you prepare for the team-based learning activities in the computer laboratory. You will be required to answer these questions on-line prior to each week's lecture. 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 30 minutes). Your team-based learning mark for that week will consist of the averaged marks between your individual submission and your submission following group discussion.

Assessment 2: Assignments

Start date: Not Applicable

Details:

This assessment consists of 6 online homework submissions, where students are required to solve problems in cardiovascular dynamics typically using Matlab software.

Additional details:

Late submission of these assignments will incur a penalty deduction of 20% per day.

Assessment 3: Final exam

Start date: Not Applicable

Details:

This is the final exam for the course. It will be online and open book.

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: 15 February - 19 February	Lecture	Overview of the Heart and Circulation
Week 2: 22 February - 26 February	Lecture	Cardiac Electrophysiology
Week 3: 1 March - 5 February	Lecture	Cardiac Mechanics
Week 4: 8 March - 12 March	Lecture	Blood Flow in Arteries
Week 5: 15 March - 19 March	Lecture	Wave Propagation in Blood Vessels
Week 7: 29 March - 2 April	Lecture	Blood Flow in Veins and the Microcirculation
Week 8: 5 April - 9 April	Lecture	Heart Assist Devices
Week 9: 12 April - 16 April	Lecture	Regulation of the Cardiovascular System
Week 10: 19 April - 23 April	Lecture	Biomedical Engineering Applications of Cardiovascular Dynamics

Resources

Recommended Resources

Textbooks

- Biomechanics: Circulation, by Y.C. Fung (New York: Springer, 1996). Note, an earlier edition by the same author - Biodynamics: Circulation (New York: Springer-Verlag, 1984) - is available in the library.
- McDonald's blood flow in arteries: theoretic, experimental and clinical principles, edited by Wilmer W. Nichols and Michael F. O'Rourke (London: Edward Arnold, 1990).
- Cardiovascular physiology, by Robert M. Berne and Matthew N. Levy (St. Louis: Mosby, 2001).
- Biofluid mechanics: the human circulation, by Krishnan B. Chandran, Stanley E. Rittgers, and Ajit P. Yoganathan (Boca Raton: CRC/Taylor & Francis, 2007).

Online Tutorials

- On-line Matlab tutorials and courses from Mathworks, Inc can be accessed from **https://www.mathworks.com/academia/tah-portal/university-of-new-south-wales-341489.html**
- 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**

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.

Laboratory Workshop Information

Students will attend the same allocated computer laboratory class each week, either the face-face or online class.

Face-face class: Tuesday 13:00 - 15:00, Rm 518, Level 5, Samuels Building (F25)
Online class: Tuesday 16:00 - 18:00 via the Online Collaboration Sessions link located near the top of the Moodle module for the course

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 1 2021 will be held on Monday 24th May – Friday 28th May (inclusive) should you be required to sit one.

Image Credit

ECG waveform from A/Prof Dokos' own research. Cardiac image sourced from https://afib.newlifeoutlook.com/what-is-afib-with-rvr/?utm_source=Pinterest&utm_medium=Social&utm_content=Article_Share

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	