Welcome to BIOM9701: Dynamics of the Cardiovascular System. This course deals primarily with the physical and mechanical principles by which the cardiovascular system functions: as targeted by numerous biomedical devices and applications. It will teach you the appropriate theory to analyse blood flow quantitatively throughout all parts of the cardiovascular system, as well as cardiac function itself. The principles are mainly fluid-mechanical, but use is made of analogies to electrical transmission lines. You will also experience examples of how mathematical modelling can be applied to this biological system to achieve insights which would be unlikely otherwise.

Lecture notes will be handed out in class, and also available on-line from the Moodle module set up for this course. Class discussions will also be encouraged. On-line quizzes provided during the laboratory sessions are assessable. Along with the lectures, class exercises provided during the tutorials will serve as the basis for the final exam. In addition, there will be homework assignments approximately every fortnight. Marks will seek to take into account your overall apparent understanding, as reflected in, for example, order-of-magnitude checking of answers or even proving that your attempt is erroneous.

This is an introductory subject. However, in order to cover the material necessary to give you adequate skills, you will be required to devote significant amounts of time to reading lecture and reference materials, and to performing the prescribed assignment tasks.

Lectures and tutorials will be held in the GSBmE teaching laboratory (Green Room 518) using the Windows XP operating system and Matlab 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).

This course is largely a standalone subject within GSBmE, serving as an introduction to cardiac biophysics and the mechanics of the Circulation. Some mathematical modelling principles taught in the course are covered in greater detail in BIOM9711 Modelling Organs, Tissues and Devices. Additional biomechanical principles are also covered in BIOM9510 Introductory Biomechanics, BIOM9561 Mechanics of Biomaterials, BIOM9541 Mechanics of the Human Body, SES95451.
Experimental Biomechanics and BIOM9551 Biomechanics of Physical Rehabilitation.

We hope you find this course enjoyable, and a catalyst for further learning in the important and fascinating field of cardiovascular dynamics!

HANDBOOK DESCRIPTION
See link to virtual handbook:

OBJECTIVES
This course provides an overview of the electrical and mechanical 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.

The assessment strategy consisting of weekly on-line quizzes, 6 assignment submissions, and a final exam, will help foster the following UNSW Engineering graduate attributes:

- The skills involved in scholarly enquiry (through the assignments)
- An in-depth engagement with the relevant disciplinary knowledge in its interdisciplinary context (through weekly quizzes and the assignment submissions)
- Capacity for analytical and critical thinking and for creative problem solving (assessed through weekly quizzes, assignments and the final exam)
- Ability to engage independent and reflective learning (via the assignments)

TEACHING STRATEGIES
This course will be taught via weekly lectures and tutorials. Students will be expected to apply theory covered in lectures to the weekly on-line quizzes and solving the tutorial assignments. Assessments and feedback of tutorial submissions will be regularly provided to the students.

Experience suggests that students learn cardiovascular dynamics effectively via participation in class discussions, weekly quizzes, problem solving exercises and computer models. Hence, a large proportion of this course is dedicated to quiz and tutorial sessions. Feedback provided by laboratory demonstrators is important in teaching correct understanding of theoretical principles.

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

<table>
<thead>
<tr>
<th>Private Study</th>
<th>Lectures</th>
<th>Tutorials</th>
<th>On-line quizzes and Assignment Submissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Review lecture material.</td>
<td>• Find out what you must learn</td>
<td>• Follow worked examples</td>
<td>• Learn and be familiar with previous lectures</td>
</tr>
<tr>
<td>• Implement example Matlab code from the lectures, and make sure you understand the code, even if you are familiar with Matlab</td>
<td>• Hear announcements on course changes</td>
<td>• Practice solving set weekly class exercises</td>
<td>• Demonstrate higher understanding and problem solving</td>
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<tr>
<td>• Read additional material pertaining to Matlab to master its use.</td>
<td>• Ask questions</td>
<td>• Ask questions</td>
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<td>• Complete the assignments.</td>
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<td>• Reflect on answers to weekly quizzes and assignment submissions.</td>
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<tr>
<td>• Keep up with notices and find out marks via Moodle</td>
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</table>
EXPECTED LEARNING OUTCOMES

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

- Cardiac mechanics and electrophysiology.
- The theory of pulsatile blood flow.
- The influence of arterial branching on blood flow.
- Mechanics of the microcirculation.
- Autonomic and humoral regulation of the cardiovascular system.
- Mathematical models of the cardiovascular system.
- Solving cardiovascular models with Matlab.

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 implementing computer-based assignments in Matlab.

ASSESSMENT

The assessment scheme for the course will be:

Weekly On-line Quizzes (10) 10%
Assignments (6) 30%
Final Exam 60%

Details of each assessment component, the marks assigned to it, and the dates of submission are set out below:

ASSIGNMENTS AND ON-LINE QUIZZES

1. Assignment 1: (5%) issued on: 1-3-2017 due on: 8-3-2017
2. Assignment 2: (5%) issued on: 8-3-2017 due on: 15-3-2017
3. On-Line Quiz 1: (1%) issued on: 8-3-2017 due on: 8-3-2017
4. Assignment 3: (5%) issued on: 15-3-2017 due on: 29-3-2017
5. On-Line Quiz 2: (1%) issued on: 15-3-2017 due on: 15-3-2017
6. On-Line Quiz 3: (1%) issued on: 22-3-2017 due on: 22-3-2017
7. Assignment 4: (5%) issued on: 29-3-2017 due on: 12-4-2017
8. On-Line Quiz 4: (1%) issued on: 29-3-2017 due on: 29-3-2017
9. On-Line Quiz 5: (1%) issued on: 5-4-2017 due on: 5-4-2017
10. Assignment 5: (5%) issued on: 12-4-2017 due on: 26-4-2017
11. On-Line Quiz 6: (1%) issued on: 12-4-2017 due on: 12-4-2017
12. On-Line Quiz 7: (1%) issued on: 26-4-2017 due on: 26-4-2017
13. Assignment 6: (5%) issued on: 3-5-2017 due on: 17-5-2017
14. On-Line Quiz 8: (1%) issued on: 3-5-2017 due on: 3-5-2017
15. On-Line Quiz 9: (1%) issued on: 10-5-2017 due on: 10-5-2017

Note that late submission of assignments will incur a penalty deduction of 20% per day. For the on-line quizzes, only your best 8 out of 10 quiz marks will go toward your final assessment.
COURSE PROGRAM
The program of lecture topics and assignment submission dates is as follows:

### SEMESTER 1, 2017

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Assessments Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-3-2017</td>
<td>Fundamental Principles of the Cardiovascular System</td>
<td>8-3-2017</td>
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<tr>
<td>2</td>
<td>8-3-2017</td>
<td>Overview of the Heart</td>
<td>15-3-2017</td>
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<td>3</td>
<td>15-3-2017</td>
<td>Cardiac Electrophysiology I</td>
<td>29-3-2017</td>
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<tr>
<td>4</td>
<td>22-3-2017</td>
<td>Cardiac Electrophysiology II</td>
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<tr>
<td>5</td>
<td>29-3-2017</td>
<td>Cardiac Mechanics</td>
<td>12-4-2017</td>
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<tr>
<td>6</td>
<td>5-4-2017</td>
<td>Blood Flow in Arteries</td>
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<td>7</td>
<td>12-4-2017</td>
<td>Wave Propagation in Blood Vessels</td>
<td>26-4-2017</td>
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<tr>
<td></td>
<td>Break</td>
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<tr>
<td>8</td>
<td>26-4-2017</td>
<td>Wave Reflection Phenomena in Large Arteries</td>
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<tr>
<td>10</td>
<td>10-5-2017</td>
<td>Regulation of the Cardiovascular System</td>
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<tr>
<td>11</td>
<td>17-5-2017</td>
<td>Biomedical Engineering Applications of Cardiovascular Dynamics</td>
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<tr>
<td>12</td>
<td>24-5-2017</td>
<td>Review</td>
<td></td>
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<td>13</td>
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</tbody>
</table>

### RELEVANT RESOURCES
- Recommended textbooks:
  - Cardiovascular physiology, by Robert M. Berne and Matthew N. Levy (St. Louis: Mosby, 2001).
- 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](http://www.mathworks.com/moler/odes.pdf)
  - Matlab Introduction (GSBmE) Moodle module

### 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.
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/