## COURSE DETAILS

<table>
<thead>
<tr>
<th>Units of Credit</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact hours</td>
<td>3 hours per week</td>
</tr>
</tbody>
</table>
| Lecture        | Weeks 1 to 8 and 13  
  Wednesday, 10:00 – 13:00  
  CLB 5 |
| Tutorial/Laboratory | Weeks 9 to 12  
  One of:  
  Tuesday 10:00 – 13:00,  
  Wednesday 09:00 – 12:00, or  
  Wednesday 12:00 – 15:00  
  Rm 518, Samuels Building |

### Course Coordinator/Lecturer
Heba Khamis  
email: h.khamis@unsw.edu.au  
office: Rm 434, Samuels Building  
phone: 9385 3904

### Guest Lecturers
Nigel Lovell  
email: n.lovell@unsw.edu.au

Vinicius Goncales  
email: v.goncales@unsw.edu.au

Jeff Armistead  
email: jeffa@resmed.com.au

### Demonstrators (to be confirmed)
Grant Kelly  
email: grant.kelly@unsw.edu.au

Michael Del Rosario  
email: m.delrosario@unsw.edu.au
INFORMATION ABOUT THE COURSE

Background

Welcome to “BIOM9650: Biosensors and Transducers”. This subject aims to impart an understanding of the physical principles which govern the measurement of a biological variable or system, using a transducer which converts the variable into an electrical signal. This course will principally focus on biosensors and transducers associated with measurement of physiological phenomena, including pressure, displacement, flow, volume and biochemistry. By the end of the course you should understand various measurement devices and techniques, including the underlying biological processes that generate the quantities to be measured or controlled. You should also be qualified to advise on the various sensing and transduction choices available to perform a given measurement, and be aware of the associated advantages and disadvantages of each technique.

Units of Credit:  6

BIOM9650 is a 6 Units of Credit (UOC) course and it is expected that you will devote a minimum of 9 hours per week to this course. In addition to the 3 hours in class, you should spend 6 hours per week reading lecture and reference materials and working on tutorial problems and assignments. This is particularly the case if you have not been exposed to the basic physics and electrical engineering concepts underpinning the course.

Presumed knowledge

A good background in mathematics and physics is essential. Basic knowledge of chemistry is assumed. Some knowledge of electrical engineering would also be extremely advantageous, although the basics will be covered in the early lectures. The MATLAB programming environment will be used in the laboratories and as part of some homework exercise, so familiarity with MATLAB or some other programming language will be helpful; if you enrol in this course, an additional Moodle module will be made available to you which contains some MATLAB tutorial material, videos and quizzes to help bring you up to speed.

How this course relates to other courses

“BIOM9640: Biomedical Instrumentation” (taught in Session 1) is a complementary course to BIOM9650, and deals with the genesis of electrical biosignals in the body and how to design measurement electronics to record these signals, which are robust against noise. It is not necessary to have completed BIOM9640 to take BIOM9650, but the background knowledge in mathematics, electrical engineering, and amplification provided by BIOM9640 will be beneficial. However, some introductory electrical engineering topics will also be revised in the first lecture of BIOM9650.

“BIOM9660: Implantable Bionics”, is also related to this course and expands on aspects of bioelectrodes, biopotentials and neural stimulation from the perspective of designing and manufacturing an implantable therapeutic device.

“BIOM9711: Modelling Organs, Tissues and Devices” provides a practical overview of computational modelling in bioengineering, focusing on a range of applications including electrical stimulation of neural and cardiac tissues. The knowledge gained in BIOM9650 will assist in understanding these processes.

“BIOM9621: Biological Signal Analysis”, (taught in Session 1) provides an understanding of linear systems and signals and knowledge of these topics is useful for understanding the response and limitations of biosensors and transducers.
This course serves as an introduction to physiological measurement using biosensors and transducers. This course deals primarily with gaining an understanding of the physical principles which govern the measurement of a biological variable or system, by a transducer which converts the variable into an electrical signal. By the end of the course you should understand various measurement devices and approaches including the underlying biological process that generates the quantity to be measured or controlled. The basic biosensors and transducers used to measure pressure, flow, volume and biochemical sensing are examined along with aspects of imaging instrumentation.


The aims of this course are to:
- introduce the student to different sensor applications in biomedical instrumentation;
- impart an understanding of the mechanisms which govern the acquisition and processing of physiological signals recorded from a human subject, both in vivo and in vitro;
- empower the student to critically evaluate sensor and transducer options for a particular biomedical application.

This course consists of integrated lecture, tutorial and practical work. For the first seven weeks of the semester there will be a three hour teaching period, which will include a lecture and tutorial, group discussions and other appropriate methods to facilitate student learning.

Weeks 2 to 7 (inclusive) will be followed up with homework assignments (six in total), which students will take away and solve and submit the following week for assessment. These will contribute towards the final course mark.

There will be a quiz assessment in Week 8 contributing to the final mark. This will assist with solidifying the theory and content covered in the earlier weeks, before the laboratory sessions start in the following weeks.

From Week 9 to Week 12, a set of laboratory experiments will be conducted to help develop a practical and intuitive understanding of a selection of sensors types.

A final extended revision tutorial will be given in Week 13, in advance of the final examination.

This course requires you to understand the lecture material and then apply the knowledge to basic biosensing applications. It is important to understand the fundamental concepts as soon as possible and to ask for help if you do not understand. Attend all the lectures and if something is unclear, please ask questions. Make sure you review all the lecture notes and read all material that is suggested or handed out. Class participation through attendance at lectures and participation in class exercises and group work is expected.

The material is diverse and not as tightly linked into an overall analytical structure as might be the case in some other subjects. You will need to be prepared to assimilate facts relating to a large number of different measuring instruments and measurement principles. If you treat this assimilation simply as an exercise in rote learning, the volume of material will make succeeding in this subject a difficult task. It is important to develop an intuitive understanding of the principles at work, rather than memorising large volumes of teaching material.
EXPECTED LEARNING OUTCOMES

Expected learning outcomes

On completion of this course, the student should:

L1. have a broad understanding of the applications of various sensors and transducers available for physiological and cellular measurements;
L2. understand fundamental transduction and biosensing principles;
L3. be able to discuss, develop and apply electrical/mechanical engineering concepts for a range of problems and medical applications;
L4. be capable of critically reviewing the literature in the application area and apply knowledge gained from the course to analyse simple biosensing and transduction problems.

Graduate capabilities

These learning outcomes relate most strongly to the following UNSW graduate outcomes:

G1. scholarly enquiry capable of independent and collaborative enquiry;
G2. understanding of their discipline in its interdisciplinary context;
G3. able to apply their knowledge and skills to solving problems, and;
G4. collaborative and effective team workers.
There will be hand-in homework assignments, a mid-session quiz, and a major laboratory report. There will also be a final examination consisting of both qualitative and quantitative long-answer questions. In addition, your attendance and completeness of your laboratory notebook will also be assessed. The following criteria will be applied in assessing your work:

- evidence of critical understanding of the concepts developed in the course;
- ability to apply these concepts to a range of bioinstrumentation problems;
- clarity of description, explanation and attention to the focus of the assessment task;
- degree to which the material submitted for assessment addresses the specified requirements.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Contribution</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Questions</td>
<td>15%</td>
<td>A major aspect of this course is problem solving. This entails choosing the appropriate model, implementing it correctly and arriving at the correct answer. To complete the homework questions, students will use fundamental material from the lectures and tutorials. Assignments should be submitted on time. Marks will be deducted for late submission without prior approval. This assessment addresses learning outcomes: L1, L2, L3, L4. Related graduate capabilities: G1, G2, G3, G4.</td>
</tr>
<tr>
<td>Mid Semester Quiz</td>
<td>20%</td>
<td>A quiz is scheduled approximately half way through the session. It comprises a mix of discursive questions, derivations and calculations, in a format similar to the final exam. The aim of this assessment is to encourage student revision during the course and to allow students to gauge their progress in different topics and receive feedback on that progress. This assessment addresses learning outcomes: L1, L2, L3. Related graduate capabilities: G2, G3.</td>
</tr>
<tr>
<td>Major Laboratory Report</td>
<td>15%</td>
<td>One of the six laboratories will be chosen and the student will be expected to prepare a formal laboratory report that will include results, discussion, error sources and reference to relevant literature. The objectives of the major report are to consolidate information learned in class and to develop critical data analysis and literature research skills. This assessment addresses learning outcomes: L1, L2, L3, L4. Related graduate capabilities: G1, G2, G3.</td>
</tr>
<tr>
<td>Laboratory Attendance</td>
<td>10%</td>
<td>It is expected that students will attend all laboratory classes and document results and discussion in a formal laboratory book. This book will be marked for completeness and consistency with a set of laboratory notebook guidelines that will be supplied to the student. This assessment addresses learning outcomes: L1, L2, L3, L4. Related graduate capabilities: G1, G2, G3, G4.</td>
</tr>
<tr>
<td>Final Exam</td>
<td>40%</td>
<td>The final exam will take a form similar to the mid-session quiz, consisting of a mix of discursive questions, derivations and calculations. The aim of this assessment is to encourage students to review the entire course, including laboratory work, and to allow students to apply all the knowledge disseminated to solve problems. This assessment addresses learning outcomes: L1, L2, L3, L4. Related graduate capabilities: G3.</td>
</tr>
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</table>
ASSIGNMENTS

1. Homework Assignment 1: Displacement issued on: 2\(^{nd}\) Aug due on: 9\(^{th}\) Aug
2. Homework Assignment 2: Flow issued on: 9\(^{th}\) Aug due on: 16\(^{th}\) Aug
3. Homework Assignment 3: Pressure issued on: 16\(^{th}\) Aug due on: 23\(^{rd}\) Aug
4. Homework Assignment 4: Volume issued on: 23\(^{rd}\) Aug due on: 30\(^{th}\) Aug
5. Homework Assignment 5: Respiration issued on: 30\(^{th}\) Aug due on: 6\(^{th}\) Sep
6. Homework Assignment 6: Chemical issued on: 6\(^{th}\) Sep due on: 20\(^{th}\) Sep
7. Lab Report and Lab Book issued on: 25\(^{th}\) Oct due on: 3\(^{rd}\) Nov

Late submission policy

All work submitted late will be subject to a 10% deduction per day. For example, if you submit your work one day late, your work will first be marked as normal and that result will then be scaled by \((100 – 10)/100 = 0.9\). If you submit your work eleven days or more late, you will receive no marks for that material. No extensions will be given after the submission deadline, and penalties will be applied accordingly. Those seeking extensions should lodge an application through myUNSW for approval with supporting evidence: https://my.unsw.edu.au/student/atoz/SpecialConsideration.html

COURSE PROGRAM

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Lecturer</th>
<th>Assessments Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26(^{th}) July</td>
<td>Introduction &amp; Background</td>
<td>Heba Khamis</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2(^{nd}) Aug</td>
<td>Measuring Displacement &amp; Position</td>
<td>Heba Khamis</td>
<td>Displacement Homework (9(^{th}) Aug)</td>
</tr>
<tr>
<td>3</td>
<td>9(^{th}) Aug</td>
<td>Measuring Flow</td>
<td>Heba Khamis</td>
<td>Flow Homework (16(^{th}) Aug)</td>
</tr>
<tr>
<td>4</td>
<td>16(^{th}) Aug</td>
<td>Measuring Pressure</td>
<td>Heba Khamis</td>
<td>Pressure Homework (23(^{rd}) Aug)</td>
</tr>
<tr>
<td>5</td>
<td>23(^{rd}) Aug</td>
<td>Measuring Volume</td>
<td>Nigel Lovell</td>
<td>Volume Homework (30(^{th}) Aug)</td>
</tr>
<tr>
<td>6</td>
<td>30(^{th}) Aug</td>
<td>Respiration</td>
<td>Jeff Armistead</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>6(^{th}) Sep</td>
<td>Chemical Biosensors</td>
<td>Vinicius Goncales</td>
<td>Respiration Homework (6(^{th}) Sep)</td>
</tr>
<tr>
<td>8</td>
<td>13(^{th}) Sep</td>
<td>MID-SEMESTER QUIZ</td>
<td>Heba Khamis</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>19(^{th})/20(^{th}) Sep</td>
<td>LAB</td>
<td>-</td>
<td>Chemical Homework (20(^{th}) Sep)</td>
</tr>
</tbody>
</table>

Mid-semester Break

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Lecturer</th>
<th>Assessments Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>3(^{rd})/4(^{th}) Oct</td>
<td>LAB</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>10(^{th})/11(^{th}) Oct</td>
<td>LAB</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>17(^{th})/18(^{th}) Oct</td>
<td>LAB</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>25(^{th}) Oct</td>
<td>Revision</td>
<td>Heba Khamis</td>
<td></td>
</tr>
<tr>
<td>Study Vacation</td>
<td>3(^{rd}) Nov</td>
<td>-</td>
<td>-</td>
<td>Lab Report and Lab Book (3(^{rd}) Nov)</td>
</tr>
</tbody>
</table>


RELEVANT RESOURCES

Online course material can be accessed through Moodle, which is managed by the UNSW Technology Enabled Learning and Teaching unit: https://moodle.telt.unsw.edu.au. Once you are enrolled in the course, BIOM9650 will be visible to you after the session starts, when you log into Moodle using your zPass.

Tutorial tasks, group discussions, lecture notes and resource materials will be made available on this site during session. Announcements made on Moodle will be forwarded to your student email; you are required to check your student email frequently for updates.

Some useful reference books that are held in the UNSW Library are:


- The Art of Electronics - Paul Horowitz, 2nd ed. (Winfield Hill).

COURSE EVALUATION AND DEVELOPMENT

Student feedback on the course and the lecturers in the course is gathered at the end of each session using the university’s Course and Teaching Evaluation and Improvement (CATEI) process. Your feedback is much appreciated and taken very seriously. Furthermore, your feedback is completely anonymous: while lecturers can see an aggregated view of student responses, and can read your comments, they cannot see who provided the feedback. Continual improvements are made to the course based in part on such feedback, and this helps us to improve 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 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/