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COURSE STAFF

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COURSE INFORMATION

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 the 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.
Aims
The aims of this course are to:
1. introduce the student to different sensor applications in biomedical instrumentation;
2. 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;
3. empower the student to critically evaluate sensor and transducer options for a particular biomedical application.

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.

Teaching strategies
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.

Suggested approach to learning
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.

COURSE 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)

CONTINUAL COURSE IMPROVEMENT

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.

ASSESSMENT

There will be hand-in tutorial 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>
<th>Comment</th>
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</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.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
<td>This assessment addresses learning outcomes: L1, L2, L3, L4. Related graduate capabilities: G3.</td>
</tr>
</tbody>
</table>
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

ADMINISTRATIVE MATTERS

1. It is very important that all students read and understand the UNSW information that relates to Academic Honesty and Plagiarism. A brief summary follows:

<table>
<thead>
<tr>
<th>Plagiarism is the presentation of the thoughts or work of another as one’s own.* Examples include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person’s assignment without appropriate acknowledgement;</td>
</tr>
<tr>
<td>• paraphrasing another person’s work with very minor changes keeping the meaning, form and/or progression of ideas of the original;</td>
</tr>
<tr>
<td>• piecing together sections of the work of others into a new whole;</td>
</tr>
<tr>
<td>• presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and,</td>
</tr>
<tr>
<td>• claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†</td>
</tr>
</tbody>
</table>

Submitting an assessment item that has already been submitted for academic credit elsewhere may also be considered plagiarism.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

Students are reminded of their Rights and Responsibilities in respect of plagiarism, as set out in the University Undergraduate and Postgraduate Handbooks, and are encouraged to seek advice from academic staff whenever necessary to ensure they avoid plagiarism in all its forms.

The Learning Centre website is the central University online resource for staff and student information on plagiarism and academic honesty. It can be located at www.lc.unsw.edu.au/plagiarism. The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

• correct referencing practices;
• paraphrasing, summarising, essay writing, and time management;
• appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle
† Adapted with kind permission from the University of Melbourne
The University has a very firm policy on Academic Honesty and Plagiarism which will be enforced during this course. Details of the UNSW plagiarism policy are available at https://my.unsw.edu.au/student/atoz/Plagiarism.html. The plagiarism policy of the Graduate School of Biomedical Engineering is derived from the University’s policy and details can be found at http://www.gsbme.unsw.edu.au/info-about/our-school/academic-matters. **Whilst we encourage discussion of assignment solutions between students, all material handed in for assessment MUST be your own work and in your own words.** Plagiarised material may result in a mark of zero for all students involved in the act.

The School’s policy also states that a non-plagiarism declaration form be attached to each assignment submitted. This course will therefore require that the form provided on the website above be attached to each assignment submitted during the session. The form can be downloaded from:

For individual assignments:

For group assignments:

2. It is expected that students attend all lectures and tutorial sessions.

3. Assignments submitted after the due date without prior notification and permission will be subject to a deduction in marks as outlined above in the Late submission policy section.

4. UNSW has a wide range of student support services. The resources listed below should be used by students needing assistance related to aspects of their overall University experience. Specific help regarding this course can be sought from the course coordinator.

   http://www.student.unsw.edu.au/
   https://my.unsw.edu.au/student/howdoi/HowDoI_MainPage.html
   http://www.counselling.unsw.edu.au/
   http://www.arc.unsw.edu.au/get-involved/volunteering/contact

5. Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (9385 4734 or http://www.studentequity.unsw.edu.au/). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

6. If you believe that your performance in an assessable component of the course has been affected by illness or another unexpected circumstance, you should make an application for special consideration as soon as possible after the event by visiting UNSW Student Central. Please talk to the course coordinator as well and note that considerations are not granted automatically.

7. UNSW has strict policies and expectations relating to Occupational Health and Safety (OHS) accessed at http://www.ohs.unsw.edu.au/
### LECTURE, TUTORIAL & LABORATORY PROGRAM

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lectures</th>
<th>Lab Group 1</th>
<th>Lab Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 Aug</td>
<td>Overview of course, revision of instrumentation including electrical engineering</td>
<td>SR</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8 Aug</td>
<td>Measuring position and displacement</td>
<td>SR</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>15 Aug</td>
<td>Measuring volume</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>22 Aug</td>
<td>Measuring respiration</td>
<td>JA</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>29 Aug</td>
<td>Chemical biosensors</td>
<td>RG</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5 Sept</td>
<td>Measuring pressure</td>
<td>SR</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>12 Sept</td>
<td>Measuring flow</td>
<td>SR</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>19 Sept</td>
<td>Quiz</td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>26 Sept</td>
<td></td>
<td>Laboratories</td>
<td>Laboratories</td>
</tr>
<tr>
<td></td>
<td>28 Sept - 7 Oct</td>
<td>Semester break</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td>10 Oct</td>
<td></td>
<td>Laboratories</td>
<td>Laboratories</td>
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<tr>
<td>11</td>
<td>17 Oct</td>
<td></td>
<td>Laboratories</td>
<td>Laboratories</td>
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<tr>
<td>12</td>
<td>24 Oct</td>
<td></td>
<td>Laboratories</td>
<td>Laboratories</td>
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<tr>
<td>13</td>
<td>31 Oct</td>
<td>Revision</td>
<td>SR</td>
<td></td>
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</tbody>
</table>

Laboratories (Weeks 9-12) are as follows:

- **A.** Measuring respiration, **B.** Measuring pressure, **C.** Measuring flow, **D.** Measuring volume, **E.** Indicator dilution methods, **F.** Ultrasound

- Group 1 will do their laboratories on Thursday, 12pm – 3pm, in Weeks 9-12. Group placement will be put on Moodle.
- Group 2 will do their laboratories Thursday, 3pm - 6pm, in Weeks 9-12. Group placement will be put on Moodle.
- A maximum of 8 groups of 3 students (total = 24) are allowed in the laboratory at one time, thus there will be one week when students will NOT attend, which will be timetabled around Week 7, with student input.
- Each laboratory experiment will take approximately 1.5 hours to complete; you will complete two experiments per 3 hour lab session.