Faculty of Engineering, Architecture and Science

Department of Electrical and Computer Engineering

**BME 674: Biomedical Instrumentation**

**Prerequisites**
BLG 600 or BLG 601, BLG 700 or BLG 701, BME 532, BME 538.

**Compulsory Texts:**

**Reference Text**

**Calendar Description**
This course deals with the application and design of medical instrumentation systems for which the source of the signals is living tissue or energy applied to living tissues. The major emphasis will be on, transduction principles, sensors, detectors, electronic signal conditioning and processing techniques, and electrical safety standards for medical instrumentation. Some of the major topics include: sensors and transducers - e.g. displacement, resistive, inductive, capacitive, piezoelectric, temperature, radiation thermometry, optical etc.; special-purpose amplification and signal processing techniques; ECG-EMG-EEG biopotential electrodes and amplifiers; non-invasive blood pressure, flow-rate and volume sensing and measurement techniques; respiratory plethysmography; electrochemical biosensors and laboratory instruments; medical imaging systems; and designs for electrical safety. Important instrumentation design concepts are illustrated through design labs, a final design project, and use of circuit simulation tools.

**Learning Objectives**
At the end of this course, the successful student will be able to:

1. Describe differences between methods and components and then perform a specific method and component integration in a hypothetical design situation. Subsequently integrate the generated ideas into a design plan for a simple biomedical instrumentation system, generating ideas creatively or ad-hoc where established methods fail. (4d)

2. Describe iterative process models of design and modify, improve or elaborate a design state using feedback (from expert or system performance results) to achieve specified targets. (4h)

3. Produce formal lab and project reports using appropriate format, grammar, and citation styles for technical and non-technical audiences. Cites evidence (e.g. data sheets, literature) to support the design considerations. (7a)

4. Know the role of the biomedical engineer in society, including responsibility for protecting, specifically, patient safety and, generally, the broader public interest. (8b)
5. Describe interactions between biomedical instrumentation system design and economic and environmental factors (9b)

Note: Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board. For more information, see: http://www.feas.ryerson.ca/quality_assurance/accreditation.pdf

Course Organization
3 hours of lecture per week for 13 weeks
2 hours of lab per week for 6 weeks and 1 major design lab (project) for 4 weeks
2 Teaching Assistants

Course Evaluation
Midterm exam 25%
Lab/Project reports 30% (5% X 3 for labs, 15% for project)
Assignments 0%
Final exam 45%
Total 100%

To be awarded a passing grade, a student must pass both the Theory and Lab/Project components of the course.

Examinations
Midterm exam in Week 7, two hours, closed book (covers Weeks 1-6).
Final exam, during exam period, three hours, closed-book (covers Weeks 1-13).

Project (Major Design Lab)
In the course project students will design a biomedical signal acquisition and processing system based on LabView-Microprocessor/Microcontroller interface. The project is open ended and the student can choose the measurand, appropriate transduction principle, components, and quantification approaches for their design however adhering to the general design process for medical instrumentation. The project groups will be same as the lab groups. The last 4 weeks of the lab sessions will be used for the project work. The students can do the ground work for the project from the start of the course and will submit a proposal outlining their design plan with proper justifications of their design considerations by Week 8 and should get it evaluated and approved by the Instructor/TA. From week 9 to 12 students will engage in the implementation phase. During this phase students will consult with the instructor/TA to discuss their weekly progress and incorporate feedbacks to improve their design. The last week of their respective lab sessions, the students will demonstrate their projects to the Instructor/TA and submit a report with the following sections: problem definition, literature survey (pertaining to justification for their design), methodology, implementation details, and performance analysis. The project reports should be written in a manner that the main theme of the project can be understood by a non-technical reader. Individual student contributions are to be highlighted with consent from all the group members. The project will be evaluated based on the proposed design considerations incorporating the following four factors: (i) Signal, (ii) Medical, (iii) Environmental, and (iv) Economic (Refer to Figure 1.8 in the Text Book for more details). The report should clearly justify the design choices with respect to the above four factors.

Time-line & Evaluation:
Week 8 - Proposal – 5%
Week 12/13 – Project Demonstration and Report – 10%
**Report Format:**

IEEE double column format. No more than 8 double column single-spaced pages. Templates can be downloaded from the IEEE website.

**Course Content**

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<thead>
<tr>
<th>Chap.</th>
<th>Sections</th>
<th>Hours/Weeks</th>
<th>Topic, description</th>
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<td>1 &amp; 14</td>
<td>1(ALL), 14.1-14.9</td>
<td>3 / 1</td>
<td>Basic Concepts of Med. Instru. &amp; Electrical Safety</td>
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<td>2 &amp; 10</td>
<td>2.1-2.12, 2.16, 10.1-10.2, 10.9</td>
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<td>Basic Sensors &amp; Principles</td>
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<td>3</td>
<td>ALL</td>
<td>6 / 4-5</td>
<td>Amplifiers and Signal Processing</td>
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<td>4-6</td>
<td>4.1-4.2, (4.3-4.9)*, 5.1-5.8, 6.1-6.7, 6.10</td>
<td>9 / 6-9</td>
<td>Bio Potential-origins, Electrodes, and Amplifiers</td>
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<td>7-9, 11</td>
<td>7.1, 7.9, 7.10, 7.13, 8.3-8.7, 9.5, 11(ALL)</td>
<td>9 / 9-12</td>
<td>Applications: Measurements of Blood Pressure, Flow, Volume, and Respiratory System. Overview of Laboratory Instrumentation</td>
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<td>12</td>
<td>12.5, 12.7, 12.8, 12.12</td>
<td>4 / 12-13</td>
<td>Medical Imaging: Radiography, Ultrasonography, Computed Tomography, Magnetic Resonance Imaging</td>
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* Self Study Material

**Laboratory/Project**

<table>
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<td>Design Lab 1: Sensors</td>
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<td>4-5</td>
<td>Design Lab 2: Amplifiers and Signal Processing</td>
<td>306/307</td>
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<td>6-8</td>
<td>Design Lab 3: ECG - Measurement and Monitoring</td>
<td>306/307</td>
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<td>9-12/13</td>
<td>Project (Major Design Lab): Biomedical Signal Acquisition - Microcontroller-Labview Interface Based System</td>
<td>306/307</td>
</tr>
</tbody>
</table>

**Important Notes**

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.

2. Should a student miss an exam or equivalent, with appropriate documentation, a make-up will be scheduled as soon as possible in the same semester. Make-ups should cover the same material as the original assessment but need not be of an identical format. Only if it is not possible to schedule such a make-up may the weight of the missed work be placed on another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student’s final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course.

3. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the Grading Promotion and Academic Standing Policy) and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

4. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.
5. Requests for accommodation of specific religious or spiritual observance must be presented to the instructor no later than two weeks prior to the conflict in question (in the case of final examinations within two weeks of the release of the examination schedule). In extenuating circumstances this deadline may be extended. If the dates are not known well in advance because they are linked to other conditions, requests should be submitted as soon as possible in advance of the required observance. Given that timely requests will prevent difficulties with arranging constructive accommodations, students are strongly encouraged to notify the instructor of an observance accommodation issue within the first two weeks of classes.

6. The results of the first test of mid-term test will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.

8. Students are required to adhere to all relevant University policies including the Student Code of Academic Conduct (www.ryerson.ca/senate/policies/pol60.pdf) and Non-Academic Conduct (www.ryerson.ca/senate/policies/pol61.pdf)

9. Students are required to obtain and maintain a Ryerson Matrix e-mail account for timely communications between the instructor and the students.

10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.