Ryerson University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Outline (W2019)

BME674: Biomedical Instrumentation

Instructor(s)	Karthikeyan Umapathy [Coordinator] Office: ENG459 Phone: (416) 979-5000 x 7207 Email: kumapath@ryerson.ca Office Hours: TBA
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.
Prerequisites	BLG 601 and BME 532 and BME 538 and BLG 701 and BME 506 and CEN 199
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. Medical Instrumentation: Application and Design, John G. Webster, 4 th edition, John Wiley and Sons, Inc, 2010.
Reference Text(s):	1. Bioinstrumentation, John G. Webster (Editor), John Wiley & Sons, Inc, 2004.
Learning Objectives (Indicators)	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. (**4b**) 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. (**4c**) 3. Demonstrate the ability to use the knowledge on biomedical instrumentation and measurement equipment for obtaining valid data. (**5a**) 4. 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**) 5. Know the role of the biomedical engineer in society. Including responsibility for protecting, specifically, patient safety, and, generally, the broader public interest. (**8b**) 6. Describe interactions between biomedical instrumentation system design and economic and environmental factors. (**9b**) 7. Demonstrate the ability to source and use technical information related to biomedical instrumentation. (**12a**) NOTE: *Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).*
Course Organization	3.0 hours of lecture per week for 13 weeks 2.0 hours of lab/tutorial per week for 12 weeks
Teaching Assistants	1. Andrew Marques, Email: andrew.marques@ryerson.ca 2. Nauman Baig, Email: nauman.m.baig@ryerson.ca

Course Evaluation	<table><tr><th>Theory</th><th></th></tr><tr><td>Midterm Exam</td><td>25 %</td></tr><tr><td>Final Exam</td><td>45 %</td></tr><tr><th>Laboratory</th><th></th></tr><tr><td>Labs</td><td>15 %</td></tr><tr><td>Project</td><td>15 %</td></tr><tr><td>TOTAL:</td><td>100 %</td></tr></table> Note: In order for a student to pass a course with **"Theory and Laboratory"** components, in addition to earning a minimum overall course mark of 50%, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the **"Course Evaluation"** section for details on the Theory and Laboratory components.
Examinations	- Midterm exam in Week 7, two hours, closed book (covers material up to and including the prior week of the midterm exam). - Final exam, during exam period, three hours, closed-book (covers materials from Week 1 to Week 13).
Other Evaluation Information	None
Other Information	Major Design Lab Project ========== 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 13 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.

Course Content

Week	Hours	Chapters / Section	Topic, description
1	3	Chapter 1 (All Sections), Chapter 14 (Sections 14.1 to 14.9)	Basic Concepts of Med. Instru. & Electrical Safety

2-3	6	Chapter 2 (Sections 2.1 to 2.12, 2.16), Chapter 10 (Sections 10.1 to 10.2, 10.9)	Basic Sensors & Principles
4-5	6	Chapter 3 (All Sections)	Amplifiers and Signal Processing
6-9	9	Chapter 4 (Sections 4.1 to 4.2), Chapter 4 (*Sections 4.3 to 4.9 self study*), Chapter 5 (Sections 5.1 to 5.8), Chapter 6 (Sections 6.1 to 6.7, 6.10)	Bio Potential-origins, Electrodes, and Amplifiers
9-12	9	Chapter 7 (Sections 7.1, 7.9 to 7.10, 7.13), Chapter 8 (Sections 8.3 to 8.7), Chapter 9 (Section 9.5), Chapter 11 (All Sections)	Applications: Measurements of Blood Pressure, Flow, Volume, and Respiratory System. Overview of Laboratory Instrumentation
12-13	4	Chapter 12 (Sections 12.5, 12.7 to 12.8, 12.12)	Medical Imaging: Radiography, Ultrasonography, Computed Tomography, and Magnetic Resonance Imaging. Course Review.
			Additional Information: ========== In addition to Chapter/Sections listed above ALL class notes and materials posted in D2L are included in the syllabus.

Laboratory/Tutorials/Activity Schedule

Week	Lab	Description
2-3	ENG306/ENG307	Design Lab 1: Sensors
4-5	ENG306/ENG307	Design Lab 2: Amplifiers and Signal Processing
6-8	ENG306/ENG307	Design Lab3: ECG - Measurement and Monitoring
9-12/13	ENG306/ENG307	Project (Major Design Lab): Biomedical Signal Acquisition - Microcontroller-Labview Interface Based System

Policies & Important Information:

1. Students are required to obtain and maintain a Ryerson e-mail account for timely communications between the instructor and the students;
2. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented;

3. Assignments, projects, reports and other deadline-bound course assessment components handed in past the due date will receive a mark of ZERO, unless otherwise stated. Marking information will be made available at the time when such course assessment components are announced.
4. Refer to our **Departmental FAQ** page for information on common questions and issues at the following link: https://www.ee.ryerson.ca/guides/Student.Academic.FAQ.html.

Missed Classes and/or Evaluations

When possible, students are required to inform their instructors of any situation which arises during the semester which may have an adverse effect upon their academic performance, and must request any consideration and accommodation according to the relevant policies as far in advance as possible. Failure to do so may jeopardize any academic appeals.

1. ***Health certificates*** - If a student misses the deadline for submitting an assignment, or the date of an exam or other evaluation component for health reasons, they should notify their instructor as soon as possible, and submit a Ryerson Student Health Certificate AND an Academic Consideration Request form within 3 working days of the missed date. Both documents are available at https://www.ryerson.ca/senate/forms/medical.pdf.. **If you are a full-time or part-time degree student, then you submit your forms to your own program department or school;**
2. ***Religious, Aboriginal and Spiritual observance*** - If a student needs accommodation because of religious, Aboriginal or spiritual observance, they must submit a Request for Accommodation of Student Religious, Aboriginal and Spiritual Observance AND an Academic Consideration Request form within the first 2 weeks of the class or, for a final examination, within 2 weeks of the posting of the examination schedule. If the requested absence occurs within the first 2 weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the absence. Both documents are available at www.ryerson.ca/senate/forms/relobservforminstr.pdf. **If you are a full-time or part-time degree student, then you submit the forms to your own program department or school;**
3. ***Academic Accommodation Support*** - Before the first graded work is due, students registered with theAcademic Accommodation Support office (AAS - www.ryerson.ca/studentlearningsupport/academic-accommodation-support) should provide their instructors with an Academic Accommodation letter that describes their academic accommodation plan.

Academic Integrity

Ryerson's Policy 60 (the Academic Integrity policy) applies to all students at the University. Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism - a serious academic offence, with potentially severe penalties and other consequences. It is expected, therefore, that all examinations and work submitted for evaluation and course credit will be the product of each student's individual effort (or an authorized group of students). Submitting the same work for credit to more than one course, without instructor approval, can also be considered a form of plagiarism.

Suspicions of academic misconduct may be referred to the Academic Integrity Office (AIO). Students who are found to have committed academic misconduct will have a Disciplinary Notation (DN) placed on their academic record (not on their transcript) and will normally be assigned one or more of the following penalties:

1. A grade reduction for the work, ranging up to an including a zero on the work (minimum penalty for graduate work is a zero on the work);
2. A grade reduction in the course greater than a zero on the work. (Note that this penalty can only be applied to course components worth 10% or less, and any additional penalty cannot exceed 10% of the final course grade. Students must be given prior notice that such a penalty will be assigned (e.g. in the course outline or on the assignment handout);
3. An F in the course;
4. More serious penalties up to and including expulsion from the University.

The unauthorized use of intellectual property of others, including your professor, for distribution, sale, or profit is expressly prohibited, in accordance with Policy 60 (Sections 2.8 and 2.10). Intellectual property includes, but is not limited to:

1. Slides
2. Lecture notes
3. Presentation materials used in and outside of class
4. Lab manuals
5. Course packs
6. Exams

For more detailed information on these issues, please refer to theAcademic Integrity policy(https://www.ryerson.ca/senate/policies/pol60.pdf) and to the Academic Integrity Office website (https://www.ryerson.ca/academicintegrity/).

Important Resources Available at Ryerson

1. The Library (https://library.ryerson.ca/) provides research workshops and individual assistance. Inquire at the Reference Desk on the second floor of the library, or go to library.ryerson.ca/guides/workshops
2. Student Learning Support(https://www.ryerson.ca/studentlearningsupport) offers group-based and individual help with writing, math, study skills and transition support, and other issues.