# BME772: Biomedical Signal Analysis

**Instructor(s)**

Sridhar Krishnan [Coordinator]
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Office Hours:

**Calendar Description**

This is course will cover the different biomedical signals and the related signal modeling and analysis techniques. The topics covered in the course include an introduction to various physiological/biomedical signals such as the action potential, the electro-neurogram (ENG), the electromyogram (EMG), the electrocardiogram (ECG), the electroencephalogram (EEG), event-related potentials (ERPs), the electrogastrogram (EGG), the phonocardiogram (PCG), the carotid pulse (CP), signals from catheter-tip sensors, speech and oto-acoustic emission signals. The biomedical signal analysis portion of the course will deal with the analysis of concurrent, coupled and correlated processes, filtering for removal of artifact from biomedical signals, event detection techniques, analysis of waveform complexity associated with biomedical signals, mathematical modeling of biomedical systems, and medical decision support systems.

**Prerequisites**

BLG 601 and BME 632 and BLG 701 and BME 639

**Antirequisites**

ELE 772

**Corequisites**

None

**Compulsory Text(s):**

TBA

**Reference Text(s):**

1. BME 772 Lecture Notes of Prof. Sri Krishnan
4. Technical articles and other material [Print-outs to be provided/posted if required]

**Learning Objectives (Indicators):**

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

1. Solve design problems (4b)
2. Analyse data to make decisions. (5b)
3. Contribute to teamwork in an equitable and timely manner. (6a)
4. Use Technical vocabulary related to Biomedical Engineering accurately. (7a)
5. Make concise technical presentations to a peer group. (7b)
6. Use graphics to analyse and display data. (7c)
7. Understand how technological innovations can affect the well-being of those that use them. (8b)
8. Gains a working knowledge of the literature of biomedical engineering and how it effects the day to day life (12b)

**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 per week for 12 weeks  
0.0 hours of tutorial per week for 12 weeks
## Teaching Assistants

Dharmendra (Guru) Gurve, dgurve@ryerson.ca  
Garima Sharma, garima.sharma@ryerson.ca  
Binh Nguyen, binh.nguyen@ryerson.ca  
Shana Beniamin, sbeniamin@ryerson.ca

## Course Evaluation

<table>
<thead>
<tr>
<th>Evaluation Type</th>
<th>Details</th>
</tr>
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</table>
| Theory          | Midterm Exam 25%  
|                 | Final Exam 30%  
| Laboratory      | Lab Reports 25%  
|                 | Project 20%  
|                 | TOTAL: 100% |

### Note:
In order for a student to pass a course, a minimum overall course mark of 50% must be obtained. In addition, for courses that have both "Theory and Laboratory" components, 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 above for details on the Theory and Laboratory components (if applicable).

## Examinations

- Midterm exam in Week 8, two hours, closed book (covers Weeks 1-7).
- Final exam, during exam period, three hours, closed-book (covers Weeks 1-13).

## Other Evaluation Information

- **Course Project**
  - Project on state-of-the-art biomedical analysis systems that may include implementation as well as a written report and presentation. The details will be discussed in class. The project will have to be done in groups of three students. A report including the problem statement, methodology, and results for each must be submitted by the date which will be provided later.
  - The report should be in IEEE double column format, and should not be more than 6 double-column, single-spaced pages (IEEE templates for Word and Latex may be downloaded from the IEEE website). The presentation of the report will also be required, and a presentation schedule will be provided later in the course.

## Teaching Methods

- Zoom link for lectures and labs  
  https://ryerson.zoom.us/j/91652370372

## Other Information

- None

## Course Content

<table>
<thead>
<tr>
<th>Week</th>
<th>Hours</th>
<th>Chapters / Section</th>
<th>Topic, description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>4</td>
<td>SK Module 1</td>
<td>Biomedical signal analysis: Opportunities and Challenges</td>
</tr>
<tr>
<td>2-3</td>
<td>3</td>
<td>SK Module 1</td>
<td>Sensing and acquisition of biomedical signals</td>
</tr>
</tbody>
</table>
### Laboratory(L)/Tutorials(T)/Activity(A) Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>L/T/A</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Virtual</td>
<td>Lab 0: Foundational aspects of biomedical signal analysis</td>
</tr>
<tr>
<td>3 and 4</td>
<td>Virtual</td>
<td>Lab 1: Synchronized averaging</td>
</tr>
<tr>
<td>5 and 6</td>
<td>Virtual</td>
<td>Lab 2: Filtering of the ECG for 60Hz removal</td>
</tr>
<tr>
<td>7 and 8</td>
<td>Virtual</td>
<td>Lab 3: QRS Detection and ECG Rhythm Analysis</td>
</tr>
<tr>
<td>9 and 10</td>
<td>Virtual</td>
<td>Lab 4: Frequency Domain Analysis</td>
</tr>
<tr>
<td>11 and 12</td>
<td>Virtual</td>
<td>Open Lab for projects</td>
</tr>
</tbody>
</table>

### Policies & Important Information:
Turnitin.com is a plagiarism prevention and detection service to which Ryerson subscribes. It is a tool to assist instructors in determining the similarity of student work.
Important Resources Available at Ryerson

Academic Accommodation Support

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.

Suspensions 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 the Academic Integrity policy (https://www.ryerson.ca/senate/policies/pol60.pdf) and to the Academic Integrity Office website (https://www.ryerson.ca/academicintegrity/).

Academic Accommodation Support

Ryerson University acknowledges that students have diverse learning styles and a variety of academic needs. If you have a diagnosed disability that impacts your academic experience, connect with Academic Accommodation Support (AAS). Visit the AAS website or contact aasadmin@ryerson.ca for more information.

Note: All communication with AAS is voluntary and confidential, and will not appear on your transcript.

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, as well as resources and checklists to support students as online learners (https://www.ryerson.ca/studentlearningsupport/online-resources/)
3. You can submit an Academic Consideration Request (https://prod.appsc.ccs.ryerson.ca/senateapps/acadconsform) when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill and academic requirement. You may always visit the Senate website (https://www.ryerson.ca/senate/) and select the blue radial button on the top right hand side entitled: Academic Consideration Request (ACR). COVID 19 specific statement for Fall 2020 related to academic consideration has been built into the on-line academic consideration system and is also on the senate website.
4. At Ryerson, we recognize that things can come up throughout the term that may interfere with a student's ability to succeed in their coursework. These circumstances are outside of one's control and can have a serious impact on physical and mental well-being. Seeking help can be a challenge,
especially in those times of crisis. Below are resources we encourage all Ryerson community members to access to ensure support is reachable. If support is needed immediately, you can access these outside resources at anytime:

- **Distress Line** - 24/7 line for if you are in crisis, feeling suicidal or in need of emotional support (phone: 416-408-4357)
- **Good2Talk** - 24/7 hour line for postsecondary students (phone: 1-866-925-5454)

5. Ryerson COVID-19 Information and Updates for Students ([https://www.ryerson.ca/covid-19/students/](https://www.ryerson.ca/covid-19/students/)) summarizes the variety of resources available to students during the pandemic.

6. Familiarize yourself with the tools you will need to use for remote learning. The Continuity of Learning Guide ([https://www.ryerson.ca/centre-for-excellence-in-learning-and-teaching/learning-guide/](https://www.ryerson.ca/centre-for-excellence-in-learning-and-teaching/learning-guide/)) for students includes guides to completing quizzes or exams in D2L or Respondus, using D2L Brightspace, joining online meetings or lectures, and collaborating with the Google Suite.