# BME632: Signals and Systems II

**Instructor(s)**
Dafna Sussman [Coordinator]
Office: ENG317
Phone: (416) 979-5000 x 3767
Email: dafna.sussman@ryerson.ca
Office Hours: Tuesday 12-1pm by appointment

**Calendar**
The topics covered in the course includes a general discussion on discrete signals (periodic signals, unit step, impulse, complex exponential), a general discussion on discrete systems, Discrete-Time Fourier Series (DTFS), Discrete-Time Fourier Transform (DTFT); analysis and synthesis, Fourier Spectra; continuous nature, periodicity, existence, Properties of the DTFT; linearity, conjugation, time/frequency reversal, time/frequency shifting, etc. LTI discrete time system analysis using DTFT, DTFT and Continuous-Time FT comparison and relation, DFT and FFT discussion and their relation to DTFT and CTFT, Discrete-Time Sampling, Z-Transform; generalization of the DTFT.

**Prerequisites**
BME 532, CEN 199

**Antirequisites**
ELE 632

**Corerequisites**
None

**Compulsory Text(s):**

**Reference Text(s):**

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

1. Describe differences between different evaluation methods and select and apply appropriate evaluation methods. Describe differences between methods, and use specified methods in hypothetical design situations. More specifically: learn frequency analysis of discrete-time signals and LTI systems and describe differences between Fourier transform and Fourier series analysis. Perform both Fourier transform and Fourier series in hypothetical design and analysis of signals and LTI systems (4b)

2. Collect and analyze biomedical signals using a signal acquisition system and Matlab. Ensure signals are correctly acquired through visual and automated analysis, investigate physiological behaviour of signals, quantify performance of algorithms through various metrics in Matlab. (5b)

3. Read and appropriately respond to technical and non-technical written instructions. Cites evidence to construct and support an argument. Produce four lab reports using appropriate format, grammar, and citation styles for technical and non-technical audiences. (7a)

4. Emphasis on bridging the medical and engineering uses of biomedical signals. Creating technologies that can make the job of the physician more accurate and efficient. (9b)

5. Ensure that data is collected and stored anonymously. (10a)

6. Students are referred to textbook, lab manual and other material to ensure labs and lecture material are learned. (12a)

**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

**NOTE:** Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).
Teaching Assistants
Matthew Basso: mnbasso@ryerson.ca
Sections: 012 (Monday 8 am - 10 am) and 032 (Wednesday 4 pm - 6 pm).
Salar Razavi: salar.razavi@ryerson.ca
Sections: 022 (Thursday 4 pm - 6 pm) and 042 (Friday 4 pm - 6 pm).

Course Evaluation

<table>
<thead>
<tr>
<th>Theory</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Midterm Exam</td>
<td>25 %</td>
</tr>
<tr>
<td>Quizzes (5 x 4%)</td>
<td>20 %</td>
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<tr>
<td>Final Exam</td>
<td>35 %</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Laboratory</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Labs</td>
<td>20 %</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>100 %</td>
</tr>
</tbody>
</table>

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
Quizzes will be administered on D2L every 2 lectures (on weeks 2, 4, 7, 10, 12) and will be 30min in duration. Midterm is a 2-hour closed-book exam on D2L on the week 9 (March 11th) during the lecture session, covering weeks 1-8. Final exam, during exam period, three hours, closed-book (covers Weeks 1-13 with emphasis on Weeks 9-13).

Other Evaluation Information
The lecture material is provided ahead of each lecture in the form of PDF notes and recorded video modules. Students are required to view and download these lecture notes (viewing the recorded videos is not mandatory) prior to each lecture, and to complete the bi-weekly quiz before its due date (right before the respective lecture that week). Late quiz submissions will not be permitted and will result in a grade of zero.

Lab will be delivered through Zoom. Lab marks are based on attendance, participation (sharing of your screen with the TA, showing your work, answering questions), successful completion of pre-lab problems, completion of experiment steps, lab reports and successful reply to your TA questions during submission. Students will have the responsibility to achieve a working knowledge of the software packages that will be used in the lab. Students will complete their lab work independently and submit their individual reports through a D2L lab submission link.

Laboratory data collection: Due to COVID19 and remote teaching, students will not be able to collect their own physiological data in the lab. Instead, the TAs will be providing sample datasets for each of the laboratory experiments.

NOTE: Students must achieve passing grades in both the lecture AND the laboratory components of the course, separately, in order to pass the course.

Teaching Methods
This course will be delivered using asynchronous teaching, aka flipped classroom approach, where the theoretical material will be posted online ahead of time and the lecture sessions will be dedicated to practical hands-on problem solving and to discussing real-life applications.

Other Information
Practice Problems
Practice problems and their solutions will be provided on the course web page. These assignments will neither be collected nor graded; they are provided only as a study guide. You are strongly recommended to attempt to solve the problems on your own without looking at the solutions first. If you have any question about an assignment problem or its respective solution, please consult the teaching assistant or course instructor during their consulting hours.

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</td>
<td>3</td>
<td>Chapter 3 Sections 1-3</td>
<td>Introduction to discrete-time systems and signals.</td>
</tr>
<tr>
<td>2</td>
<td>3.5</td>
<td>Chapter 3 Sections 3</td>
<td>Time domain analysis of discrete time systems useful discrete-time signals. <em>Quiz 1</em> (Jan. 21st)</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Chapter 3 Sections 4-6</td>
<td>Classification of discrete systems discrete system equations system response to internal conditions.</td>
</tr>
<tr>
<td>4</td>
<td>3.5</td>
<td>Chapter 3 Sections 6-8</td>
<td>Unit impulse response, system response, BIBO stability criterion. <em>Quiz 2</em> (Feb. 4)</td>
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<tr>
<td>5</td>
<td>3</td>
<td>Chapter 3 Sections 8-10</td>
<td>Convolution and its properties LTI systems and impulse response.</td>
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<tr>
<td>6</td>
<td></td>
<td></td>
<td>Reading Week (week of Feb. 15th)</td>
</tr>
<tr>
<td>7</td>
<td>3.5</td>
<td>Chapter 5 Sections 1-4</td>
<td>Fourier analysis of discrete systems DTFS periodic and aperiodic signal representation. <em>Quiz 3</em> (Feb. 25th)</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>Chapter 5 Sections 5,8,9</td>
<td>Properties of DTFT system analysis using DTFT digital filters.</td>
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<tr>
<td>9</td>
<td>3</td>
<td></td>
<td>Midterm Exam (Mar. 11th)</td>
</tr>
<tr>
<td>10</td>
<td>3.5</td>
<td>Chapter 8 Sections 1-6</td>
<td>Sampling theorem signal reconstruction. Spectral Sampling DFT properties and applications FFT. <em>Quiz 4</em> (Mar. 18th)</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>Chapter 9 Sections 1-4</td>
<td>z-Transform properties inverse transform solution to difference equations. z-Transform system realization frequency response of discrete systems pole-zero analysis stability.</td>
</tr>
<tr>
<td>12</td>
<td>3.5</td>
<td>Chapter 9 Sections 5-6</td>
<td>DTFT connection with CTFT, DTFT and z-Transform. <em>Quiz 5</em> (Apr. 1)</td>
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Chapter 9 Section 6

System realization. Review major topics, sample questions for final exam.

Laboratory(L)/Tutorials(T)/Activity(A) Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>L/T/A</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Lab 1 Intro</td>
<td>Lab 1: Introduction to Matlab DSP Toolbox (independent work - no lab session)</td>
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<tr>
<td>2</td>
<td>Lab 1</td>
<td>Lab 1: Pulse Oximetry &amp; Blood Pressure Measurement</td>
</tr>
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</tr>
<tr>
<td>4</td>
<td>Lab 2</td>
<td>Lab 2: EMG</td>
</tr>
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<td>5</td>
<td>Lab 2</td>
<td>Lab 2: EMG</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
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</tr>
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<td>7</td>
<td>Lab 3</td>
<td>Lab 3: ECG</td>
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<tr>
<td>13</td>
<td>Lab 4</td>
<td>Lab 4: EEG</td>
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</tbody>
</table>

Policies & Important Information:

Students must be reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on the following URL: [http://ryerson.ca/senate/course-outline-policies](http://ryerson.ca/senate/course-outline-policies)

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. Ryerson senate policy 157 requires that any electronic communication by students to Ryerson faculty or staff be sent from their official Ryerson email account.

5. Familiarize yourself with the tools you will need to use for remote learning. The Continuity of 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.

6. The University has issued a minimum technology requirement for remote learning. Details can be found at https://www.ryerson.ca/covid-19/students/minimum-technology-requirements-remote-learning. Please ensure you meet the minimum technology requirements as specified in the above link.

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

8. Refer to our Departmental FAQ page for information on common questions and issues at the following link: https://www.cc.ryerson.ca/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. Academic Consideration Requests for missed work - (e.g. missing tests, labs, etc) - According to Ryerson Senate Policy 134, sections 1.2.3, if you miss any exams, quizzes, tests, labs, and/or assignments for health or compassionate reasons you need to inform your instructor(s) (via email whenever possible) in advance when you will be missing an exam, test or assignment deadline. When circumstances do not permit this, you must inform the instructor(s) as soon as reasonably possible "In the case of illness, a Ryerson Student Health Certificate, or a letter on letterhead from an appropriate regulated health professional with the student declaration portion of the Student Health Certificate attached. For reasons other than illness, proper documentation is also required (e.g. death certificate, police report, TTC report). ALL supporting documentation for illness or compassionate grounds MUST be submitted within three (3) working days of the missed work." NOTE: You are required to submit all of your pertinent documentation through Ryerson's online Academic Consideration Request system at the following link: prod.apps.ccs.ryerson.ca/senateapps/acadconsform.

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/relabor/relaborformintr.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 the Academic 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.

Virtual Proctoring Information (if used in this course)

Online exam(s) within this course may use a virtual proctoring system. Please note that your completion of any such virtually proctored exam may be recorded via the virtual platform and subsequently reviewed by your instructor. The virtual proctoring system provides recording of flags where possible indications of suspicious behaviour are identified only. Recordings will be held for a limited period of time in order to ensure academic integrity is maintained and then will be deleted.

Access to a computer that can support remote recording is your responsibility as a student. The computer should have the latest operating system, at a minimum Windows (10, 8, 7) or Mac (OS X 10.10 or higher) and web browser Google Chrome or Mozilla Firefox. You will need to ensure that you can complete the exam using a reliable computer with a webcam and microphone available, as well as a typical high-speed internet connection. Please note that you will be required to show your Ryerson OneCard prior to beginning to write the exam. In cases where you do not have a Ryerson OneCard, government issued ID is permitted.

Information will be provided prior to the exam date by your instructor who may provide an opportunity to test your set-up or provide additional information about online proctoring. Since videos of you and your environment will be recorded while writing the exam, please consider preparing the background (room / walls) so that personal details are not visible, or move to a room that you are comfortable showing on camera.

Turnitin (if used in this course)

Turnitin.com is a plagiarism prevention and detection service to which Ryerson subscribes. It is a tool to assist instructors in determining the similarity between students' work and the work of other students who have submitted papers to the site (at any university), internet sources, and a wide range of books, journals and other publications. While it does not contain all possible sources, it gives instructors some assurance that students' work is their own. No decisions are made by the service; it generates an "originality report," which instructors must evaluate to judge if something is plagiarized.

Students agree by taking this course that their written work will be subject to submission for textual similarity review to Turnitin.com. Instructors can opt to have student's papers included in the Turnitin.com database or not. Use of the Turnitin.com service is subject to the terms-of-use agreement posted on the Turnitin.com website. Students who do not want their work submitted to this plagiarism detection service must, by the end of the second week of class,
consult with their instructor to make alternate arrangements.

Even when an instructor has not indicated that a plagiarism detection service will be used, or when a student has opted out of the plagiarism detection service, if the instructor has reason to suspect that an individual piece of work has been plagiarized, the instructor is permitted to submit that work in a non-identifying way to any plagiarism detection service.

**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.

Suspictions 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](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/](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](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](https://www.ryerson.ca/studentlearningsupport.online-resources)).
3. You can submit an Academic Consideration Request ([https://prod.apps.ccs.ryerson.ca/senateapps/acadconsform](https://prod.apps.ccs.ryerson.ca/senateapps/acadconsform)) when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill academic requirements. You may always visit the Senate website ([https://www.ryerson.ca/senate/](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.
   - 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.
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.