## Course Outline (W2019)
### ELE635: Communication Systems

### Instructor(s)
Lian Zhao [Coordinator]
Office: ENG434
Phone: (416) 979-5000 x 6101
Email: l5zhao@ryerson.ca
Office Hours: Mondays, 12-1pm

### Calendar Description
This course studies basic principles of communication theory as applied to the transmission of information. The course topics include: baseband signal transmission, amplitude, phase and frequency modulation, modulated waveform generation and detection techniques, effects of noise in analog communication systems, frequency division multiplexing. Digital Signals: sampling, aliasing, quantization and introduction to pulse code modulation.

### Prerequisites
ELE 532 and MTH 514 and CEN 199

### Antirequisites
None

### Corequisites
None

### Compulsory Text(s):
2. M. Zeytinoglu, ELE 635 Course Notes, available from course homepage on D2L
3. Laboratory experiment descriptions and procedures, available from course home page on D2L

### Reference Text(s):
1. None.

### Learning Objectives (Indicators)
At the end of this course, the successful student will be able to:

1. Learn mathematical analysis of non-linear modulated signals (e.g. frequency and phase modulated signals) using Bessel functions and series expansions to estimate their spectra. Learn mathematical formulation and analysis of stochastic signals. (1b)
2. Study characteristics of communication channels. Learn basic modulation techniques for efficient transmission of signals over communication channels. Learn modulation techniques to counteract frequency-dependent limitations of transmission (attenuation, frequency-selective fading). Learn effects of noise on systems and signals. (1c)
3. Learn to model complete communication systems including transmitter and receiver structures. Study bandwidth efficient communication techniques. Learn to formulate and analyze effects of noise on model communication systems and signal propagation. (2b)
4. Learn how to use the measurements of AM and FM signals to extract signal characteristics (e.g., modulation indices), so that signal characteristics can be modified to conform to regulatory conditions. (3b)
5. Study different amplitude- and frequency modulation systems, study their characteristics, power efficiency and limitations. Learn coherent and non-coherent coherent communication systems. (3a)
6. Learn to conduct lab experiments with specialized test and measurement equipment to measure modulated signal characteristics in time- and frequency domains. Learn to measure modulation indices of modulated signals. (5b)

**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
3.0 hours of lab/tutorial per week for 12 weeks

### Teaching Assistants
TBA
### Course Evaluation

<table>
<thead>
<tr>
<th>Theory</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Midterm Exam</td>
<td>25 %</td>
<td></td>
</tr>
<tr>
<td>Final Exam</td>
<td>45 %</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Laboratory</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Experiments</td>
<td>24 %</td>
<td></td>
</tr>
<tr>
<td>Formal Lab Report</td>
<td>6 %</td>
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</tbody>
</table>

**TOTAL:** 100 %

**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, problems and solutions, closed book (covers Weeks 1-6).  
Final exam, during exam period, two hours, and closed-book (covers Weeks 4-13).

### Other Evaluation Information

**IMPORTANT:** Students must achieve passing grades in both the lecture and the laboratory components of the course in order to pass the course.

### Other Information

**Assignments:** There are six assignments, which include problems selected from the course reference text. These questions and their respective solutions are available from the course home page on D2L. 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 assignment 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 course instructor or the teaching assistant 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>Chp 2</td>
<td>Introduction Representation of signals and systems.</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>Chp 3 Sect 1-3</td>
<td>Analysis and transmission of signals.</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Chp 3 Sect 4-8</td>
<td>Analysis and transmission of signals.</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>Chp 4 Sect 1-3</td>
<td>Amplitude modulation.</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>Chp 4 Sect 4-6</td>
<td>Amplitude modulation (cont'd).</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>Chp 4 Sect 7-8</td>
<td>Amplitude modulation (cont'd).</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>Chp 5 Sect 1</td>
<td>Introduction to angle modulation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Midterm Examination</td>
</tr>
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</table>
Laboratory/Tutorials/Activity Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Lab</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4</td>
<td>ENG311</td>
<td>Spectral Analysis.</td>
</tr>
<tr>
<td>5-6</td>
<td>ENG311</td>
<td>Amplitude Modulation and Demodulation.</td>
</tr>
<tr>
<td>9-10</td>
<td>ENG311</td>
<td>Frequency Modulation and Demodulation.</td>
</tr>
<tr>
<td>12-13</td>
<td>ENG311</td>
<td>AM FM and Software Defined Radio.</td>
</tr>
</tbody>
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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 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.

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 the Academic 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.