Carleton University  
Department of Systems and Computer Engineering  
SYSC3501 Communication Theory – Summer 2019  
Course Outline

Instructor Information and Office hours

<table>
<thead>
<tr>
<th>Section</th>
<th>Name</th>
<th>E-Mail</th>
<th>Telephone</th>
<th>Office</th>
<th>Office Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Prof. Xiaoping Liu</td>
<td><a href="mailto:xpliu@sce.carleton.ca">xpliu@sce.carleton.ca</a></td>
<td>(613) 520-2600 ext. 1774</td>
<td>7040 MC</td>
<td>MW 14:30-15:30</td>
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TA Information and Office hours
See the information in your CU Learn account.

Course Number and Calendar Description

SYSC 3501 Communication Theory [0.5 credit]
Review of signals, linear systems and Fourier theory; signal bandwidth and spectra; digital waveform coding. Introduction to analog and digital modulation systems; synchronization; characterization and effects of noise; link budgets; communications media and circuits; applications to current communications systems.

Prerequisites
MATH 3705 and (SYSC 3600 or SYSC3610)
Students who have not satisfied the prerequisites for this course must either:
a) Withdraw from the course immediately; or
b) Submit a prerequisite waiver request and have it approved (Please visit www.sce.carleton.ca/ughelp for more information); otherwise they will be de-registered from the course after the last day to register for courses in the Summer 2019 term.

Course Objectives
The objective of the course is to provide a refresher on signals, transforms, sampling and quantization and then present different analog and digital modulation schemes. Towards the end of the course, students are introduced to error analysis and the notion of matched filter receiver. In addition to fundamental analytical skills, the course aims at offering students hands-on training using five laboratories based on equipment from National Instruments.
Learning Outcomes

After successful completion of this course, the students will:

1. Develop a good understanding of both time and frequency domain representations of signals and LTI systems (power and energy signals, spectral analysis, power spectral density, impulse response and transfer function etc.)
2. Understand basic elements of a communication system
3. Develop good understanding of various analog (e.g. AM and PM and FM) and digital modulation (e.g. ASK, PSK, QAM etc.) and demodulation techniques
4. Understand and be able to implement noise and error analysis of an analogue or digital telecommunication system
5. Understand the notions of sampling, quantization, pulse shaping, bit rate, channel capacity and bandwidth.
6. Be able to examine and analyse the performance of modulation and demodulation techniques in various transmission environments. Understand the notion of matched filter receiver and optimal demodulation.
7. Implement and perform measurements on practical communication systems and circuits through a series of five labs

Graduate Attributes (GA’s)

The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess 12 attributes. Activities related to the learning outcomes listed here are intended to develop students' competence in the following GA’s:

- 1.6S Signals and systems
- 2.2 Approach to the problem
- 3.5 Interpretation of data (synthesis) and discussion
- 5.1 Diagrams and engineering sketches
- 5.2 Document processing and graphics packages
- 5.3 Tools for design, experimentation, simulation, visualization, and analysis

Data obtained from quiz, exam and/or lab questions related to learning outcomes 1-7 outlined previously will be collected to assess students' progress towards possessing all the above GA’s.

Textbooks and Other References


Other References

Lecture Schedule

<table>
<thead>
<tr>
<th>Section</th>
<th>Room</th>
<th>Lecture Time</th>
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<tbody>
<tr>
<td>A</td>
<td>ME 3275</td>
<td>MW 8:35 -11:25</td>
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Laboratory Schedule

<table>
<thead>
<tr>
<th>Section</th>
<th>L1</th>
<th>L2</th>
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<tbody>
<tr>
<td>Time</td>
<td>M 11:35 – 14:25</td>
<td>T 11:35 – 14:25</td>
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<tr>
<td>Location</td>
<td>MC 6070</td>
<td>MC 6070</td>
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Assignments

Assignments and solutions will be posted on the course website on a regular basis. Do the assignments as soon as you can to avoid many assignments piling up. Note that assignments will not be marked and therefore do not have to be handed in.

Laboratories

There will be in total five scheduled labs plus a lab preamble, which you need to read ahead of time in order to familiarize yourself with the lab equipment. Each student will be required to perform all the labs. All the scheduled labs will be conducted in MC6070. Detailed lab material, instructions and schedule can be found in the course web site.

Students are required to do their labs in their assigned group and during their scheduled lab sessions.

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for a missed lab must contact the professor and the head TA in a timely fashion and provide a valid medical report no later than three (3.0) working days after their scheduled lab date; otherwise a mark of zero will be assigned for that lab.

Note that the class is relatively big and it is virtually impossible to reschedule missed labs. Students who miss a lab with valid documentation may write with another section in which there is room. If that is not possible, the weight will be added to other labs.

Students who missed attendance for two labs or more without a valid excuse will automatically receive an F (or FND) in the course.

Lab Groups

The laboratories will be performed in groups and lab groups will be formed by yourselves during the first two weeks of the term, or otherwise you will be randomly assigned on-site during the first lab. A lab group normally consists of two students and, once formed, it should remain the same throughout the term.
Lab Manuals

Laboratory manuals will be posted on the course web site.

Lab Reports

Each group must complete one joint report for each lab, which must include answers to all the questions (theoretical and experimental) in the lab manual. Students must demonstrate their experiment to the TAs during their lab session. Notes, data, sketches etc. must be initialed by one of the TAs responsible for the lab and included in the report. The ones not initialed may be given a zero mark.

Lab reports are due at 4:00 pm one week after the completion of your lab session. For example, if you performed your lab on a Monday, it would be due the following Monday at 4:00 pm. Any lab report submitted after the deadline will be given a mark of zero. No exceptions. Do not leave things to the last minute to avoid unforeseen circumstances (e.g. printer problems and transportation problems). A good way to avoid these problems is to finish the lab at least a day earlier.

Lab reports shall be dropped off by the due date in the designated drop box, which is located near the men's washroom, down the hall from the SYC office on the 4th floor of Mackenzie building.

Quizzes and Exams

There will be one quiz, one in-class midterm exam and one final exam.

Students must arrive for the exams on time and may not leave early. A student arriving late may not be allowed to write the exam and receive a grade of zero.

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work (quiz or in-class midterm exam) must inform the professor and submit a valid excuse no later than three (3.0) working days after the examination; otherwise, a zero mark will be assigned for that quiz or exam.

Students who miss the quiz with an excuse that is deemed valid may have the portion of the mark allocated to the quiz to be split evenly and reallocated towards the midterm and final exam. Students who miss the in-class midterm exam may be granted permission to write a make-up examination (to be scheduled before the last day of class).

Students who miss the final exam may be granted permission to write a deferred examination (see the Undergraduate Calendar for regulations on deferred exams). These students have additional months to study and a less crowded examination schedule compared to their colleagues who write the normal final exam. As such, it is only fair to expect substantially better performance from these students on the deferred examination than on the regular final exam, or a deferred examination with increased difficulty.
Evaluation and Marking Scheme

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<tbody>
<tr>
<td>Laboratories</td>
<td>20%</td>
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<tr>
<td>Quiz</td>
<td>10%</td>
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<tr>
<td>Midterm Exam</td>
<td>25%</td>
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<tr>
<td>Final Exam</td>
<td>45%</td>
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A student will receive an F (or FND) if she/he:
1. Failed to achieve a passing grade (50%) in the laboratories OR
2. Missed more than one lab.

The final exam is for evaluation purposes only and will not be returned to the student. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available.

Any makeup term work (if any) will be for evaluation purposes only and will not be returned to the student.

Week to Week Outline

Week 0 (Jul 1-5)
Introduction and overview of communication theory and systems (Chapter 1)
Review of complex arithmetic (notes)

Week 1 (Jul 8-12)
Properties of signals and noise (Section 2.1)
Fourier Transform and Spectra (Section 2.2)
Power Spectrum (Section 2.3)
Fourier Series and periodic signals (Section 2.5)
Review of linear systems (Section 2.6)

Week 2 (Jul 15-19)
Bandwidth (Section 2.9)
Limiter, mixers, up- and down-converters (notes, Sections 4-10-12)
AM-DSB-C and noncoherent detection (Sections 5.1, 4-13)
AM-DSB-SC and coherent detection (Sections 5.3, 4-13)
SSB and VSB (brief, Section 5.5)
Phase and frequency modulation and demodulation (Sections 5.6, 4-13)

Week 3 (Jul 22-26)
Quiz: Monday July 22
Superheterodyne receiver and image frequencies (4-16)
Sampling, quantization, and PCM systems (Sections 3.1 - 3.3)
Digital baseband modulation, binary and multilevel signaling (Section 3-4)

Week 4 (Jul 29 - Aug 02)
Digital bandpass modulation: BASK, BPSK, BFSK, QPSK, M-ary PSK, QAM (Sections 5.9 and 10)
Random processes (Sections 6.1-6.5, brief)
Thermal noise (Section 6.6)
Error probabilities for binary signals (Sections 7.1-7.2)
Matched filter (Section 6.8)
Midterm Exam: Wednesday July 31

Week 5 (Aug 5 – 9)
Coherent demodulation of digital bandpass modulation (Section 7.3)
Noncoherent demodulation of digital bandpass modulation (brief Section 7.4)

Week 6 (Aug 12 –16)
Comparison of digital signaling systems (Section 7.6)
Free space radio propagation, antennas, and link budgets (Section 8.6)
TDM, FDM, CDM and Spread Spectrum (Sections 3.9, 5.7 and notes) if time permits

General Regulations

Attendance: Students are expected to attend all lectures and lab periods. The University requires students to have a conflict-free timetable. For more information, see the current Undergraduate Calendar, Academic Regulations of the University, Section 1.2, Course Selection and Registration and Section 1.5, Deregistration.

Health and Safety: Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: http://sce.carleton.ca/courses/health-and-safety.pdf

Deferred Term Work: Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately...
informing the instructor concerned and for making alternate arrangements with the instructor and
in all cases this must occur no later than three (3.0) working days after the term work was due.
The alternate arrangement must be made before the last day of classes in the term as published in
the academic schedule. For more information, see the current Undergraduate Calendar,
Academic Regulations of the University, Section 2.6, Deferred Term Work.

Appeal of Grades: The processes for dealing with questions or concerns regarding grades
assigned during the term and final grades is described in the Undergraduate Calendar, Academic
Regulations of the University, Section 2.7, Informal Appeal of Grade and Section 2.8, Formal
Appeal of Grade.

Academic Integrity: Students should be aware of their obligations with regards to academic
integrity. Please review the information about academic integrity at:
https://carleton.ca/registrar/academic-integrity/. This site also contains a link to the complete
Academic Integrity Policy that was approved by the University's Senate.

Plagiarism: Plagiarism (copying and handing in for credit someone else's work) is a serious
instructional offense that will not be tolerated.

Academic Accommodation: You may need special arrangements to meet your academic
obligations during the term. You can visit the Equity Services website to view the policies and to
obtain more detailed information on academic accommodation at
http://www.carleton.ca/equity/For an accommodation request, the processes are as follows:

- **Pregnancy obligation:** write to me with any requests for academic accommodation
during the first two weeks of class, or as soon as possible after the need for
accommodation is known to exist. For more details see https://carleton.ca/equity/wp-

- **Religious obligation:** write to me with any requests for academic accommodation during
the first two weeks of class, or as soon as possible after the need for accommodation is
known to exist. For more details see https://carleton.ca/equity/wp-

- **Academic Accommodations for Students with Disabilities:** The Paul Menton Centre
for Students with Disabilities (PMC) provides services to students with Learning
Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity
Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and
impairments in mobility, hearing, and vision. If you have a disability requiring academic
accommodations in this course, please contact PMC at 613-520-6608
or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC,
contact your PMC coordinator to send me your Letter of Accommodation at the
beginning of the term, and no later than two weeks before the first in-class scheduled test
or exam requiring accommodation (if applicable). After requesting accommodation from
PMC, meet with me to ensure accommodation arrangements are made. Please consult
https://carleton.ca/pmc/students/dates-and-deadlines/ for the deadline to request
accommodations for the formally-scheduled exam (if applicable).
- **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton’s Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: [https://carleton.ca/sexual-violence-support/](https://carleton.ca/sexual-violence-support/).

- **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see [https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf](https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf)

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