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 15:00-16:00</td>
</tr>
<tr>
<td>B</td>
<td>Prof. Ioannis Lambadaris</td>
<td><a href="mailto:ioannis@sce.carleton.ca">ioannis@sce.carleton.ca</a></td>
<td>(613) 520-2600 ext. 1974</td>
<td>4448 ME</td>
<td>TR 1:30-2:30</td>
</tr>
</tbody>
</table>

Course Website

http://www.sce.carleton.ca/courses/sysc-3501/w19

The course website is password-protected: Login:sysc3501; Password: sysc3501_19

TA Information and Office hours

Ali Ihbeel (aliihbeel@cmail.carleton.ca)
Chowdury Saleha Ferdowsy (chowdhurysalehaferdo@cmail.carleton.ca)
Honeyeh Yazdizadeh (honeyehyazdizadeh@cmail.carleton.ca)
Hossein Chahrour (hosseinchahrour@cmail.carleton.ca)
Sima Naseri (simanaseri@cmail.carleton.ca)

Please consult the course web site for details regarding each TA.

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](http://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 Winter 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)

Graduate Attributes measured in this course are: 1.9.E-Knowledge Base: Discipline-specific concept DOE-6: Signals and Communications and GA 1.6.S Discipline specific Signals and Systems SCE-3.

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 GA 1.9.E (a knowledge base in Signal and Communication Theory for Electrical and Computer Engineering) and GA 1.6.S (a knowledge base in Signals and Systems for Systems and Computer Engineering). Data obtained from exam and/or lab questions related to learning outcomes 1-7 outlined previously will be collected to assess students' progress towards possessing GA 1.9.E and GA 1.6.S. In particular learning outcomes 6-7 are intended to prepare students to undertake learning activities that develop competence in measurement, analysis and design for communication systems in subsequent courses in Electronics and Systems Engineering.

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>MC5050</td>
<td>MW 10:05 -11:25</td>
</tr>
<tr>
<td>B</td>
<td>Azrieli Theatre 102</td>
<td>TR 14:35 - 15:55</td>
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</tbody>
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Laboratory Schedule

<table>
<thead>
<tr>
<th>Section</th>
<th>L1E</th>
<th>L2E</th>
<th>L3O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Mon(even) 14:30-17:30</td>
<td>Mon(even) 11:30-14:30</td>
<td>Fri(odd) 14:30-17:30</td>
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<tr>
<td>Section</td>
<td>L4O</td>
<td>L5E</td>
<td>L5O</td>
</tr>
<tr>
<td>Time</td>
<td>Wed(odd) 14:30-17:30</td>
<td>Thu(even) 11:30-14:30</td>
<td>Tue(odd) 11:30 - 14:30</td>
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Odd and even weeks are determined by the course outline below. Note that winter break is not counted as a week. Refer to the course outline and the course website to avoid confusion. **It is your responsibility not to miss a laboratory!**

**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 website.

**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 (lab tutorial and lab quiz) 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 (lab tutorial and lab quizzes) 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.
More information on lab groups will be posted on the Laboratory Section of the course website.

**Lab Manuals**

Laboratory manuals will be posted on the course web site in the Laboratory Section of 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 Tests**

**There will be two in-class quizzes and two in-class tests.**

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work (quiz or in-class test) must inform their 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 test.

Students who miss quiz #1 with an excuse that is deemed valid may have the portion of the mark allocated to quiz #1 to be reallocated towards test #1. Students who miss in-class test #1 or #2 may be granted permission to write a make-up examination (to be scheduled before the last day of class).
Students must write their quizzes and tests in their assigned section. Students must arrive for their tests on time and may not leave the test early. A student arriving late for a test may not be allowed to write the test and receive a grade of zero.

**Evaluation and Marking Scheme**

<table>
<thead>
<tr>
<th>Evaluation and Marking Scheme</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Laboratories</td>
<td>20%</td>
</tr>
<tr>
<td>Quiz #1</td>
<td>10%</td>
</tr>
<tr>
<td>Quiz #2</td>
<td>10%</td>
</tr>
<tr>
<td>In-Class Test 1</td>
<td>25%</td>
</tr>
<tr>
<td>In-Class Test 2</td>
<td>35%</td>
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The second in class quiz and exam is for evaluation purposes only and will not be returned to students. 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.

Whichever marking scheme is used, 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 **OR**

**Week to Week Outline**

**Week 1 (Jan 7-10)**
Introduction and overview of communication theory and systems (Chapter 1)
Review of complex arithmetic (notes)
Properties of signals and noise (Section 2.1)

**Week 2 (Jan 14-17)**
Fourier Transform and Spectra (Section 2.2)
Power Spectrum (Section 2.3)

**Week 3 (Jan 21 –24)**
Review of linear systems (Section 2.6)
Fourier Series and periodic signals (Section 2.5)
**Week 4 (Jan 28 –31)**

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)

**In-Class Quiz #1 for Section A:** Wednesday January 30

**In-Class Quiz #1 for Section B:** Thursday January 31

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**Week 5 (Feb 4 - 7)**

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)

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**Week 6 (Feb 11-14)**

Superheterodyne receiver and image frequencies (4-16)

Sampling, quantization, and PCM systems (Sections 3.1 - 3.3)

**Winter break: Feb 18-22**

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**Week 7 (Feb 25-28)**

**In-Class Test #1 for Section A:** Monday February 25

**In-Class Test #1 for Section B:** Tuesday February 26

Digital baseband modulation, binary and multilevel signaling (Section3-4)

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**Week 8 (Mar 4- 7)**

Digital bandpass modulation: BASK, BPSK, BFSK, QPSK, M-ary PSK, QAM (Sections 5.9 and 10)

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**Week 9 (Mar 11-14)**

Random processes (Sections 6.1-6.5, brief)

Thermal noise (Section 6.6)

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**Week 10 (Mar 18- 21)**

Error probabilities for binary signals (Sections 7.1-7.2)
Matched filter (Section 6.8)

**Joint Test #2 for sections A and B on Saturday March 23**

**Week 11 (Mar 25 – 28)**
Coherent demodulation of digital bandpass modulation (Section 7.3)
Noncoherent demodulation of digital bandpass modulation (brief Section 7.4)
Comparison of digital signaling systems (Section 7.6)

**Week 12 (Apr 1 – 4)**
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

**Week 13 (Apr 8 – 9)**
In-Class Quiz #2 for Section A: Monday April 8
In-Class Quiz #2 for Section B: Tuesday April 9

**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](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-content/uploads/Student-Guide-to-Academic-Accommodation.pdf
- **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-content/uploads/Student-Guide-to-Academic-Accommodation.pdf
- **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/.
- **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

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