Instructor Information and Office hours

Dr. Bruce Wallace
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MC6015
Office Hours: Monday 2:30-3:30pm and Tuesday 10:30-11:30am

TA Information and Office hours

TBD

Calendar Description

SYSC 4405 - Digital Signal Processing


http://calendar.carleton.ca/undergrad/courses/SYSC/

Prerequisites

SYSC 3500 or SYSC 3600 or SYSC 3610

Students who have not satisfied the prerequisites for this course must either withdraw from the course or obtain a prerequisite waiver by visiting the Engineering Undergraduate Academic Support Office.

Assumed Knowledge

Upon entry into this course, students are expected to have knowledge of:
System analysis using Laplace/Fourier techniques
System modeling using impulse response and convolution
Programming techniques (e.g. Matlab, C and or Python)

Course Objectives

The relationship between discrete-time and continuous-time signals and systems is emphasized throughout the course. Students will have the opportunity to apply the theory
in several laboratory sessions that deal with the design and implementation of basic DSP functions such as FIR and IIR filters as well as spectral analysis using the FFT.

Learning Outcomes
By the end of this course students should be able to:

1. Understand the differences between analog, discrete time and digital signals.
2. Describe and analyze discrete time signals in the time and frequency domains.
3. Apply digital signal processing techniques to design discrete time systems.
4. Learn the z-transform and its applications in the analysis and design of discrete time systems, and how to use for frequency response computation.
5. Design digital filters, meeting given specifications, using windowing techniques.
6. Design digital filters using transformation techniques from analog designs.
7. Use the Discrete Fourier Transform (DFT) and the FFT for the analysis of arbitrary signals.
8. Program digital signal processing algorithms in MATLAB

Graduate Attributes (GA’s)

The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess 12 attributes at the time of graduation. Activities related to the learning outcomes listed above are measured throughout the course and are part of the department’s continual improvement process. Graduate attribute measurements will not be taken into consideration in determining a student’s grade in the course. For more information, please visit: https://engineerscanada.ca/.

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<thead>
<tr>
<th>Graduate Attribute</th>
<th>Learning Outcome(s)</th>
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<tr>
<td>1.6.S Signals and systems</td>
<td>all</td>
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<tr>
<td>2.1 Problem definition</td>
<td>all</td>
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<tr>
<td>2.2 Approach to the problem</td>
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<tr>
<td>2.3 Use of assumptions</td>
<td>5-8</td>
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<tr>
<td>2.4 Interpreting the solution - validity of results</td>
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<tr>
<td>3.1 Complex problem assessment</td>
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<tr>
<td>3.4 Data reduction methods and results</td>
<td>all</td>
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<tr>
<td>3.5 Interpretation of data (synthesis) and discussion</td>
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<tr>
<td>4.5 Design implementation / task(s) definition</td>
<td>5-8</td>
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<tr>
<td>4.6 Alternate solution(s) definition</td>
<td>5-8</td>
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<tr>
<td>5.3 Tools for design, experimentation, simulation, visualization, and analysis</td>
<td>all</td>
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Textbooks (or other resources)

SYSC 4405: Introduction to DSP – Lecture Notes (Lecture notes will be available through CULearn)

Educational Matlab GUIs: Graphical User Interfaces developed by the members of the Center for Signal and Information Processing (CSIP), a part of the School of Electrical and Computer Engineering at the Georgia Institute of Technology. [http://dspfirst.gatech.edu/matlab/](http://dspfirst.gatech.edu/matlab/)

Optional Course textbooks:


Other Resources (not mandatory):


Evaluation and Grading Scheme

Assignments: 10% (up to 5 assignments max)

Labs: 5% (1% for attendance and completion of each of labs 1 through 5)

5% (For lab 6)

Midterm Examination: 20% (In class)

Final Examination: 60% (Scheduled by University)

Breakdown of course requirements

Lectures three hours a week, laboratory three hours alternate weeks.

The final examination 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.
CU Learn will be used for the course web page, which is accessible at [http://culearn.carleton.ca](http://culearn.carleton.ca)

- The web page will list your official midterm, laboratory, and assignment grades throughout the semester.
- Under cases where reevaluation of midterm exams need to be done, it would be performed without student’s presence.
- It is your responsibility to double check that the grades are recorded correctly for your work.
- Check the course web page regularly for announcements and postings.

It is your responsibility to submit Instructor Verification Points document to the TA at the end of every lab. Failure to submit the Instructor Verification Points document to the TA will be treated as lab not done.

Use of cell phones is strictly prohibited during lectures/exams/quizzes/tests/labs.

To obtain a final grade higher than F,

- students must obtain a passing grade on the final exam
- have attended and completed all laboratory requirements

Please make a note of the following:

If a midterm is missed, procedure laid out by Carleton must be followed when you seek re-administration (please check Carleton’s Exam policies)

If no valid documentation as per Carleton University guideline is provided for not taking midterms due to unavoidable circumstances, a zero grade will be given.

If valid documentation is provided, then re-administration of midterm will be done. Date and time for re-administration of midterms will be announced either in the class or through an email.

Assignments submitted late will not be graded. Students may consult with each other to understand assignments but each student must submit their own assignment that is 100% their own work.

Problems will be provided for practice. Solutions may be given only for selected problems.

Any bonus point obtained by a student will be included in grade calculation only if the student obtains a passing grade on the final exam is obtained.

Final Exam, Midterm Exams and Quizzes will be closed book. Duration of final exam will be 3 hours. Only non-programmable calculating devices will be allowed.

Crib sheets are not allowed unless provided with the exam. If there are changes to the policy during the course of the semester, it will be announced in the class before the test/exam.
Tentative Week-by-Week breakdown

- Introductory concepts to digital signal processing
- Discrete-time signals and sequences, unit impulse and unit step functions, properties of systems, filters described by difference equations and block diagrams
- Impulse response, convolution, discrete-time linear convolution, stability in time
- Spectrum representation, sampling, Shannon sampling theorem, Nyquist rate, aliasing
- Frequency response, sinusoidal filtering, z-transform representation of sequences and filters
- Transfer functions, pole-zero plots, z-domain, frequency domain relationship
- Stability in z-domain, frequency response, impulse response
- FIR filter design, ideal frequency selective filters, FIR filter transformations, FIR windowed filtering, linear phase filters, group delay
- IIR filter design, Butterworth filters, analog filter transformations
- IIR filter design by impulse invariance, bilinear transformation
- Filter structures, Direct Form I and II structures, cascade structures, parallel structures, discrete Fourier series (DFS), discrete Fourier transform (DFT)
- Discrete Fourier transform (DFT), signal analysis with the DFT, fast Fourier transform (FFT)
- Introduction to time-frequency analysis issues and spectrograms

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 2.1.3, Course Selection and Registration and Section 2.1.7, 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 4.4, 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 3.3.4, Informal Appeal of Grade and Section 3.3.5 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/](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/](http://www.carleton.ca/equity/). For an accommodation request, the processes are as follows:

- **Pregnancy or Religious obligation:** 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/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](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](mailto: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*). **Requests made within two weeks will be reviewed on a case-by-case basis.** After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website ([www.carleton.ca/pmc](http://www.carleton.ca/pmc)) 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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