Department of Systems and Computer Engineering

SYSC 3500
Signals and Systems

Calendar description

Signals: energy and power signals, discrete-time and continuous. Linear systems and convolution. Fourier Transform; complex Fourier series; signal spectral properties and bandwidth. Laplace transform and transient analysis. Transfer functions, block diagrams. Baseband and passband signals, with applications to communications systems.

Includes: Experiential Learning Activity.

Lectures three hours a week, problem analysis three hours alternate weeks.

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

Prerequisites

MATH 1005 and enrolment in Communications Engineering, and second-year status in Engineering.

Precludes additional credit for SYSC 3600 and SYSC 3610.

Prior knowledge

Students should have knowledge of:

- Elementary linear algebra
- Trigonometry
- Manipulation of vectors and complex numbers
- Formulating and solving first and second linear differential equations with constant coefficients

Course objectives

- Introduction to fundamental concepts of signals and systems.
- Definition and characteristics of deterministic signals, both analogue and digital.
- Developing a thorough understanding of Fourier series and Fourier transforms for continuous and discrete time.
- Review of Laplace transform and system transient response.
- Study of systems that manipulate signals focusing on Linear Time-Invariant (LTI) systems.

- Time domain analysis of systems, including impulse response and convolution. Frequency domain analysis and system frequency response will be discussed in details.
- Applications of learned concepts on basic building blocks of communication systems: ADC, DAC, Multiplexing, Modulation etc.

List of topics

- Overview of a communication system
- Classifications of signals: continuous-time vs. discrete-time, continuous amplitude vs. discrete amplitude, energy vs. power, deterministic vs. random, periodic vs. aperiodic
- Commonly used signals: Unit step function, rectangular pulses, triangular pulses, ramp functions, the Dirac delta (impulse function), and complex sinusoids
- Time shifted signals
- Classification of systems: Linear vs. nonlinear, time invariant vs. time- variant, realizable vs. non-realizable, memoryless vs. with memory
- Linear time-invariant systems
- Transmission of signals through linear time-invariant systems
- Impulse response
- Convolution sum and convolution integral
- Difference equations and differential equations
- Complex Fourier series
- Line spectrum representation
- Fourier transforms and inverse Fourier transforms
- Fourier transforms of common signals
- Energy/power spectrum. Bandwidth
- Parseval's Theorem
- Properties of the Fourier transform and transform pairs
- Discrete-time Fourier transforms
- Discrete Fourier transforms and Fast Fourier Transform (FFT)
- Spectrum of discrete-time signals
- Fourier analysis of Systems
- Analysis of ideal filters
- Lowpass, bandpass, highpass filters
- Nyquist's sampling theorem
- Sampling frequency
- Signal reconstruction
- Aliasing
- Amplitude Modulation
- Filtering: Lowpass and bandpass signals
- Multiplexing and demultiplexing
- Up and Down converters
- Modulation & demodulation

Learning outcomes

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

- Be familiar with the fundamental terminology and theory behind signals and systems analysis.
- Develop the mathematical skills required to model and analyze signals and systems: including transforms, convolution, sampling, quantization and filtering.
- Acquire the necessary background for further study in fields such as communication theory, signal processing, and control systems.
- Design experiments that explore the mathematical foundation of signals and systems and verify them using computer simulations.
- Identify hypotheses that need to be verified experimentally. Study experimental procedures. Carry out experiments to produce measured data. Plot the experimental results.
- Express their ideas in terms of sound technical writing, experimental documentation and oral presentation.

Graduate Attributes (GAs)

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/.

Graduate Attribute	Learning outcome(s)
1.6.S: Knowledge Base: Developed: Signals and systems	1
3.3: Investigation: Developed: Experimental procedure	2, 3, 4
4.4: Design: Developed: Design solution(s)	3, 4
5.3: Use of Engineering Tools: Developed: Tools for design experimentations, simulations, visualization and analysis	5
7.2: Communications Skills: Developed: Professional documents, writing, design notes, drawings, attributions, and references	6

Accreditation Units (AUs)

For more information about Accreditation Units, please visit: https://engineerscanada.ca/.

The course has a total of 46 AUs, divided into:

- Engineering Science: 100%

Instructor and TA contact

Specific to course offering (tbd)

Textbook (or other resources)

Specific to course offering (tbd)

Evaluation and grading scheme

Specific to course offering (tbd)

Breakdown of course requirements

Specific to course offering (tbd)

Tentative week-by-week breakdown

Specific to course offering (tbd)

General regulations

Specific to course offering (tbd)