Carleton UNIVERSITY | Department of Systems and Computer Engineering

SYSC 3501
Communication Theory

Calendar description

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.

Includes: Experiential Learning Activity.

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

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

Prerequisites

SYSC 3600 or SYSC 3610.

Precludes additional credit for SYSC 3503.

Prior knowledge

Students should have knowledge of:

- Linear systems
- Transfer functions
- Frequency and time response
- Basic analog and digital circuits
- Basic probability

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.

List of topics

- Introduction and overview of communication theory and systems
- Properties of signals and noise
- Fourier Transform and Spectra

- Power Spectrum
- Review of linear systems
- Fourier Series and periodic signals
- Bandwidth
- Limiter, mixers, up- and down-converters
- AM-DSB-C and noncoherent detection
- AM-DSB-SC and coherent detection
- SSB and VSB
- Phase and frequency modulation and demodulation
- Superheterodyne receiver and image frequencies
- Sampling, quantization, and PCM systems
- Digital baseband modulation, binary and multilevel signaling
- Digital bandpass modulation: BASK, BPSK, BFSK, QPSK, M-ary PSK, QAM
- Random processes
- Thermal noise
- Error probabilities for binary signals
- Matched filter
- Coherent demodulation of digital bandpass modulation
- Noncoherent demodulation of digital bandpass modulation
- Comparison of digital signaling systems
- Free space radio propagation, antennas, and link budgets
- TDM, FDM, CDM and Spread Spectrum

Learning outcomes

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

- 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.).
- Understand basic elements of a communication system.
- 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.
- Understand and be able to implement noise and error analysis of an analogue or digital telecommunication system.
- Understand the notions of sampling, quantization, pulse shaping, bit rate, channel capacity and bandwidth.
- Be able to examine and analyze the performance of modulation and demodulation techniques in various transmission environments.
- Understand the notion of matched filter receiver and optimal demodulation.
- Implement and perform measurements on practical communication systems and circuits through a series of five labs based on equipment from National Instruments.

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	1-7
2.2: Problem Analysis: Developed: Approach to the problem	2, 3, 4, 6, 7
3.5: Investigation: Developed: Interpretation of data (synthesis) and discussion	7
5.1: Use of Engineering Tools: Developed: Diagrams and engineering sketches	7
5.2: Use of Engineering Tools: Introduced: Document processing and graphics packages	7
5.3: Use of Engineering Tools: Developed: Tools for design, experimentation, simulation, visualization, and analysis	7

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: 75%
- Engineering Design: 25%

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)