Carleton UNIVERSITY | Department of Systems and Computer Engineering

SYSC 4607
Wireless Communications

Calendar description

Wireless radio channel characterization, diversity, equalization; cellular architecture, multiple access principles, spread spectrum systems, radio resource management; examples from modern wireless systems, networks, and standards, including cellular networks, WLANs, ad hoc networks, and satellite systems.

Includes: Experiential Learning Activity.

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

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

Prerequisites

SYSC 3501 or SYSC 3503.

Prior knowledge

Students should have knowledge of:

- Probability theory
- Calculus
- Complex numbers
- Signals and systems
- Digital communications
- MATLAB

Course objectives

The course is aimed to demonstrate to the students the wide range of wireless communication applications. Within the context of such applications, the course discusses the wireless communication channel, its characteristics and capacity for both fixed and mobile scenarios, as well as techniques to transmit information over this channel reliably and efficiently.

List of topics

- Overview of wireless communications, radio wave propagation, transmit and receive signal models, free-space path-loss, ray tracing, empirical path-loss models, simplified path-loss model.

- Shadow fading, combined path-loss and shadowing, outage probability under path-loss and shadowing, cell coverage area, time-varying channel impulse response, narrowband fading models.
- Narrowband fading models (autocorrelation, cross-correlation, power spectral density, envelope and power distributions, level crossing rate and average fade duration).
- Wideband fading models (power delay profile, coherence bandwidth, Doppler power spectrum and channel coherence time), capacity of wireless channels.
- Capacity in AWGN, capacity of flat fading channels (channel side information at receiver, channel side information at transmitter and receiver, capacity comparisons), capacity of frequency selective channels.
- Review of digital modulations (signal space analysis, passband modulations, amplitude and phase modulations, frequency modulation, pulse shaping), performance of digital modulations over fading channels (probability of error over AWGN channel, outage probability and average probability of error for fading channels).
- Effect of Doppler spread on differential modulations, inter-symbol interference for frequency selective fading, modulations for major wireless standards, diversity systems, methods of obtaining diversity branches.
- Receiver diversity (diversity combining techniques, performance of diversity in fading channels), transmitter diversity, adaptive modulation and coding.
- Adaptive techniques (variable-rate, variable-power, variable-rate variable-power), variable-rate variable power MQAM, channel estimation error and delay.
- MIMO systems, parallel decomposition of MIMO channels MIMO channel capacity, MIMO diversity gain: beamforming.
- Diversity-multiplexing tradeoff, ISI counter measures, multicarrier modulation (MCM), MCM with overlapping subchannels, mitigation of subcarrier fading.
- Discrete implementation of MCM, FFT implementation of MCM-OFDM, OFDM challenges (peak-to-average power ratio, intercarrier interference).
- Spread spectrum, direct sequence spread spectrum, ISI and interference rejection properties of spread spectrum, basics of frequency hopping spread spectrum, maximum length sequences, rake receivers.

Learning outcomes

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

- The students should have a good understanding of the characteristics of a wireless communication channel and its modeling for both fixed and mobile scenarios.
- They should be able to calculate the capacity of different wireless communication channels with Gaussian noise.
- They should know the techniques used for transmission of information over different wireless communication channels and their analysis/design.

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: Applied: Signals and systems	
3.2: Investigation: Applied: Design of experiment	1-3
3.5: Investigation: Applied: Interpretation of data (synthesis) and discussion	1-3
5.2: Use of Engineering Tools: Applied: Document processing and graphics package	1-3

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)