Course Objectives:
- To learn the fundamental analytical dynamics of wireless communications (theory)
- To become familiar with the current and emerging wireless technologies (applications)

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Lectures:   Tuesdays and Thursdays, 6:05 – 7:25 pm, 3235 ME (Mackenzie)

Office Hours: After the lectures and by appointment

Course Website: http://www.sce.carleton.ca/courses/sysc-5608/w18

Course Description: This course covers mainly the systems aspects of wireless communications. The emphasis is on the multiple access and related issues; the course also covers certain aspects of radio propagation, physical layer, medium access control (MAC) layer and networking layer. The course relies on fundamentals of communication theory and stochastic processes.

Prerequisites: Carleton University, Graduate Calendar: “SYSC 5503 (Stochastic Processes) and SYSC 5504 (Digital Communications), or their equivalents. May be taken concurrently.”

Marking Scheme:
- Term Exam 1: 20% – Tue, Feb 06
- Term Exam 2: 20% – Tue, Mar 13
- Final Exam: 60% – (date and time will be set by the Examinations Services)

Note 1: The final examination is for evaluation purposes only. It will not be returned to the student. In order to pass the course, the final exam mark should be at least 50%.
Note 2: Exercise questions will be posted regularly (but there will be no collected assignments).

Textbook: There is no single textbook that covers all the topics in this course. The students should rely mainly on the lecture notes. More than half of the lecture notes will be available online.

Reference Books:
  [www.cambridge.org/9780521837163](www.cambridge.org/9780521837163)

**Important Dates (tentative):**

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<td>Jan 09:  L01</td>
<td>Jan 11: L02</td>
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<td>Jan 16:  L03</td>
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<td>Jan 23:  L05</td>
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<td>Jan 30:  L07</td>
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<td>Feb 06:  L09 TL1</td>
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<td>Feb 13:  L11</td>
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<td>Feb 20:  Fall break</td>
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<td>Feb 27:  L13</td>
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<td>Apr 03:  L23</td>
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**Special Academic Accommodations for Students with Disabilities:** You may need special arrangements to meet your academic obligations during the term. 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 visit the Equity Services website: [http://www2.carleton.ca/equity/](http://www2.carleton.ca/equity/).

- **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 visit the Equity Services website: [http://www2.carleton.ca/equity/](http://www2.carleton.ca/equity/).

- **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 the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable) at [http://www2.carleton.ca/pmc/new-and-current-students/dates-and-deadlines/](http://www2.carleton.ca/pmc/new-and-current-students/dates-and-deadlines/).
You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at http://www2.carleton.ca/equity/.
Topics Covered: Actual coverage (as we progress) will be listed on the course web site.

- **Fundamentals of Digital Communications**

- **Propagation and Link Budget**
  - dB notation
  - Antennas
  - Pathloss in different wireless environments
  - Shadowing, reflection, diffraction, scattering, coverage
  - Multipath and small scale signal variations
  - Channel measurements and simulation
  - Link budget

- **Cellular Communications**
  - Cellular communications principles
  - Multiple access methods: FDMA, TDMA, CDMA, OFDM
  - Interference characterization
  - Capacity, outage
  - Macrocell, microcell, picocell, radio-over-fiber, distributed antennas
  - 1G, 2G, 3G, 4G, 4G+ cellular networks

- **Wireless Channel Characterization**
  - Multipath fading
  - Coherence time, Doppler spread
  - Coherence bandwidth, power delay profile

- **Digital Modulation and Interference**
  - Spectral efficiency
  - Digital modulation methods
  - Error performance in interference and fading

- **Diversity and Adaptive Equalization**
  - Principles, types and performance of diversity combining
  - Adaptive equalization techniques for combating multipath

- **Systems Issues**
  - Scheduling
  - Call admission control
  - Multiuser diversity
  - Interference management
  - Radio resource management
  - Routing

- **Brief Discussions on Various Applications**
  - Sensor networks
  - Cognitive radio
  - Multihop/mesh/relay networks
  - Cooperative communications
  - WLAN (802.11), WiMax (802.16)
Lecture Breakdown:

1. Introduction to digital and wireless communications (2 lectures)
2. Antennas (1)
3. Electromagnetic propagation, path loss, shadowing, link budget (3)
4. Multiple access, FDMA, TDMA, CDMA, OFDMA, contention-based (2)
5. Interference, interference management (1)
6. Radio access network architectures; cooperative communications; distributed antennas (1)
7. Cellular communications; 1G, 2G, 3, 4G technologies (3)
8. Scheduling (2)
9. Fading (3)
10. Error analysis in fading channels; spectrum, spectral efficiency (1)
11. Diversity and its impact on performance (2)
12. Sensor networks, cognitive radio, dynamic spectrum access (1)