Carleton University
Department of Systems and Computer Engineering

SYSC 5804W Advanced Topics in Communications Systems
COMP 5900E Selected Topics in Computer Science
ITEC 5910W Selected Topics in Network Technologies
(Equivalent to ELG 6184 Advanced Topics in Communication Systems)

5G Networks – Winter 2026

Course Outline

Instructor Information

Names: Jun (Steed) Huang & Stephen Rayment
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Teaching Assistant

Teaching Assistant: Qianzhu Li
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Graduate Advisors: Kathy Waitschat-Drew, Phone: 613-520-2600 x 8751, Office: HP 5320, Mark Williams, Phone: 613-520-2600 x 8751, Email: grad.scs@carleton.ca

Office Hours

Half hour before the class time or by appointment on Saturdays.

Course Website:

- For Carleton University students, please use: https://brightspace.carleton.ca/d2l/home
- For University of Ottawa Students; please see: https://gradstudents.carleton.ca/faculty-of-graduate-and-postdoctoral-affairs-access-to-brightspace/

Calendar Information

- http://calendar.carleton.ca/grad

Assumed Knowledge

- Undergraduate familiarity with computer communications, wireless networks, and communications systems
- Intermediate level skills in one of the following programming languages: Python, MATLAB, Linux scripting, Java, C/C++
- Recommend having some familiarity with any of the following: Mathematical Modelling, Information Security, Antenna Theory, Blockchain, Cloud Computing, or Machine Learning.

Course Description

Principles enabling 5G communications; physical, link and network layer protocols used for 5G communications and networking. Topics include evolution from 1G to 6G, standardization, spectrum planning, 4G LTE Fundamentals, 5G New Radio enhancements, 5G Core, Post Quantum Cryptography, Quantum Radio and Reconfigurable Intelligent Surface.

Course Objectives

As part of this course, students will:

- Become familiar with mobile network evolution from 1G to 6G
- Learn the 5G use cases families: EMBB, URLLC, mMTC, V2X, D2D
- Understand principles enabling 5G communications
- Identify the deployment scenarios (DRAN, CRAN, ERAN, VRAN)
- Study tools for the design or deployment of 5G networks
- Describe Network Evolution proposals from LTE - NSA, SA
- Explain Network Slicing across Core, Transport and Access
- Overview the NFV/SDN and management infrastructure
- Address post quantum encryption as a key security topic in a growing MTC ecosystem
- Know synchronization options for New Radio NSA: PTP/GNSS and NTN
- Simulate massive MIMO, beam forming, spectrum planning and dynamic TDD
- Examine 5G/6G network complexity and the role of AI to reduce TCO.

Learning Outcomes

- Plan, design, develop and manage 5G networks by applying and contributing the best practices, standards, algorithms, and tools

- Understand research papers and perform research within the area of 5G network planning using a variety of resources
- Communicate 5G/6G subject matters effectively to a range of audiences, orally, in writing and visually.

Textbooks

Book 1 is used as a main (mandatory) lecture and homework book (focusing on all posted chapters), Book 2 is used as (optional) your project source (any combination of chapters):

1. William Stallings, 5G Wireless: A Comprehensive Introduction, Addison-Wesley Professional, 2021.
2. Erik Dahlman, Stefan Parkvall, Johan Skold, 5G NR: The Next Generation Wireless Access Technology, Academic Press, 2018.

Both textbooks are available through the Carleton University Library (https://library.carleton.ca/). The textbooks are free when you access them from the library.

Evaluation and Grading Scheme

- Homework 32%
- Progress Talk 15%
- Attendance and involvement 5%
- Take home exam 16%
- Lab project report 32%

Breakdown of Course Requirements (labs, assignments, quizzes, exams, etc.)

Homework and Midterm: There will be three homework assignments and one midterm; they will be all returned to students for further studying.

Lab Project: Students will be required to form groups of 2 members and work on projects related to the simulation aspects of 5G networks. Projects will involve a literature review and code implementation. Students are responsible for forming and managing their groups.

Instructor and TA will include two hands-on sessions on MATLAB, Python or Q# for simulation.

Final: There will be one final exam. The final exam will be scheduled (on brightspace). Since 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.

Ericsson may offer invited expert talk(s).

Week-by-Week Breakdown

Tentative Lecture Schedule:

- Week 1: Course Overview, Textbooks, Logistics, Cellular Networks: Concepts and Evolution
- Week 2: Standards & Specifications, Use Cases & Architecture
- Week 3: eMBB, mMTC & URLLC
- Week 4: Software Defined Networking, Network Function Virtualization
- Week 5: Core Network Functions & QoS Slicing
- Week 6: The Role of AI to Reduce TCO, TBD
- Week 7: Wireless Transmission, Antennas
- Week 8: Physical Layer, RAN
- Week 9: Post quantum encryption as a key security topic, TBD
- Week 10: 6G - Plans & Alternatives, 6G - Technologies

Academic Accommodation and Regulations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows:

Pregnancy 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, visit Equity Services.

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, visit https://carleton.ca/equity/focus/discrimination-harassment/religious-spiritual-observances/.

Academic Accommodations for Students with Disabilities If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC 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 your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the Paul Menton Centre website.

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 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: 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 the policy.

Student Academic Integrity Policy. Every student should be familiar with the Carleton University student academic integrity policy. A student found in violation of academic integrity standards may be awarded penalties which range from a reprimand to receiving a grade of *F* in the course or even being expelled from the program or University. Examples of punishable offences include: plagiarism and unauthorized co-operation or collaboration. Information on this policy may be found here.

Plagiarism. As defined by Senate, "plagiarism is presenting, whether intentional or not, the ideas, expression of ideas or work of others as one's own". Such reported offences will be reviewed by the office of the Dean of Science. Standard penalty guidelines can be found here.

Unauthorized Co-operation or Collaboration. Senate policy states that "to ensure fairness and equity in assessment of term work, students shall not co-operate or collaborate in the completion of an academic assignment, in whole or in part, when the instructor has indicated that the assignment is to be completed on an individual basis". Please refer to the course outline statement or the instructor concerning this issue.

Documenting use of AI: It is necessary to document your use of AI in this course, using the following guidelines:

- Transparently document AI usage, including specific tools and contributions, e.g. Literature review section generated using ChatGPT
- Critically evaluate and refine AI-generated outputs to demonstrate understanding and originality
- AI should enhance, not replace, the student's learning process
- No AI tool usage for examination.