

Advanced Wireless and 5G Networks

2025 - 2026

Is part of the next programmes:

- M0012004 Master of Computer Science: Software Engineering
- M0012005 Master of Computer Science: Data Science and Artificial Intelligence
- M0012006 Master of Computer Science: Computer Networks
- M0048004 Master of Computer Science: Software Engineering
- M0048005 Master of Computer Science: Data Science and Artificial Intelligence
- M0048006 Master of Computer Science: Computer Networks
- M0090004 Master of Teaching in Science and Technology: Computer Science
- U0001008 Courses open to exchange students in Sciences

Course Code:	2001WETMWN
Study Domain:	Computer Science
Semester:	1E SEM
Contact Hours:	45

Credits:	6
Study Load (hours):	168
Contract Restrictions:	Exam contract not possible
Language of Instructions:	ENG
Lecturer(s):	 Michael Peeters  Johan Bergs  Arno Troch
Examperiod:	exam in the 1st semester

1. Prerequisites *

speaking and writing of:

- English

general notion of the basic concepts of

- the layered architecture of modern communication systems
- digital signal processing as applied to communication systems

specific prerequisites for this course

- an overview of the most important protocols of each layer, such as ethernet, IP, TCP, IEEE802.11, ...
- a grasp of the basics of wireless communication systems

2. Learning outcomes *

- The student has a good insight in the most important characteristics of the PHY, MAC, network and transport layer in wireless and mobile networks. Specifically with a deepening of knowledge in 5G and WiFi.

- The student has a good overview of wireless and mobile networks in use and to be in use in the near future, in the area of public cellular networks, wireless LAN, wireless personal networks, ad hoc networks and sensor networks.
- The student can study the behavior of contemporary wireless and mobile systems (performance, robustness, scalability, etc.) using models and simulations.

3. Course contents *

This course consists of 3 main parts:

1. A general introduction which covers the applications, markets, dynamics needed to understand the balance between different approaches. Next to this, the introduction covers the basics of DSP that CS Masters need to be able to do a first order analysis of wireless and mobile networks at the physical layer in order to plan out a realistic architecture.
2. A deep dive starting from first principles into 5G which will allow students to understand the challenges and analyze current telecommunication networks. The student will end with sufficient basics to be able to find their way in the forest of standards and dig deeper in their professional career.
3. A similar deep dive into WiFi, where we track from basics to the state-of-the-art and student will be able to place new developments into a broader context. At the end, we also cover other protocols by contrasting them with these two.

This course consists of two parts. In a first part, important characteristics of the PHY, MAC, network and transport layer of wireless and mobile networks are considered. In addition a number of important protocols for each of these layers are studied. In a second part mobile and wireless networks are discussed. The following systems are studied: cellular networks: 4G & 5G, UMTS, TETRA; wireless personal area networks: bluetooth, zigbee; Wireless LAN: WiFi; Wireless MAN: WiMAX; sensornetworks, ad hoc networks.

4. International dimension *

- This course stimulates international and intercultural competences.
- Students use course materials in a foreign language.

5. Teaching method and planned learning activities

5.1 Used teaching methods *

Class contact teaching

- Lectures

Personal work

Assignments

- Individually
- Directed self-study

5.2 Planned learning activities and teaching methods

While small changes are made to the order of these depending on the speed and interest in certain topics of the class, we will cover the following topics more or less in this order (L = Licensed Wireless; U = Unlicensed Wireless). Recent recordings are available - there are no plans to do new recordings of the '24-'25. Attendance in person is strongly recommended, as the standards do change from year to year, and interactive sessions are by far the best way to learn.

- Introduction, market, industry, bands, licensed vs. unlicensed, ...
- Technology baselining (a.k.a. refreshing what you should have known): 2G, WiFi, ...
- L 3GPP Network Architecture: 2-3-4-5G and mobility
- L 4G: Air interface, Scheduler, QoS, VoLTE, NB-IoT
- L 5G: Air interface, NR, mmWave, FWA
- L Other licensed and special cases (CBRS, LAA, Public Safety, Loon, V2V, Satellite)
- U IEEE Wifi Network Architecture: the 802.11 family and "mobility"
- U 802.11 abgn + QoS
- U 802.11 ac,ax and 802.11 ad,ay
- U short range 802.15.4: Zigbee, BLE, and UWB
- U Specials: LoRa, Sigfox (perhaps), proprietary, 802.11p

- Extra: Technology enablers and acronyms you need to be aware of: ADC, FEM, PA, LSA, and other key analog and digital HW blocks
- Extra: mMIMO, Beam management, 802.11be, AI, 6G, THz and their implications to the network

5.3 Facilities for working students *

Classroom activities

- Lectures: recording available via video link on Blackboard

Others

Self-learning with check-in sessions can be organized on demand.

6. Assessment method and criteria *

6.1 Used assessment methods *

Examination

- Written examination without oral presentation
- - Open book
- - Open-question
- - Exercises

6.2 Assessment criteria *

The exam consists of a number of open-book questions in order to verify whether the student has understood the concepts, ideas, etc... that are explained in the course.

The ability to reproduce from memory concepts and ideas is not the focus. The student should also be able to apply the concepts, ideas, techniques, etc... to specific examples, given a prompt or domain.

Both first and second sessions exams are similar; for foreign students, an alternative examination approach in case of second session can be provided.

Example exams will be provided.

7. Study material

7.1 Required reading *

Slides that cover the entire curriculum are made available.

7.2 Optional reading

The following study material can be studied voluntarily :

- 5G NR, The Next Generation Wireless Access Technology - Erik Dahlman
- 802.11 Wireless Networks - Matthew Gast
- 802.11ac, a survival guide - Matthew Gast
- Wireless Connectivity, an intuitive and fundamental guide - Peter Popovski
- Mobile Communication - Joachim Schiller
- Fundamentals of Wireless Communication - David Tse

8. Contact information *

Prof. Dr. Ir. Michael Peeters

- michael.peeters2@uantwerpen.be
- michael.peeters@imec.be

9. Tutoring

Active participation during the lectures will be very helpful to better understand the concepts and ideas that are discussed. Be aware that redigesting everything just before the exam will be hard. This course aims to build a shared understanding of the field _during_ the interactive lectures.