Extended syllabus and study guide 2026

Site: TalTech Moodle
Course: IEE2650 Cellular Communication Technologies (2026 spring)
Book: Extended syllabus and study guide 2026
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1. Course aims and learning outcomes

Course name and code: Cellular Communication Technologies IEE2650

Course volume: 6.00 ECTS

Language of instruction: English

Faculty: Thomas Johann Seebeck Department of Electronics, School of Information Technologies, Tallinn University of Technology.

Lecturer and contact details: Professor Muhammad Mahtab Alam muhammad.alam@taltech.ee, consultations are given based on prior agreement.

Form of study and target group: Daytime study, elective course, study programme IAVM23/25

Objective of the course: The course aim is to give an overview of 5G cellular communication system, particularly 5G NR radio access network.

Brief description of the content of the course:
4G/5G and beyond communication systems: wireless evolution, 5G air interface, 5G NR physical resource, channels and signals, 5G handover and mobility management.

Core network: 3GPP 5G Standard Overview, 5G core network, network slicing, Internet of Things (IoT) - communication technologies.

Advanced topics: cellular IoT, mobile positioning, radio access techniques, Open RAN and interfaces, Reconfigurable Intelligent Surfaces, cooperative communication.

Learning outcomes: After completing this course, the student:

1. describes the architecture of 5G cellular communication network
2. explains main functions of the core of 5G cellular network
3. analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network
4. explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing

E-support and study materials for the course: https://moodle.taltech.ee/course/view.php?id=35747

2. Prerequisites

Course prior knowledge: basic knowledge about radio communication and networking, OSI model.

MATLAB is used in practices and provided in the classroom. Materials to study: Get started with MATLAB. Install MATLAB for Taltech students.

Recommended toolboxes to install for MATLAB: 5G Toolbox, Communications Toolbox, Communications Toolbox Wireless Network Simulation Library, Signal Processing Toolbox, Statistics and Machine Learning Toolbox, LTE Toolbox.

Special needs: Students with special needs can participate in the course. Please inform the lecturer at the beginning of the course of any special needs that may affect your participation in the study activities or assessment activities.

3. Study process description

The course has 16 weeks of classes, followed by an examination period.

Each week there is a lecture. Lectures are held in Teams and recordings are available in Teams.

After some topics there is a self-assessment quiz or student quiz in the moodle.

Practices start on study week 2. There are 8 practices.

Project topic is selected on study week 10. Consultation times are at lab times. Project presentation is done on study week 15 or 16.

Details are included in the description of a study week in moodle.

4. Requirements for completing the course

Assessment preconditions: both individual work in labs and presentation of final project. Each lab is graded by max 5 points, presentation is graded in the scale of 1 (poor) - 5 (excellent).

The assessment results are automatically in Moodle, within two weeks after the submission deadline.

Assessment: exam (written, open-book).

Final grade:

- Open book exam - 50%:
  - 10 multiple choice questions - 40%
  - 2 detailed questions - 60%
- Practical work - 50%:
  - 4 self-assessment quizzes - 10%
  - 4 student quizzes - 10%
  - 8 lab reports - 40%
  - 1 final project - 40%

5. Assessment principles and criteria

Total grade 100 points consists of exam grade (50%) and sum of practical work grades (50%).

Students are allowed to take the exam when all practical work is completed.

Final Grade	Total Points
„excellent“ (5)	91...100
„very good“ (4)	81...90
„good“ (3)	71...80
„satisfactory“ (2)	61...70
„sufficient“ (1)	51...60
„fail“ (0)	50 and below

Use of AI in the course!!

6. Feedback principles

Written feedback is given to the lab reports.
During the course project preparation it is possible to consult for oral feedback on the lab times or via e-mail.
Oral feedback is given to the project presentation.
Self-assessment Quizzes provide automatic numerical feedback.

7. Action Plan / Schedule

Study week	Sections	Lecture topic	Tasks in moodle	Practice	Learning outcome #

1	Part I. 5G and beyond communication systems	Lecture 1: Introduction: Wireless Evolution and Current State of Play	Self-assessment Quiz 1		1 (describes the architecture of 5G cellular communication network), 2 (explains main functions of the core of 5G cellular network), 3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network), 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)
2		Lecture 2: 5G Air Interface		Lab 1: Resource grid of 5G cellular radio access network of new radio (NR)	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network)
3		Lecture 3: 5G NR Physical Resource	Student Quiz 1	Lab 2: 5G NR DL control signals, synchronization signals	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network)
4		Lecture 4: 5G NR channels and signals		Lab 3: 5G NR channels and signals in DL	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network)
5		Lecture 5: 5G NR channels and signals (continued)	Self-assessment Quiz 2	Lab 4: 5G NR DCI	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network)
6		Lecture 6: 5G Handover and Mobility Management		Lab 5: Data and signal processing on physical layer of 5G-NR	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network)
7	Part II: Core network	Lecture 7: 3GPP 5G Standard Overview, 5G Core network	Student Quiz 2	Lab 6: 5G NR channels and signals in UL	1 (describes the architecture of 5G cellular communication network), 2 (explains main functions of the core of 5G cellular network), 3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network)
8		Lecture 8: 5G Core (continued), network slicing		Lab 7: Connect Quectel UE to academic 5G network in Taltech	2 (explains main functions of the core of 5G cellular network), 3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network), 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)
9		Lecture 9: Internet of Things - Communication technologies	Self-assessment Quiz 3	Lab 8: Broadband internet via 5G network in Taltech using Quectel UE	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network)
10	Part III Advanced topics	Lecture 10: 5G and IoT, mobile postioning		Project topic selection	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network), 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)

11		Lecture 11: Mobile Positioning	Student Quiz 3	Project consultations	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network), 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)
12		Lecture 12: Radio Access Techniques		Project consultations	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network), 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)
13		Lecture 13: Open RAN and Interfaces	Self-assessment Quiz 4	Project consultations	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network), 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)
14		Lecture 14: Reconfigurable Intelligent Surfaces		Project consultations	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network), 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)
15		Lecture 15: Cooperative communication	Student Quiz 4	Project topic presentation	3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network), 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)
16		Mock exam		Project topic presentation (reserve)	1 (describes the architecture of 5G cellular communication network), 2 (explains main functions of the core of 5G cellular network), 3 (analyses the quality of service provided by 5G test network based on self-collected parameters of radio signal, communication channel and network, 4 (explains main principles of advanced topics including cellular internet of things, mobile positioning, radio access techniques, cooperative communication, reconfigurable intelligent surfaces and network slicing)

8. Recommendations for successful completion of the course

There are activities each week. Try to accomplish them on schedule.

If quizzes exist, plan extra time. Lab reports are due one day before next lab.

9. Course literature

Study book of 5G:

- 5G New Radio. Fundamentals, procedures, testing aspects. 2020. Rohde&Schwarz [Online]. Available: https://gloris.rohde-schwarz.com/ebooks/5G (Create an user to the site, free).

Recommended book for catchup of basic cellular communication topics:

- Wireless Communication by Prof. Andrea Goldsmith, https://www.ester.ee/record=b2204985*eng. Available in electronic version: https://www.cambridge.org/core/books/wireless-communications/800BA8A8211FBECB133A7BB77CD2E2BD via Taltech network.

10. Requirements of honesty and use of AI

Academic Practices and Honesty Requirements

As a student of Tallinn University of Technology, you are obliged to follow the academic practices of the university in your studies. It is assumed that you do the work you submit under your name. Plagiarism and cheating are not acceptable. Good practices: Taltech good practice guidelines. If it is confirmed that you have engaged in such activities, it will be followed by a grade of "0" for the specific work/assessment and a proposal will be submitted to the programme director." Depending on the proposal, this may result in a reprimand from the dean or, in the case of a very significant violation, expulsion from the university.

Rules for the use of artificial intelligence

- The use of artificial intelligence is prohibited when conducting quizzes and exams
- When writing code and creating task-solving, the use of AI applications is allowed; there are no restrictions.
- The assistance of artificial intelligence is allowed in the preparation of the lab report and project presentation, if its use is clearly described in the methodology chapter. Similarly, it has been pointed out how you validated the content provided by the AI so that it would be correct, e.g., as a base source, finding additional references that proved what the AI was proposing.