



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

4G and 5G Wireless Systems

### Course

Field of study

Electronics and Telecommunications

Area of study (specialization)

Mobile and Wireless Technologies

Level of study

Second-cycle studies

Form of study

full-time

Year/Semester

2/3

Profile of study

general academic

Course offered in

polish

Requirements

elective

### Number of hours

Lecture

30

Laboratory classes

Other (e.g. online)

Tutorials

Projects/seminars

15

### Number of credit points

4

### Lecturers

Responsible for the course/lecturer:

dr hab. inż. Rafał Krenz

Responsible for the course/lecturer:

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### Prerequisites

Knowledge of cellular systems technology, with emphasis on radio access network. Knowledge of EM wave propagation and antenna systems. Understanding computer simulation of communication systems.

### Course objective

The course presents the state-of-the-art transmission techniques and resource management algorithms implemented in latest generations of cellular systems, including 5G-NR, LTE/LTE-Advanced as well as HSPA+/HSPA-Advanced.

### Course-related learning outcomes

Knowledge

Knows the state-of-the-art transmission techniques and resource management algorithms implemented in latest generations of cellular systems, including 5G-NR, LTE/LTE-Advanced as well as HSPA+/HSPA-Advanced.



Understands the application of coordinated multipoint transmission and relay stations (multihop transmission), etc.

#### Skills

Can analyse standardisation documents produced by working groups, e.g. belonging to 3GPP.

Is able to design and implement modern radio access network for 4G/5G cellular systems.

Can use custom simulation tools based on IT++ libraries for simulation of modern communication systems.

#### Social competences

Is aware of the impact of modern communication technologies on the society.

#### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: written/oral exam consisting of 5-6 questions, based on the list of 25 topics shared during the course duration. 50% of the total number of points necessary to pass.

Project: evaluation of the project; final grade in the range 2-5

#### Programme content

Lecture:

1. 4G multiple access methods - OFDMA, SC-FDMA.
2. 3GPP LTE/LTE-Advanced system architecture. Uplink and downlink physical layer.
3. LTE/LTE-Advanced logical and transport channels.
4. Physical layer procedures: cell search, UE registration, paging, resource allocation requests.
5. LTE/LTE-Advanced MIMO transmission.
6. LTE-Advanced extensions.
7. Coordinated multipoint transmission.
8. Relay stations.
9. Advanced scheduling algorithms.
10. 5G-NR standard.
11. 3G Evolution - towards HSPA+

Project: simulation of LTE system functional blocks using IT++ software library



## Teaching methods

Lecture: multimedia presentation

Project: student projects assigned by the teacher, based on simulation software

## Bibliography

Basic

H. Holma, A. Toskala, WCDMA for UMTS ? HSPA Evolution and LTE, Wiley, 2010

S. Sesia, I. Toufik, M. Baker (eds.), LTE: The UMTS Long Term Evolution: From Theory to Practice, Chichester, 2010

A. OSSEIRAN, J. F. MONSERRAT, P. MARSCH (EDS.), 5G MOBILE AND WIRELESS COMMUNICATION TECHNOLOGY, CAMBRIDGE UNIVERSITY PRESS, 2016

Additional

E. Dahlman, S. Parkvall, J. Skold 4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2009

## Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	58	2,0
Student's own work (literature studies, preparation for exam, project preparation) <sup>1</sup>	42	2,0

<sup>1</sup> delete or add other activities as appropriate