SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications and Information Technology
1.3	Department	Communications
1.4	Field of study	Electronics and Telecommunications Engineering
1.5	Cycle of study	Master
1.6	Program of study/Qualification	Telecommunications (in English)
1.7	Form of education	Full time
1.8	Subject code	TC-E09.00

2. Data about the subject

2.1	Subject name	3G, 4G, 5G mobile communications									
2.2	Subject area	Electronics and Telecommunications Engineering									
2.3	Course leader/lecturer	Professor Romulus Terebes, PhD									
2.4	Teacher in charge of applications	Professor Romulus Terebes, PhD									
2.5	Year of study	I	2.6	Semester	2	2.7	Assessment	Exam	2.8	Subject category	DA/DOB

3. Estimated total time

Year/ Sem.	Subject name	No. of weeks	Course [hours/week]	Applications [hours/week] S	Applications [hours/week] L	Applications [hours/week] P	Course [hours/sem.]	Applications [hours/sem.] S	Applications [hours/sem.] L	Applications [hours/sem.] P	Indiv. study [hours/sem.]	TOTAL	Credits
IV / 1	Mobile communications	14	2	-	1	-	28	-	14	-	58	100	4

3.1	Number of hours per week	3	3.2	of which, course	2	3.3	applications	1
3.4	Total hours in the curriculum	42	3.5	of which, course	28	3.6	applications	14

Individual study	Hours
Manual, lecture material and notes, bibliography	40
Supplementary study in the library, online and in the field	-
Preparation for laboratory works and for the project	42
Tutoring	3
Exams and tests	3
Other activities	0

3.7	Total hours of individual study	58
3.8	Total hours per semester	100
3.9	Number of credit points	4

4. Pre-requisites (where appropriate)

4.1	Curriculum	N / A
4.2	Competence	Basic knowledge regarding mobile and wireless communications

5. Requirements (where appropriate)

5.1	For the course	Amphitheatre, Cluj-Napoca
5.2	For the applications	Laboratory, Cluj-Napoca

6. Specific competences

Professional competences	Theoretical knowledge (what the student must know):	Mobility management in mobile communications systems • 3G and 4G mobile communication standards • The UMTS standard: WCDMA, architecture, services, quality of service, radio interface (physical, logical and transport channels), duplexing techniques (FDD, TDD), transmission and signaling procedures over the radio interface, core networks (CN-PS and CN-CS), CN-CS protocols and procedures, CN-PS protocols and procedures • HSPA and HSPA+ networks• IP Multimedia Subsystem (IMS) • 4th generation networks (LTE and LTE-A): architecture, multiple access, protocols, services, diversity
	Acquired skills (what the student is able to do):	After completing the discipline, students will be able to: - analyze various mobility scenarios and identify how they are handled by major mobile communication systems; - characterize and model propagation through mobile radio channels; - propose adequate solutions for handling fading effects induced by the mobile radio environment; - characterize and analyze mobile signaling and transmission protocols ; - propose own solutions for mobile communication systems.
	Acquired abilities: (what type of equipment the student is able to handle)	After completing the discipline, students will be able to: - use various software (Matlab, Labview, Simulink) for modeling mobile communication systems; - configure GSM pieces of equipment (BTS, BSC, OMC-R) on an fully functional GSM cell; - use dedicated software for performing trace decoding and fine parameter tuning for mobile networks.
	In accordance with Grila1 and Grila2 RNCIS	
Cross competences (Grila1 and Grila2 RNCIS)		

7. Discipline objectives (as results from the key competences gained)

7.1	General objectives	By the end of the course, the students will gain a deep understanding of the operation and of the current trends of modern mobile communication systems.
7.2	Specific objectives	1. To give to the students a deep understanding of the 3G and 4G mobile communication systems (UMTS, LTE and LTE-A) 2. To enable the students to synthesize and analyze wireless and mobile cellular communication systems over fading channels 3. To provide the students with an understanding of advanced multiple access, diversity and channel coding techniques used

		in mobile communication.

8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
1	2.5G mobile communications: mobility specific concepts: (terminal, session, personal and service mobility). Mobility management in E-GPRS and GPRS network. Mobility management in UMTS	Presentation, exemplification, problem presentation, exercises and case studies, formative evaluation	Use of overhead projector and of simulation platforms
2	The UMTS standard: architecture, QoS issues, services, multiple access (WCDMA), scrambling, spreading and synchronization codes.		
3	The UMTS's radio interface: logical channels, physical and transport channels, physical layer procedures.		
4	Signaling and transmission protocols and procedures in UTRA and UTRAN (I).		
5	Signaling and transmission protocols and procedures in UTRAN (II).		
6	The UMTS circuit-switched core network (CN-CS). Architecture, signaling and transmission protocols and procedures. CN-CS evolution (Release 4): architecture, protocols and procedures.		
7	The UMTS circuit-switched core network (CN-PS). Architecture, signaling and transmission protocols and procedures.		
8	Evolutions of the UMTSs radio interface: HDSPA, DC-HSDPA		
9	Evolutions of the UMTSs radio interface: HSUPA. HSPA and HSPA+ networks		
10	The IP multimedia subsystem (IMS). SIP signaling.		
11	IMS signaling procedures		
12	EPS: architecture (EPC/SAE, E-UTRA/LTE), functional description, multiple access over E-UTRA, diversity techniques, data and voice services		
13	The LTE-Advanced standard		
14	Recap. Exam preparation		
8.2. Applications (lab) – 4h modules		Teaching methods	Notes
1	Introduction. Presentation of laboratory platform. Project presentation	Practical demonstration, lab experiments, applications	Use of emulators, mobile phones and devices computers
2	GERAN – hardware configuration (BSC). BSC operation and maintenance		
3	GERAN – hardware configuration (BTS). Logical configuration using OMC-R.		
4	Signaling over the GSM radio interface. Trace decoding.		
5	Signal processing on the UMTS radio interface		
6	IMS signaling procedures		
7	Physical layer processing in LTE		

Projects

Individual literature review project on predefined themes.

Bibliography

1 R. Terebes – "Mobile communication systems. Part one: GSM networks", Editura UTPRES, Cluj-Napoca, 2006, ISBN 978-973-662-221, 978-973-622-222-9.

2. C. Kappler – "UMTS networks and beyond", John Wiley and sons, 2009

3. Ralf Kreher, Torsten Ruedebusch, "UMTS Signaling: UMTS Interfaces, Protocols, Message Flows and Procedures Analyzed and Explained" [Hardcover], Wiley; 2 edition (March 19, 2007), ISBN-10: 0470065338 ISBN-13: 978-0470065334

4. J. Bannister, P. Mather, S. Coope –"Convergence Technologies for 3G Network: IP, UMTS, EGPRS and ATM", Editura John Wiley and sons, 2004

5. Harri Holma ; Antti Toskala, “LTE Advanced”, Editura: Wiley John + Sons, august 2012 ISBN-10: 1119974054.

On-line references
1. Terebes Romulus. Mobile communications (lecture notes, lab guides), http://ares.utcluj.ro/c3g_2014.html
2. ETSI/3GPP specifications http://www.3gpp.org

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The acquired skills and competencies could be employed by professionals working on the following occupations according to COR (Classification of Occupations in Romania): electronic engineers, telecommunications engineers, electro-technology engineers, ICT specialists.

10. Evaluations

Activity type	10.1	Assessment criteria	10.2	Assessment methods	10.3	Weight in the final grade
Course		The level of acquired theoretical knowledge and practical skills		- written exam (multiple choice questionnaire)		-E max 10 pts. 70%
Lab		The level of acquired abilities		- project – literature review project on predefined themes		- P, max. 10 pts. 30%
10.4 Minimum standard of performance						
E ≥ 5 , and 0.7E+0.3P ≥ 4.5						

Date of filling in
12.09.2018

Course leader
Professor
Romulus Terebes, PhD

Teacher in charge of applications
Professor Romulus Terebes PhD

Date of approval in the department
12.09.2018

Head of Department
Professor Virgil Dobrota, PhD