SYLLABUS

1. Data about the program of study

1.1	Institution	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	Multimedia Technologies/ Telecommunications/ Master
1.7	Form of education	Full-time
1.8	Subject code	TM-E17.30/ TC-E16.10

2. Data about the subject

2.1	Subject name					Planning of Radio Networks					
2.2	Subject area					Electronics and Telecommunications Engineering					
2.3	Course responsible/lecturer					Associate Professor Emanuel PUSCHITA, Ph.D.					
2.4	Teachers in charge of applications					Associate Professor Emanuel PUSCHITA, Ph.D.					
2.5	Year of study	II	2.6	Semester	3	2.7	Assessment	Exam	2.8	Subject category	DS/DO

3. Estimated total time

Year/ Sem.	Subject name	No. of weeks	Course [hours/ week]	Applications [hours/ week]			Course [hours/ semester]	Applications [hours/ semester]			Indiv. study	TOTAL	Credits
				S	L	P		S	L	P			
II/3	Planning of Radio Networks	14	2	0	1	0	28	0	14	0	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	56	3.5	of which, course	28	3.6	applications	14

Individual study	Hours
Manual, lecture material and notes, bibliography	14
Supplementary study in the library, online and in the field	10
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	10
Tutoring	7
Exams and tests	3
Other activities	14

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	Cellular Radiocommunications, Fixed and Mobile Communications Systems
4.2	Competences	NO

5. Requirements (where appropriate)

5.1	Course	The Technical University of Cluj-Napoca (Video-projector, screen, whiteboard)
5.2	Applications	The Technical University of Cluj-Napoca (PCs with Internet access, video-projector, screen, dedicated software and hardware tools, QualNet licences, AirMagnet licence)

6. Specific competences

Professional competences	Theoretical knowledge (What do the student should know)	The students will know: – the mission of the standardisation bodies and regulatory authority, the emission rules for radio networks; – radio cell concept, cell geometry and cell splitting, co-channel and adjacent channel interference reduction techniques; – spectral efficiency indicators and cellular traffic flow estimation models; – propagation mechanisms and radio channel characteristics for mobile environments; – Fresnel zone and Earth bugle effect on planning outdoor radio links; – link budget and fade margin; – indoor and outdoor propagation models and fading models; – duplexing techniques and multiple access techniques; – WLAN network architecture (entities, functionalities and interfaces).
	Acquired skills (What the student is able to do)	The students will be able to: – determine the co-channel and adjacent channel interference levels and apply adequate reduction techniques; – apply the emission rules for dimensioning PtP and PtMP radio links; – apply optimal strategies for planning the radio links for given constraints: user requirements, technology limitations and the configuration of the implementing area; – analyze and explain the results obtained during the simulation process while using dedicated radio planning tools (QualNet).
	Acquired abilities (what equipment/ instruments/ softwares the student is able to handle)	The students will be able to: – measure the co-channel and adjacent channel interference levels using dedicated hardware tools; – configure WLAN dedicated hardware (Cisco, DLink, Netgear); – use dedicated software tools for network planning (QualNet); – elaborate a complete site survey (AirMagnet Site Survey).
Transversal competences		Adapting to new technologies, professional and personal development through continuing education using electronic documentation and printed sources, in Romanian and in at least one international language (English). Competencies for analysis and synthesis and optimization systems thinking. Flexibility in thinking and ability to work with interdisciplinary concepts and tools.

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

7.1	General objective	Developing the competences regarding the use, analysis and (re)design of fundamental electronic circuits.
7.2	Specific objectives	1. To apply the theoretical concepts of radio network planning while using professional software tools for design, test and measurements (QualNet, AirMagnet Laptop Analyzer). 2. To develop skills and abilities to plan, implement, test and evaluate the radio networks.

8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
1	Evolution of radiocommunication systems. Licensed and unlicensed frequencies bands. Standardisation bodies and regulatory authority for transmissions in radio networks.	Presentation, exemplification, problem presentation, case study, discussions	Use of .ppt presentation, video-projector, whiteboard
2	Radio spectrum management. Legislative and regulatory issues. Rules for dimensioning intentional radiator (IR) and passive gain (G) in order to estimate the effective isotropic radiated power (EIRP). Point-to-point (PP) and point-to-multipoint (PMP) radio links.		
3	Radio channel characteristics. Propagation mechanisms and models.		
4	Fundamentals of radio planning in cellular systems. Cell geometr. Frequencies reuse. Interference and system capacity. Handover.		
5	Narrowband transmission techniques and spread spectrum. System co-location, interference and throughput.		
6	Rules for radio networks dimensioning. Cellular network traffic. Spectral efficiency and spectral efficiency indicators in cellular radio systems.		
7	Link budget and fade margin. Fresnel zone, RF LOS and visual RF.		
8	Multiple access techniques. Efficiency of the medium access techniques for radio transmission.		
9	IEEE 802.11 WLAN network architecture		
10	IEEE 802.11 PHY layer. IEEE 802.11 spread spectrum techniques.		
11	IEEE 802.11 PHY layer. IEEE 802.11 modulation and coding techniques.		
12	IEEE 802.11 MAC layer. Network topologies. IEEE 802.11 frame format.		
13	IEEE 802.11 MAC layer. CSMA/CA technique, inter-frame spaces, QoS support.		
14	WLAN planning tools (QualNet, AirMagnet Laptop Analyzer). Site Survey.		

8.2. Applications (laboratory work)			Teaching methods	Notes
1	RF link dimensioning, validation rules for emission compliance.		Didactic and experimental proof, didactic exercise, simulations, team work	Use of laboratory instrumentation, wireless network simulators, computers
2	Emission rules in unlicensed bands. Equipments configuration under the existing rules.			
3	Indoor and outdoor RF links evaluation through simulation.			
4	Using QualNet simulator for modeling radio networks: file format.			
5	Modeling radio transmissions in QualNet: emitter and receiver.			
6	Modeling radio transmissions in QualNet: radio channel.			
7	The effect of radio channel characteristics on IEEE 802.11 networks using QualNet.			
8	The effect of medium access characteristics on IEEE 802.11 networks using QualNet.			
9	IEEE 802.11 QoS support using QualNet.			
10	The effect of OSI upper layers on radio transmissions in IEEE 802.11 networks.			
11	IEEE 802.11 measurements using AirMagnet Site Survey.			
12	IEEE 802.11 traffic analysis using AirMagnet Laptop Analyzer.			
13	Project: Generating a site survey report using AirMagnet or QualNet simulator.			
14	Project evaluation.			

References:

1. T. Rappaport, *Wireless Communications Principles and Practice*, 2nd edition, Prentice Hall, ISBN 0-13-042232-0, 652 pag, 2002.
2. H. Hammuda, *Cellular mobile radio systems: designing systems for capacity optimization*, John Wiley & Sons, ISBN 0471956414, 211 pag., 1997.
3. A. Mishra, *Advanced Cellular Network Planning and Optimisation: 2G/2.5G/3G...Evolution to 4G*, John Wiley & Sons, ISBN-10 0-470-01471-7, 542 pag, 2007.
4. A. Mishra, *Cellular Technologies for Emerging Markets: 2G, 3G and Beyond*, John Wiley & Sons, ISBN 9780470779477, 330 pages, 2010.
5. C. Kappler, *UMTS Networks and Beyond*, John Wiley & Sons, ISBN 9780470031902, 388 pag, 2009.

6. T. Carpenter, *Certified Wireless Network Administrator – Official Study Guide 4th Edition*, McGraw&Hill, 2007.
7. V. K. Garg, *Wireless communications and networking*, Elsevier, 1st ed., ISBN: 978-0-12-373580-5, 2007.
8. L. Song, J. Shen (ed.), *Evolved Cellular Network Planning and Optimization for UMTS and LTE*, Taylor and Francis Group, CRC Press, 2011.
9. M. Stasiak, M. Glabowski, A. Wisniewski, *Modelling and Dimensioning of Mobile Wireless Networks from GSM to LTE*, John Wiley & Sons, 2011.
10. J. Olenewa, *Guide to Wireless Communications*, Cengage Learning, 3rd edition, ISBN-10: 1111307318ISBN-13: 978-1111307318, 528 pag., 2013.
11. E. Puschita, s.a., *Radiocomunicatii Celulare - canalul radio - antene - proiectarea sistemelor – Manual de laborator*, U.T. PRESS, ISBN 978-973-662-496-4, 170 pag., 2009.

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

Competences acquired will be used in the following COR occupations (Electronics Engineer; Telecommunications Engineer; Electronics Design Engineer; System and Computer Design Engineer; Communications Design Engineer) or in the new occupations proposed to be included in COR (Sale Support Engineer; Multimedia Applications Developer; Network Engineer; Communications Systems Test Engineer; Project Manager; Traffic Engineer; Communications Systems Consultant).

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		- Summative evaluation (E) written exam (theory and problems)		- E, 50% (max. 5 pts.)
Applications		The level of acquired abilities and practical skills		- Practical evaluation (L) - planning a wireless network scenario using QualNet		- L, 50% (max. 5 pts.)
10.4 Minimum standard of performance						
$E \geq 5$ and $L \geq 5$ and $0.5E + 0.5L \geq 4.5$						

Date of filling in
07.02.2020

Course responsible
Associate Professor
Emanuel PUSCHITA, PhD

Teachers in charge of applications
Associate Professor
Emanuel PUSCHITA, PhD

Date of approval in the department
01.10.2020

Head of Communications Department
Professor Virgil DOBROTA, PhD