Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Networks and Telecommunications Software

2. Date despre disciplină

2.1 Course name (ro) (en)				Reţele de comunicaţii mobile Mobile Communications Networks			
2.2 Course Lecturer				Professor Roxana Zoican, PhD			
2.3 Instructor for practical activities				Professor Roxana Zoican, PhD/Assistant Professor Teodora Cristina Stoian			
2.4 Year of studies	4	2.5 Semester	2	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.S.08.O.311		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	5	Out of which: 3.2 course	3	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	70	Out of which: 3.5 course	42	3.6 seminary/laboratory	28
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					50
Tutoring					0
Examinations					5
Other activities (if any):					0

3.7 Total hours of individual study	55.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion of the following disciplines: Architectures and Communications Protocols, Data Communications, Networks and Services
4.2 Results of learning	Knowledge accumulation regarding: notions of interconnection and routing, routing algorithms and protocols, knowledge of interfaces and services, transport and network level protocols

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The course will take place in a room equipped with video projector and computer.
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a room with specific equipment, which must include: computers and installed software (OPNET, Matlab, GSM simulator, Pathloss simulation program, Orange equipment)

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

This course is studied within the field of Electronic Engineering, Telecommunications and Information Technologies /specialization Telecommunications Networks and Software and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in the design of mobile communication networks, with relevance for stimulating the students learning process.
The course provides students with the necessary knowledge to understand, deepen and design mobile communication networks in general and the evolution and characteristics of each of the technologies covered in this field, insisting on their influence on performance. In the first part of the course, there are described the general characteristics of mobile telecommunications systems, deepening the fundamental design elements of these telecommunications networks. The second part is dedicated to the detailed presentation of the generations of mobile radio systems: GSM, GPRS, UMTS, LTE, 5G, ad hoc networks, mesh. In each case, there are presented the architecture, the transmission and signaling protocols, the services offered to mobile subscribers, the interconnection possibilities with other mobile and fixed networks.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	•Demonstrates basic/advanced knowledge of Electronic Engineering, Telecommunications and Information Technologies. •Analyzes mobile communication systems, based on physical level technologies. •Analyze the characteristics of different types of cells, communication channels and multiple access techniques. •Analyzes the characteristics and problems that appear in the design of systems with different traffic and quality requirements. •It calculates the limits for different performance requirements of mobile communication networks. •It compares different implementation plans and evaluates the overall performance of mobile communication systems. •Analyzes the propagation characteristics for systems with different transmission environments: attenuation, fading, minimizing fading methods. •Analyze and compare in different practical applications, the methods of reusing frequencies, reducing interference, increasing traffic capacity and estimating coverage in mobile networks. •Compare and analyze the methods of using small cells and heterogeneous networks. •It applies standardized methods and tools, specific to the field, to carry out the evaluation and diagnosis process of a situation, depending on the identified/reported problems, and identifies solutions. •Coherent and correct argumentation and analysis of the basic knowledge of the field application context, using key concepts of the discipline and specific methodology. •Oral and written communication in Romanian: uses the scientific vocabulary specific to the field, in order to communicate effectively, in writing and orally. •Oral and written communication in a foreign language (English): demonstrates understanding of subject-related vocabulary in a foreign language.
Transversal (General) Competences	•Works in a team and communicates effectively, coordinating efforts with others to solve problem situations of medium complexity. •Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions. •Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis. •Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. •Integrates elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* •Creating the skills to analyze and design a minimal mobile communication system, based on physical level technologies. •Creating the skills to analyze, describe and compare the characteristics of different types of cells, communication channels and multiple access techniques . •Ensuring the necessary knowledge for the design of systems with different traffic and quality requirements. •Ensuring the necessary knowledge to design minimal systems with propagation characteristics in different transmission environments.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* •Selects and groups relevant information in a given context. •Reasonably uses specific principles in order to solve various problems with the help of a program. •Can communicate, motivate and think creatively regarding specific issues and principles underlying mobile communications networks •Works productively in a team, having the ability to design, implement and use minimal mobile communication systems •Elaborate a scientific text. •Experimentally verifies identified solutions. •Solve practical applications. •Adequately interpret causal relationships. •Analyzes and compares various ways of solving a problem. •Identifies solutions and develops resolution plans. •Formulates conclusions to the solved problems. •Argues the identified solutions and ways of solving them.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* •Select appropriate bibliographic sources and analyze them. •Respect the principles of academic ethics, correctly citing the bibliographic sources used. •Demonstrates responsiveness to new learning contexts. •Demonstrates collaboration with other colleagues and teaching staff in carrying out teaching activities. •Demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved . •Demonstrates social responsibility through active involvement in student social life/involvement in academic community events •Promotes/contributes through new solutions related to the specialized field to improve the quality of social life. •Realizes the value of his contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility). •Apply principles of professional ethics/deontology in the analysis of the technological impact of the proposed solutions in the specialized field on the environment. •Analyzes and capitalizes on business/entrepreneurial development opportunities in the specialized field. •Demonstrates real-life situation management skills (collaborative vs. conflict time management).

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilities of direct and indirect exploration of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.
In the teaching activity will be used lectures, based on some presentations that will be made available to the students. Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course. Presentations use images and diagrams so that the information presented is easy to understand and assimilate. This course covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conductive to discovery learning. It will be considered the practice of active listening and assertive communication skills, as well as feedback construction mechanisms, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs. Teamwork skills will be practiced to solve different learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction •General Characteristics •Performance Criteria •The New Generations of Mobile Communications Development	2
2	Design Elements for Cellular Telecommunications Systems •General description of the problems and the proposed objectives •Signal propagation elements, propagation losses, fading •Establishing the optimal value of C/I for systems with omnidirectional and directional antennas •Components of cellular telecommunications systems	4
3	Cells Design and Mobility Principles •Cells Division •Geometric Analysis of Cellular Networks and of Reuse Area Dimensions •Mobility and Communication Link Transfer (handover) Analysis •Intersystemic Handover, Cell Division •Mobile Subscribers Locating Methods, Probability of Missed Calls Definition and its Evaluation	4

4	GSM (Global System for Mobile Communication) •GSM Architecture •Interfaces and Signaling Protocols in GSM: RR, MM, CM procedures •Data and Support Services in GSM. Interworking with other networks: adaptive function, interworking with PSTN, ISDN, PSPDN. Transmissions in GSM. • HSCSD: Basic Concepts and GSM Networks Changes for HSCSD Speed Adaptation •Radio Resource Management •Mobility Management •Switching in GSM •Communications Security in GSM	6
5	GPRS (General Packet Radio Service) Networks •PDP Context Definition •Transmission Protocols Stack •Signaling and Transmission Procedures •GPRS Attach Procedure •PDP Context Activation Procedure •IP Routing in GPRS •Location Update and Routing Procedures •GSM / GPRS Networks (GPRS logic and physic channels, QoS in GPRS, Resources Used in common with GSM Networks)	4
6	MANET (Mobile Ad-hoc NETworks) •IEEE 802.11 Standard •Bluetooth Protocol •Types of Routing Protocols	3
7	UMTS (Universal Mobile Telecommunications System) Networks •Characteristics and Objectives of 3G Systems •UMTS System. UMTS/3GPP Standard (The 3rd Generation Partnership Project Agreement) •UMTS Architecture •Functional Description of the UTRAN •Multiple Access Techniques •Specific Procedures and methods for Network Access and Handover in UMTS	4
8	LTE (Long-Term Evolution) Networks •LTE Architecture •SAE (System Architecture Evolution)/EPC (Evolved Packet Core) •LTE-RAN Architecture and Functions •LTE Interfaces and Protocols •OFDMA and MIMO •Voice over LTE (VoLTE) Implementation •Using IMS (IP Multimedia Subsystem) in LTE •LTE vs LTE-A	5

9	5G Networks •Classification of small cells and heterogeneous network •Advantages of cell densification: area capacity and energy efficiency •Motivation for cloud-based networking •Network function virtualisation (NFV): concept, architecture •Software defined networking: (SDN) concept, architecture, protocols •Combination of NFV and SDN •Cloud radio access network (CRAN) •5G and Internet of Things	5
10	Artificial Intelligence (AI) and Machine Learning (ML) in 5G •AI and ML in mobile communications networks •The need and advantages of using AI in mobile communications •Big Data - a prerequisite for the integration of AI in mbile communications networks •IA and ML in 5G networks •Using Deep Learning in 5G •Using IA and ML in planning and optimizing 5G networks	5
	Total:	42

Bibliography:

1.https://curs.upb.ro/2021/mod/assign/view.php?id=153028
2.X.Lin, J. Zhang, Y. Liu, J.Kim, Fundamentals of 6G Communications and Networking, Ed. Springer 2023
2.A.Kumar, J.Hussain, A.Chun, Connecting the Internet of Things, Ed. Apress, 2023
3.A.Kumar, J.Hussain, A.Chun, Connecting the Internet of Things: IoT Connectivity standards and Solutions, Ed. Apress, 2023
4.A.Bajpai, A.Balodi, Applications of 5G and Beyond in Smart Cities, Ed.CRC Press, 2023
5.M.Bozanic, S.Sinha, Mobile Communications Networks: 5G and a vision of 6G, Ed. Springer, 2021
6.R.Shetty, 5G Mobile Core Network: Design, Deployment, Automation and Testing Strategies, Ed.Apress, 2021 Gestionarea resurselor radio in sistemele mobile de mare capacitate
7.M. Sauter, From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband, Ed. Wiley and Sons, 2021
8.Cristopher Cox, An Introduction to 5G: The New Radio, 5G Network and Beyond, Ed. Wiley &Sons, 2020
9.A.C.Garcia, S.Maier, A.Phillips, Location-Based Services in Cellular Networks, from GSM to 5G NR, Ed. Artech House, 2020
10.C. Mavromoustakis, G.Mastorakis, J.M. Battala, Internet of Things (IoT) in 5G Mobile Technologies, Ed.Springer, 2018
11.Juha Korhonen, Introduction to 4G Mobile Communications, Ed. John Wiley and Sons, 2014
12.R. Zoican, Sisteme celulare de telecomunicaţii, Ed. MATRIX ROM, 2003
13.R. Zoican, S. Zoican, D. Constantinescu, A.Constantin, E.Popovici, Comunicaţii mobile-Îndrumar de laborator, tipografia U.P.B., 1999
14.http://discipline.elcom.pub.ro/rcm/
15.A. Mateescu, I.Bănicã, E.Borcoci, I.Marghescu, T.Rãdulescu, C.Negrescu, S.Zoican, Roxana Zoican, I.Dragu, Sisteme şi reţele GSM, Ed. Tehnicã, Bucureşti, 1999

LABORATORY

Crt. no.	Content	No. hours
1	Radio Resources Management in High Capacity Mobile Systems	2

2	Error Handling in Mobile Communications Systems	2
3	Signal Modulation and Reception in Mobile Communications Systems	2
4	GSM network monitoring using TEMS Investigation program	4
5	LTE network monitoring using TEMS Investigation program	4
	Total:	14

SEMINARY

Crt. no.	Content	No. hours
1	Fixed and Dynamic Radio Channel Assignment Algorithms	4
2	Design Problems of Cellular Systems under Co-channel Interference and Interference between Adjacent Channels Conditions	4
3	Transmission Protocols	4
4	Propagation Problems in Mobile Communications Sytems	2
	Total:	14

Bibliography:

1.https://curs.upb.ro/2021/mod/assign/view.php?id=153028
2.X.Lin, J. Zhang, Y. Liu, J.Kim, Fundamentals of 6G Communications and Networking, Ed. Springer 2023
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3.A.Kumar, J.Hussain, A.Chun, Connecting the Internet of Things: IoT Connectivity standards and Solutions, Ed. Apress, 2023
4.A.Bajpai, A.Balodi, Applications of 5G and Beyond in Smart Cities, Ed.CRC Press, 2023
5.M.Bozanic, S.Sinha, Mobile Communications Networks: 5G and a vision of 6G, Ed. Springer, 2021
6.R.Shetty, 5G Mobile Core Network: Design, Deployment, Automation and Testing Strategies, Ed.Apress, 2021 Gestionarea resurselor radio in sistemele mobile de mare capacitate
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11.Juha Korhonen, Introduction to 4G Mobile Communications, Ed. John Wiley and Sons, 2014
12.R. Zoican, Sisteme celulare de telecomunicaţii, Ed. MATRIX ROM, 2003
13.R. Zoican, S. Zoican, D. Constantinescu, A.Constantin, E.Popovici, Comunicaţii mobile-Îndrumar de laborator, tipografia U.P.B., 1999
14.http://discipline.elcom.pub.ro/rcm/
15.A. Mateescu, I.Bănicã, E.Borcoci, I.Marghescu, T.Rădulescu, C.Negrescu, S.Zoican, Roxana Zoican, I.Dragu, Sisteme şi reţele GSM, Ed. Tehnicã, Bucureşti, 1999

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	- knowledge of the basic theoretical concepts - knowledge of the specific problems theory application - theoretical methods and techniques differential analysis	Written test	40%
11.5 Seminary/laboratory/project	Laboratory -the basis of mobile communication networks software design knowledge -the ability to design a minimal mobile network -the ability to analyze the traffic and data transmissions in mobile communications systems and to evaluate the performances for various simulation scenarios	Written and practice test	30%
	Seminary the ability to achieve an efficient frequency band exploitation in a mobile radio system the ability to design a mobile communication network in specific interference conditions -understanding the operation of LTE and 5G networks, and of the implementation of the Network Slicing functions	Written test	30%
11.6 Passing conditions			
TOTAL SCORE: laboratory – 30 points, tutorial- 30 points, tests – 40 points Passing conditions: - fulfilling the obligations characteristic of laboratory activities (participation in the planned works, preparation of reports) and tutorial (participation in tutorial classes, completion of homework); - obtaining the minimum score of 50% both after completing the evaluations in the practical activities (laboratory and tutorial), as well as in the tests			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

Through the activities carried out, students develop skills to offer solutions to problems and to propose ideas to improve the existing situation in the field of Electronic Engineering, Telecommunications and Information Technologies, the industrial branch Networks and telecommunications software.
•In the development of the content of the discipline, knowledge described by specialized literature and own published and presented research were taken into account.
•The course has a similar content to the courses held by the National University of Science and Technology POLITEHNICA Bucharest.
It is intended to develop the graduate's skills to manage practical situations that he may face in real life in order to increase his contribution to the improvement of the socio-economic environment

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Date	Course lecturer	Instructor(s) for practical activities
21.09.2026	Professor Roxana Zoican, PhD 	Professor Roxana Zoican, PhD 
		Assistant Professor Teodora Cristina Stoian 

Date of department approval	Head of department
22.09.2026	Conf. Dr. Serban Georgica Obreja 

Date of approval in the Faculty Council	Dean
22.09.2026	Prof. Dr. Mihnea Udrea 