Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

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	Masters
1.6 Programme of studies	Services and Network Management

2. Date despre disciplină

2.1 Course name (ro) (en)				Mobilitatea în rețelele wireless Mobility in Wireless Networks			
2.2 Course Lecturer				Professor Roxana Zoican			
2.3 Instructor for practical activities				Professor Roxana Zoican			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M1.O.11-05		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	4	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	28	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.					40
Tutoring					0
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	44.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion of the following disciplines: Architectures and communications protocols, Networks and services, Mobile communication networks

4.2 Results of learning	Knowledge accumulation regarding: interconnection and routing concepts, routing algorithms and protocols, knowledge of interfaces and services, transport and network level protocols, location update algorithms and routing, characteristics of LTE, 5G networks

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, GNS3, LTEsim, Mobisim)

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 / the Service and Network Management master's program and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in the design of wireless communication networks and the study of mobility within these networks, with relevance for stimulating the learning process in students
The course provides students with the necessary knowledge to understand, deepen and design mobile communication networks and mobility management techniques in different types of wireless networks.
In the first part of the course, the general techniques of mobility management in wireless networks are presented, as well as the database architectures used both in the algorithms for registering and determining the location of mobile subscribers, as well as in those for performing the handover. In the second part of the course, the mobility management protocols in PLMN, ad-hoc, mesh, IP, 3G, 4G, 5G networks and in mobile networks with satellite transmissions are presented , and their performances are analyzed.

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	•Demonstration of basic/advanced knowledge in Electronic Engineering, Telecommunications and Information Technologies. •General understanding of wireless networks as distributed, multi-user systems with limited resources, of the need for multiple access control and the solutions adopted for this purpose. •Understanding the effects of mobility in mobile systems 3G-5G, WSN, MANET and VANET networks and the algorithms used. •Deep knowledge of layered architectural network design principles. •Explore and understand wireless network performance analysis methods for assessing and maintaining quality of service (QoS) in broadband networks. •Understanding the context needed to distinguish between different performance metrics for different wireless infrastructures. •Development of a practical experience for demonstrating and evaluating the creating of topologies and the efficient use of resources, through experimental platforms. •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 the vocabulary related to the field, 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. •Integrating 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.* •Understanding of the communications techniques and protocols used in cellular networks, LTE, 4G/5G mobile systems, MP2P, WSN and MANET/VANET. •Understanding of the main concepts underlying the development of mobile and wireless broadband systems, as well as the ability to evaluate application-specific scenarios, identifying any related problems or issues and solutions to resolve them. •Creating the skills necessary to successfully evaluate communications protocols, their performances, for different scenarios, with the help of different simulators (for example, NS3). •The development of advanced knowledge in the application of wireless network monitoring techniques, as well as the identification of inter-operational characteristics in a wireless system.
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 the specific problems and principles underlying mobility techniques in wireless networks. •Works productively in a team, being able to evaluate the performances of some protocols used in wireless networks, as well as in the case of specific scenarios to mobile systems or broadband wireless 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 problems 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	Mobility Management Concepts • Technologies for Wireless Networks • Location Management • Handover Management • Mobility Management Protocols • NEMO (NEtwork MObility protocol) Protocol	4

2	Mobility Management in PLMN • Current Location Management Protocols • Location Registration and Call Delivery Procedures • Database Architectures for Mobility Management	4
3	Mobility Management in 1G-5G Networks • Mobility Management Evolution from 1G to 5G • Location Management • Mobility Management Protocols • GMM (GPRS Mobility Management) Protocol • MME Functions in LTE • Handover in LTE: intra-LTE, inter-LTE, inter-RAT • Mobility management in 5G. Analysis of 5G Access functions and Mobility Management Function (AMF) • Inter-slice Mobility Management in SDN/NFV Networks	7
4	Mobility Management in Mesh Networks • Mesh Networks Architecture • SMesh System • Mobility Management Performances in MeshDVNet	3
5	Mobility Management in Mobile IP Networks • Mobile IP Architecture • Location Registration • Handover Management • Model TMIP (Transparent Mobile IP) Analysis • HIP (Host Identity Protocol) Application	3
6	Mobility Management for Satellite Networks • Location Management • Handover Management • Intersatellite Handover Algorithm • Mobility Management in Satellite Networks IoT 6G (SioT)	4
7	Mobility Management in IoT Networks • RPL Protocol • CARP and E-CARP Protocols • CORPL Protocol	3
	Total:	42

Bibliography:
1.https://curs.upb.ro/2023/pluginfile.php/120857/mod_resource/content/1/CURS%20MRW.pdf
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.J.Shen, Z.Du, Z.Zhang, N.Yang, H.Tang, 5G NR and Enhancements, Ed. Elsevier, 2021
6.B.Nayak, S.K. Pani, T.Choudhury, S.Satpathy, S.N. Mohanty, Wireless Sensor Networks and the Internet of Things, Ed.CRC Press, 2021
7.E.Dahlman, S.Parkval, J.Skold, 5G NR The Next Generation Wireless Access Technology, Ed. Elsevier, 2020
8.S.Misra, S.Goswami, Network Routing: Fundamentals, Applications, and Emerging Technologies, Ed.Wiley&Sons, 2017
9.Miguel Elias Mitre Campista, Advanced Routing Protocols for Wireless Networks, Ed. John Wiley and Sons, 2014
10.Juha Korhonen, Introduction to 4G Mobile Communications, Ed. John Wiley and Sons, 2014
11.Paolo Santi, Mobility Models for Next Generation Wireless Networks: Ad Hoc, Vehicular and Mesh Networks, Ed. John Wiley and Sons, 2012
12.R. Zoican, Sisteme celulare de telecomunicaţii, Ed. MATRIX ROM, 2003
13.I.Marghescu, Şt.Nicolaescu, N. Coţanis, Comunicaţii mobile terestre, Editura Tehnică, 1999
14.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

LABORATORY

Crt. no.	Content	No. hours
1	Routing Protocols for Ad Hoc Networks	6
2	Handover Algorithms (initiated by network/mobile user, hard/soft)	4
3	Mobility Management in GPRS, 3G, 4G	6
4	Routing and Channel Assignment in Mesh Networks	4
5	Vertical Handover 4G/WLAN Performance evaluation	4
6	Evaluating handover performance in LTE networks for different scenarios	4
	Total:	28

Bibliography:
1.https://curs.upb.ro/2023/pluginfile.php/120857/mod_resource/content/1/CURS%20MRW.pdf
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.J.Shen, Z.Du, Z.Zhang, N.Yang, H.Tang, 5G NR and Enhancements, Ed. Elsevier, 2021
6.B.Nayak, S.K. Pani, T.Choudhury, S.Satpathy, S.N. Mohanty, Wireless Sensor Networks and the Internet of Things, Ed.CRC Press, 2021
7.E.Dahlman, S.Parkval, J.Skold, 5G NR The Next Generation Wireless Access Technology, Ed. Elsevier, 2020
8.S.Misra, S.Goswami, Network Routing: Fundamentals, Applications, and Emerging Technologies, Ed.Wiley&Sons, 2017
9.Miguel Elias Mitre Campista, Advanced Routing Protocols for Wireless Networks, Ed. John Wiley and Sons, 2014
10.Juha Korhonen, Introduction to 4G Mobile Communications, Ed. John Wiley and Sons, 2014
11.Paolo Santi, Mobility Models for Next Generation Wireless Networks: Ad Hoc, Vehicular and Mesh Networks, Ed. John Wiley and Sons, 2012
12.R. Zoican, Sisteme celulare de telecomunicaţii, Ed. MATRIX ROM, 2003
13.I.Marghescu, Şt.Nicolaescu, N. Coţanis, Comunicaţii mobile terestre, Editura Tehnică, 1999
14.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	Written exam	20%
	knowledge of the specific problems theory application	Written exam	40%
	theoretical methods and techniques differential analysis	Written exam	40%
11.5 Seminary/laboratory/project	knowledge of the operation principles of routing protocols in different mobile communications networks	Written and practice test	30%
	demonstration the analyzing ability of the subscribers mobility in 3G, 4G networks and solving capacity of the critical situations, for different types of traffic	Written and practice test	40%
	the performances evaluation capacity, in terms of mobility, for ad-hoc networks, GPRS, ATM, 3G, 4G, IP	Written and practice test	30%
11.6 Passing conditions			
•fulfilling the obligations characteristic of laboratory activities (participating in the planned works, making reports); •obtaining the minimum score of 50% both after completing the evaluations in the applications (laboratory and seminar), as well as in the exam			

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

Date	Course lecturer	Instructor(s) for practical activities
09.09.2022	Professor Roxana Zoican	Professor Roxana Zoican

Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja

Date of approval in the Faculty Council	Dean
01.11.2024	Prof. Dr. Mihnea Udrea