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)				Protocoale şi arhitecturi de reţele wireless de senzori Wireless Sensor Networks Protocols and Architectures			
2.2 Course Lecturer				Professor Roxana Zoican			
2.3 Instructor for practical activities				Professor Roxana Zoican			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M3.O.11-39		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):					65

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 for networks and services, Mobility in wireless networks, Internet applications and services
4.2 Results of learning	Knowledge accumulation regarding : mobility management in mesh networks, routing protocols based on distance vectors (distance vector) and link state (link state), inter-domain routing based on policies in the Internet, ad hoc 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, OMNET++, Matlab, Sensoria, NS2, Qualnet, Wireless Sensor Network Localization Simulator)

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 sensor networks, with relevance for stimulating the students learning process.
The course provides students with the necessary knowledge to understand, deepen and design wireless sensor networks for different applications.
There are presented the designing sensor networks principles, the hardware architecture of a node, as well as the main communication protocols. There are also analyzed the need for time synchronization in wireless sensor networks and distributed allocation algorithms of addresses in WSN.

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. • Understanding the operating principles of sensor networks for various application configurations. • Creating the skills needed to explore the design space and perform a performance-resource trade-off analysis. • Creating the necessary skills for coverage assessment and node • Determining the appropriate protocols for data transmission and medium access. • Understanding of sensor network design methods in compliance with service quality requirements, error tolerance, security and reliability requirements • 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 reallife/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.* • The working principles of sensor networks and ad hoc mobile networks and their impact on the design of a network. • Development of MAC and routing protocols for sensor networks. • IEEE 802.11 protocol specifications for data link layer, medium access control and logical link control techniques, quality of service and security features. • Ability to analyze efficient routing protocols for sensor networks. • Understanding the principles of operation and the importance of energy saving protocols in wireless sensor networks. • Creating the skills needed to specify requirements for hardware and software solutions of energy-efficient sensor networks • Creating the skills to apply appropriate algorithms to improve the existing applications or develop new wireless sensor network applications. • Creating the skills needed to analyze the specific requirements of wireless sensor. network applications to ensure energy efficiency, computing, storage and transmission.
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 performance requirements specific to wireless sensor networks. • Work productively in a team, being able to specify the requirements for hardware and software solutions of energy-efficient sensor networks and to evaluate the performance of a network. • Elaborate a scientific text. • Experimentally verifies identified solutions • Solve practical applications, having the necessary knowledge to design a minimal sensor network • 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. • Formulates conclusions to the solved problems

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 situation of the problems 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 teachingprocess 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, lectures will be used, 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 discipline 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 - Types and examples of Wireless Sensor Network (WSN) applications - Differences between ad-hoc networks and sensor networks - Challenges for WSN	2
2	The Architecture of a Node in WSN - Hardware component - Communication devices - Sensors and elements of execution	4
3	The WSN Architecture - Scenarios for Sensor Networks - Optimizations and performance values - Principles of WSN designing - Service interfaces in WSN - The Gateway Device concept	4
4	Communication Protocols - Physical level and design considerations of receivers in WSN - MAC Protocols - Basic Aspects of MAC Protocols (Wireless) - Low-cycle protocols and activation concepts: STEM, S-MAC, Mediation Device Protocol - Protocols based on scheduling: LEACH- - IEEE 802.15.4 MAC Protocol	4
5	WSN Assigning Aames and Addresses - Fundamental notions - Shared allocation of unique local addresses	4
6	Time Synchronization - The need of time synchronization in wireless sensor networks - Protocols based on transmitter / receiver synchronization = Protocols based on receiver / receiver synchronization	4
7	Topology Control - Topology control in flat architectues networks-power control - Hierarchical networks using dominant sets - Hierarchical networks using clusters	2
8	Routing Protocols - Gossiping and uni-destination retransmission based on agent - Energy-efficient uni-destination transmission - Geographic routing	2
9	Data-Centric and Content-Based Networks - Routing centered on data - Data Aggregation	2
	Total:	28

Bibliography:

Bibliography:
1.https://curs.upb.ro/2023/mod/folder/view.php?id=30213
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.B.Nayak, S.K. Pani, T.Choudhiry, S.Satpathy, S.N. Mohanty, Wireless Sensor Networks and the Internet of
Things, CRC Press, 2021
6.A.Yarali, Wireless Sensor Networks. Technology and Applications, Ed. Nova, 2020
7.T. Samant, Y.S. Kumar, S.Swayamsiddha, Comparison Analysis of MAC Protocols for Wireless Sensors: A
Comprehensive Survey, IGI Global, 2020
8.John Vacca, Handbook of Sensor Networking: Advanced Technologies and Applications, CRC Press, 2015
9.Ibrahiem El Emary, S. Ramakrishnan, Wireless Sensor Networks: From Theory to Applications, CRC Press,
2013
10.H. Karl, A.Willig, Protocoale si arhitecturi pentru retele de senzori wireless, MatrixRom, 2012

LABORATORY

Crt. no.	Content	No. hours
1	Comparison of WSN Networks Performances for Star, Tree and Mesh Topologies	4
2	Evaluation of Zigbee Protocol Performance	4
3	Modeling a ZigBee Routing Scheme for Slotted and Unslotted CSMA / CA modes	6
4	Evaluation of LEACH Protocol Performances	6
5	Evaluation of PEGASIS Protocol Performances	4
6	Comparative Evaluation of the Performances of DSR (Dynamic Source Routing) and AODV (Ad hoc On Demand Distance Vector) Routing Protocols in WSN networks	4
	Total:	

Bibliography:

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1.https://curs.upb.ro/2023/mod/folder/view.php?id=30213
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,
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Things, CRC Press, 2021
6.A.Yarali, Wireless Sensor Networks. Technology and Applications, Ed. Nova, 2020
7.T. Samant, Y.S. Kumar, S.Swayamsiddha, Comparison Analysis of MAC Protocols for Wireless Sensors: A
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8.John Vacca, Handbook of Sensor Networking: Advanced Technologies and Applications, CRC Press, 2015
9.Ibrahiem El Emary, S. Ramakrishnan, Wireless Sensor Networks: From Theory to Applications, CRC Press,
2013
10.H. Karl, A.Willig, Protocoale si arhitecturi pentru retele de senzori wireless, MatrixRom, 2012

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 test	20%
	knowledge of the specific problems theory application	Written test	40%
	theoretical methods and techniques differential analysis	Written test	40%

11.5 Seminary/laboratory/project	knowing the principles of routing protocols in different sensor networks	Written and practicetest	30%
	demonstrating the ability to analyze the assignment of names and addresses in wireless sensor networks	Written and practicetest	30%
	knowing the principles of the data link protocols in sensor networks	Written and practicetest	40%
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 laboratory and 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

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

Universitatea Națională de Știință și Tehnologie Politehnica București

Facultatea de Electronică, Telecomunicații și

Tehnologia Informației

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