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	Advanced Wireless Communications

2. Date despre disciplină

2.1 Course name (ro) (en)				Sisteme integrate Embeded Systems for Wireless Communications			
2.2 Course Lecturer				Conf. Dr. Alexandru RUSU			
2.3 Instructor for practical activities				Conf. Dr. Alexandru RUSU			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		DS	2.9 Course code	UPB.04.M2.O.21-11		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	2.5	Out of which: 3.2 course	1.50	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	35.00	Out of which: 3.5 course	21	3.6 seminary/laboratory	14
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.					38
Tutoring					0
Examinations					2
Other activities (if any):					0

3.7 Total hours of individual study	40.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Promotion of disciplines: Signals and Systems, Analog and digital communications, Signal processors in communications
4.2 Results of learning	NA

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 equipped with a video projector and computers for students, equipped with systems on a chip and the corresponding programming environment.

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)*

The aim is to familiarize students with the main aspects related to integrated systems for communications. Also, the discipline provides students with knowledge and skills related to sensor networks (of the Internet of Things IoT type), with an emphasis on their architecture, as well as on personal coverage network technologies and how they are integrated into applications in the fields of ehealth and that of smart homes. The main features, elements and functions of IoT devices are presented. The main performance evaluation parameters and specific techniques for their improvement are also presented.

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	Prove that you own basic knowledge in the field of communications in wireless networks. Correlates general knowledge of access technologies and deepens them in the IoT domain. Apply in practice acquired knowledge. Apply standardized methods and tools, specific to the field, for carrying out the assessment and diagnosis process of a situation, depending on the problems identified/reported, and identify solutions. Argue and analyze coherent and correct context of application of the basic knowledge of the field, using key concepts of the discipline and the specific methodology. Oral and written communication in a foreign language (English): demonstrate understanding of the vocabulary related to the field, in a foreign language.
Transversal (General) Competences	Work in a team and communicate effectively, coordinating their efforts with others to solve problems of medium complexity. Autonomy and critical thinking: the ability to think in scientific terms, to search and analyze data independently, as well as to draw and present conclusions / identify solutions. Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a systematic analysis process. Respect the principles of academic ethics: in the documentation activity correctly cite the bibliographic sources used.

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.* Can list the most important stages that marked the development of the field. Can define domain-specific notions. Describes/classifies notions/processes/phenomena/structures. Highlights consequences and relationships.
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).* The student selects suitable bibliographic sources and analyzes them. Respects the principles of academic ethics, correctly citing the bibliographic sources used. Demonstrate responsiveness for new learning contexts. Show collaboration with other colleagues and teaching staff in carrying out teaching activities Demonstrate autonomy in the organization of the learning situation/context or the problem situation to be solved Promotes/contributes through new solutions related to the specialized field to improve the quality of social life.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Starting from the analysis of the 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 facilitated by 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 of Communication Systems will be used in the form of Power Point presentations or different videos that will be made available to the students. Each course begins 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 communication relationships in a climate conducive to learning through discovery. 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.

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.)*

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10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction in IoT networks	2
2	Physical and MAC layers for PAN networks	3
3	Architecture of the Embedded system NXP K32W061	2
4	Bluetooth standard	3
5	Security in Bluetooth technology	3
6	Bluetooth Low Energy Mesh	2
7	Thread technology	2
8	CHIP technology	2
9	NXP Smart lighting technology	2
	Total:	21

Bibliography:
Bluetooth® Low Energy Application Developer's Guide, 2018,
https://community.nxp.com/pwmxy87654/attachments/pwmxy87654/wireless-connectivity/7638/1/Bluetooth%2520Low%2520Energy%2520Application%2520Developer%27s%2520Guide.pdf&ved=2ahUKEwi0raf9yaP-AhUahGMGHYuLAWsQFnoECBMQAQ&usg=AOvVaw0DEh7vkzTpEXozA-gny6xt
Bluetooth® Core Specification Version 5.4, 2023
2301_5.4_Tech_Overview_FINAL.pdf (bluetooth.com)
Ultra-Low Energy Wireless Sensor Networks inPractice: Theory, Realization and Deployment | Wiley
Mesh Protocol Bluetooth® Specification 2023
https://www.bluetooth.org/DocMan/handlers/DownloadDoc.ashx?doc_id=574298
Thread 1.2 in Commercial White Paper, 2019
ThreadInCommercialWhitePaper_2542_1.pdf (threadgroup.org)

LABORATORY

Crt. no.	Content	No. hours
1	1 Introduction to MCU Xpresso Environment: Running an UART Application	2
2	L2 Application for adding Bluetooth attributes and security levels to a medical sensor	2
3	L3 Development of a Bluetooth attribute for CAN 2	2
4	L4 Bluetooth packet analysis	2
5	P1 Presentation of the project topics	2
6	P2 Evaluation of the project's progress	2
7	P3 Evaluation of the project	2
	Total:	14

Bibliography:
Laboratory practical instructions documents

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	knowledge of fundamental theoretical notions; knowledge of how to apply theory to specific problems; differential analysis a techniques and theoretical methods.	Exam	40
11.5 Seminary/laboratory/project	Understanding some notions and fundamental concepts about Bluetooth technology and their implementation in the development environment.	Laboratory activity and project completion	60
11.6 Passing conditions			
Obtaining 50% of the total score. Obtaining 50% of the score related to the laboratory activity. Attendance at laboratory activities			

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)

Internet of Things sensor networks are in the midst of a worldwide revolution, their numbers growing exponentially in recent years. They have applications in the fields of smart homes and cities, autonomous vehicles, automated industry and medicine. Thus, there is an extremely high demand from industry in the mentioned sectors for qualified engineers with a solid foundation in the main aspects of the architecture and modeling of these systems, as well as in the implementation of the actual systems.

The course curriculum responds concretely to these current requirements of development and evolution, subscribed to the economy of European services in the field of IoT. In the context of current technological progress, the fields of activity concerned start from the analysis of the Bluetooth protocol levels and continue to the software development of the components of a network of sensors. In this way, the graduates are provided with adequate skills, corresponding to the needs of the current industrial qualifications and a modern, competitive, scientific and technical education, which will allow them to be quickly employed after graduation. This is perfectly framed in the policy of the National University of Science and Technology Politehnica from Bucharest, from the point of view of content and structure, as well as from the point of view of skills and openness offered to the students.

Date	Course lecturer	Instructor(s) for practical activities
09.09.2022	Conf. Dr. Alexandru RUSU	Conf. Dr. Alexandru RUSU

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

Date of approval in the Faculty Council	Dean
25.10.2024	Prof. Dr. Mihnea Udrea