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	**Applied Electronics and Information Engineering**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Applied Electronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Sisteme hibride de comunicații mobile			
2.2 Course Lecturer				Conf. Dr. Razvan Craciunescu			
2.3 Instructor for practical activities				Conf. Dr. Razvan Craciunescu			
2.4 Year of studies	4	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.S.08.O.115		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	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.					28
Tutoring					3
Examinations					2
Other activities (if any):					0

3.7 Total hours of individual study	33.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	
4.2 Results of learning	

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

5.1 Course	
5.2 Seminary/ Laboratory/Project	Attendance at the laboratories is mandatory (according to the undergraduate studies regulation at UNSTPB).

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 integration of IoT within mobile communications, especially in the 5G context, represents another critical dimension of the course. Students will explore how IoT and 5G complement each other, facilitating the development of innovative and efficient solutions for a wide range of applications, from smart cities to Industry 4.0. The course will also cover IoT-specific emerging technologies, such as advanced sensors and edge computing, focusing on how these can be integrated into 5G ecosystems to enhance performance, efficiency, and security.

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	Correlates knowledge, coherently and correctly argues and analyzes the context of applying basic domain knowledge, using key concepts of the discipline and specific methodology.
Transversal (General) Competences	Analytical and synthesis ability: concisely presents the acquired knowledge, as a result of a systematic analysis process.

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.* It lists the most important stages in an IoT and 5G-IoT system. Defines notions specific to the field of hybrid communications. Describes/classifies notions/processes/phenomena encountered in a hybrid communication 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).* Analyzes and compares different techniques encountered in hybrid communication systems

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 collaboration with other colleagues and teaching staff in carrying out teaching activities

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.)*

The teaching is based on the use of the video projector (covering the communication function and demonstrative); the oral communication methods used are the expository method and the problematization method, used frontally. Course materials are: course notes and presentations, collections of proposed problems (theoretical and with computer or blackboard solutions). All materials are available in electronic format, through the course site (Moodle)

10. Contents

COURSE

Chapter	Content	No. hours
1	Introduction to Mobile Communications and Hybrid Systems (IoT + Mobile Communications) - Overview of mobile communications. History, evolution, and the concept of communication systems	4
2	Fundamentals of 5G Technology - 5G vision, differences from 4G, use cases, benefits. Overview of key technologies	4
3	5G Architecture and Components - Exploring 5G network architecture, core components, and how they support mobile communications, 5G security	6
4	Internet of Things (IoT) and Its Role in 5G - Introduction to IoT, how it works, and its relationship to 5G. Overview of IoT components and technologies.	4
5	Deepening IoT in 5G Context Detailed exploration of how 5G enhances IoT capabilities. Discussion of communication protocols, security in IoT, and integration with other technologies.	4
6	Emerging Technologies in IoT - Exploration of specific emerging technologies in IoT, such as advanced sensors, low-power communication networks (LPWAN), and Edge Computing.	4
7	Use Cases, Challenges and Trends in 5G and IoT - Analyzing concrete use cases in 5G and IoT, discussing current challenges and exploring future trends.	2
	Total:	28

Bibliography:

Razvan Craciunescu - lecture notes - Moodle
STEFAN ROMMER, PETER HEDMAN, MAGNUS OLSSON, LARS FRID, SHABNAM SULTANA, CATHERINE MULLIGAN, 5G CORE NETWORKS, Academic Press 2020, ISBN 978-0-08-103009-7

LABORATORY

Crt. no.	Content	No. hours

1	Introduction to communication systems	2
2	Introduction to Flora in OMNeT++ for network simulations	2
3	IOT SYSTEM WITH LONG DISTANCE TRANSMISSION (LORA+DATA PROCESSING PLATFORM)	2
4	LTE CAT-M AND NB-IOT. THEORETICAL INTRODUCTION AND APPLICATIONS	2
5	DATA ANALYTICS. THEORETICAL INTRODUCTION AND APPLICATIONS	2
6	EXPLORING CLOUD TECHNOLOGIES: USING RASPBERRY PI SENSORS FOR INNOVATIVE SOLUTIONS	2
7	EXPLORING CLOUD TECHNOLOGIES: ATTENDANCE MONITORING SYSTEM WITH RASPBERRY PI CAMERA AND MQTT COMMUNICATION	2
	Total:	14

Bibliography:
Razvan Craciunescu, Lucrari de laborator SHCM, Moodle

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge of theoretical notions fundamentals related to IoT and 5G-IoT systems. Knowing how to apply of the theory at solving some problems specific the domain.	Written exam in last week, of courses.	50%
11.5 Seminary/laboratory/project	Understanding techniques fundamentals of IoT and 5G-IoT systems.	Laboratory sheet for each laboratory work	50%
11.6 Passing conditions			
Obtaining 50% of the total score. Carrying out the obligations characteristic of the laboratory activity (participation in the planned works)			

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)

The correlation of the "Hybrid Mobile Communications Systems" course content with the expectations of employers and representative professional associations in the relevant field, as well as with the current state of knowledge in the field of mobile communications and IoT, is essential to ensure the relevance and applicability of the knowledge conveyed to students. In the context of rapid technological advances and the increasing need for innovation in the telecommunications sector, employers are looking for well-prepared

professionals capable of understanding and implementing advanced solutions that integrate 5G and IoT technologies. This course is designed to directly meet these requirements, providing students with critical skills in designing, implementing, and managing advanced mobile communication systems.

Professional associations emphasize the importance of a deep understanding of new technologies and their impact on society, promoting high standards in education and professional practice. The course aligns with these expectations by integrating the latest research and innovations in the field, as well as by adopting a practical approach that allows students to apply theory to concrete projects and case studies relevant to the industry.

Furthermore, correlating the course content with educational practices in higher education institutions within the European Higher Education Area (EHEA) ensures that the program remains up-to-date with international standards in engineering education. This includes the adoption of innovative learning methods, such as project-based learning and interdisciplinary collaboration, which are essential for training graduates capable of navigating technological complexity and effectively collaborating within multidisciplinary teams.

By aligning with industry expectations, professional standards, and leading educational practices, the "Hybrid Mobile Communications Systems" course positions itself as a crucial element in training future specialists in mobile communications and IoT, preparing students not only for current challenges but also for future innovations in the field.

Date	Course lecturer	Instructor(s) for practical activities
	Conf. Dr. Razvan Craciunescu	Conf. Dr. Razvan Craciunescu

Date of department approval	Head of department
04.11.2024	Conf. Dr. Bogdan Cristian FLOREA

Date of approval in the Faculty Council	Dean

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

04.11.2024 Prof. Dr. Mihnea Udrea