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	Applied Electronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Sisteme de comunicații mobile hibride Hybrid Mobile Communications Systems			
2.2 Course Lecturer				Conf. Dr. Carmen Florea			
2.3 Instructor for practical activities				Conf. Dr. Carmen Florea			
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.515		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.					30
Tutoring					0
Examinations					3
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	Completion of the following courses: Signals and systems, Analysis and synthesis of circuits

4.2 Results of learning	General knowledge regarding signals, systems, modulation, analysis of discrete systems

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

5.1 Course	The course will take place in a classroom equipped with a video projector and blackboard
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a classroom with specific equipment, which must include: computers, signal generators, oscilloscope, etc. Compulsory presence at laboratory classes, according to current UPB regulations.

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 Applied Electronics specialization and aims to familiarize the students with the main aspects related to the techniques applied in analog and digital communication systems. A number of technologies and transmission systems are briefly presented, such as GSM, GPRS, UMTS, LTE, 5G systems and applications for telecommunication services.
The following aspects are mostly taken into account: analog and digital communication issues; the main analog modulation techniques; the steps taken to convert an analog signal into a digital one, represented on a finite number of bits; baseband techniques used to transmit digital data.
Different types of multiple access technologies such as orthogonal multiple access and non-orthogonal multiple access will also be studied. Different types of transmission media will be analyzed: guided/wired; unguided/using electromagnetic waves (types of antennas, propagation models, fading etc.). Communication networks and services will also be covered: network components and functions; basic services; communications traffic; LAN, MAN, WAN and Internet; OSI Reference Model and TCP/IP Architecture.
The discipline addresses concepts that contribute that students have an overview of the functioning of a communication system.

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 knowledge of Electronics, Telecommunications and Information Technology Engineering domain Correlate knowledge It argues and analyzes coherently and correctly the 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	Works in a team and communicates effectively, coordinating the efforts with others to solve problem situations of medium complexity. 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.

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.* List the most important stages in a mobile communication system. Defines notions specific to the field of communications. Describes/classifies notions/processes/phenomena encountered in a mobile 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 found in mobile 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.)*

Teaching is based on the usage of video projection (for communication and demonstration); the oral communication is based on face-to-face presentations and problematizations. The course materials are the course notes and handouts and proposed exercises (both theoretically and computer-aided solved). All materials are available in electronic form via the course site (Moodle).

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction. The role and the structure of a communication system. Evolution and perspectives of communication systems	2
2	Analogue and digital transmission of information bearing signals. Analogue modulation techniques using a sine-wave carrier signal (linear modulation, exponential modulation) and using a periodic pulse of square-waves signals. Analogue-to-digital conversion: sampling, quantizing, coding. Digital modulation techniques (BPSK, QPSK, MPSK, BFSK, MFSK, BASK, MQAM). The advantages of data transmissions.	10

3	Transmission media. Twisted cables (structure, technical characteristics, applications). Coaxial cables (structure, technical characteristics, applications). Optical fibers (structure, technical characteristics, applications). Electromagnetic waves propagation (radio waves, antennas, propagation, link budget)	6
4	Multiple access techniques. Fixed allocation multiple access techniques, random multiuser access techniques, controlled multiuser access techniques and hybrid access techniques. Orthogonal frequency division access technique and non-orthogonal access technologies in the power domain, non-orthogonal access technologies in the code domain and non-orthogonal access technologies with multiplexing in different domains.	4
5	Communication networks and services. Network components and functions. Fundamental services. OSI reference model. TCP/IP architecture. LAN, MAN, WAN and Internet.	2
6	Machine to Machine(M2M) / Internet of Things (IoT) Communications. Introduction. Requirements. Technologies. Comparison LTE vs LPWA IoT. IoT Celular (LTE-M, NB-LTE (NBIoT), EC-GSM). IoT LPWA (Sigfox, LoRa, Weightless, Ingenuu). IoT SRWA (Bluetooth, Zigbee, Wi-Fi)	4
	Total:	28

Bibliography:

Florea Carmen, Sisteme de comunicaţii mobile hibride, https://curs.upb.ro/2024
Florea Carmen, Tehnici de acces și transport în comunicații mobile, Editura Politehnica Press, ISBN 978-606-9608-07-4, București 2022 (online http://cr.uk.to/edi_final.pdf)
O. Fratu, S. Halunga, "UMTS – O nouă generaţie în comunicaţiile mobile digitale (Aspecte generale. Interfaţa radio)", Editura Electronica 2000, Bucureşti, 2003, ISBN 973-99878-5-0;
J. Andrews, A. Ghosh, R. Muhamed, "Fundamentals of WiMAX (Understanding Broadband Wireless Networking)", Prentice Hall, Upper Saddle River, NJ, 2007, ISBN 0-13-222552-2;
R. Prasad, L. Munoz, "WLANs and WPANs towards 4G Wireless", Artech House, Boston, USA, 2003, ISBN 1-58053-090-7;
A. Brand and H. Aghvami, Multiple Access Protocols For Mobile Communications. Wiley, 2002
S. Halunga, O. Fratu "Simularea sistemelor de transmisiune analogice şi digitale folosind mediul Matlab/Simulink "(Simulation of analog and digital communication systems using Matlab)- Editura Matrix Rom, Bucureşti, 2004
I. Constantin, S. Halunga, I. Marcu, „Transmisiuni analogice şi digitale – culegere de probleme", editura Electronica 2000, 2010

LABORATORY

Crt. no.	Content	No. hours
1	Simulation and analysis of LM modulated signals	2
2	Simulation and analysis of FM modulated signals	2
3	Sampling, quantizing, compression, coding. PCM, APCM, ΔM.	2
4	Line coding: NRZ, RZ, Manchester	2
5	Simulation and analysis of BPSK, BFSK, M-QAM digital communication systems.	2
6	Simulation and analysis of a wireless LAN network.	2
	Total:	14

Bibliography:
Florea Carmen, Sisteme de comunicaţii mobile hibride, https://curs.upb.ro/2024
Florea Carmen, Tehnici de acces şi transport în comunicaţii mobile, Editura Politehnica Press, ISBN 978-606-9608-07-4, Bucureşti 2022 (online http://cr.uk.to/edi_final.pdf)
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11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	knowledge of the fundamental theoretical knowledge (first 2 chapters)	one text during the semester, at pre-defined date;	20
	differential analysis of mobile communication techniques and systems	Exam held in the last week of the semester	40
11.5 Seminary/laboratory/project	appreciation of individual solving of the proposed problems by simulation and directly measuring on the circuit during each lab	assessment during each laboratory work	40
11.6 Passing conditions			
Obtaining 50% of the total score. Obtaining 50% of the score related to the laboratory activity, according to the UPB regulation. Obligatory notions for promotion: knowledge of fundamental theoretical notions regarding analog and discrete signals. Differential analysis of multiple access techniques and systems of communications			

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)

Mobile communications systems and networks became a mature market with an increased with high rate growth. Specific equipment manufacturers and operators have a high demand for qualified engineers with specializations related to communications systems and networks and with a solid foundation in telecommunications so as to be able to keep the pace of development of new hardware and software applications.
The course curriculum answers these trends regarding the developments and evolution requirements,

demanded by the general framework of the European economy of services in the IC&T domain.
This provides graduates with the appropriate skills and training requirements according to current qualifications, and a modern, high quality and competitive scientific and technical training, enabling them acquiring a working place after the graduation. The course fits therefore perfectly to the University Politehnica of Bucharest policy, considering both its content and structure, and the skills and international openness it offers to students

Date	Course lecturer	Instructor(s) for practical activities
24.09.2024	Conf. Dr. Carmen Florea	Conf. Dr. Carmen Florea

Date of department approval	Head of department
16.10.2024	Conf. Dr. Bogdan Cristian FLOREA

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