Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

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	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Microelectronics, Optoelectronics and Nanotechnologies

2. Date despre disciplină

2.1 Course name (ro) (en)				Sisteme de comunicaţii Communications systems			
2.2 Course Lecturer				S.l./Lect. Dr. Razvan Florentin Trifan			
2.3 Instructor for practical activities				S.l./Lect. Dr. Razvan Florentin Trifan			
2.4 Year of studies	3	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Op
2.8 Course type		D	2.9 Course code	04.D.06.A.415		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	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42	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.					8
Tutoring					0
Examinations					0
Other activities (if any):					0

3.7 Total hours of individual study	8.00
3.8 Total hours per semester	50
3.9 Number of ECTS credit points	2

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion of the following subjects: Signals and Systems 1, Signals and Systems 2
4.2 Results of learning	General knowledge of signals and systems, modulation, analysis of discrete signals.

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

5.1 Course	Classroom with video projector and whiteboard

5.2 Seminary/ Laboratory/Project	Laboratory, a room with specific equipment, which must include: computers, signal generators, oscilloscope, etc. Mandatory attendance at laboratories (according to UPB undergraduate study 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 discipline is studied within the specialization Microelectronics, Optoelectronics and Nanotechnologies and aims to familiarize students with the main aspects related to techniques encountered in analog and digital communication systems. A number of transmission technologies and systems are briefly presented, such as GSM, GPRS, UMTS, LTE, 5G systems and applications for telecommunications services.

The following aspects are largely considered: aspects regarding analog and digital communications; the main analog modulation techniques; the steps performed to convert an analog signal into a digital one represented on a finite number of bits; baseband techniques used for transmitting digital data.

Different types of multiple access technologies will also be studied, such as orthogonal multiple access and non-orthogonal multiple access. Different types of transmission media will be analyzed: guided/cabled; unguided/using electromagnetic waves (types of antennas, propagation models, fading, etc.). Communications networks and services will also be addressed: network components and functions; fundamental services; communications traffic; LAN, MAN, WAN and Internet; OSI reference model and TCP/IP architecture.

The discipline addresses concepts that help students form an overview of how a communications system operates.

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	Developing the skills to apply general knowledge to the understanding of modern transmission systems. In particular, familiarization with: - analog and digital modulation techniques used in telecommunications; - types of signals used in telecommunications; - communication systems used in telecommunications.
Transversal (General) Competences	CT1 Fulfilling professional tasks with an exact identification of the objectives to be achieved, available resources, completion conditions, work stages, working time, and corresponding deadlines.

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.* Enumerates the most important elements in the structure of a communications system. Defines the main types of modulations specific to the field of communications. Describes the blocks that characterize different mobile communication networks
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 the advantages and disadvantages of different transmission media. Experimentally verifies the parameters of the presented modulation schemes. Identifies the shortcomings of previous-generation communication networks and argues their resolution in latest-generation networks.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Selects suitable bibliographic sources and analyzes them. Respects the principles of academic ethics by correctly citing the bibliographic sources used. Demonstrates collaboration with other colleagues and teaching staff in carrying out instructional 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 use of a video projector (covering the communication and demonstration functions); the oral communication methods used are the expository method and the problematization method, used frontally. The course materials are: course notes and presentations, collections of proposed problems (theoretical and solved by computer or at the board). All materials are available in electronic format via the course site (Moodle)

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction to communication systems. Role and structure of a communications system. Evolution and perspectives of communication systems.	2
2	Transmission of analog signals. Techniques used for analog transmission: sinusoidal carrier modulation (linear modulation, exponential modulation).	2
3	Transmission of digital signals. Techniques used for digital transmission of signals: analog-to-digital conversion, specific digital modulation techniques (BPSK, QPSK, MPSK, BFSK, MFSK, BASK, MQAM). Advantages of digital transmission of signals.	4
4	Multiple access techniques. Multiple access techniques with fixed allocation, random-access-based techniques, controlled access techniques, and hybrid access techniques. Orthogonal frequency-division access and non-orthogonal access technologies in the power domain, non-orthogonal access technologies in the code domain, and non-orthogonal access technologies with multiplexing across different domains. 2G, 3G, 4G, 5G	8

5	Transmission media. Twisted pairs (overview, technical characteristics, applications, advantages, disadvantages). Coaxial cable (overview, technical characteristics, applications, advantages, disadvantages). Optical fibers (overview, technical characteristics, applications, advantages, disadvantages). Propagation of electromagnetic waves (radio waves, antennas, propagation, link budget).	4
6	Communication networks.	2
7	Machine-to-Machine (M2M) / Internet of Things (IoT) communications	2
	Total:	28

Bibliography:

1. Razvan Trifan, Sisteme de comunicații, https://archive.curs.upb.ro/2024/course/view.php?id=8687
2. 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)
3. S. Halunga. "Sisteme de comunicaţie cu acces multiplu" –Editura PRINTECH, Bucureşti, 2005, (286 pag.), ISBN 973-718-218-9
4. O. Fratu si S. Halunga, “UMTS – o nouă generaţie în comunicaţiile mobile digitale (Aspecte generale. Interfaţa radio)”, Editura Electronica 2000, Bucureşti, 2003
5. E. Dahlman, S. Parkvall, si J. Sköld, „4G, LTE-Advanced Pro and The Road to 5G”, Editura Elsevier, Academic Press, 2016, ISBN 978-0-12-804575-6
6. J. Campos, „Understanding the 5G NR Physical Layer”, Keysight Technologies, 2017
7. H Holma, A. Toskala, si T. Nakamura, „5G Technology, 3GPP New Radio”, Editura Wiley, 2020, ISBN 9781119236313
8. A. Brand si H. Aghvami, Multiple Access Protocols For Mobile Communications. Wiley, 2002. doi: 10.1002/0470846224.
9. Y. S. Cho, J. Kim, W. Y. Yang, si C. G. Kang, MIMO-OFDM wireless communications with MATLAB. Wiley-IEEE Press, 2010.
10. M. Y. Rhee, Mobile Communication Systems and Security. Wiley-IEEE Press, 2010.
11. A. Benjebbour, K. Saito, A. Li, Y. Kishiyama, si T. Nakamura, “Non-Orthogonal Multiple Access (NOMA): Concept and Design,” in Signal Processing for 5G, Chichester, UK: John Wiley & Sons, Ltd, 2016, pp. 143–168. doi: 10.1002/9781119116493.ch7

LABORATORY

Crt. no.	Content	No. hours
1	Simulation and analysis of ML-type analog communication systems	2
2	Simulation and analysis of MF-type analog communication systems	2
3	Sampling, compression, quantization, digital coding. PCM, APCM, ΔM	2
4	Line codes: NRZ, RZ, Manchester	2
5	Simulation and analysis of digital communication systems BPSK, BFSK, M-QAM	2
6	Simulation and analysis of the parameters of a wireless LAN communication network	2
7	Colloquium	2
	Total:	14

Bibliography:

1. Razvan Trifan, Sisteme de comunicații,https://archive.curs.upb.ro/2024/course/view.php?id=8687
2. 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
3. I. Constantin, S. Halunga, I. Marcu, „Transmisiuni analogice şi digitale – culegere de probleme", editura Electronica 2000, 2010

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 concepts	Test held on the date set at the beginning of the semester.	40
	differential analysis of communication techniques and systems	Test held in the pre-exam session	20
11.5 Seminary/laboratory/project	assessment of the student's verification by simulation and by direct measurement on the circuit of the problems proposed and analyzed within each laboratory work	assessment during each laboratory work. Final practical test.	40
11.6 Passing conditions			
Obtaining 50% of the total score. Obtaining 50% of the score related to the laboratory activity, according to UPB regulations.			

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 have become a mature market with a very high growth rate. Producers of specific equipment and operators have a significant demand for qualified engineers with specializations related to communications systems and networks, with a solid foundation in electronics and telecommunications so that they can keep pace with the development of new hardware products and software applications.

The course syllabus responds concretely to these current development and evolution needs, aligned with the European service economy in the field of Microelectronics, Optoelectronics and Nanotechnologies (MON).

Thus, it isensured that graduates have competencies appropriate to the current qualification needs and a modern, high-quality, and competitive scientific and technical training that will allow them rapid employment after graduation, the course being perfectly integrated into the policy of the University Politehnica of Bucharest, both in terms of content and structure, as well as in terms of the skills and international openness offered to students.

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Date	Course lecturer	Instructor(s) for practical activities
	S.l./Lect. Dr. Razvan Florentin Trifan	S.l./Lect. Dr. Razvan Florentin Trifan
Date of department approval	Head of department	
	Prof. Dr. Claudius Dan	
Date of approval in the Faculty Council	Dean	
	Prof. Mihnea UDREA	