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

2. Date despre disciplină

2.1 Course name (ro) (en)				Comunicaţii de date			
2.2 Course Lecturer				Prof. Dr. Calin Vladeanu			
2.3 Instructor for practical activities				Prof. Dr. Calin Vladeanu			
2.4 Year of studies	4	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.S.07.O.301		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	3.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	42	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.					60
Tutoring					0
Examinations					9
Other activities (if any):					0

3.7 Total hours of individual study	69.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion and/or promotion of the following disciplines: • Signals and Systems • Information Transmission Theory • Decision and Estimation in Information Processing • Digital Signal Processing • Analog and Digital Communications
4.2 Results of learning	• Data transmissions (DT) and data communications (DC): definitions of concepts, systems and performance meters. • Baseband data transmissions: signal encodings, asynchronous and synchronous data transmissions. Nyquist criterion for no ISI, Raised-Cosine filters, scrambler-descrambler, block scheme of baseband DT modem, Shannon's analytical expression of channel's capacity for DT. • Performance analysis of DT systems: Eye pattern, Bit Error Rate (BER), Symbol Error Rate (SER). • Passband data transmissions: modulation techniques for DT (time domain expressions, spectra, constellations, performance meters), Frequency Modulation (Frequency Shift Keying - FSK), Phase Modulation (Phase Shift Keying - PSK), Amplitude Modulation and Quadrature Amplitude Modulation (QAM), Trellis-Coded Modulation, Staggered- or Offset-PSK modulation, Continuous Phase PSK modulation, Orthogonal Frequency Division Multiplexing (OFDM) • Data Link Control for DC: DL definitions and protocols, Channel Error Coding (Forward Error Control - FEC: block codes, convolutional codes and Automatic Repeat reQuest - ARQ: Stop and Wait, Go Back N, Selective Repeat methods), flow control, bit and character synchronization for protocols, bit-oriented and character-oriented DL protocols, High-level Data Link Control (HDLC) protocol. • Local Area Networks (LANs): transmission media, topologies, signal types, Medium-Acces Control (MAC) strategies, LAN addressing, LLC services and protocols, Ethernet MAC (Carrier Sense Multiple Access / Collision Detection - CSMA/CD) and physical IEEE 802.3 standards, LAN interconnection devices, wireless LAN (WiFi - IEEE 802.11) - WiFi network components, WiFi network architecture, MAC CSMA/CA protocol.

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

5.1 Course	• Completion and/or promotion of the following disciplines: Signals and Systems; Information Transmission Theory; Analog and Digital Communications. • The course will take place in a room equipped with blackboard or whiteboard, and video projector • Under UNSTPB undergraduate regulations.
5.2 Seminary/ Laboratory/Project	Under UNSTPB undergraduate 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 in the field of Electronic Engineering, Telecommunications and Information Technologies, Telecommunications Networks and Software specialization and aims to familiarize the students with the main theoretical and practical developments concerning data communications concepts, physical layer signal processing techniques, and systems and data link layer functions and protocols.

The subject covers the following basic notions, which are necessary for understanding the functioning of modern data communication systems: digital signal analysis and processing, digital coding and modulation techniques, distortion effect reduction methods for digital transmissions and the performance analysis of data communication systems. Finally, some advanced signal processing techniques and data link error correction methods for the last generation data communication systems are 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	The students prove they own basic knowledge in the field of data communication systems and equipment. It correlates the specific knowledge of the field of data communications with those of other disciplines belonging to the area of electronic engineering, telecommunications and information technologies. Apply in practice the knowledge specific to the field of data communications. Apply standardized methods and tools, specific to the field, for carrying out the evaluation and diagnosis process of a situation, depending on the identified/reported problems, and identify solutions. Argue and analyze 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 Romanian: uses the scientific vocabulary (in Romanian and English) specific to the field, in order to communicate effectively, in writing and orally.
Transversal (General) Competences	Work in a team and communicate effectively, coordinating his efforts with others to solve problematic 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 systematic analysis process. Respect the principles of academic ethics: in the documentation activity correctly cite the bibliographic sources used. Put into practice elements of emotional intelligence in the adequate socio-emotional management of real-life/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.* Lists the most important stages that marked the development of the field: Nyquist's theory of optimal sampling and filtering, Shannon's channel capacity theorem, Ungerboeck's method for Trellis-Coded Modulation, optimum decoding for convolutional encoded sequences using the Viterbi's algorithm. Defines domain-specific notions: BB and PB data transmissions, Nyquist criterion for no ISI, Raised-Cosine filters, scrambler-descrambler, performance analysis of DT systems (Eye pattern, BER, SER), modulation techniques for DT (FSK, PSK, QAM, TCM, OQPSK, MSK, OFDM), DL functions and protocols (block codes, CC, FEC, ARQ (SW, GBN, SR), flow control, bit and character synchronization for protocols, bit-oriented and character-oriented DL protocols, HDLC protocol), LANs (PHY, MAC (CSMA/CD, CSMA/CA), LLC), WiFi network and protocols. Describes/classifies notions/processes/phenomena/structures. It 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).* Selects and groups relevant information in a given context. Works productively in the team. Elaborates a scientific text in the field of DC. Experimentally verifies identified solutions. Solves practical application of DC systems and networks. Interprets appropriately the causal relationships between a DC network's components. Identifies solutions and develops resolution/project plans. Formulates conclusions to the theoretical analysis carried out for DC techniques and protocols. Argues identified solutions/workarounds.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Selects appropriate bibliographic sources and analyzes them. Respects 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 unsolved problem situation. 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. He/she 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). Applies principles of professional ethics/deontology in the analysis of the technological impact of the solutions proposed in the specialized field on the environment. Analyzes and capitalizes on business/entrepreneurial development opportunities in the field of specialty. Demonstrates real-life situation management skills (time management, collaboration vs. conflict).

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 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 exploration and indirect way of reality (demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.
In the teaching activity, lectures will be used, with Power Point presentations or different videos that will be made available to the students. Each course will begin with the recapitulation 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 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.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Data Communications - Introduction: data, Data Transmissions (DT) and Data Communications (DC), the OSI reference model.	4
2	Baseband (BB) data transmissions: synchronous and asynchronous transmissions, BB signals, inter-symbol interference (Nyquist criterion), DT system performance analysis, scrambling;	8
3	Data transmissions by modulating a carrier: MF/FSK, MΦ/PSK, MAQ, trellis-coded modulation, OQPSK, MSK, OFDM	10
4	Data protection against channel errors: error causes, FEC, ARQ	8
5	Data transport on the data link: DL, DTE-DCE interface, sequence numbers, flow control, data station states, HDLC	6
6	Local area networks: media access control (MAC), LAN addresses, LLC, CSMA/CD, WLAN	6
	Total:	42

Bibliography:

C. Vlădeanu - Lecture notes (https://curs.upb.ro/2025/course/view.php?id=1200)
I. Bănică, Data Communications, in Romanian, Editura Politehnica Press, Bucharest, Romania, 2008.
B. Sklar and F. Harris, Digital communications: Fundamentals and Applications – Third edition, Pearson, 2021.
J. G. Proakis, Digital Communications – Fourth edition, McGraw-Hill, New York, 2001.
S. Lin and D. J. Costello, Error Control Coding – Second edition, Pearson Education Int., Prentice Hall, 2004.

SEMINARY		
Crt. no.	**Content**	**No. hours**
1	Signal Processing for Data Transmissions: periodical and random signals, filters, bandwidth analysis, data rate and signaling rate	2
2	Asynchronous and synchronous data transmissions. Signal coding for baseband transmissions.	2
3	Inter-symbol interference. Nyquist signal design for no ISI. Raised-Cosine filters. Eye-pattern.	2
4	Modulation techniques for passband DT: FM/FSK, PM/PSK, AM/QAM. Scrambling.	2
5	Polynomial codes - CRC, Trellis-Coded Modulation.	2
6	Data Link error control ARQ strategies: SW, GBN, SR.	2
7	Medium Access Control for LANs: Ethernet (CSMA/CD) and WiFi (CSMA/CA).	2
	Total:	14

Bibliography:

1. C. Vladeanu - Lecture notes (https://curs.upb.ro/2025/course/view.php?id=1200)
2. I. Bănică, Comunicaţii de date, Editura Politehnica Press, Bucharest, Romania, 2008.
3. B. Sklar and F. Harris, Digital communications: Fundamentals and Applications – Third edition, Pearson, 2021.
4. J. G. Proakis, Digital Communications – Fourth edition, McGraw-Hill, New York, 2001.

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 concepts;	Session: written exam - essay-type description	30%
	- knowing how to apply theory to specific problems;	Session: written exam - exercises	20%
11.5 Seminary/laboratory/project	- student activity during the seminary activities	During semester - oral presentation	10%
	- homework	During semester - essay-type description	10%
	- verification tests	During semester - 3 written tests - exercises	30%
11.6 Passing conditions			
Mandatory attendance at seminar sessions. Obtaining 50% from the total grade.			

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)

Current telecommunications systems use physical layer signal processing methods combined with data link coding/decoding methods for error control in order to maximize the data rate in the sense of Shannon's theorem.

Through specific learning activities, students develop skills to solve various engineering problems and propose solutions to improve the performance of data communication systems.

The course has a similar content to other courses within bachelor programs organized at the "Gheorghe Asachi" Technical University from Iaşi, the Technical University of Cluj-Napoca, "Ferdinand I" Military Technical Academy from Bucharest, and other universities in the European space.

The course curriculum responds to the current requirements of organization and development, subscribed to the European and global evolution in the field of information and communication technology (ICT).Through seminary and course activities, engineering management skills are developed, considering theoretical and practical situations that students can face in real life, in order to increase their contribution to the improvement of the socio-economic environment.

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Calin Vladeanu	Prof. Dr. Calin Vladeanu
		

Date of department approval	Head of department

Date of approval in the Faculty Council	Dean