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	Technologies and Telecommunications Systems

2. Date despre disciplină

2.1 Course name (ro) (en)				Comunicaţii de date			
2.2 Course Lecturer				Prof. Dr. Simona HALUNGA			
2.3 Instructor for practical activities				Conf. Dr. Carmen FLOREA, Prof. dr. Răzvan CRĂCIUNESCU			
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.201		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	Parcurgerea și/sau promovarea următoarelor discipline: Signals and Systems Circuit Analysis and Synthesis Analogue and Digital Communications
4.2 Results of learning	• Optimal reception of signals in the base band; adapted filter. • Average power spectral density • Baseband transmissions; Nyquist's criteria for ensuring null IIS • Partial response systems • Standard modulation techniques; modulators and demodulators; signal constellations and error probability.

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; Analysis and synthesis of circuits. • The course will take place in a room equipped with video projector and computer.
5.2 Seminary/ Laboratory/Project	Not applicable

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 field of Telecommunications / TST specialization and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in solving practical applications and problems, with relevance for stimulating the learning process in students.
The discipline addresses advanced notions, concepts and specific principles as a specific topic, all of which contribute to the transmission/formation to/of students of an overview of the methodological and procedural milestones related to the field.
The aim is to familiarize students with the main aspects related to the optimal reception of signals in the baseband. Average power spectral density. Baseband transmissions; Nyquist's criteria for ensuring null IIS. Partial response systems. Standard modulation techniques; modulators and demodulators; signal constellations and error probability.
Specific techniques for analysis, characterization in the time / frequency domain are presented, as well as demodulation production techniques specific to each type of modulation. From the point of view of performance evaluation, the probability of error calculated on the basis of the signal constellation is determined for each type of modulation.

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 aim of this discipline is to familiarize students with the main fundamental aspects related to data communications. The main types of digitally modulated signals are presented and analyzed in terms of shape over time, occupied bandwidth, production / demodulation possibilities, and the probability of error is evaluated. The adapted filter as an optimal receiver for binary transmissions and its applications are presented. Specific methods for evaluating the power spectral density of baseband and bandpass modulated signals are presented. Techniques for designing baseband data transmissions and modulated signals to eliminate or reduce intersymbol interference are presented. Also presented are a number of aspects related to the synchronization of the carrier and the reception clock
Transversal (General) Competences	This discipline aims to familiarize students with the main aspects related to data communications. Specific techniques of analysis, characterization in the time / frequency domain are presented, as well as a number of demodulation production techniques. The main performance evaluation parameters and specific techniques for their improvement are also presented.

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.* Optimal reception of signals in the baseband with the adapted filter. Average power spectral density. Baseband transmissions; Nyquist's criteria for ensuring null IIS.Partial response systems.Standard modulation techniques; modulators and demodulators; signal constellations and error probability.
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 a signal from the point of view of behavior in time / frequency - analyzes reasonedly and determines the signal at the output of a modulator / demodulator type circuit; - analyze and compare different implementations from the point of view of the output signal - identify design solutions for a modulator/demodulator; - determine the signal-to-noise ratio of a certain type of modulation - calculates the numerical output of a sampling/quantization/encoding assembly - determines the output of a PLL circuit
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* - optimal reception conditions are determined. - the average power spectral density of baseband and modulated signals is determined - the principles of baseband transmissions are presented; Nyquist's criteria; the conditions for obtaining null IIS and systems with partial response. - Standard modulation techniques; modulators and demodulators; signal constellations and error probability.

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 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 of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.
In the teaching activity, lectures will be used, based on Power Point presentations or different videos / simulations 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 discovery learning.
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	Communication systems - generalities. Introduction elements, concepts, models. The model of a digital communication chain. Protocol hierarchies. The OSI model.	4
2	Detection of binary signals in white, additive and Gaussian noise. The optimal receiver. Optimization criteria. Adapted filter. Implementation with correlator. Applications of adaptive filters to binary detection	8
3	Densitatea spectrală de putere. Definiții: staționaritate, ciclostaționaritate, densitate spectrală medie de putere (DSmP). DSmP pentru semnalul MIA digital în banda de bază. Metoda Bennet pentru semnale binare în banda de bază. DSmP a semnalelor modulate trece bandă	8
4	Baseband transmissions. Introduction. Definitions. The linear model for baseband transmission. Minimum-band and non-minimum-band Nyquist I criterion. Compensation filter in the base band. Distribution of filtering between transmitter and receiver in the baseband with IIS=0. Partial response systems: Duobinary coding. Modified duobinary encoding. Systems with partial response. Generalization. Combating the propagation of errors. Precoding.	9
5	Digital modulation techniques. Modulators and demodulators. Binary signals with phase modulation (BPSK). Differential PSK (DPSK) and Differential Coded PSK (DEPSK) signals. Signals with quadrature modulation (OQPSK/QPSK). Signals with phase modulation on M levels (M-PSK). Signals with quadrature amplitude modulation (Q-ASK); rectangular constellations. Binary signals with frequency modulation (B-FSK). Signals with frequency modulation on M levels (M-FSK). MSK signals. OFDM signals	9

6	Multiple access techniques generalities: FDMA, TDMA, CDMA, OFDMA	4
	Total:	42

Bibliography:

S Halunga - Note de curs (https://curs.upb.ro/2021/course/view.php?id=9106)
ZIEMER, Rodger E.; TRANTER, William H. Principles of communications. John Wiley & Sons, 2014.
GITLIN, Richard D.; HAYES, Jeremiah F.; WEINSTEIN, Stephen B. Data communications principles. Springer Science & Business Media, 2012.
GHASEMI, Abdollah; ABEDI, Ali; GHASEMI, Farshid. Propagation engineering in wireless communications. Berlin: Springer, 2012.

SEMINARY

Crt. no.	Content	No. hours
1	Matched filter. Examples. Correlator implementation.	2
2	Mean Power Spectral Density of the baseband signals	2
3	Mean Power Spectral Density of the modulated signals	2
4	Baseband transmissions. Nyquist's Criterion I. Optimizing the transceiver feature.	2
5	Partial response systems. Precoding	2
6	BPSK, DPSK, DEPSK, QASK modulation	2
7	QAM, BFSK, MFSK, MSK modulation	2
	Total:	14

Bibliography:

S Halunga - Note de curs (https://curs.upb.ro/2021/course/view.php?id=9106)
ZIEMER, Rodger E.; TRANTER, William H. Principles of communications. John Wiley & Sons, 2014.
GITLIN, Richard D.; HAYES, Jeremiah F.; WEINSTEIN, Stephen B. Data communications principles. Springer Science & Business Media, 2012.
GHASEMI, Abdollah; ABEDI, Ali; GHASEMI, Farshid. Propagation engineering in wireless communications. Berlin: Springer, 2012.
Probleme rezolvate – disponibile pe Moodle
Set de probleme propuse – disponibil pe Moodle

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;	questions	10%
	- knowing how to apply theory to specific problems;	problems	40%
11.5 Seminary/laboratory/project	- appreciation in the individual, independent solution of the proposed problems, within a control work and a homework;	problems	30%
	- verification paper	problems	20%

11.6 Passing conditions
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)

• Through the activities carried out, students develop skills to offer solutions to problems and to propose ideas to improve the situation of existence in the telecommunications field.
• In the development of the content of the discipline, the knowledge described by the specialized literature and in the own materials presented on the Moodle platform were taken into account
• The course has similar content to the courses held by the Military Technical Academy in Bucharest, the Gheorghe Asachi University in Iasi, the Technical University in Cluj

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Simona HALUNGA	Conf. Dr. Carmen FLOREA, Prof. dr. Răzvan CRĂCIUNESCU

Date of department approval	Head of department

Date of approval in the Faculty Council	Dean