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	Technologies and Telecommunications Systems

2. Date despre disciplină

2.1 Course name (ro) (en)				Comunicaţii analogice şi digitale Analog and Digital Communications			
2.2 Course Lecturer				Prof. Dr. Dragos-Nicolae VIZIREANU, Prof. Dr. Simona HALUNGA			
2.3 Instructor for practical activities				Prof. Dr. Simona HALUNGA			
2.4 Year of studies	3	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.S.06.O.211		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.					45
Tutoring					0
Examinations					5
Other activities (if any):					6

3.7 Total hours of individual study	19.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Parcurgerea și/sau promovarea următoarelor discipline: · Signals and Systems · Circuit Analysis and Synthesis Fundamental Electronic Circuits
4.2 Results of learning	• Modulated signals and their characteristics • Generation of different types of modullated signals • Demodulation (extracting the information carrier signal from the modulated signal) • Performance in terms of signal to noise ratio • Sampling. Quantization. Numerical coding. • PLL circuits

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	- 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.

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 analog modulation techniques (production, demodulation, signal-to-noise ratio) and the transformation of the analog signal into a digital signal.

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 signal-to-noise ratio 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 aspects related to analog modulation techniques (production, demodulation, signal-to-noise ratio) and the transformation of the analog signal into a digital signal. 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 signal-to-noise ratio is determined for each type of modulation. The operating principles of PLL circuits are presented
Transversal (General) Competences	The main fundamental aspects related to analog modulation techniques are presented. The main types of amplitude, phase and frequency modulated signals are presented and analyzed in terms of shape over time, occupied bandwidth, production/demodulation techniques and signal to noise ratio. The steps to be taken to transform an analog signal into a digital one, using a finite number of bits, as well as digital signal transmission techniques are presented. The operating principles of PLL circuits are 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.* - to present the types of analog modulated signals - the main modulation / demodulation techniques are presented - their performance in terms of signal/noise ratio is presented - the techniques for sampling / quantization / numerical coding of the signal are presented - the characteristics of PLL circuits are presented
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.* The student - demonstrates autonomy in the design and analysis of implementation schemes - shows collaboration with other colleagues and teaching staff in solving specific problems - promotes new solutions and ideas for implementing specific circuits within transmitter/receiver assemblies

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 start with a recap 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	Analogue Communication systems – generalities. Definitions, main concepts, brief history. Communication chain, signals, signal-to-noise ratio. Classification.	2
2	Linear modulated signals. General expression for linear modulated (LM) signals. Amplitude Modulation (AM). Double Sideband Modulation (DSB). Single Sideband Modulation (SSB). Vestiginal Sideband Modulation (VSB)	4
3	Generation of LM Signals. Implementation of the product operator. Generation of AM and DSB signals. USB signals generation.	4
4	Demodulation of LM signals. Sinchronous demodulation using and adder and a product operator. Phase and frequency error effects on AM, DSB and SSB signals demodulation. LM demodulators using product operator and low-pass filter. Mean value rectifiers. Peak detectors.	4
5	Signal-to-Noise Ratio (SNR) at LM signals. SNR determination for AM signals. SNR determination for DSB signals. SNR determination for SSB signals. Performance comparison.	4
6	Exponential modulated signals. Frequency modulated (FM) signals. Phase modulated (PM) signals.	2

7	FM signals generation. Integro-differential equation of generation for FM signals and implementation. Quasi-sationarity conditions. Implementation of FM modulators in quasi-sationarity conditions. The square wave FM generator. The Armstrong method.	4
8	FM signals demodulation. Principles of FM demodulators. Direct demodulation. Clarke-Hess demodulator. Demodulation using circuits that approximates the derivation in frequency domain. Demodulation using circuits that approximates the derivation using delay circuits.	4
9	Signal-to-Noise Ratio (SNR) at FM signals. SNR for FM signals. Caption phenomenon. Emphasizing and deemphasizing of FM signals.	4
10	Transforming analogue signals into digital ones. Analogue signal sampling in the baseband. Analogue pass-band signals sampling. Quantizing sampled signals. Uniform / non-uniform	4
11	Transmission of digital signals in the baseband. Modulation of pulses in code (MIC). Pulse amplitude modulation (MIA). Modulation of pulses in position (MIP). Differential digital modulation (DNUM). Delta modulation. Adaptive Delta Modulation. Line codes.	4
12	PLL circuits	2
	Total:	42

Bibliography:

S Halunga - Note de curs (https://curs.upb.ro/2021/course/view.php?id=9106)

I. Constantin, S. Halunga, I. Marcu, „Transmisiuni analogice şi digitale – culegere de probleme”, editura Electronica 2000, 2010

3) V. Croitoru (coordonator), „Comunicaţii digitale. Teorie şi experiment”, Ediţia a II –a, Ed. Printech, Bucureşti, 2003.

S Haykin, M Moerer, An introduction to digital and analogue communications, 2nd Edition, Wiley 2017 (available on Moodle)

S. Kundu, Analog and Digital Communications, Pearsons, 2010

SEMINARY

Crt. no.	Content	No. hours
1	LM signals	2
2	LM signal generation. Product operators implementation. SSB signals generation	2
3	LM signals demodulation. Specific implementations for DSB, SSB.	2
4	Demodulators for AM signals. Rectifiers. Peak demodulators.	2
5	FM signals generation	2
6	FM signals demodulation	2
7	Sampling, quantizing and coding. Line codes	2
	Total:	14

Bibliography:

S Halunga - Probleme rezolvate (https://curs.upb.ro/2021/course/view.php?id=9106)
I. Constantin, S. Halunga, I. Marcu, „Transmisiuni analogice şi digitale – culegere de probleme", editura Electronica 2000, 2010
V. Croitoru (coordonator), „Comunicaţii digitale. Teorie şi experiment", Ediţia a II –a, Ed. Printech, Bucureşti, 2003.
S Haykin, M Moerer, An introduction to digital and analogue communications, 2nd Edition, Wiley 2017 (available on Moodle)
S. Kundu, Analog and Digital Communications, Pearsons, 2010

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

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Dragos-Nicolae VIZIREANU, Prof. Dr. Simona HALUNGA	Prof. Dr. Simona HALUNGA

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

Date of department approval	Head of department
Date of approval in the Faculty Council	Dean