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)				Semnale și sisteme 2 Signals and Systems 2			
2.2 Course Lecturer				S.l./Lect. Dr. Victor Popa			
2.3 Instructor for practical activities				S.l./Lect. Dr. Victor Popa			
2.4 Year of studies	2	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.04.O.015		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	2.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	28
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.					57
Tutoring					6
Examinations					6
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	Mathematical Analysis, Special Mathematics, Fundamentals of Electrical Engineering, Physics, Signals and Systems 1

4.2 Results of learning	Accumulation of the following knowledge: Basic concepts related to: the theory of electric and electronic circuits Comprehensive and in-depth knowledge of the basic notions related to the theory of signals and systems (Fourier series, Convolution and correlation for periodic and non-periodic signals, Distributions (generalized functions), Fourier transform, Systems (analog)

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

5.1 Course	Amphitheater with multimedia equipment (video projector, graphics tablet + accessories, computer) Course participation is mandatory (according to the regulation for undergraduate studies in UPB)
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a room with specific equipment, which must include: signal generators, multimeters, oscilloscopes, spectrum analyzers, power supplies, computers, Matlab Seminar and laboratory classes participation is madatory (according to the regulation for undergraduate studies in UPB)

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)*

The course presents analysis methods in the time domain and in the frequency domain of analog and discrete linear and time-invariant systems. The Laplace transform is studied, which will allow further analysis of analog systems, and the Z transform, which will introduce the student to the study of discrete systems.
During the seminar and laboratory activities, applications directly related to the concepts taught in the course are presented. Problems related to discrete signals and systems, the Laplace transform, and the analysis of analog systems using the operational transfer function are presented and solved.
The discipline provides powerful design analysis and synthesis tools for analog and digital electrical systems and aims to equip the student with the ability to master them at an adequate level and to use them efficiently.

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	Competences acquired after properly passing the Circuit Analysis and Synthesis discipline aim at the partial fulfillment of the C1, C2 and C4 competencies from the list of competencies specific to the TST study program (Technologies and Telecommunications Systems), as follows: C1. The ability to analyze discrete signals in time and in the transformed domain C2. Application, in typical situations, of the basic methods of acquisition and processing of discrete signals C3. Understanding and using fundamental concepts related to discrete systems In addition, the skills acquired in this discipline are as follows: Demonstrate the possession and ability to use basic knowledge in the field of Electronics, Telecommunications and Information Technologies Demonstrate the ability to correlate previously acquired knowledge with that accumulated in the field of signal and systems theory Demonstrate the ability to apply basic knowledge and tools in signals and systems theory Demonstrate the ability to correlate and apply in practice the knowledge assimilated at the course Demonstrate the ability to apply standardized methods and tools, specific to the field of signal processing, to carry out the process of evaluating a real situation, and identify solutions to some specific problems Demonstrate the ability to reason and analyze coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline, the tools made available by it, as well as the specific methodology presented both in the course and in the applications (seminar and laboratory). Demonstrate oral and written communication skills in English: demonstrating understanding of ETTI domain-specific scientific vocabulary in the context of circuit analysis and synthesis as well as the ability to communicate effectively orally and in writing
Transversal (General) Competences	• Methodically analyze the problems encountered in the activity, proving the ability to identify the elements for which there are established solutions, thus ensuring the fulfillment of professional tasks; • Demonstrate autonomy and critical thinking by demonstrating the ability to think in scientific terms, search and analyze data independently, identify solutions, and draw and present conclusions; • Demonstrate minimal teamwork skills to solve problems of medium complexity; • Demonstrate the capacity for analysis and synthesis: having the ability to present synthetically the knowledge acquired as a result of a systematic analysis process; • Respect the principles of academic ethics in all his conduct; • Practices elements of emotional intelligence in appropriate social-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.* Analyzing analog and discrete systems in time: it is capable of determining the response of a linear and time-invariant system, whether analog or discrete. It is able to analyze, design, test feasibility and implement a discrete system either starting from the input and output signals or starting from its analog equivalent.
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).* • Select and group relevant information in a given context; • Use specific principles with reason; • Teamwork; • Elaborate a scientific text in the field of signals; • Experimentally verifies identified solutions, solve practical applications, formulate conclusions to the realized experiments; • Argue the identified solutions/ways of solving.
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; • Demonstrate responsiveness to new learning contexts; • Demonstrate collaboration with other colleagues and teaching staff in carrying out teaching activities; • Apply principles of professional ethics/deontology in the analysis of the technological impact of the solutions proposed in the specialized field on the environment.

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-centered learning models facilitated by direct and indirect exploration 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 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 favorable for learning through discovery.
The presentations take into account 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	The unilateral Laplace transform. Original signals. Region of convergence. Theorems and properties. The Laplace transform for distributions. The link between the Laplace and Fourier transforms	4
2	Analog systems. The operational transfer function. The BIBO stability condition. The nondistortion condition. Clasification of transfer functions. Cascading analog systems	2
3	Discrete signals. The sampling theorem. The discrete convolution and correlation	4
4	The Z Transform: Motivation, Definitions, Domain of convergence. Examples. Properties and theorems (linearity, delay theorem, time domain reflection theorem, conjugation theorem, convolution algebraization theorem, correlation algebraization theorem, Parseval's Lemma). Z image inversion (Laurent series expansion method, recognition method, inversion integral method). One-sided Z-transform. Discrete-Time Fourier Transform (DTFT): Problem Formulation. Definitions. Properties. The relation theorem between the DTFT image and the spectrum of the original analog signal. Discrete Fourier Transform (DFT) Definitions. Inversion theorem for signal recovery from DFT image). Properties and theorems (linearity, delay theorem, reflection theorem in time domain, circular convolution algebraization theorem in time domain and the transformed domain, Parseval's equality), Using DFT as an estimator for the Fourier image of analog signals (Problem formulation, Theorem, Meaning and physical interpretation)	6
5	Discrete systems: Introduction (Definitions, Classes of problems, Fundamental properties, Elementary blocks for discrete systems, Characterization of discrete systems (characteristic operator, impulse response/weight function (2D and 1D), Transfer functions (in the Z domain and in the frequency domain), Expression of the BIBO stability condition, Expression of the minimum phase condition – reversible systems, Cascaded discrete systems, Discrete simulation of an analog system (problem formulation, definitions, validity conditions expressed in terms of transfer function and impulse response)	6
6	Two-port networks.	3
	Total:	28

Bibliography:

- Cristian Negrescu, Dumitru Stanomir “Semnale şi sisteme – Probleme”, Editura AGIR, 2020, Bucureşti.
- Teodor Petrescu „Semnale și sisteme”, Editura Politehnica Press, 2019
- Dumitru Stanomir „Semnale și sisteme analogice”, Editura Politehnica Press, 2005
- Adelaida Mateescu, Niculae Dumitriu, Lucian Stanciu „Semnale și sisteme. Aplicații în filtrarea semnalelor”, Editura Teora, 2001
- Ioan Constantin „Semnale și răspunsul circuitelor”, București, Editura Bren, 1999
- Teodor Petrescu, Octavian Fratu, Carmen Voicu, Simona Halunga, Ioana Marcu, Răzvan Crăciunescu „Analiza și sinteza circuitelor”, Editura Politehnica Press, 2016

LABORATORY

Crt. no.	Content	No. hours
1	The Laplace transform in Matlab	2
2	Discrete signals in Matlab	2
3	Sistem response to signals on a breadboard	4
4	Two-port networks on breadboards	4
5	Final laboratory colloquium	2
	Total:	14

SEMINARY

Crt. no.	Content	No. hours
1	The Laplace transform. Analog systems	3
2	The convolution and correlation for discrete signals	2
3	The Z transform	3
4	Analysis and synthesis of discrete systems	3
5	Determining the response of analog systems	3
	Total:	14

Bibliography:

- Cristian Negrescu, Dumitru Stanomir “Semnale şi sisteme – Probleme”, Editura AGIR, 2020, Bucureşti.
- Teodor Petrescu „Semnale și sisteme”, Editura Politehnica Press, 2019
- Dumitru Stanomir „Semnale și sisteme analogice”, Editura Politehnica Press, 2005
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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 concepts of the theory of signals and systems	Final exam (oral) held in the exam session	17
	Evaluation of the independent and individual solving of the proposed problems	Final exam (oral) held in the exam session	33
11.5 Seminary/laboratory/project	Evaluation for understanding some fundamental notions and concepts of spectral analysis of signals	The final laboratory colloquium comprising a practical component and a theoretical component	10
	Knowing how to compare experimental and theoretical results	The theoretical component is evaluated when checking the experimental results by calculation	10
	Evaluation of independent and individual solving of the proposed problems	Seminar test	20
11.6 Passing conditions			
50% of the total points			

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)

The course presents the theory of analog and discrete systems from the perspective of signal processing. In the first part of the course the theory is presented and in the second part of the course the theory is exemplified through their implementation. The course has a content similar to that of the subjects taught at universities/specialized schools, both in Europe and in the United States of America.

Date	Course lecturer	Instructor(s) for practical activities
	S.l./Lect. Dr. Victor Popa	S.l./Lect. Dr. Victor Popa

Date of department approval	Head of department
	Conf. dr. ing. Șerban Obreja

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

Date of approval in the Faculty Council

Dean

Prof. dr. ing. Radu Mihnea Udrea