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)				Semnale şi sisteme 1 Signals and Systems 1			
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	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.03.O.001		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	5	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	3
3.4 Total hours in the curricula	70.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	42
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.					68
Tutoring					6
Examinations					6
Other activities (if any):					0

3.7 Total hours of individual study	80.00
3.8 Total hours per semester	150
3.9 Number of ECTS credit points	6

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Mathematical Analysis, Special Mathematics, Fundamentals of Electrical Engineering, Physics

4.2 Results of learning	Accumulation of the following knowledge: • Basic notions related to integral and differential calculus, complex functions, integral transformations; • Fundamental notions of linear algebra; • Basic notions of mechanics, electricity, electromagnetic field, thermodynamics; • Basic knowledge of electrical circuits.

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 UNSTPB)
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 UNSTPB)

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 aims to familiarize the students with the basic notions of signal theory, as well as with the associated systems and general concepts. The signals and systems are analyzed in continuous time in detail. The aim is to create the skillset to apply the fundamental notions related to signal and system concepts, as well as signal processing methods in order to achieve specific functionalities in electronics. The discipline provides powerful signal analysis and processing tools and aims to equip the student with the ability to master them at an adequate level and to use them effectively.

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 Signals and Systems 1 discipline aim at the partial fulfillment of the C1, C2 and C3 competencies from the list of competencies specific to the study program, as follows: C1. The ability to understand signal analysis in the time and frequency domain for different classes of signals C2. The ability to use signal processing techniques in the time and frequency domain C3. The capacity to associate and use analog sistems 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.* Understand, define, describe, use domain-specific notions: the spectrum of a signal, transformed domain analysis (Fourier) for periodic and non-periodic signals, specific convolution and correlation operations, the concept, properties, classification, characterization and utility of systems
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	Introduction. Course objective. Classifications. Elementary signals. Periodic signals – Fourier series: Trigonometric Fourier series. Convergence conditions. Theorems and properties. Examples. Synthesis of periodic signals. Compact Harmonic Fourier Series). Bandwidth. Complex Fourier series. Correlation of periodic signals. Parseval's equality. Power and RMS for periodic signals. Harmonic distortions. Periodic convolution.	8
2	Convolution and correlation of non-periodic signals: Offset and reflection operators. Convolution of non-periodic signals (definitions, conditions of existence, properties, analytical and graphical calculation methods). Correlation of non-periodic signals (definitions, conditions of existence, properties, analytical and graphical calculation methods)	2
3	Distributions (generalized functions): Motivation. Functions vs. distributions. Stages of the study of distributions. Definitions and notations (Space of test functions. Definition of distributions. Concept of introduction of distributions. What do good functions mean? Definition of regular distributions). Properties of distributions (Cancellation of one distribution on an interval. Equality of two distributions. Change of affine variable. Derivation of distributions. Weak convergence in D. Series of representative functions for a distribution). Dirac distribution. (Definition. Properties and theorems. Representative series for the Dirac distribution and its derivative. Riemann-Lebesgue theorem. Remarkable representative series). Distributional derivative of a discontinuous function. Periodic Dirac distribution. The method of successive derivatives and integrations. Temperate distributions. Convolution and the Dirac distribution	8
4	Fourier transform in signal and systems study: Motivation. Fourier transform for signals of class L1 (Definitions. Convergence. Physical interpretation. Inversion theorem. Theorems and properties.) Fourier transform for signals of class L2 (Definitions. Theorems and properties). Fourier transform for class S signals (Definitions. Theorems and additional properties). Fourier transform for signals represented as tempered distributions. Fourier transform for periodic signals.	6
5	Analog systems: Definitions. Classes of problems related to systems. Fundamental properties of systems (Linearity, Realism, Time invariance, Causality, BIBO stability. Characterization of time-invariant and stationary analog linear systems (ATILS): Characterization by characteristic operator. Impulse response (weight function). Characterization by circuit functions (transfer functions) in the frequency and operational domains. Expression of BIBO stability conditions. Classification of circuit functions. The nondistortion condition. Cascading analog systems	4
	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

LABORATORY

Crt. no.	Content	No. hours
1	Spectral analysis of analog periodic signals	4
2	Introduction in Matlab	2
3	Fourier trasform analysis in Matlab	2
4	The convolution of signals with Matlab	4
5	Final laboratory colloquium	2
	Total:	14

SEMINARY

Crt. no.	Content	No. hours
1	General properties of signals. Periodic analog signals. The Fourier Series	8
2	Convolution and correlation of non-periodic signals	4
3	Distributions	6
4	Analog systems – Fundamental properties	2
5	The Fourier Transform	6
6	Analog systems – Weight function and transfer functions	2
	Total:	28

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- Cristian Negrescu, Dumitru Stanomir “Semnale şi sisteme – Probleme”, Editura AGIR, 2020, Bucureşti.
- Teodor Petrescu „Semnale și sisteme”, Editura Politehnica Press, 2019
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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
	Knowing how to apply signal analysis and processing methods in order to solve specific 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	Evaluation of exercises solved as homework	10
	Evaluation of the 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)

Innovation and development are possible through a solid understanding of the underlying principles. The theory of signals and systems is one of the fundamentals, which will be the basis of research and development for years to come.
It is not simple to learn or teach Signals and Systems, because of the combination of mathematical abstraction and concrete engineering applications. Rigorous knowledge and advanced knowledge of mathematics as well as maturity in engineering thinking are required. A Signals and Systems course needs to be designed both to increase students' interest in applications and to make them appreciate the mathematical apparatus. The course has a similar content to that of equivalent subjects taught at universities/faculties of the same profile both in Europe and in the United States.

Date	Course lecturer	Instructor(s) for practical activities
	S.l./Lect. Dr. Victor Popa	As. drd. ing. Horia Sebastian Ioniță

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Date of department approval	Head of department Conf. dr. ing. Șerban Obreja
Date of approval in the Faculty Council	Dean Prof. dr. ing. Mihnea Udrea