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	Masters
1.6 Programme of studies	Advanced Wireless Communications

2. Date despre disciplină

2.1 Course name (ro) (en)				Tehnici avansate în prelucrarea digitală a semnalelor Advanced Digital Signal Processing Techniques			
2.2 Course Lecturer				Prof. Constantin PALEOLOGU			
2.3 Instructor for practical activities				Conf. Dr. Cristina Oprea			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M1.O.21-03		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	2	Out of which: 3.2 course	1.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	28.00	Out of which: 3.5 course	14	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.					32
Tutoring					5
Examinations					3
Other activities (if any):					0

3.7 Total hours of individual study	47.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Special Mathematics, Signals and Systems, Circuit Analysis and Synthesis, Project – Signals and Programming

4.2 Results of learning	Common knowledge regarding mathematics, signals and programming.

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

5.1 Course	The course takes place in a hall owning a white/black board, video-projector and a computer.
5.2 Seminary/ Laboratory/Project	The seminar/laboratory/project activities are held in an suitable space having computers, video-projector and adequate furniture.

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 main purpose of the ADSPT subject is to develop the student abilities to apply the general knowledge on signal processing and to develop specific projects using a given object-oriented language. We will focus on random processes, adaptive systems, spectral estimation algorithms and their applications. Laboratory (in Matlab) targets the development of advanced digital processing techniques, starting from the specifications list and going to the execution, debugging and results interpretation.

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 content of the discipline provides the necessary knowledge to be able to understand principles of advanced signal processing (random processes, adaptive systems, spectral estimation), which are the basis of the operation of various classes of applications within integrated telecommunications networks. Also, students will be able to analyze and design such systems, understanding in this way the importance of the technology, but also the economic aspects, related to the cost and complexity of implementations.
Transversal (General) Competences	Honorable, responsible, ethical behavior in the spirit of the law to ensure the reputation of the profession.

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 main methods of advanced digital signal processing; Defines domain-specific basic notions; Describes the most important modern techniques of signal processing by means of adaptive systems; Develops the ability to expand and use the knowledge bag acquired in the course for applications that involve digital signal extraction and processing; Identifies the main problems related to the digital processing of signals in the context of adaptive systems and spectral estimation. Acquire the basic technical skills needed to find practical solutions to problems in the field of adaptive signal processing.
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. It uses principles specific to adaptive systems in a reasoned way. Work productively in a team. Elaborate a scientific text. Experimentally verifies identified solutions in the Matlab environment. Solve practical applications in the Matlab environment. Interpret causal relationships appropriately. Analyze and compare the methods and techniques that can be used to solve a given practical problem. Identifies solutions and develops resolution plans. Formulate conclusions to the experiments carried out. Argue the identified solutions and ways of solving them.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Select and analyze suitable references Respect principles of ethic in academia by citing the sources used. Prove beeing receptive to new learning contexts. Colaborate with coleagues in teaching activities. Selfcontained and autonomous in organizing the learning process Social responsible and actively involved in student activities Understand the value of its own work in identifying solutions

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 (experiment, demonstration, modelling), but also on action-based methods, such as the deprogramming exercise in Matlab, practical applications and problem solving.

In the teaching activity, lectures will be used, based on PowerPoint presentations or different materials 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 communication relationships in a climate conducive to learning through discovery.

The practice of active listening and assertive communication skills, as well as feedback construction mechanisms, will be taken into account as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Cap.1. Random process in discrete time 1.1. Basic notions. 1.2. General properties. 1.3. System response for random signals 1.4. Spectral factorization. Wold's theory. 1.5. Random processes modelling.	2
2	Cap.2. Adaptive systems 2.1. Basic notions. 2.2. Optimal filtering theory 2.3. Adaptive filters based on mean square error minization. LMS algorithms. 2.4. Adaptive filters based on least squares optimizations. RLS algorithms. 2.5. System identification applications and interference cancellation applications.	7
3	Cap.3. Random signals modelling and spectral analysis 3.1. ARMA models 3.2. Classical methods in spectral estimation 3.3. Sinus based models. Subspaces separation based methods – MUSIC, ESPRIT. 3.4. Sensors nets application.	5
	Total:	14

Bibliography:
1. Mateescu A., Ciochină S., Dumitriu N., Şerbănescu A., Stanciu L., Prelucrarea numerică a semnalelor,Ed. Tehnică, 1997.
2. Ciochină S., Negrescu C., Sisteme adaptive, Ed. Tehnică, 1999.
3. Paleologu C., Ciochină S., Enescu A.A., Algoritmi adaptivi de tip RLS, Ed. Printech, 2007.
4. L. Weifeng Liu, J. Principe and S. Haykin, Kernel Adaptive Filtering: A Comprehensive Introduction ,John Wiley, 2010, ISBN 0-470-44753-2
5. D. Comminiello; J. C. Príncipe (2018). Adaptive Learning Methods for Nonlinear System Modeling .Elsevier Inc. ISBN 978-0-12-812976-0.
6. “Adaptive Filter Theory (5th Edition)”, Author: Simon Haykin, Publisher: Pearson, 2014.
7. "Digital Signal Processing - Fundamentals and Applications" (Third Edition), Authors: Lizhe Tan and Jean Jiang, Publisher: Academic Press, 2019.

LABORATORY

Crt. no.	Content	No. hours
1	Lab.1. Random processes	2
2	Lab.2. Optimal Wiener filtering	2
3	Lab.3. LMS algorithms	2
4	Lab.4. RLS algorithms	2
5	Lab.5. Adaptive algorithms applications	2
6	Lab.6. Spectral estimation techniques	2
7	Lab.7. Spectral estimation techniques applications	2
	Total:	14

Bibliography:
1. Mateescu A., Ciochină S., Dumitriu N., Şerbănescu A., Stanciu L., Prelucrarea numerică a semnalelor,Ed. Tehnică, 1997.
2. Ciochină S., Negrescu C., Sisteme adaptive, Ed. Tehnică, 1999.
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7. "Digital Signal Processing - Fundamentals and Applications" (Third Edition), Authors: Lizhe Tan and Jean Jiang, Publisher: Academic Press, 2019.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Criteria 1	Exam	20%
11.5 Seminary/laboratory/project	Laboratory criteria	Reports presented at the end of the laboratory works	80%
11.6 Passing conditions			
- minimum 50% of the laboratory score; - minimum 50% of the total score.			

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 subject meets national and international requirements in the domain of electronics and its economic-financial impact, being correlated with similar subjects in and outside Romania;

- In the present development context the domain electronics offers a wide range of activity, potential employers belonging to the industry, to education and research and development with NGOs and national, international and multinational enterprises from the field of electronics;

- The students aquire competencies that meet the present requirements and allow them a rapid insertion on the labour market after graduation, as well as the chance to continue to study various master and doctoral programms, this program being well integrated in the policies and strategies of the University POLITEHNICA Bucharest regarding its content and its structure, as well as the skills and the international perspective offered to the students.

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Constantin PALEOLOGU	Conf. Dr. Cristina Oprea

Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja

Date of approval in the Faculty Council	Dean
25.10.2024	Prof. Dr. Mihnea Udrea