Universitatea Națională de Știință și Tehnologie Politehnica București

Facultatea de Electronică, Telecomunicații și

Tehnologia Informației

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	**Applied Electronics and Information Engineering**
1.4 Domain of studies	Computers and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Information Engineering

2. Date despre disciplină

2.1 Course name (ro) (en)				Prelucrarea digitală a semnalelor			
2.2 Course Lecturer				Prof. Dr. Georgeta-Mihaela NEAGU			
2.3 Instructor for practical activities				Prof. Dr. Georgeta-Mihaela NEAGU			
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.010		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.					15
Tutoring					0
Examinations					4
Other activities (if any):					0

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	Attending and/or graduating the following courses: • Mathematical Analysis • Linear Algebra, Analitic and Differential Geometry • Computer Programming and Programming Languages 1 and 2 • Special Mathematics • Object Oriented Programming • Signals and Systems 1 and 2 • Algorithms and Data Structures
4.2 Results of learning	Acquiring the following knowledge: • mathematics • programming • algorithms

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

5.1 Course	• The lectures will be presented using the videoprojector and the computer.
5.2 Seminary/ Laboratory/Project	• The lab will be run using the videoprojector and the computers having installed on Matlab, with Simulink and ”Signal processing” Toolbox. • The labs are mandatory, as stipulated by the „Regulamentul studiilor universitare de licenţă” (available only in Romanian) and „Regulamentul privind activitatea profesională a studenţilor” (Romanian version only).

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 provides the basic knowledge in digital signal processing and develops the ability to manipulate in real signal processing applications, especially in the domains of telecommunications and information technology.

The common digital signal processing principles are discussed, considering the theoretical background, the available algorithms, the ubiquitous architectures and well known applications.

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	• Demonstrates the **common/advanced knowledge** in Digital Signal Processing • Understands the acquired knowledge • Applies the knowledge • Demonstrate the ability to operate with basics of digital signal processing to succesfully evaluate/diagnose a specific digital signal processing problem, identifying proper solutions. • Provides solid arguments and properly estimate the digital signal processing sulutions, correctly applying the domain specific knwledge. • Communicates fluently, verbally and in written, in Romanian, using the vocabulary specific to the course domain. • Communicates fluently, verbally and in written, in English, using the vocabulary specific to the course domain.
Transversal (General) Competences	• Throughly investigates a digital signal processing problem, looking for available solutions, to offer the best solving strategy. • Work within teams and efficiently communicate with the colleagues to solve problems of a medium complexity. • Critical and independent evaluation: the students have the scientific ability to look for the necessary information and to present valuable conclusions/solutions. • The ability to analyse and synthesize: the students have the ability to present efficiently the acquired knowledge, applying the systematisation. • Respect the academic ethics: proper citation. • Apply emotional intelligence principles to emotionally and socially solve some situations regarding the real life/academic/professional tasks, showing self control and objectivity when deciding and under stress.

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.* **List** the most important information regarding the domain development. **Defines** domain specific concepts. **Describes/classify** domain specific concepts/processes/fenomena/structures. **Reveals domain specific consequences and relations.**

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. • **Apply logically argued the domain specific principles.** • **Efficiently work within teams.** • **Generate scientific documents.** • **Experimentally verify the identified solutions.** • **Solve** practical applications. • **Correctly identify the causal relations**. • **Analise and compare available domain solutions.** • **Identify solutions** and **propose** solving plans/projects. • **Formulate conclusions regarding the realized experiments.** • **Give arguments** when identifying solving solutions/steps.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* · **Select** and analyze the appropriate literature. · **Respect the academic ethics,** correctly citing the used literature. · **Are open** to learn new concepts. · **Collaborate** with the colleagues and the academic staff during the didactical activities. · **Show authonomy** when organizing some applications, learning activities or when solving specific problems **Show social responsability** by getting involved in the academic social life. **Promote and contribute to the domain, offering new solutions,** to improve the quality of the social life. **Realistically identify the contribution of the engineering domain** to the social and economic life by offering reliable and sustenable solutions. · **Apply professional ethics/deonthology when evaluating the technological impact of the domain specific proposed solutions,** considering the environmental impact. · **Analise and take business opportunities** specific to the domain. · **Demonstrate management skills** in real life situations (time administration, conflict elimination).

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.)*

- The teaching will include both knowledge presentation and interactive discussions, considering the learning preferences of the students and their learning needs; the direct and inderect exploration will be considered (experiments, demonstrations, modelling), and also active learning will be involved (exercises, problems solving, practical activities)
- Power point presentations and specialized videos will be considered. Each course will summarize the information from the previous lectures, stressing especiallly the knowledge from the last course.
- The lectures will contain images, plot and diagrams that facilitate information acquiring.
- The course provides knowledge and practical activities that support students development by establishing optimal communication and collaboration steps and by discovery.
- The active information listening and assertive communication skills will be considered, and the feedback will be implemented to include the needs of the students.

- Team working activities will be also implemented.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	C1. Signals. Definition. Common types of discrete-time signals. The typical continuous- time signal processing application based on a digital signal system. Signal properties. Discrete-time signals: properties, operators, particular sequences.	1
2	C2. The Z Transform The Z transformata - definition, properties, Z transform of common sequences. Inverse Z transform – computation methods. Solving difference equation using the Z transform. Discrete Hilbert Transform.	2
3	C3. Discrete-time Fourier Transform (DTFT). Discrete Fourier Transform (DFT) Fourier Transform for discrete-time signals (definition, properties). Discrete Fourier Transform (definition, properties). Fast Fourier Transform (FFT).	2
4	C4. Discrete-time systems (representation in the time, frequency and Z domains) Discrete-time liniar systems, time invariant systems, and linear time-invariant systems (LTI systems). Discrete-time systems: causality, stability, impulse response, defference equation, frequency response, graph representation, state variable description of digital filters	4
5	C5. Continuous-time signal sampling. Nyquist (sampling) theorem Periodic sampling and its frequency representation. Sampling (Nyquist, Shannon, Nyquist-Shannon theorem). Continuous-time signal recovery from samples.	3
6	C6. Digital filters. Finite Impulse Response (FIR) filters Linear phase FIR filters. FIR design methods: design of FIR filters using windows, frequency sampling method, optimal FIR filter design.	7
7	C7. Infinite impulse response (IIR) filters IIR design methods: methods that start from analog design (Impulse Invariance, Bilinear Transform, Matched Z-transform), direct Z domain design (zeros-poles IIR design method), frequency transformations (in the analogue/digital domains), optimal design methods.	7
8	C8. Scaling and round-off noise in LTI discrete-time systems	2
	Total:	28

Bibliography:

11. M. Neagu – Prelucrarea Digitală a Semnalelor – Note de curs. M. Neagu – Prelucrarea digitală a semnalelor – Power Point Presentations.
22. Ungureanu Georgeta Mihaela (2013): Analiza şi prelucrarea semnalelor: aplicaţii în ingineria biomedicală (Digital Signal Processing and Analysis: biomedical engineering applications), MATRIX ROM, ISBN 978-973-755-946-3 (253 pages)
33. Georgeta-Mihaela Ungureanu - Prelucrarea digitala a semnalelor. Probleme si aplicatii Matlab (Digital Signal Processing. Problems and Matlab Applications), Ed. Matrix ROM, 2016, ISBN: 978-606-25-0247-8 (124 pages).
44. G. M. Ungureanu, Prelucrarea digitala a semnalelor, MATRIX ROM, 2008
55. Fausto Pedro Garciia Maarquez and Noor Zaman. (2013). Digital Filters and Signal Processing. Publisher: IN-TECH (January 16, 2013) ()https://www.intechopen.com/books/3198)

LABORATORY

Crt. no.	Content	No. hours
1	Matlab programming. Discrete-time signals.	4
2	Discrete Fourier Transform. Properties. Discrete-time systems.	4
3	Finite Impulse Response Filters	6
4	Infinite Impulse Response Filters	6
5	Multirate digital systems	4
6	Lab examination, homeworks presentation/evaluation	4
	Total:	28

Bibliography:

11. M. Neagu – Prelucrarea Digitală a Semnalelor – Note de curs. M. Neagu – Prelucrarea digitală a semnalelor – Power Point Presentations.
22. Ungureanu Georgeta Mihaela (2013): Analiza şi prelucrarea semnalelor: aplicaţii în ingineria biomedicală (Digital Signal Processing and Analysis: biomedical engineering applications), MATRIX ROM, ISBN 978-973-755-946-3 (253 pages)
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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	Proving the undestanding of the fundamental knowledge of the first half of the course. Differential analysis of the theoretical methods/techniques. Proving the ability to apply the theory when solving specific problems.	Written evaluation (2 hours) on a date established by the faculty (during week 8 or 9)	25%
	Proving the undestanding of the fundamental knowledge of the second half of the course. Differential analysis of the theoretical methods/techniques. Proving the ability to apply the theory when solving specific problems.	Written final exam (2 hours) during the examination session.	25%
11.5 Seminary/laboratory/project	Proving the ability to design a digital signal processing algorithm to solve a domain specific problem. Proving the ability to implement a digital signal processing algorithm in Matlab.	Written evaluation during the last lab. (2 hours)	25%
	Proving the ability to succesfully apply the digital signal processing algorithms.	written/project (2 hours)	25%
11.6 Passing conditions			
Graduation rules valid for the students enrolled at ETTI/UPB. Obtaining 50% of the evaluation mark. The final grade can be evaluated only if the student attend the final exam, otherwise the student is declared Absent, its final grade being not validated.			

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 planned activities allow students to develop the ability to find and improve the available solutions in the digital signal processing domain.
- The considered lectures cover the domain specific knowledge/ aspects/ applications available in the current literature/ the personal publications/presentations.
- The allocated labs allow students to handle real time applications, having then a socioeconomic development contribution.
- The curriculum addresses the current development plan, connected with the European strategies in Computer and Information Technology.
- The Digital Signal Processing course is highly useful in critical domains (e.g., speech processing, audio/image/video compression, image processing, biomedical signal processing, voice recognition, seismology, etc).
- The acquired knowledge/skills are in line with the current professional requirements in electronics, telecommunications and information technology, allowing the students to rapidly enter the (international) labor market after the graduation.

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Date	Course lecturer	Instructor(s) for practical activities
09.09.2022	Prof. Dr. Georgeta-Mihaela NEAGU	Prof. Dr. Ionut Pirnog

Date of department approval

Head of department

Conf. Dr. Bogdan Cristian FLOREA

Date of approval in the Faculty Council

Dean

Prof. Dr. Mihnea Udrea