SYLLABUS

1. Data about the program of study

1.1 Institution	Technical university of Cluj-Napoca
1.2 Faculty	Faculty of Electronics, Telecommunications and information Technology
1.3 Department	Bases of Electronics
1.4 Field of study	Electronic Engineering, Telecommunications and Information Technologies
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Telecommunications Technologies and Systems / Engineer
1.7 Form of education	Full time
1.8 Subject code	45.00

2. Data about the subject

2.1 Subject name	Digital Signal Processing						
2.2 Subject area	Signal processing						
2.3 course responsible	Assoc.Prof. Lăcrimioara GRAMA, PhD eng						
2.4 Teachers in charge with laboratory	Assoc.Prof. Lăcrimioara GRAMA, PhD eng						
2.5 Year of study	IV	2.6 Semester	1	2.7 Assessment	Exam	2.8 Subject category	DID/DOB

3. Estimated total time

3.1 Number of hours per week	4	Of which: 3.2 course	2	3.3 laboratory	2
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 laboratory	28

Distribution of time	hours
Manual, lecture material and notes, bibliography	24
Supplementary study in the library, online and in the field	6
Preparation for laboratory works, homework, reports, portfolios, essays	12
Tutoring	3
Exams and tests	3
Other activities:	0

3.7 Total hours of individual study	48
3.8 Total hours per semester	104
3.9 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 curriculum	N/A
4.2 competence	Knowledge of mathematics (Mathematical Analysis, Linear Algebra, Special Mathematics, Differential Equations, Discrete Mathematics), signal theory (Signals Theory, Analysis and Synthesis of Circuits), electronic devices, digital integrated circuits; use of MATLab development environment (Fundamentals of Computer Aided Graphics)

5. Requirements (where appropriate)

5.1. for the course	Amphitheatre, Cluj-Napoca
5.2. for the laboratory	Laboratory with computers, Cluj-Napoca

6. Specific competences

Professional competences	Theoretical knowledge. The students will know: • Techniques for the analysis of periodic and aperiodic sequences and discrete-time systems • Appropriate software for the analysis of discrete-time signals and systems, for the design of digital filters, and the advantages and limitations posed by them • Assessment and interpretation methods of the data obtained from analysis of discrete-time signals and systems Acquired skills. After completing the discipline, the students will be able to: • Implement different structures of digital filters based on the design data • Design, evaluate and optimize the structures of digital filters based on the application • Analyze data obtained by analyzing signals using DFT • Interpret specific phenomena in signal analysis using Fast Fourier Transform Acquired abilities. After completing the discipline, the students will be able to: • Use programs for signal analysis and for design of FIR and IIR digital filters • Evaluate the quantities which characterize the performance of digital filters based on the family of DSP circuits in which they are implemented In accordance with Grila1 and Grila2 RNCIS C2. To apply basic methods for signal acquisition and processing C3. To apply knowledge, concepts and basic methods regarding computing systems' architecture, microprocessors, microcontrollers, programming languages and techniques
Cross competences	CT1. To methodically analyze engineering problems, by identifying the basic elements for which well - established solutions already exist, ensuring the fulfillment of the professional assignments

7. Discipline objectives (as results from the key competences gained)

7.1 General objective	At the end of the semester, students should be able to: • Apply methods of analysis and synthesis of discrete-time signals and systems • Design digital filters (FIR and IIR) for different applications
7.2 Specific objectives	At the end of the semester, students should be able to: • Use techniques for analyzing periodic and aperiodic sequences and discrete systems • Use the appropriate software for sequences analysis and to design digital filters • Illustrate the advantages and limitations posed by the designed filters • Interpret the data obtained from analysis of discrete signals and systems • Effectively use information sources and computer aided communication and training resources (internet, signal processing software, scientific databases in the field of digital signal processing) both in Romanian and in English • Evaluate the quantities which characterize the performance of the digital filters based on the family of DSP circuits in which they are implemented

8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
1. Course overview. Introduction to digital signal processing	Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, demonstration, questioning	Use of blackboard and video projector
2. Discrete-time signals and systems		
3. Analysis of discrete-time linear time invariant systems (LTIS)		
4. Direct-Form implementation of discrete-time systems.LTIS characterized by difference equations		
5. The z-transform		
6. z-Domain analysis of LTIS. Fourier Series for Discrete-Time Periodic Signals		
7. Fourier Transform for Discrete-Time Aperiodic Signals and Frequency Domain Characteristics of LTIS		
8. Discrete Fourier Transform		
9. Fast Fourier Transform		
10. Implementation of Discrete-Time Systems		
11. Lattice and Lattice-Ladder Structures for IIR Systems. LTIS as Frequency Selective Filters		
12. Linear-Phase FIR Filters. Design of Digital FIR Filters		
13. Design of Digital IIR Filters		
14. Digital Signal Processing Summary. Exam Example		

Bibliography

[1]. C. Rusu, L. Grama, Lecture notes in digital signal processing, Ed. Risoprint, 2009.
[2]. C. Rusu, Prelucrarea numerică a semnalelor, Ed. Risoprint, 2002.
[3]. C. Rusu, Prelucrări digitale de semnale, Ed. Risoprint, 2000.
[4]. L. Grama, C. Rusu, Prelucrarea numerică a semnalelor – aplicaţii şi probleme, Ed. UTPRESS, 2008.
[5]. L. Grama, A. Grama, C. Rusu, Filtre numerice – aplicaţii şi probleme, Ed. UTPRESS, 2008.
[6]. J. G. Proakis, D. G. Manolakis, Digital signal processing – principles, algorithms and applications, Pearson, 2013.
[7]. S. Mitra, Digital signal processing – a computer-based approach, McGraw Hill, 2006.
[8]. Discipline web page (lecture description, laboratory examples and exercises, solved problems, proposed problems)– http://sp.utcluj.ro/Teaching_IVTST.html

8.2 Seminar / laboratory / project	Teaching methods	Notes
1. Introduction to MATLab	Conversation, explanation, case study, practical demonstration, debate, surveying, questioning, teamwork	Use of PCs, specific software and laboratory guide for teaching, blackboard
2. Discrete-time signals		
3. Sampling of analog signals		
4. Discrete-time linear time-invariant systems		
5. Fourier transform and Discrete Fourier transform		
6. Linear and circular convolution		
7. Practical evaluation from laboratories 1 - 6 (laboratory test): 30 minutes for each student		
8. Finite impulse response filters. Design method		
9. Discrete-time linear time-invariant systems as frequency selective filters		
10. Infinite impulse response filters. Indirect design methods		
11. Infinite impulse response filters. Direct design methods		
12. Practical evaluation from laboratories 8 - 11 (laboratory test): 30 minutes for each student. Responses to questions		
13. Seminar		

14. Seminar		

Bibliography

[1]. L. Grama, Digital signal processing – laboratory guide, Ed. UTPRESS, 2014.
[2]. Discipline web page (lecture description, laboratory examples and exercises, solved problems, proposed problems) – http://sp.utcluj.ro/Teaching_IVTST.html

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The discipline content and the acquired skills are in agreement with the expectations of the professional organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job (in the field of signal analysis, and digital system design, simulation and testing), and the expectations of the national organization for quality assurance (ARACIS).

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	The level of acquired theoretical knowledge and practical skills	**B** – Continuous formative evaluation (classes attendance and responses to questions during lecture class) **WE**– Summative evaluation written exam (problems solving)	-B, max. 2 pct. -WE, max. 10 pct., 60%
10.5 Seminar /Laboratory	The level of acquired knowledge and abilities	**PE** – 2 formative evaluation tests (practical lab exam – exercises must be implemented in MATLab)	-PE1, max 10 pct., 20% -PE2, max 10 pct., 20%
10.6 Minimum standard of performance			
$WE \geq 4$ și $0,6WE + 0,2PE1 + 0,2PE2 \geq 4.5$ Final grade = $0,6(WE+ B) + 0,2PE1 + 0,2PE2$			

Date of filling in:	**Responsible**	**Title surname NAME**	**Signature**
29.09.2019	Course	Assoc.Prof. Lăcrimioara GRAMA, PhD eng	
	Applications	Assoc.Prof. Lăcrimioara GRAMA, PhD eng	

Date of approval in the Department of Bases of Electronics
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Head of Department
Prof. Sorin HINTEA, Phd eng.

Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology
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Dean
Prof. Gabriel OLTEAN, PhD eng.