

## 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 Technology and Systems / Engineer
1.7 Form of education	Full time
1.8 Subject code	TST-E45.00

### 2. Data about the subject

2.1 Subject name	Digital Signal Processing						
2.2 Subject area	Theoretical area Methodical area Analytic area						
2.3 course responsible	Assoc. Prof. Lăcrimioara-Romana GRAMA, Ph.D. – <a href="mailto:Lacrimioara.Grama@bel.utcluj.ro">Lacrimioara.Grama@bel.utcluj.ro</a>						
2.4 Teachers in charge with laboratory	Assoc. Prof. Lăcrimioara-Romana GRAMA, Ph.D. – <a href="mailto:Lacrimioara.Grama@bel.utcluj.ro">Lacrimioara.Grama@bel.utcluj.ro</a>						
2.5 Year of study	IV	2.6 Semester	1	2.7 Assessment	Exam	2.8 Subject category	DD/DI

### 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 specialized platforms and in the field					6
Preparation for seminars / laboratories, homework, reports, portfolios and essays					12
Tutoring					3
Exams and tests					3
Other activities: NA					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	Mathematical Analysis, Linear Algebra, Applied Informatics, Special Mathematics, Differential Equations, Electronic Devices, Computer Aided Graphics, Signals and Systems, Digital Integrated Circuits, Circuits Analysis and Synthesis, Systems with Digital Integrated Circuits, Software Engineering
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4.2 competence	Knowledge of mathematics, signal theory, electronic devices, digital integrated circuits; use of MATLAB development environment
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### 5. Requirements (where appropriate)

5.1. for the course	Amphitheatre (with blackboard and video projector), Cluj-Napoca
5.2. for the seminars/ laboratories/ projects	Laboratory (with computers and blackboard), Cluj-Napoca

### 6. Specific competences

Professional competences	<p>C2 Applying the basic methods for signal acquisition and processing</p> <ul style="list-style-type: none"> <li>• C2.1 Temporal, spectral and statistical characterization of signals</li> <li>• C2.2 Explaining and interpreting the methods of acquisition and processing of signals</li> <li>• C2.3 Use of simulation environments for signal analysis and processing</li> <li>• C2.4 Use of the specific method and tools for signal analysis</li> </ul> <p>C3 Application of the basic knowledge, concepts and methods regarding the architecture of computing systems, microprocessors, microcontrollers, programming languages and techniques</p> <ul style="list-style-type: none"> <li>• C3.4 Development of programs for a general and / or specific programming language, starting from the specification of the requirements and until the execution, debugging and interpretation of the results in correlation with the processor used</li> <li>• C3.5 Projects involving hardware (processors) and software (programming) components</li> </ul>
Cross competences	

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

7.1 General objective	<p>Development of professional skills in the field of</p> <ul style="list-style-type: none"> <li>• signal and system analysis,</li> <li>• digital filter design</li> </ul>
7.2 Specific objectives	<ul style="list-style-type: none"> <li>• Assimilating theoretical knowledge regarding signal and system analysis, digital filter design using appropriate software tools (MATLAB)</li> <li>• Interpretation of specific phenomena from signal analysis using <ul style="list-style-type: none"> <li>○ Fourier transform,</li> <li>○ discrete Fourier transform,</li> <li>○ fast Fourier transform</li> </ul> </li> <li>• Obtaining the skills needed to implement and evaluate the performance of digital filters</li> </ul>

### 8. Contents

8.1 Lecture (syllabus)	Teaching methods	Notes
1. Course overview. Introduction to digital signal processing	Presentation, heuristic conversation, exemplification,	Use of blackboard and video projector
2. Discrete-time signals and systems		
3. Analysis of discrete-time linear time invariant systems		
4. Direct-form implementation of discrete-time systems. Linear time		

invariant systems characterized by difference equations	problem presentation, teaching exercise, case study, demonstration, questioning			
5. The z-transform				
6. z-domain analysis of LTI systems. 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, <i>Lecture notes in digital signal processing</i> , Ed. Risoprint, 2009.				
[2]. J. G. Proakis, D. G. Manolakis, <i>Digital signal processing – principles, algorithms and applications</i> , Pearson, 2013.				
[3]. C. Rusu, <i>Prelucrarea numerică a semnalelor</i> , Ed. Risoprint, 2002.				
[4]. C. Rusu, <i>Prelucrări digitale de semnale</i> , Ed. Risoprint, 2000.				
[5]. Discipline web page (lecture slides (password required), solved problems, proposed problems) – <a href="http://sp.utcluj.ro/Teaching_IVTST.html">http://sp.utcluj.ro/Teaching_IVTST.html</a>				
[6]. S. L. Marple Jr., <i>Digital Spectral Analysis</i> , Dover Publications, 2 <sup>nd</sup> ed, 2019.				
[7]. R. H. McClellan, R. Schafer, M. Yoder, <i>DSP First</i> , Pearson, 2 <sup>nd</sup> ed, 2015.				
[8]. R. Allred, <i>Digital Filters for Everyone</i> , Creative Arts & Sciences House, 3 <sup>rd</sup> ed, 2015.				
[9]. S. Smith, <i>Digital Signal Processing: A Practical Guide for Engineers and Scientists</i> , Newnes, 1 <sup>st</sup> ed, 2013.				
[10]. A. V. Oppenheim, <i>Discrete-Time Signal Processing</i> , Pearson, 3 <sup>rd</sup> ed, 2009.				
[11]. S. Mitra, <i>Digital signal processing – a computer-based approach</i> , McGraw Hill, 2006.				
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]. L. Grama, C. Rusu, *Prelucrarea numerică a semnalelor – aplicații și probleme*, Ed. UTPRESS, 2008.  
 [3]. L. Grama, A. Grama, C. Rusu, *Filtre numerice – aplicații și probleme*, Ed. UTPRESS, 2008.  
 [4]. Discipline web page (laboratory examples and exercises) – [http://sp.utcluj.ro/Teaching\\_IVTST.html](http://sp.utcluj.ro/Teaching_IVTST.html)  
 [5]. S. L. Marple Jr., *Digital Spectral Analysis MATLAB® Software User Guide*, Dover Publications, 2019.  
 [6]. L. Chaparro, *Signals and systems using MATLAB*, Academic Press, 2<sup>nd</sup> ed, 2014.  
 [7]. M. X. Cohen, *Fundamentals of time-Frequency analyses in Matlab/Octave*, sinc(x) Press, 1<sup>st</sup> ed, 2014.

### 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 of design, simulation and testing digital system), 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>B</b> – Continuous formative evaluation (classes attendance and responses to questions during lecture class) <b>WE</b> – 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	<b>PE</b> – 2 formative evaluation tests (practical lab exam – exercises must be implemented in MATLAB) <ul style="list-style-type: none"> <li>the grades obtained on these tests also consider the activity during the semester (problem solving and implementation; responses to questions)</li> </ul>	-PE1, max 10 pct., 20% -PE2, max 10 pct., 20%
10.6 Minimum standard of performance			
<p><b>Quality level:</b>            Minimum knowledge:</p> <ul style="list-style-type: none"> <li>Knowledge of the main type and properties of discrete-time signal and systems</li> <li>Knowledge of the main transforms used for digital signal processing</li> </ul> <p>Minimum competences:</p> <ul style="list-style-type: none"> <li>Apply methods of analysis and synthesis of discrete-time signals and systems</li> <li>Design digital filters for different applications</li> <li>Interpret the data obtained from analysis of discrete-time signals and systems</li> </ul> <p><b>Quantitative level:</b></p> <ul style="list-style-type: none"> <li><math>WE \geq 4</math> and <math>0,6WE + 0,2PE1 + 0,2PE2 \geq 4.5</math></li> <li>Final grade = <math>0,6(WE+ B) + 0,2PE1 + 0,2PE2</math></li> </ul>			

Date of filling in:	Responsible	Title surname NAME	Signature
20.06.2023	Course	Assoc. Prof. Lăcrimioara-Romana GRAMA, PhD	
	Applications	Assoc. Prof. Lăcrimioara-Romana GRAMA, PhD	

Date of approval in the Council of the Communications Department 11.07.2023	Head of Communications Department Prof. Virgil DOBROTA, Ph.D.
Date of approval in the Council of the Faculty of Electronics, Telecommunications and Information Technology 12.07.2023	Dean Prof. Ovidiu POP, Ph.D.