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	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, PhD eng – Lacrimioara.Grama@bel.utcluj.ro						
2.4 Teachers in charge with laboratory	Assoc.Prof. Lăcrimioara-Romana GRAMA, PhD eng – Lacrimioara.Grama@bel.utcluj.ro Eng. Carla-Mihaela BULZESCU – Carla.Bulzescu@bel.utcluj.ro						
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	100	Of which: 3.5 course	28	3.6 laboratory	28
Distribution of time					hours
Manual, lecture material and notes, bibliography					22
Supplementary study in the library, online specialized platforms and in the field					6
Preparation for seminars / laboratories, homework, reports, portfolios and essays					10
Tutoring					3
Exams and tests					3
Other activities: NA					0

3.7 Total hours of individual study	44
3.8 Total hours per semester	100
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
4.2 competence	Knowledge of mathematics, signal theory, electronic devices, digital integrated circuits; use of MATLab development environment

5. Requirements (where appropriate)

5.1. for the course	Amphitheatre (with blackboard/whiteboard and video projector), Cluj-Napoca – if onsite; PC/laptop + graphical tablet – if online
5.2. for the seminars/ laboratories/ projects	Laboratory (with computers and blackboard/whiteboard), Cluj-Napoca – if onsite; PC/laptop – if online

6. Specific competences

Professional competences	C2 Applying the basic methods for the acquisition and processing of signals • C2.1 Temporal, spectral and statistical characterization of signals • C2.2 Explaining and interpreting the methods of signal acquisition and processing • C2.3 Use of simulation media for signal analysis and processing • C2.4 Use of specific methods and tools for signal analysis C3 Application of basic knowledge, concepts and methods regarding the architecture of computer systems, microprocessors, microcontrollers, languages and programming techniques • C3.4 Elaboration of programs in a general and/ or specific programming language, starting from the specification of the requirements to the execution, debugging and interpretation of the results in correlation with the processor used
Cross competences	

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

7.1 General objective	Development of professional skills in the field of • Digital signal and system analysis and synthesis, • Digital filter design for different applications: FIR and IIR

7.2 Specific objectives	• Assimilating theoretical knowledge regarding digital signals and systems analysis, digital filters design using appropriate software tools (MATLab)
	• Interpretation of specific phenomena from signal analysis using
	  ○ Fourier transform,
	  ○ Discrete Fourier transform,
	  ○ Fast Fourier transform
	• Obtaining the skills needed to implement and evaluate the performance of digital filters (FIR & IIR)

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 (if onsite)/ Use of presentation + graphical tablet (if online)
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 different equations		
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 and its applications		
9. Fast Fourier transform and its applications		

10. LTIS as frequency selective filters. Linear-phase FIR filters		
11. Design of digital filters		
12. Direct Design Methods for IIR Systems. Implementation of Discrete-Time FIR Systems		
13. Implementation of discrete-time IIR systems		
14. Digital signal processing summary. Exam example		

Bibliography

[1]. Discipline web page (lecture slides (password required), solved problems, proposed problems) – https://sp.utcluj.ro/Teaching_4TTS.html
[2]. Microsoft Teams

Recommended highly, but not mandatory:

[3]. J. G. Proakis, D. G. Manolakis, *Digital signal processing – principles, algorithms and applications*, Pearson Education, 5th ed., 2022.
[4]. C. Rusu, L. Grama, *Lecture notes in digital signal processing*, Ed. Risoprint, 2009.

Other references:

[5]. C. Rusu, *Prelucrarea numerică a semnalelor*, Ed. Risoprint, 2002.
[6]. C. Rusu, *Prelucrări digitale de semnale*, Ed. Risoprint, 2000.
[7]. A. V. Oppenheim, R. W. Schafer, *Discrete-Time Signal Processing*, Pearson, 3rd ed, 2009.
[8]. T. Holton, *Digital Signal Processing: Principles and Applications,* Cambridge University Press, 2021.
[9]. R. G. Lyons, *Understanding Digital Signal Processing*, Prentice Hall, 2011.
[10]. S. L. Marple Jr., *Digital Spectral Analysis*, Dover Publications, 2nd ed, 2019.
[11]. R. H. McClellan, R. Schafer, M. Yoder, *DSP First*, Pearson, 2nd ed, 2015.
[12]. R. Allred, *Digital Filters for Everyone*, Creative Arts & Sciences House, 3rd ed, 2015.
[13]. S. Smith, *Digital Signal Processing: A Practical Guide for Engineers and Scientists*, Newnes, 1st ed, 2013.

8.2 Laboratory	Teaching methods	Notes
1. Short Introduction to MATLAB for Digital Signal Processing	Conversation, explanation, case study, practical demonstration, debate, surveying, questioning, teamwork	Use of PCs, specific software and laboratory guide for teaching, whiteboard (if onsite)/ graphical tablet (if online)
2. Most Used Discrete-Time Signals for Digital Signal Processing		
3. Sampling and Reconstruction of Analog Signals. Correlation of Discrete-Time Signals		
4. Discrete-Time Linear Time-Invariant Systems		
5. *z*-Transform. Analysis of Linear Time-Invariant Systems in *z*-Domain		
6. Evaluation from laboratories 1 - 5: laboratory test (MATLAB, ½ hour)		
7. Fourier Transform. Discrete Fourier Transform		
8. Linear Convolution. Circular Convolution		
9. Design of Finite Impulse Response Filters		
10. Discrete-Time Linear Time-Invariant Systems as Frequency Selective Filters		
11. Design of Infinite Impulse Response Filters		
12. Evaluation from laboratories 7 – 11: laboratory test (MATLAB; ½ hour)		
13. Seminar - Implementation of Discrete-Time Systems		
14. Seminar		

Bibliography

[1]. Discipline web page (laboratory theory, examples and exercises) – password required https://sp.utcluj.ro/Teaching_4TTS.html
[2]. Microsoft Teams

Other references:

[3]. L. Grama, *Digital signal processing – laboratory guide*, Ed. UTPRESS, 2014.
[4]. O. Alkin, *Discrete-Time Signals and Systems: A MATLAB Integrated Approach*, CRC Press, Inc., 2nd ed., 2025.
[5]. S. K. Mitra, *Digital signal processing – a computer-based approach*, McGraw-Hill, 4th ed., 2010.
[6]. L. Grama, C. Rusu, *Prelucrarea numerică a semnalelor – aplicaţii şi probleme*, Ed. UTPRESS, 2008.
[7]. L. Grama, A. Grama, C. Rusu, *Filtre numerice – aplicaţii şi probleme*, Ed. UTPRESS, 2008.

[8]. S. L. Marple Jr., *Digital Spectral Analysis MATLAB® Software User Guide*, Dover Publications, 2019.
[9]. L. Chaparro, *Signals and systems using MATLAB*, Academic Press, 2nd ed, 2014.
[10]. M. X. Cohen, *Fundamentals of time-Frequency analyses in Matlab/Octave*, sinc(x) Press, 1st 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	**WE** – Summative evaluation • written exam (problems solving) – if onsite • quiz (theory and problems) – if online • the grade obtained on WE also consider the activity during the semester: **B** – Continuous formative evaluation (classes attendance and responses to questions during lecture class; grades obtained for quizzes)	-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) • the grades obtained on the tests also consider the activity during the semester (problem solving and implementation; responses to questions)	-PE1, max 10 pct., 20% -PE2, max 10 pct., 20%
10.6 Minimum standard of performance			

Quality level:
Minimum knowledge:
- Knowledge of the main types and properties of discrete-time signal and systems
- Knowledge of the main transforms used for digital signal processing (i.e., ZT, FT, DFT, FFT)

Minimum competences:
- Apply methods of analysis and synthesis of discrete-time signals and systems
- Design digital filters for different applications (FIR & IIR)
- Interpret the data obtained from analysis of discrete- time signals and systems

Quantitative level:
- WE ≥ 4 and 0.6WE + 0.4PE ≥ 4.5
- Final grade = 0.6(WE + B) + 0.4PE

Date of filling in:	Responsible	Title First Name SURNAME	Signature
16.06.2025	Course	Assoc. Prof. Lăcrimioara-Romana GRAMA, PhD eng.	
	Applications	Assoc. Prof. Lăcrimioara-Romana GRAMA, PhD eng. Eng. Carla-Mihaela BULZESCU	

Date of approval in the Department of Communications 17.06.2025	Head of Department Prof. Virgil DOBROTA, PhD
Date of approval in the Council of Faculty of Electronics, Telecommunications and Information Technology 25.06.2025	Dean Prof. Ovidiu POP, PhD