SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications and Information Technology
1.3	Department	Bases of Electronics
1.4	Field of study	Electronics and Telecommunications Engineering
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	Signal Processing
2.3	Course responsible/lecturer	Assoc.Prof. Lăcrimioara GRAMA, PhD eng.
2.4	Teachers in charge of applications	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

Year / Sem.	Subject name	No. of weeks	Course [hours/week]	Applications S	Applications L	Applications P	Course [hours/sem.]	Applications S	Applications L	Applications P	Indiv. study	TOTAL	Credits
IV / 1	Digital Signal Processing	14	2		2		28		28		48	104	4

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

Individual study	Hours
Manual, lecture material and notes, bibliography	24
Supplementary study in the library, online and in the field	6
Preparation for seminars/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 applications	Laboratory, Cluj-Napoca

6. Specific competences

Professional competences	Theoretical knowledge (what the student must know):	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 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 (what the student is able to do):	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 Discrete Fourier Transform ✓ Interpret specific phenomena in signal analysis using Fast Fourier Transform
	Acquired abilities: (what type of equipment the student is able to handle)	After completing the discipline, the students will be able to: ✓ Use programs for signal analysis and for design of FIR or IIR digital filters ✓ Use specific software and hardware tools for properly design of FIR and IIR systems ✓ 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 (Grila1 and Grila2 RNCIS)		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 objectives	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 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 the analysis of discrete-time signals 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 discrete 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	Introduction to digital signal processing. Discrete-time signals and systems (Signals and systems: frequency, angular frequency, alias effect; Discrete-time signals: definition, classification, manipulation; Discrete-time systems: block diagram, classification, interconnection)	Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, demonstration, questioning	Use of blackboard
2	Analysis of discrete-time linear time invariant systems (Convolution sum and impulse response sequence; Causality; Stability; FIR and IIR systems; Direct-forms; Correlation)		
3	Frequency analysis of discrete-time signals and systems (Fourier series and transform)		
4	Frequency domain characteristics of of linear time invariant systems		
5	Discrete Fourier transform and its applications		
6	Fast Fourier transform and its applications		
7	The *z*-transform (definition, convergence, inversion, properties)		
8	Applications of the *z*-transform		
9	Analysis of linear time invariant systems in *z* domain (Transient and steady-state response; Causality and stability; Schur-Cohn stability test)		
10	Structures for implementing finite impulse response systems (direct-form, cascade-form, frequency-sampling structure, lattice structure)		
11	Structures for implementing infinite impulse response systems (direct-		

	forms, cascade-form, parallel-form, lattice and lattice-ladder structures)		
12	Design of filters in frequency domain. Design of finite impulse response filters (Linear-phase FIR filters: windowing method, frequency-sampling method; optimum equiripple FiR filters)		
13	Design of infinite impulse response filters (Design of IIR filters from analog filters: approximation of derivatives, impulse invariance and bilinear transformation methods; Frequency transformations; Pade approximation)		
14	Recapitulation. Preparation for the final exam		

8.2. Applications (lab)		Teaching methods	Notes
1	Introduction to MatLAB	Conversation, explanation, case study, practical demonstration, debate, surveying, questioning, team work	Use of PCs, specific softwares and laboratory quide for teching, 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	Finite impulse response filters. Design method		
8	Discrete-time linear time-invariant systems as frequency selective filters		
9	Infinite impulse response filters. Indirect design methods		
10	Infinite impulse response filters. Direct design methods		
11	Structures for the realization of finite impulse response systems		
12	Structures for the realization of infinite impulse response systems		
13	Practical evaluation (laboratory test): 30 minutes for each student		
14	Lab recovery and finalization of laboratory activity (100 minutes for each lab which must be recovered)		

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, *Digital signal processing – laboratory guide*, Ed. UTPRESS, 2014.
5. L. Grama, C. Rusu, *Prelucrarea numerică a semnalelor – aplicaţii şi probleme*, Ed. UTPRESS, 2008.
6. L. Grama, A. Grama, C. Rusu, *Filtre numerice – aplicaţii şi probleme*, Ed. UTPRESS, 2008.
7. L. Grama, *Prelucrarea numerică a semnalelor – îndrumător de laborator*, Ed. UTPRESS, 2014.
8. J. G. Proakis, D. G. Manolakis, *Digital signal processing – principles, algorithms and applications,* Prentice Hall International, 2006.
9. S. Mitra, *Digital signal processing – a computer based approach,* McGraw Hill, 2006.

On-line references

1. Discipline web page (lecture description, laboratory examples and exercises, solved problems, proposed problems, homework) – http://sp.utcluj.ro/Teaching_IIIEA.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. Evaluations

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
Course	The level of acquired theoretical knowledge and practical skills	H – continuous formative evaluation (homework) – max. 2 pts. B – continuous formative evaluation (responses to questions) – max. 2 pts. WE – Summative evaluation written exam (problems solving)	WE – max. 10 pts., 50%
Applications	The level of acquired knowledge and abilities	LE - Continuous formative evaluation (lab activity, etc.) PE - Practical lab exam (exercises must be implemented in MatLAB)	L= PE+LE - max. 10 pts., 50%
10.4 Minimum standard of performance			
L ≥ 5 and WE ≥ 4 and 0,5WE+0,5L+ H + B ≥ 4.5			

Date of filling in
19.01.2015

Course responsible
Assoc.Prof. Lăcrimioara Grama, PhD

Teachers in charge of applications
Assoc. Prof. Lăcrimioara Grama, PhD

Date of approval in the department
19.01.2015

Head of department
Prof. Sorin Hintea, PhD