COURSE SHEET

Mathematical Methods in Signal Processing

Academic year 2022-2023

1. About the program

1.1	University	University of Piteşti
1.2	Faculty	Sciences, Physical Education and Computer Science
1.3	Department	Mathematics-Computer Science
1.4	Field of study	Informatics
1.5	Cycle of studies	Master
1.6	Study Program / Qualification	*Advanced techniques for information processing/ Advanced techniques for information processing*

2. Discipline data

2.1	Name of the discipline					*Mathematical Methods in Signal Processing*					
2.2	The holder of the course activities					Assoc.prof.PhD Doru Constantin					
2.3	Holder of laboratory activities					Assoc.prof.PhD Doru Constantin					
2.4	Year of study	2	2.5	Semester	1	2.6	Type of assessment	E	2.7	Discipline regimen	O

3. Estimated total time

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

Distribution of the time fund	hours
Study by textbook, course support, bibliography and notes	48
Additional documentation in the library, on specialized electronic platforms and in the field	52
Preparation of seminars/ laboratories, themes, papers, portfolios, essays	34
Tutoring	6
Examination	4
Other activities.....	-

3.7	Total hours of self-study	144
3.8	**Total hours per semester**	**200**
3.9	**Number of credits**	**8**

4. Preconditions (where applicable)

4.1	Curriculum	-
4.2	Skills	-

5. Conditions (where applicable)

5.1	Conduct of the course	Room with video projector
5.2	Conducting the seminar/laboratory	Laboratory room with video projector and computer equipment

6. Acquired specific skills

Professional skills	Operation with scientific concepts and methods in the field of information processing in information systems; Development of theoretical concepts and practical methods regarding the process of development and maintenance of computer applications; Advanced information processing; Realization of it projects in an interdisciplinary context; Conceiving, designing and implementing information systems; Management of information systems.
Transversal competences	Applying the rules of organized and efficient work, of responsible attitudes towards the scientific-professional field, for the creative capitalization of one's own potential, respecting the principles and norms of professional ethics; Efficiently carrying out the activities organized in an interdisciplinary team by assuming execution and leadership functions, with the development of empathic capacities of inter-personal communication, networking and collaboration with various groups; Elaboration of own professional development project; the use of effective methods and techniques for learning, information, research and capacity development, for valuing knowledge, for adapting to the requirements of a dynamic society and for communicating in Romanian and English.

7. The objectives of the discipline

7.1 The general objective of the discipline	► The acquisition by students of the basic knowledge concepts in the field of digital signal processing in the time and frequency domains - transformations, wavelet techniques and multiresolution analysis.
7.2 Specific objectives	*Cognitive objectives:* ► Knowledge of the mathematical and computer fundamentals of the main concepts in the field of signal processing; ► Knowledge of signal processing algorithms based on wavelets or Fourier transform representations. *Procedural objectives:* ► Training the skills to implement the main algorithms used in signal processing applications. *Attitudinal objectives:* ► Rigor in modeling, design and implementation of signal processing algorithms.

8. Contents

8.1. Course		Nr. hours	Teaching methods	Resources used
1.	Introduction to signal processing	2	Explication Description and exemplification Demonstration Problematization Heuristic conversation Exercise	Blackboard Pen tablet Computer Video projector Documentary support E-learning platform Zoom
2.	Time and frequency domain modeling and signal mixing	2		
3.	Fourier transform and FFT algorithms (Fast Fourier Transform)	2		
4.	Geometric representation of signal mixtures	2		
5.	Blind signal model estimation by maximizing non-Gaussianity - objective functions	4		
6.	Algorithms for estimating the blind source signals from signal mixtures by maximizing nongaussianity	4		
7.	Model estimation with blind signals	4		
8.	Algorithms for estimating the blind source signals from signal mixtures by mutual information minimization and maximum likelihood model estimation	4		
9.	Using the non-linear PCA criterion and the RLS algorithm	4		

Bibliography

1. Note de curs și laborator - *suport electronic* - Doru Constantin.
2. Rao, K.R., Yip, P.C.,*The Transform and Data Compression Handbook*, CRC Press, 2001.
3. Allen, R., Mills, D., *Signal Analysis. Time, Frequency, Scale and Structure*, Wiley-Interscience, 2004.
4. Gray, R.M., Davisson, L.D., *An Introduction to Statistical Signal Processing*, Cambridge University Press, 2004.
5. Akansu, A.N., Haddad, R.A., *Multiresolution Signal Decomposition. Transforms, Wavelets*, Academic Press, 2001.
6. Stein J.Y., *Digital Signal Processing. A Computer Science Perspective*, Wiley, 2000.
7. Bracewell, R.N., *The Fourier Transform and Its Applications*, McGraw Hill, 2000.

8.2. Applications – Laboratory		Nr. hours	Teaching methods	Observations Resources used
1.	Applications of signal modeling by mixing	2	Explication Description and exemplification Case study Exercise Debate	Blackboard Pen tablet projector E-learning platform Zoom
2.	Applications on the geometric representation of signal mixtures	2		
3.	Applications and implementations for the Fast Fourier Transform	4		
4.	Applications and implementations of algorithms for estimating the blind source signals from signal mixtures by maximizing non-Gaussianity (negentropy versions)	4		
5.	Applications and implementations of algorithms for estimating the blind source signals from signal mixtures by maximizing non-Gaussianity (kurtosis versions)	4		
6.	Applications and implementations of algorithms for estimating the blind source signals from signal mixtures by minimizing mutual information	4		
7.	Applications and implementations of algorithms for estimating the blind source signals from signal mixtures by Maximum Likelihood model estimation	4		
8.	Applications with non-linear PCA criterion and the RLS algorithm	4		

Bibliography

1. Note de curs și laborator - *suport electronic* - Doru Constantin.
2. Rao, K.R., Yip, P.C.,*The Transform and Data Compression Handbook*, CRC Press, 2001.
3. Allen, R., Mills, D., *Signal Analysis. Time, Frequency, Scale and Structure*, Wiley-Interscience, 2004.
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9. Corroborating the contents of the discipline with the expectations of the representatives of the epistemic community, professional associations and employers in the field related to the program

The competences acquired within the discipline allow the graduates to efficiently use the models and techniques specific to signal processing in solving the requirements related to the practice and research in the field of informatics. The contents are correlated with those of similar disciplines in prestigious universities in the country and abroad (such as MIT) and adjusted after discussions with representatives of local IT employers (such as RoWeb, Lisa, Prodinf, Kepler, Osf, Endava).

10. Evaluation

Activity Type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Percent of final grade
10.4 Course	Final evaluation	Practical test (algorithms and problems)	50%
10.5 Seminar/ Laboratory	Participatory activity, Project Activity (solving proposed problems) Periodical evaluation	Verification of project, practical test	10% 40%
10.6 Minimum performance standard	* Minimum knowledge set for passing the final exam: knowledge of the fundamental principles of the signal processing field; knowledge of basic techniques and methods, implementations of basic algorithms used in signal processing tasks.		

Date of completion 15.09.2022	Course holder Assoc.prof.PhD Doru CONSTANTIN	Laboratory holder Assoc.prof.PhD Doru CONSTANTIN
Date of approval in the Department 15.09.2022	Director Department (provider) Assoc.prof.PhD Doru CONSTANTIN	Director Department (*beneficiary)* Assoc.prof.PhD Doru CONSTANTIN