COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	POLITEHNICA University of Bucharest
1.2 Faculty	Electronics, Telecommunications and Information Technology
1.3 Department	Telecommunications
1.4 Domain of studies	Electronic Engineering, Telecommunications and Informational Technologies
1.5 Cycle of studies	License
1.6 Program of studies/Qualification	Technologies and Systems of Telecommunications (TSTeng)

2. Course identification information

2.1 Name of the course				Digital Signal Processing			
2.2 Lecturer				Assoc. Prof. PhD Eng. Mihnea Udrea			
2.3 Instructor for practical activities				Assoc. Prof. PhD Eng. Udrea			
2.4 Year of studies	III	2.5 Semester	6	2.6 Evaluation type	Exam	2.7 Course choice type	Compulsory

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week, out of which	5	3.2 course	3	3.3 practical activities	3
3.4 Total hours in the curricula, out of which	84	3.5 course	42	3.6 practical activities	42

Distribution of time	hours
Study according to the manual, course support, bibliography and hand notes	24
Supplemental documentation (library, electronic access resources, in the field, etc)	4
Preparation for practical activities, homework, essays, portfolios, etc.	14
Tutoring	0
Examinations	4
Other activities	

3.7 Total hours of individual study	46
3.9 Total hours per semester	130
3. 10 Number of ECTS credit points	5

4. Prerequisites (if applicable)

4.1 curricular	Special Mathematics, Signals and Systems, Circuit Analysis and Synthesis, Project – Signals and Programming
4.2 competence-based	

5. Requisites (if applicable)

5.1 for running the course	Not necessary
5.2 for running of the applications	Compulsory attendance at laboratories (in accordance with the regulations for license university studies in UPB).

6. Specific competences

Professional competences	Applications of usual methods for acquisition and digital signal processing of continuous time signals. Ability to use MATLAB simulation environment for digital signal processing applications. Elementary functional digital signal processing blocks design and evaluation.
Transversal competences	Methodical analysis of the encountered problems in activity, by identifying elements with consecrated solutions, so insuring accomplishment of professional charges.

7. Course objectives (as implied by the grid of specific competences)

7.1 General objective of the course	Presentation of basic analysis and synthesis methods and implementation of the usual structures in digital signal processing.
7.2 Specific objectives	Creation of abilities to apply general knowledge concerning techniques of digital signal processing in various practical applications. Presentation of specific algorithms. Utilization of digital signal processing in diverse technical fields. Abilities of analysis, design and testing for specific functional blocks. Utilization of MATLAB programming environment for simulation of the algorithms and digital signal processing schemas.

8. Content

8.1 Lectures	Teaching techniques	Remarks
Digital signals and systems – review of basic concepts	Teaching is performed using an overhead projector (PowerPoint) and classical methods at blackboard, for specific applications. Documentation offered on Moodle platform (COURSE).	3 hours
Finite impulse response (FIR) digital filters. Specific features. Linear phase FIR filters. Design by windowing method. Design by frequency domain sampling method. Design methods based on error minimization in the frequency domain.		8 hours
Infinite impulse response (IIR) digital filters. Specific features of the IIR filters. Indirect design methods of the digital IIR filters: design of the analogical prototype, transformation methods of the analogical prototype in a digital filter, frequency transformations.		6 hours
Digital filters structures. Direct, transposed and lattice form realizations for FIR filters. Direct, cascade, parallel, lattice form realizations for IIR filter. Shur-Cohn criterion.		6 hours

Multirate systems. Decimation. Interpolation. Sampling rate conversion by rational factors. Equivalences in multirate circuits. Efficient realizations of the decimation and interpolation filters. Applications of the multirate systems: filter banks, sigma-delta A-D converters, transmultiplexers, subband coding.		12 hours
Fast algorithms for convolution and Discrete Fourier Transform. Linear and cyclic convolutions: representations, segmentation procedures, fast algorithms. Discrete Fourier Transform-general features. Decimation-in-time Radix-2 FFT algorithm and decimation-in-frequency Radix-2 FFT algorithm. Mixed-radix algorithms, prime factor algorithm.		7 hours

Bibliography

- S. Ciochină, R.M. Udrea, "Digital signal processing techniques for telecommunications", Editura Printech, ISBN 978-606-23-0677-9, 2016.
- Ad. Mateescu, S. Ciochină, N. Dumitriu, Al. Șerbănescu, L. Stanciu, Prelucrarea numerică a semnalelor, Ed. Tehnică, 1997.
- S. Ciochină, D. N. Vizireanu, Prelucrarea numerică a semnalelor, Probleme, partea I, Litografia UPB, 1998.
- C. Paleologu, M. Udrea, A. Enescu, Prelucrarea numerică a semnalelor, Îndrumar de laborator, Editura „Electronica 2000", 2004.
- Mihnea Udrea - note de curs platforma MOODLE – anul III http://electronica.curs.pub.ro/2007/course/view.php?id=288
- Sophocles J. Orfanidis - Introduction to Signal Processing http://www.ece.rutgers.edu/~orfanidi/intro2sp/
- J. G. Proakis, D. G. Manolakis: Digital Signal Processing: Principles, Algorithms, and Applications, Prentice Hall, 2007, 4th edition
- A. V. Oppenheim, R. W. Schafer: Discrete-time signal processing, Prentice Hall, 1999, 2nd edition

8.2 Seminar	Teaching techniques	Remarks
1) Discrete time signals – specific transformations.	Typical problems are solved at the seminar, by analytic calculus. The seminar has a function of teaching and also of knowledge evaluation.	3 hours
2) FIR filters design.		3 hours
3) IIR filters design.		2 hours
4) Digital filters structures.		2 hours
5) Multirate systems.		4 hours
8.3 Laboratory	Teaching techniques	Remarks
1) Introduction. Discrete-time signals. Spectral representation.	The laboratory documentation is available for the students in electronic form, on the Moodle platform. Laboratory works are created to apply analysis, synthesis, design algorithms presented at the course,	2 hours
2) Discrete systems - general properties.		2 hours
3) Finite impulse response digital filters.		2 hours
4) Infinite impulse response digital filters.		2 hours
5) Digital filters structures.		2 hours
6) Multirate systems.		2 hours

7) Laboratory assessment.	on specific cases, by using MATLAB programming environment.	2 hours
8.4 Project	Teaching techniques	Remarks
1) Generating and representation in the time domain and frequency domain signals in discrete time	Homework in MATLAB to solve the studied problems	2 ore
2) Signal filtering		2 ore
3) FIR filters design		2 ore
4) IIR filters design		2 ore
5) Graphical interfaces for signal processing simulation		2 ore
6) Applications for multirate systems		2 ore
7) Final evaluation		2 ore

Bibliography

- Ad. Mateescu, S. Ciochină, N. Dumitriu, Al. Şerbănescu, L. Stanciu, Prelucrarea numerică a semnalelor, Ed. Tehnică, 1997;
- S. Ciochină, D. N. Vizireanu, Prelucrarea numerică a semnalelor, Probleme, partea I, Litografia UPB, 1998;
- C. Paleologu, M. Udrea, A. Enescu, Prelucrarea numerică a semnalelor, Îndrumar de laborator, Editura „Electronica 2000", 2004.
  http://electronica.curs.pub.ro/2007/course/view.php?id=143
- Sanjit K. Mitra - Digital Signal Processing: A Computer-Based Approach, McGraw Hill Higher Education, 2006, 3rd edition
  http://highered.mheducation.com/sites/0072865466/student_view0/lab_manual.html
- Mihnea Udrea - platforma MOODLE – anul III
  http://electronica.curs.pub.ro/2007/course/view.php?id=288

9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program

Accumulated competences allow the understanding of the new communication technologies and the afferent equipments. This discipline offers fundamental knowledge in the wide field of signal processing, that will be continued in the next year and in the numerous sections of master, by other courses, in specific fields, as image processing, multimedia signal processing, medical electronics applications.

This provides graduates with the appropriate skills and training requirements according to current qualifications, and a modern, high quality and competitive scientific and technical training, enabling them acquiring a working place after the graduation. The course fits therefore perfectly to the Bucharest Polytechnic University policy, considering both its content and structure, and the skills and international openness it offers to students.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final mark
10.4 Lectures	- knowledge of the analysis, synthesis, implementation fundamental notions for the used structures in digital signal processing; - application mode knowledge of the analysis and design methods and abilities assimilation of testing these techniques by simulation.	-control paper sustained in the week fixed at the begining of the semester; –final exam in the session.	15% 50%
10.5 Seminar	- appreciation for individual independent solving of the proposed problems; - appreciation for understanding fundamental notions and concepts in digital signal processing.	- appreciation for solving seminar problems; - appreciation for solving homework problems; - appreciation for solving control paper problems	10%
10.6 Laboratory	-utilization mode knowledge of the possibilities offered by the MATLAB programming medium in the design, analysis, simulation of the discrete time or digital signal and systems;	- laboratory tests with practical and theoretical components.	15%
10.7 Project	- knowledge of the methodology to compare experimental and theoretical results.	- homework in MATLAB to solve the problems studied in the laboratory	10%

10.8 Minimal performance standard

- application of the adequate algorithms to solve a real simple problem of digital signal processing and the implementation of the afferent structures;
- evaluation of the functionality for a simple solution of a digital systems design and analysis problem.

Date	Lecturer	Instructor for practical activities
18.09.2017	Assoc. Prof. PhD Eng. Mihnea Udrea	Assoc. Prof. PhD Eng. Mihnea Udrea

Date of department approval

25.09.2017

Director of Department,

Assoc. Prof. PhD Eng.. Eduard POPOVICI