

SYLLABUS
for the discipline:

"ADVANCED DIGITAL SIGNAL PROCESSING"

FACULTY: AUTOMATION AND COMPUTERS

DOMAIN / SPECIALIZATION: COMPUTER ENGINEERING

Year of Studies: I or II (MASTER)

Semester: 1

Course instructor: associate professor Mihai V. Micea, PhD.

Applications instructor: associate professor Mihai V. Micea, PhD.

Number of hours/week/Evaluation/Credits					
Course	Seminar	Laboratory	Project	Evaluation	Credits
2	0	0	1	Exam	9

A. COURSE OBJECTIVES

The course focuses on the advanced techniques and algorithms used in digital signal processing. Students will learn the main design and analysis techniques of advanced types of digital filters such as: efficient FIR and IIR filters, adaptive filters, linear prediction and optimum filters. Students will also gain abilities of designing and implementing advanced digital signal processing algorithms and systems using generic and specialized digital devices (Digital Signal Processors – DSPs).

B. COURSE SUBJECTS

Implementation of discrete-time systems (4 h): Structures for FIR and IIR systems; State-space system analysis and structures; Quantization of filter coefficients; Round-off effects in digital filters. **Design of digital filters (6 h):** Generic model for digital filter design; Design of FIR and IIR filters; Frequency transformations; Design of digital filters based on Least-Squares Method. **Multirate digital signal processing (4 h):** Decimation and interpolation; Sampling rate conversion; Filter design and implementation for sampling-rate conversion; Multistage implementation of sampling-rate conversion; Applications of multirate signal processing. **Design of adaptive digital filters (6 h):** Goal of adaptive digital filtering; General concepts; Theory of Wiener-type digital filters; Adaptive LMS algorithm; Least-Squares recursive algorithm; Applications of adaptive digital filtering. **Elements of spectral analysis and estimation (4 h):** Principle and traditional methods of spectral estimation; Modern methods of parametric estimation; Applications of spectral analysis. **Linear prediction and optimum linear filters (4 h):** Forward and backward linear prediction; Properties of the linear prediction – error filters; Applications of linear prediction.

C. APPLICATIONS SUBJECTS (projects, 14 h)

1. Architecture and programming of the Freescale StarCore DSP system.
2. FFT implementation and evaluation on a PC and on the StarCore DSP.
3. Implementation and evaluation of FIR digital filters on a PC and on the StarCore DSP.
4. Implementation and evaluation of IIR digital filters on a PC and on the StarCore DSP.
5. Design and implementation of a digital audio effects processor.
6. Design and implementation of a digital audio equalizer on specialized devices (DSP).
7. Design, implementation and analysis of multirate systems.

8. Adaptive digital filters: design, implementation and evaluation.
9. Linear prediction filters: design, implementation and evaluation.

D. BIBLIOGRAPHY

1. G. Proakis, D. G. Manolakis, "Digital Signal Processing. Principles, Algorithms and Applications", 3rd Edition, *Prentice-Hall*, 1996.
2. A. V. Oppenheim, R. W. Schaffer, "Digital Signal Processing", *Prentice-Hall*, 1996.
3. S. Stergiopoulos (editor), "Advanced Signal Processing Handbook: Theory and Implementation for Radar, Sonar, and Medical Imaging Real-Time Systems", *CRC Press LLC*, 2001.

E. EVALUATION PROCEDURE

The final grade is composed of the evaluation during the semester at the project workshops and at the course classes (50%), and of the final written exam evaluation (3 hours, 50%).

F. INTERNATIONAL COMPATIBILITY

1. **Massachusetts Institute of Technology**, SUA, Department of Electrical Engineering and Computer Science, Basic Undergraduate Program: "Discrete-Time Signal Processing" (6.341, A. V. Oppenheim, V. K. Goyal), "Digital Speech Processing" (6.343, T. F. Quatieri), "Introduction to Communication, Control, and Signal Processing" (6.011, A. V. Oppenheim, G. C. Verghese)
2. **Carnegie Mellon University**, SUA, Department of Electrical and Computer Engineering, Undergraduate Program: "Advanced Digital Signal Processing" (18-792), "Digital Signal Processing" (18-491), "Digital Communication and Signal Processing Systems Design" (18-551)
3. **University of Cambridge**, UK, Department of Engineering, Undergraduate Program: "Digital Filters and Spectrum Estimation" (4F7, S. J. Godsill, S. Singh), "Signals and Systems" (3F1, J.M. Goncalves, N.G. Kingsbury), "Signal and Pattern Processing" (3F3, S. J. Godsill)

G. OBSERVATIONS

1. The course is presented using PowerPoint slides with a video projector. Students can receive the course support (course slides) in electronic or printed format.
2. The project and application workshops will be hosted by the Digital Signal Processing Laboratories – DSPLabs, which provides latest generation equipments and specialized modules through various partnerships with top-ranking companies in the domain, such as: Motorola/Freescale, Alcatel-Lucent, etc.
3. Interested students have the opportunity to collaborate at various projects and research contracts, developed within the DSPLabs. Such participation replaces the applicative activities required by the syllabus.

26.03.2007

HEAD OF DEPARTMENT
Prof. Dr. Eng. Vladimir CRETU

COURSE INSTRUCTOR,
Assoc.Prof. Dr. Eng. Mihai V. MICEA