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<tr><td>INSTITUTION</td><td colspan="6">NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS</td></tr>
<tr><td>SCHOOL</td><td colspan="6">SCHOOL OF SCIENCE</td></tr>
<tr><td>DEPARTMENT</td><td colspan="6">INFORMATICS AND TELECOMMUNICATIONS</td></tr>
<tr><td>COURSE LEVEL</td><td colspan="6">UNDERGRADUATE</td></tr>
<tr><td>COURSE TITLE</td><td colspan="6">Digital Signal Processing</td></tr>
<tr><td>COURSE CODE</td><td colspan="2">C01</td><td>Semester</td><td>fall</td><td>ECTS</td><td>6</td></tr>
<tr><td>TEACHING HOURS per week</td><td>THEORY</td><td>4</td><td>SEMINAR.</td><td></td><td>LABORATORY</td><td>2</td></tr>
<tr><td>URL</td><td colspan="6">https://eclass.uoa.gr/courses/DI444/</td></tr>
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COURSE CONTENT

The course focuses on digital signals and systems covering the basic mathematical tools for their qualitative and quantitative characterization as well as their processing. In the first part of the course, the basic definitions related to discrete time signals are introduced together with the linear time invariant systems, the convolution operation, and Z transform in conjunction with its basic properties. Furthermore, the first part includes: the transfer function of a system, the bounded input and bounded output stability, the discrete time Fourier transform, the Nyquist sampling theorem, as well as the discrete Fourier transform with its properties, the cyclic convolution, and the fast Fourier transform. In the second part of the course, the well-known implementation schemes of transfer functions are introduced (direct forms, serial and parallel) together with the design principles of digital FIR filters, linear phase filters, the windowing approach, and the optimum filtering methodology. Additionally, the design of analog filters is studied (Butterworth, Chebychev, elliptic) and its principles are further used in the design of digital IIR filters. The methods of impulse invariance and bilinear transformation are investigated through representative examples. The theory and exercises of the course include representative application examples in the fields of sound and speech signals, images, and communication signals.

STUDENT LEARNING OBJECTIVES

Upon successful completion of the course the student will be able to:

- *Define* and execute the operations of conventional and cyclic convolution for sequences of samples of digital signals.
- *Distinguishes* digital and analog signals and their properties as well as of the different types of systems (linear, linear and time invariant, bounded input and bounded output).
- *Calculate* Fourier (discrete-time and discrete) and Z transforms of digital signals as well as the inverse transforms.
- *Understands* sampling of analog signals as well as the Nyquist criterion.
- *Develops* implementation schemes for linear and time invariant transfer functions.
- *Designs* digital linear phase filters and FIR filters (lowpass, highpass, bandpass, bandstop, as well as multi-band) using the windowing method with various windows.
- *Selects* the appropriate window for the design of digital FIR filters.
- *Understands* the optimal design methodology of digital filters by defining and solving an appropriate mathematical design problem.
- *Designs* Butterworth analog filters based on specific specifications.
- *Designs* IIR digital filters (lowpass, highpass, bandpass, bandstop,) using the impulse invariance and the bilinear transformation methods.
- Recognizes the appropriateness of the different digital filter design methods in various applications of digital signal processing.

TEACHING AND LEARNING METHODS - ASSESSMENT

TEACHING METHOD	In Class (Face to Face)
USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES	Learning process supported by the e-class platform. More specifically: Course Description, Material Supply, Announcements, Calendar, Assignment and Submission of Exercises, Discussion on Exercises, Questionnaires, External Links) E-mail communication Live transmission of lectures Ability to follow recorded lectures

TEACHING ORGANIZATION

Describe in detail the way and methods of teaching:
Enhanced Lectures,
Online Lectures,
Seminars,
Tutorial,
Laboratory,
Laboratory Exercise,
Study & analysis of literature,
Practice (Positioning),
Interactive teaching,
Developing a project,
Individual / group work
Telework (reference to tools)etc.

Details of the student's study hours for each learning activity and hours of non-guided study are shown to ensure that the total workload at the semester corresponds to the ECTS

Activity	***Student Workload*** *(hours)*
Lectures	52
Laboratory	14
Two (2) Personalized Programming Exercises	24+24=48
Independent Study	36
Total Course (25 hours of workload per unit of credit)	***150***

The course's lectures and seminars are given through slide show presentations in the amphitheater. The laboratory takes places in a dedicated room including 29 desktop computers with the Matlab mathematical programming software installed. Two individual programming exercises (one for each part of the course) are given in order to embed the theory through the programming of taught methods of digital signal processing in Matlab or Python mathematical programming software. Support for the exercises is given via discussions in eclass.

ASSESSMENT OF STUDENTS

Description of the assessment process

Assessment Methods, Formative or Concluding, Multiple Choice Test, Quick Response Questions, Test Development Questions, Problem Solving, Written Work, Report / Report, Oral Examination, Public Presentation, Laboratory Work, Other / Other

Fully defined evaluation criteria are mentionedand if and where they are accessible to students.

Students are assessed with two (2) compulsory individual exercises and one (1) final written examination. The written examination covers the theoretical part of the course, while the exercises are based on the programming of applications for understanding the theory. The laboratory exams are based on the lab exercises target at verifying the students' programming skills in digital signal processing. The exercises are evaluated with classified criteria and communicated to the students. Complaints and retrains are allowed.

Assessment methods	***Number***	***Percentage***
Personalized Programming Exercises	2	20%+20%=40%
Laboratory Exams	1	10%
Final Exams	1	50%

LITERATURE AND STUDY MATERIALS / READING LIST

1. S. Theodoridis, K. Berberidis, E. Kofidis, Introduction to the Theory of Signals and Systems, Τυπωθήτω – Georgios Dardanos, 2005. **(available online via eudoxus.gr)**

2. N. Kalouptsidis, Signals, Systems and Algorithms, Diaulos, 1994. **(available online via eudoxus.gr)**
A. V. Oppenheim, R. W. Schafer, J.R. Buck, Discrete-time Signal Processing, Prentice-Hall, 1999.
3. J. Proakis and D. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson, 4η έκδοση, 2007.
4. Γ. Καφεντζής, Επεξεργασία Σήματος Συνεχούς & Διακριτού Χρόνου: Μια Πρώτη Εισαγωγή, Εκδόσεις Gutenberg, 2019.