COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF ELECTRONICS ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	2605004	**SEMESTER**	5
COURSE TITLE	Digital Signal Processing		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS (ECTS)**
Lectures	4	6
Laboratory	2	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialisation Course
PREREQUISITE COURSES:	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES (in English)
COURSE WEBSITE (URL)	http://rangoussi.teipir.gr

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

Upon successful completion of this course module students possess advanced knowledge, skills and competences in the subject of Digital Signal Processing that enable them to:

1. Describe general and specific DSP processes by block diagrams.
2. Select the appropriate form of digital system description, among alternatives, for the problem at hand.
3. Perform spectral analysis of digital signals and systems using simulation tools for the computation of the digital output signal.
4. Interpret the results of spectral analysis of digital signals and systems, so as to conclude on their characterization and classification.
5. Analyze signal processing problems under realistic application scenarios (processing of

audiovisual / biomedical / telecom signals) and compose solutions (design digital systems) on the basis of methods taught in the course.

6. Collaborate with fellow students in a team, in order to thoroughly address complex DSP problems (analysis – synthesis) and to critically evaluate alternative solutions, leading to decisions as to the feasibility of hardware implementations.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Working independently
- Team work
- Production of free, creative and inductive thinking

(3) COURSE CONTENT

<u>Lectures</u>

UNIT I: Introduction

1. General placement of the DSP subject in the field of study of the electronics and telecommunications engineer. Survey of major modern DSP applications, with emphasis on telecoms. Placement of the DSP course and connections with previous and next semester courses.
2. Basic mathematics background revisited (Laplace, Z and Fourier Transforms and Inverses). Discrete-time versus continuous-time signals and systems. Discrete Fourier Transform and Inverse, properties.
3. Simulation and graphics display of discrete-time signals and systems in Matlab.

UNIT II: A-to-D and D-to-A conversion

1. Fundamental theorems and methods, electronic circuits, survey of contemporary hardware available (A/D and D/A convertors, DSP boards) and selection criteria.
2. Introduction to A/D and D/A devices and systems using modern hardware; application to speech and audio signals. Experimental acquaintance with the fundamental characteristics of A/D conversion and their impact on digital signal quality.

UNIT III: Elementary DSP functions and properties

1. Instrumental DSP functions and their properties: convolution, (auto-)correlation);

methods for their computation in the time and the frequency domains.
2. Use of simulation software for the computation and representation of the correlation and the convolution of digital signals / systems.

UNIT IV: The Discrete Fourier Transform (DFT) and its fast implementations (FFT)

1. Discrete Fourier Transform, Fast Fourier Transform fundamentals. Algorithms for their computation and algorithmic complexity. Hardware implementations.

UNIT V: Linear Prediction

1. Introduction of the central notion of linear prediction in discrete-time systems, through the solution of linear problems of special forms. Prediction error and optimal prediction. System modeling.

UNIT VI: Modern Spectral Analysis

1. Modern spectral analysis, parametric and non-parametric Spectral analysis of stationary and quasi-stationary signals: Fourier-based methods, examples. Spectral analysis of non-stationary signals: time-frequency and time-scale representations, examples.
2. Experimental application of spectral analysis methods in real signals, stationary or not. Use of simulation software for the representation of the spectra in order to comparatively evaluate the quality of the results.

UNIT VII: Introduction to digital filter design

1. Major design methods for FIR and IIR filters. Window functions and windowing. Introduction to adaptive digital filters.
2. Design and application of digital filters in specific speech and audio processing scenarios. Experimental acquaintance with digital filters design and comparative evaluation of the quality of the results.

Laboratory

1. TMS320C5505 Digital Signal Processor and the Integrated Development Environment “Code Composer Studio v.5” of Texas Instr. Inc.
2. Echo and reverberation
3. Sine waves generation
4. Alien voices generation
5. Dual tone multi-frequency signal generation
6. Comb digital filters
7. FIR digital filters
8. IIR digital filters
9. Adaptive filters
10. Adaptive filters applied to active noise reduction (ANR).

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face to face lectures</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>

Use of electronic presentation with multimedia content in class,
Student support through the course webpage and the departmental e-learning platform,
Electronic communication of instructors and students, through the course webpage and by e-mail.
Use of simulation software for digital processes in the lab.
Use of Integrated Development Environment (IDE) Software for the programming and running of applications on the TMS DSP dedicated hardware in the lab.

</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail.
Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td>Lectures, Laboratory experiments, study.

<table>
<tr><th>Activity</th><th>Semester workload (hours)</th></tr>
<tr><td>Lectures</td><td>52</td></tr>
<tr><td>Study for lectures</td><td>52</td></tr>
<tr><td>Laboratory experiments</td><td>26</td></tr>
<tr><td>Report on lab experiments</td><td>26</td></tr>
<tr><td>Study and preparation for exams</td><td>24</td></tr>
<tr><td>Course Total</td><td>180</td></tr>
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</td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Final course grade = Lectures part grade x 60% + Laboratory part grade x 40%

<u>Lectures part grade:</u>
Midterm written exam – 2 hours (30%)
Final written exam – 2 hours (70%)

Final written exam covers all taught material. During the exam, students may consult a list of formulae provided by the examiner as a reminder. Students must prove mastery of the material through stating and interpreting definitions of all quantities, handling relations among quantities and solving of design problems based on specs.

<u>Laboratory part grade:</u>
Participation in all lab experiments and oral evaluation – (20%)</td></tr>
</table>

	Mid-term on-line test (40%) End-term on-line test (40%)

(5) ATTACHED BIBLIOGRAPHY

Essential reading

1. HAYES, M., Digital Signal Processing, Schaum's Outline Series, 2nd Edition, Paperback 2011.
2. OPPENHEIM, A.V., SCHAFER, R.W., BUCK, J.R., Discrete-Time Signal Processing, Prentice-Hall, 1999.
3. PROAKIS, G., MANOLAKIS, D., Digital Signal Processing, Prentice-Hall, 3rd. ed., 1996.
4. TMS320C5505 USB Stick Teaching Materials, Texas Instruments – University Programme, 2010.

Recommended Books

1. HAYKIN, S., Adaptive Filter Theory, 4th Edition, Prentice-Hall, 2001.
2. PORAT, B., A course in Digital Signal Processing, Wiley, 1997.
3. PROAKIS, J., RADER, C.M., LING, F., NIKIAS, C.L., Advanced Digital Signal Processing, McMillan, New York, 1992.
4. KALOUPTSIDIS, N., THEODORIDIS, S., Adaptive System Identification and Signal Processing Algorithms, Prentice-Hall Intl., UK, 1993.
5. PORAT, B., Digital Processing of Random Signals, Prentice-Hall, New Jersey, 1994.
6. GOLD, B., MORGAN, N., Speech and Audio Signal Processing, Wiley, 2000.
7. QUATIERI, T. F., Discrete-time Speech Signal Processing, Prentice-Hall, 2000.
8. RABINER, L.R., SCHAFER, R.W., Introduction to Digital Speech Processing, Foundation & Trends in Signal Processing, 2007.