Department of Computer Science and Engineering
School of Engineering
University of Ioannina

Graduate Program of Studies
«Data and Computer Systems Engineering»
Courses Outline

ACADEMIC YEAR 2022/2023

Table of Contents

A0. Introduction to Algorithm and Information Technologies

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**A0**	**SEMESTER**	
COURSE TITLE	Introduction to Algorithm and Information Technologies		
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**
Lectures/Laboratory Exercices		4	7
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*	Special background		
PREREQUISITE COURSES:	NO		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/enrol/index.php?id=1736		

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*

The course covers the necessary background that is required for attending the elective courses of Module A: Algorithm and Information Technologies. The objective of the course is to acquaint students with:

- More elaborate use of fundamental techniques for the design and analysis of algorithms.
- Advanced techniques for the design and analysis of algorithms.
- Mathematical tools such as probabilistic analysis, amortized analysis, and competitive analysis.
- Topics in computational complexity, approximate solutions, and randomization.

Students who complete the course successfully learn to:

- Apply advanced techniques for the design and analysis of algorithms.
- Provide appropriate mathematical models for various problems.
- Compare the efficiency and suitability of different algorithmic techniques for solving specific problems.
- Recognize in which of the basic complexity classes (e.g. P, NP) a specific problem belongs to.

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…*
	…….

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

SYLLABUS

Basic and advanced techniques for algorithms design and analysis. Data structures. Graph algorithms. Computational geometry. Randomized algorithms and tools for probabilistic analysis. Computational complexity and NP-completeness. Approximation algorithms. Elementary number theory and applications in security and cryptography.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector and interactive board during lectures. • Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs). • Announcement of assessment marks via the e-course platform by UOI.

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*	***Activity***	***Semester workload***
	Lectures	13 × 3 = 39 hours
	Laboratory practice	13 × 1 = 13 hours
	Student's study hours	123 hours
	Course total	***175 hours***

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.*	Language of evaluation: Greek Methods of Evaluation: • Final written examination with problem solving questions. • Homework assignments. The evaluation procedure is accessible to students via the course website.

ATTACHED BIBLIOGRAPHY

- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, MIT press, 3rd edition, 2009.
- Jon Kleinberg and Éva Tardos, Algorithm Design, 1st edition, Pearson, 2006.

A1. Algorithmic Graph Theory

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**A1**	**SEMESTER**	**Fall**
COURSE TITLE	**ALGORITHMIC GRAPH THEORY**		

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**
Lectures/Laboratory Exercices	4	7
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*	Specialised general knowledge
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://www.cs.uoi.gr/~stavros/mypage-teaching-MSc-AGT.html

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*

The main objective of this course is to study the main concepts of graph theory and to recognize graphs as an important modeling technique in several applications. In addition the course introduces the students to algorithmic graph theory which has become one of the major tools for the design and analysis of algorithms. The course focuses on the most interest topics in theoretical computer science.

The course's aim is to develop interest in graph theory and its many applications. In particular, at the end of this course, a student should be able to

- apply the abstract concepts of graph theory in several practical problems;
- develop a number of standard and powerful algorithms, as well as demonstrate methodologies in graph techniques; and
- use the graphs in the solution of complex problems.

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…*
	…….

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

SYLLABUS

- Graph theoretic foundations.
- The design of efficient algorithms (complexity of algorithms, data structures). Perfect graphs. Holes and antiholes in graphs. Triangulated graphs.
- Comparability graphs. Split graphs. Permutation graphs. Interval graphs. Cographs, Quasi-threshold (or, trivially perfect), and threshold graphs.
- Perfectly orderable graphs.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of projector and interactive board during lectures. •Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs). •Announcement of assessment marks via the e-course platform by UOI.
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*	

Activity	***Semester workload***
Lectures	13x3=39 hours
Laboratory practice	13x1=13 hours
Student's study hours	123 hours
Course total	***175 hours***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of*	Language of evaluation: Greek Methods of Evaluation: i) Final written examination

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.*	ii) Lab projects examination iii) Evaluation of weekly assignments The evaluation procedure is accessible to students via the course website.

ATTACHED BIBLIOGRAPHY

- M.C. Golumbic, Algorithmic Graph Theory and Perfect Graphs. Academic Press, Inc., New York, 1980. Second edition, Annals of Discrete Mathematics 57, Elsevier, 2004.
- A. Brandstadt, V.B. Le, and J. Spinrad, Graph classes -- A survey, SIAM Monographs in Discrete Mathematics and Applications, SIAM, Philadelphia, 1999.

A2. Algorithms for Data Science

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**A2**	**SEMESTER**	Spring
COURSE TITLE	ALGORITHMS FOR DATA SCIENCE		

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**
Lectures/Laboratory Exercices	4	7
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*	Special background
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

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*

The course focuses on algorithmic techniques that are used in practice to solve basic problems in data processing and extraction and can be successfully applied even to large-scale data.

After attending the course students should be able to:

- Apply techniques for the design and analysis of algorithms suitable for the processing of large scale data.
- Provide appropriate mathematical models for data mining problems.
- Compare the efficiency and suitability of different algorithmic techniques to solve a problem.

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…*
	…….

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

SYLLABUS

Design, analysis and application of algorithms in areas where there is a direct practical interest in processing large scale data. In particular, the following topics are considered: algorithms and data structures for string processing, data compression, information theory and codes, multi-dimensional data calculations, algorithms in graphs and networks, linear programming, combinatorial optimization.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector and interactive board during lectures. • Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs). • Announcement of assessment marks via the e-course platform by UOI.
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,*	

Activity	*Semester workload*
Lectures	13 × 3 = 39 hours
Laboratory practice	13 × 1 = 13 hours
Student's study hours	123 hours

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*	<table><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td>Course total</td><td>***175 hours***</td></tr></table>
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.*	Language of evaluation: Greek Methods of Evaluation: • Final written examination with problem solving questions. • Homework assignments. • Individual presentation of a research topic related to the subject matter of the course. The evaluation procedure is accessible to students via the course website.

ATTACHED BIBLIOGRAPHY

- Jure Leskovec, Anand Rajaraman, Jeff Ullman, Mining of Massive Datasets, Cambridge University press, 2nd edition, 2014.
- Avrim Blum, John Hopcroft, Ravindran Kannan, Foundations of Data Science. Unpublished, available online.
- Steven S. Skiena, The Data Science Design Manual, Springer, 2017.
- Brian Steele, John Chandler, Swarna Reddy: Algorithms for Data Science, Springer, 2016.

D0. Introduction In Data Analysis And Processing

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPT. OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	D0	**SEMESTER**	
COURSE TITLE	INTRODUCTION IN DATA ANALYSIS AND 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**
Lectures / Labs / Tutorials		4	7
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	General background		
PREREQUISITE COURSES:	NO		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK or ENGLISH		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/enrol/users.php?id=1720		

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
This introductory course exposes the students to the main concepts and methodologies in Data Science. The course comprises a series of lectures that concisely cover the necessary mathematical background as well as essential topics in Data Science, such as data types and representation, clustering techniques, learning and generalization, optimization, data transformations and compression, text processing and information retrieval. Moreover, it offers an overview of popular programming tools used in Data Science. After the successful completion of this course, students will be exposed to: ● The fundamental mathematical background that is necessary for the in-depth study of specialized topics in Data Science. ● The basic fields of study that they can deepen in data analysis and processing. ● Modern programming tools that are highly useful in Data Science.

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

- Production of free, creative and inductive thinking.
- Decision-making.
- Search for, analysis and synthesis of data and information.
- Development of algorithmic thinking.
- Ability of analyzing and modelling problems.

SYLLABUS

- Elements of Linear Algebra
- Elements of Optimization
- Overview of Probability Theory and Statistics
- Data Types and Representation
- Clustering
- Data Transformations
- Data Compression
- Learning and Generalization
- Text Processing and Information Retrieval
- Programming Tools in Data Science

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Weekly lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Course webpage where literature and free material is provided. • Live simulations in the classroom. • Use of email services and social media for communication with the students.
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*	

Activity	*Semester workload*
Lectures	13*3 = 39 hours
Labs	13*1 = 13 hours
Self-study	123 hours

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*		
	Course total	***175 hours***
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.*	LANGUAGE OF EVALUATION: Greek or English METHODS OF EVALUATION: Written exam	

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- A. Blum, J. Hopcroft, R. Kannan, **Foundations of Data Science**, Cornell University, 2015, e-book available at: https://www.cs.cornell.edu/jeh/book.pdf
- J. Grus, **Data Science from Scratch: First Principles with Python**, O'Reilly Media, 2015.

- Related academic journals:

D1. Machine Learning

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**D1**	**SEMESTER**	**Spring**
COURSE TITLE	**MACHINE LEARNING**		

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**
Lectures / Tutorials	**3/1**	**7**
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*	Special background
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://www.cs.uoi.gr/~arly/courses/ml/ml.html

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*

The objective of this course is to provide a detailed description of machine learning problems and solutions. The main problems presented and studied are related to supervised learning (classification, regression), unsupervised learning (clustering, dimensionality reduction, density estimation) and reinforcement learning. State-of-the-art methods are presented and compared for all the above problems.

It is expected that after taking the course the student will have:

- knowledge of machine learning problems
- a clear understanding of the notions of learning and generalization

- the ability to solve classification, regression and clustering problems using state-of-the-art approaches such SVMs, deep neural networks, Gaussian Processes, mixture models.
- the skill to apply all the algorithmic steps required for building machine learning models from a given dataset.

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…*
	…….

- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Team work
- Algorithmic thinking
- Apply research results in solving practical problems
- Literature studying and management

SYLLABUS

Introduction to Machine Learning, probability distributions, linear models. Neural Networks, the multilayer perceptron, overfitting and regularization, deep neural networks. Kernel methods, Support Vector Machine, Relevance Vector Machine, Gaussian Processes. Clustering Methods, k-means, kernel k-means, spectral clustering. Dimension reduction. PCA, probabilistic PCA, autoencoders. Graphical models, inference methods, EM algorithm, mixture models, sampling methods, Hidden Markov Models, reinforcement learning.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Weekly Lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector during lectures. • Method demonstration using demos and videos. • Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs).

<table>
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- Use of email to improve communication with students.

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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

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<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>13*3 = 39 hours</td></tr>
<tr><td>Tutorials</td><td>13*1 = 13 hours</td></tr>
<tr><td>Self-study</td><td>123 hours</td></tr>
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<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>175 hours</td></tr>
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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.

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LANGUAGE OF EVALUATION: Greek

METHODS OF EVALUATION

(i) Final exams
(ii) Project

</td></tr>
</table>

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

C. Bishop, “Pattern Recognition and Machine Learning”, Springer 2007.

P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.

D3. Optimization

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPT. OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**D3**	**SEMESTER**	**Fall**
COURSE TITLE	**OPTIMIZATION**		

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**
Lectures / Labs / Tutorials	4	7
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*	Special background
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK or ENGLISH
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/enrol/index.php?id=553

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*
Optimization is the branch of Mathematics that deals with the detection of optimal solutions. Typically, a solution to a given problem is modeled via a parametric “objective” function (model), the minima of which may correspond to desired solutions. Also, the problem may contain a set of constraints, typically defined through equality and / or inequality relations. The Optimization course aims at equipping the students with essential knowledge in local and global Optimization algorithms of various types. Among other, these include: • Gradient-based algorithms that use first- and second-order derivatives information,

such as Gradient Descent, Newton, Quasi-Newton, Conjugate Gradients, in combination with Line Search and Trust Region techniques.
- Derivative-free algorithms such as Nelder-Mead, Hooke-Jeeves, and Pattern Search.
- Stochastic and evolutionary algorithms such as Genetic Algorithms and Particle Swarm Optimization.

Moreover, different techniques for solving problems with constraints are given, along with techniques for the detection of multiple minimizers.

After the successful completion of this course, students are expected to be able to:

- Implement and apply local and global Optimization algorithms.
- Determine the most appropriate algorithm for a given problem.
- Design variants of the algorithms for serial and parallel computing environments, as well as for challenging applications.

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

- Production of free, creative and inductive thinking.
- Decision-making.
- Search for, analysis and synthesis of data and information.
- Development of algorithmic thinking.
- Ability of analyzing and modelling problems.

SYLLABUS

- Introduction to Optimization
- Optimality conditions
- One-dimensional optimization
- Derivative-free methods: Steepest Descent, Nelder-Mead, Hook-Jeeves, Pattern Search.
- Gradient-based methods: Newton, Quasi-Newton, Conjugate Gradients.
- Line Search and Trust Region techniques.
- Stochastic and evolutionary algorithms: Multistart, Simulated Annealing, Genetic Algorithms, Particle Swarm Optimization.
- Solution techniques for constrained problems.

- Techniques for the detection of multiple minimizers. Parallel coordinates.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Weekly lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Course webpage where literature and free material is provided. • Live simulations in the classroom. • Use of email services and social media for communication with the students.
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*	

Activity	***Semester workload***
Lectures	13*3 = 39 hours
Labs	13*1 = 13 hours
Self-study	123 hours
Course total	***175 hours***

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.*	LANGUAGE OF EVALUATION: Greek or English METHODS OF EVALUATION: Projects and written report.

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- W. Sun, Y. Yuan: **Optimization Theory and Methods**, Springer, 2006.
- R. Fletcher: **Practical Methods of Optimization**, 2nd edition, Wiley, 2000.
- D. Bertsekas: **Nonlinear Programming**, 2nd edition, Athena Scientific, 2004.
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, **Nonlinear Programming, Theory and**

Algorithms, 3rd edition, Wiley, 2006.

- I. Griva, S.G. Nash, A. Sofer, **Linear and Nonlinear Optimization**, 2nd edition, SIAM, 2008.
- J. Nocedal, S.J. Wright, **Numerical Optimization**, 2nd edition, Springer, 2006.
- Z. Michalewicz: **Genetic Algorithms + Data Structures = Evolution Programs**, 3rd edition, Springer, 1999.
- K.E. Parsopoulos, M.N. Vrahatis: **Particle Swarm Optimization and Intelligence: Advances and Applications**, IGI Global, 2010.
- A. Inselberg, **Parallel Coordinates**, Springer, 2009.

- Related academic journals:

- Optimization Letters, SPRINGER.
- Optimization Methods and Software, TAYLOR & FRANCIS.
- Journal of Global Optimization, SPRINGER.
- Journal of Optimization Theory and Applications, SPRINGER.
- Mathematical Programming, SPRINGER.
- SIAM Journal on Optimization, SIAM.
- IEEE Transactions on Evolutionary Computation, IEEE.
- Applied Soft Computing, SPRINGER.
- Soft Computing, ELSEVIER.
- European Journal on Operational Research, ELSEVIER.
- Computers & Operations Research, ELSEVIER.
- Computers & Industrial Engineering, ELSEVIER.
- Annals of Operations Research, SPRINGER.

D4. Video Processing and Compression

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**D4**	**SEMESTER**	**Fall**
COURSE TITLE	Video Processing and Compression		
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**
	Lectures / Labs / Tutorials	**4**	**7**
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/enrol/index.php?id=1629		

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*

The goal of the course is the learning of the basic theory of video processing and compression.

After successfully passing this course the students will be able to:

- Understand the basic principles of video capture and display.
- Apply tools of multidimensional signal processing to video applications.
- Understand and use video sampling theory.
- Implement various motion estimation algorithms.
- Understand the fundamentals of compression and their application to video coding.

- Be familiar with current video compression standards.

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

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Decision-making
- Production of free, creative and inductive thinking
- Evaluation of different solutions and selection of the most appropriate one
- Use of structured mathematical thinking for the development and reinforcement of arguments

SYLLABUS

Video Capture: Color coordinate systems. Video camera. Video display. Progressive and Interlaced scan.

Multidimensional signal processing: Multidimensional signals and systems. Multidimensional continuous and discrete Fourier Transform. Frequency response of the human visual system.

Video sampling theory: Generalized Nyquist sampling theorem. Sampling rate conversion.

Motion estimation: Motion modeling. Optical flow equation. Block matching.

Fundamentals of compression: Information theory basics. Quantization. Transform theory. DCT, KLT, DWT transforms. Motion compensated prediction.

Video compression standards: H.264, H.265, VP9, AV1.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, lab sessions
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector during lectures. • Use of Matlab in the lab. • Use of the ecourse electronic platform for course announcements, uploading of class notes, homework assignment, and grade announcement.

<table>
<tr><td></td><td>

- Use of email and social media for more effective communication with the students

</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>

Activity	*Semester workload*
Lectures	13*3 = 39 hours
Labs	13*1 = 13 hours
Self-study	123 hours
Course total	**175 hours**

</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>

LANGUAGE OF EVALUATION: Greek

METHODS OF EVALUATION

(i) Final examination. The students are tested in theory and exercises of video processing and compression.

(ii) Homework assignments. The students are asked to solve video processing and compression exercises.

(iii) Lab reports. The students turn in their code and answer questions regarding their results.

The evaluation procedure is accessible to students via the course website.

</td></tr>
</table>

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Video Processing and Communications, Y. Wang, J. Ostermann, Y.-Q. Zhang, Prentice-Hall, 2002.
- Multidimensional Signal, Image and Video Processing and Coding, J.W. Woods, Academic Press, 2nd edition, 2012.

- Related academic journals:

- IEEE Transactions on Image Processing
- IEEE Transactions on Circuits and Systems for Video Technology
- IEEE Transactions on Multimedia

D5. Computer Vision

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**D5**	**SEMESTER**	**Spring**
COURSE TITLE	**Computer Vision**		
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**
Lectures / Labs/ Exercises		3/1/0	7
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialised general knowledge		
PREREQUISITE COURSES:	NO		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	http://www.cs.uoi.gr/~cnikou/Computer%20Vision.html		

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 completion of this course, students will:

- Have acquired the intuition behind understanding the 3D world from images s
- Be familiar with both the theoretical and practical aspects of computing with images;
- Have described the foundation of image formation, measurement, and analysis;
- Have implemented common methods for robust image matching and alignment;
- Understand the geometric relationships between 2D images and the 3D world.
- Have gained exposure to object and scene recognition and categorization from images;
- Grasp the principles of state-of-the-art regression and classification methods in computer vision;

- Have developed the practical skills necessary to build computer vision ;applications.

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.
- Decision making
- Production of free, creative and inductive thinking
- Team work
- Autonomous work
- Production of new research ideas

SYLLABUS

- Linear filtering
- Edge detection
- Frequency representation, image pyramids, template matching
- Local features: corners
- Local features: scale and interest point descriptors
- Machine learning for computer vision
- Segmentation by clustering: mean shift
- Segmentation by clustering: normalized cut
- Segmentation by fitting a model: Hough transform and least squares fitting
- Segmentation by fitting a model: robust estimators and RANSAC
- Registration
- PCA and eigenfaces
- Face detection
- Fitting probability models
- Learning and inference in computer vision
- The pinhole camera
- Singular value decomposition
- Models for transformations
- Multiple cameras
- More features (LBP, shape context, dual PCA)
- Models for grids (grpah cut)
- Regression

- Classification

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Lecture slides, multimedia (video demonstrations), e-mail communication, course Web page maintenance.
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*	***Activity*** / ***Semester workload*** Lectures — 13x3=39 hours Labs — 13x1=13 hours Student's autonomous study of the theory, problem solving and response to homework assignments — 123 hours Course total — ***175 hours***
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.*	Language of evaluation: Greek Methods of Evaluation: i) Weekly lab and theoretical assignments ii) Mid-term examination iii) Final examination The evaluation procedure is accessible to students via the course website.

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. D. Forsyth and J. Ponce. Computer Vision: A Modern Approach. Second edition. Prentice Hall, 2011.

2. S. Prince. Computer Vision: Models, Learning and Inference. Cambridge University Press, 2012.

- Related academic journals:

IEEE Transactions on Pattern Analysis and Machine Intelligence

International Journal of Computer Vision

IEEE Transactions on Image Processing

Image and Vision Computing

Computer Vision and Image Understanding

Pattern Recognition

Journal of Mathematical Imaging and Vision

Machine Vision and Applications

D7. Management of Non-traditional Data

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**D7**	**SEMESTER**	**Fall**
COURSE TITLE	Management of Non-traditional Data		
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**
	Lectures / Tutorials	**4**	**7**
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*	Special background		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)			

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*

The course **Management of Non-traditional Data** typically focuses on database management topics for which the traditional relational database technology is not adequate. It specializes on data management subjects which belong to two big categories, specifically: (a) the area of complex query evaluation (e.g., dynamic ranking queries based on multidimensional aggregate functions, or distance to a reference point) and (b) the area of data management for non-traditional formats and environments (e.g., with a focus on spatial data, time-series, text, and multidimensional data in general). The course specialises each year to a possibly different subarea; however, it begins by covering the fundamental concepts of each area (as well as how they are related to traditional database management)

and later on goes deeper to techniques that cover research efforts and state-of-the-art tools.

After successfully passing this course the students will be able to:

- Understand the state-of-the-art and the historical evolution of research in the area under study
- Understand in depth the critical elements of the DBMS architecture
- Organize the data using appropriate data representations both at the logical and physical levels, such that the data can be easily and efficiently retrieved
- Use specialized query evaluation algorithms, depending on the data domain
- Develop a complete project wherein they apply the design and algorithmic knowledge obtained from the course in order to manage complex data collections

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…*
	…….

- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Team work
- Algorithmic thinking
- Abstraction ability for problem modeling
- Apply research results in solving practical problems
- Literature studying and management

(1) SYLLABUS

Spatial Indexes and Queries

Dimensionality Reduction for Multimedia Data

Top-k queries and skyline queries

Data Warehouses and OLAP

Processing aggregate queries

Time-series and Prediction

Large project development in phases

TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Weekly 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 projector and interactive board during lectures.
• Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs).
• Announcement of assessment marks via the course web site.
• Use of email and social media for information exchange and improved communication with students.</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>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>13*3 = 39 hours</td></tr>
<tr><td>Tutorials</td><td>13*1 = 13 hours</td></tr>
<tr><td>Self-study</td><td>148 hours</td></tr>
<tr><td></td><td></td></tr>
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<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>200 hours</td></tr>
</table>
</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>LANGUAGE OF EVALUATION: Greek

METHODS OF EVALUATION
(i) At each lecture, the students are asked to be prepared on the material of the lecture and to participate in the critical discussions that arise.
(ii) At each lecture, the students are asked to answer to questions and exercises related to the learning outcomes of the previous lecture.
(iii) A large programming assignment (project).

The evaluation procedure is accessible to students via the course website.</td></tr>
</table>

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Book [22683637]: Θεμελιώδεις αρχές συστημάτων βάσεων δεδομένων, Συγγραφείς: Elmasri Ramez,Navathe Shamkant B., Έκδοση: 6η Έκδοση Αναθεωρημένη/2012, ISBN: 978-960-531-281-7, Διαθέτης (Εκδότης): ΔΙΑΥΛΟΣ Α.Ε. ΕΚΔΟΣΕΙΣ ΒΙΒΛΙΩΝ

Book [18548901]: Συστήματα διαχείρισης βάσεων δεδομένων, Συγγραφείς: Ramakrishnan Raghu, Gehrke Johannes, Έκδοση: 3η Έκδοση/2011, ISBN: 978-418-960-371-5, Διαθέτης (Εκδότης): ΕΚΔΟΣΕΙΣ Α. ΤΖΙΟΛΑ & ΥΙΟΙ Α.Ε.

Book [12535833]: Συστήματα Βάσεων Δεδομένων, Συγγραφείς: Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Έκδοση: 6η έκδ./2011, ISBN: 978-960-512-623-0, Διαθέτης (Εκδότης): Χ. ΓΚΙΟΥΡΔΑ & ΣΙΑ ΕΕ

- Related academic journals:

- ACM Transactions on Database Systems
- IEEE Transactions on Knowledge and Data Engineering
- The VLDB Journal, Springer

D8. Biomedical data analysis

H0. Introduction to Computer Hardware Systems

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**H0**	**SEMESTER**	**-**
COURSE TITLE	Introduction to Computer Hardware Systems		

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**
Lectures / Tutorials	**3+1**	**7**
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*	Specialized general Knowledge
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK & ENGLISH
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/course/view.php?id=1727

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*

The primary aim of the course is to convey an in-depth understanding of modern computer systems hardware. After successfully passing this course the students will be able to:

- Describe the structure and operational characteristics of the core and memory hierarchy of a microprocessor.
- Demonstrate an understanding of
  - VLSI Design (full custom, standard cells, gate arrays), CMOS technology, manufacturing technologies and ASICs
  - Basic theory of MOS transistors, elementary & complex gates
  - low-power design techniques at device, module and system levels
- Understand testing requirements in modern VLSI systems, explain testing procedures and describe basic design for testability structures and testing standards.

- Demonstrate an understanding of
  - the basic components of a robotic system and their functions
  - the basic concepts of the kinematics of robotic systems

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…*
	…….

- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Analysis of requirements for problem solving
- Working independently
- Use abstraction to understand and analyze complex systems/problems

SYLLABUS

Processor core and cache organization: Instruction set architecture, Instruction-level parallelism, Organization and operation of cache memories, Performance evaluation of a computer

VLSI: VLSI design technologies, ASICs, packaging technologies, DRC, economics, MOS transistors, inverter, basic gates, complex gates, standard cells, gate arrays, basic transistor theory.

Testing and Design for Testability: VLSI testing, scan testing, built-in self test (BIST), testing standards (JTAG, IEEE1500).

Low-power design: Power consumption in CMOS circuits, modelling and evaluation of power, low-power design techniques

Robotics: Basic components of a robotic system and their functions, sensors and actuators, position and orientation of a robot, kinematics of a robot.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures and tutorials
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector and interactive board during lectures. • Use of special electronic equipment and software for delivering the project. • Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs). • Announcement of assessment marks via the ecourse platform by UOI. • Use of email for information exchange and improved communication with students.

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

Activity	*Semester workload*
Lectures	13x3 = 39 hours
Tutorials	13x1 = 13 hours
Quizzes	5x1=5 hours
Self-study	118 hours
Course total	**175 hours**

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.

LANGUAGE OF EVALUATION: Greek

METHODS OF EVALUATION

Quiz-style written exam at the end of each sub-module. Overall course mark is the average of the module quiz scores. The Quiz may include problem solving, multiple-choice, and short-answer questions. The quizzes are evaluated based on the correctness and completeness of answers.

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- SYSTEM ON CHIP TEST ARCHITECTURES, L-T. Wang, C. Stroud, N. Touba, Εκδ.: Morgan-Kaufmann, 2008.
- CMOS VLSI DESIGN: A CIRCUITS AND SYSTEMS PERSPECTIVE, N. Weste and D. Harris, Addison-Wesley, 2011.
- Modern Processor Design, J.P. Shen, M. H. Lipasti, Waveland Press, 2013
- Robotics: Modeling, Planning and Control, Siciliano B., Sciavicco L., Oriolo G., Springer, 2009

-Συναφή επιστημονικά περιοδικά:

- IEEE Transactions on Computers,
- IEEE Transactions on Computer Aided Design of Integrated Circuits and Systems,
- IEEE Transactions on VLSI Systems,
- IEEE Design & Test of Computers
- IEEE Transactions on Robotics
- IEEE/ASME Transactions on Mechatronics

H1. Modern Computer Architecture

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	GRADUATE			
COURSE CODE	**H1**	**SEMESTER**	**Spring**	
COURSE TITLE	**MODERN COMPUTER ARCHITECTURE**			
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**
Lectures / Project			**3**	**7**
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialized general Knowledge			
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK & ENGLISH			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/enrol/index.php?id=1850			

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*

The primary aim of the course is to convey an in-depth understanding of modern, high-performance processor micro-architecture and the memory hierarchy. After successfully passing this course the students will be able to:

- Describe the structure and operational characteristics of a pipelined microprocessor.
- Demonstrate an understanding of pipeline hazards and interlocks, out-of-order execution, scoreboards and reservation tables, branch prediction
- Evaluate the performance of a processor and memory system.
- Describe the memory coherency issues involved when designing a multiprocessor system, and explain the behaviour of a typical cache coherency protocol.
- Adapt existing simulators, run simulations and present a critical evaluation of the

results.

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…*
	…….

- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Analysis of requirements for problem solving
- Team work
- Use abstraction to understand and analyze complex systems/problems
- Adapting to new situations

SYLLABUS

Introduction: Performance measurement. Energy consumption metrics. Reliability metrics. Benchmark programs. Simulators.
Pipelined processor organization: Instruction dependencies, pipeline hazards, data forwarding, pipeline stall, delayed branches. Code scheduling.
Instruction-level parallelism: Dynamic/static superscalar processors. Dynamic scheduling. .Out of order execution. Speculative execution. Branch prediction.
Memory subsystem: memory technology. Organization and operation of cache memories. Performance evaluation of cache memory. Virtual memory, fast memory address translation, virtually/physically addressed caches.
Parallel systems: Shared-memory multicore systems. Memory coherence, memory consistency.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, Project
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector and interactive board during lectures. • Use of special electronic equipment and software for delivering the project. • Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs). • Announcement of assessment marks via the ecourse platform by UOI. • Use of email for information exchange and improved communication with students.

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*	

Activity	*Semester workload*
Lectures	13*3 = 39 hours
Tutorials	
Project	10*2 = 20 hours
Self-study	116 hours
Course total	**175 hours**

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.*	LANGUAGE OF EVALUATION: Greek METHODS OF EVALUATION (i) Final examination, which includes problem solving. The exam papers are evaluated based on the correctness and completeness of answers. (ii) Laboratory & Project Examination

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

J.P. Shen, M. Lipasti: Modern Processor Design: Fundamentals of Superscalar Processors

-Συναφή επιστημονικά περιοδικά:

- IEEE Micro, IEEE Computer Architecture Letters, IEEE Transactions on Computers
- Transactions on Architecture and Code Optimization, Transactions on Computer Systems, ACM.
- Microprocessors and Microsystems, Journal of Systems Architecture, Elsevier.

H2. Reliable Integrated Systems

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	POSTGRADUATE - MASTER LEVEL			
COURSE CODE	**Y2**	**SEMESTER**	**Fall**	
COURSE TITLE	Reliable Integrated Systems			
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**
Lectures / Labs / Tutorials			**4**	**7**
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*	Specialized General knowledge, Skills development			
PREREQUISITE COURSES:	Digital Design I and II, Computer Architecture, VLSI Circuits			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK - ENGLISH			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	http://www.cs.uoi.gr/~tsiatouhas/Y2-RIS.htm			

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*

This course aims at introducing to students the fundamentals of integrated circuits and systems testing and design for testability and reliability.

At the end of the course students should be able to perform the following:

- Understand the importance of integrated circuits and systems testing as well as design for testability and reliability, its impact on the total cost and the quality of the designed product.
- State the trends and challenges in the field of VLSI testing and reliable design.
- Understand defect as well as wear out and aging generation mechanisms in

nanometer technologies.

- Analyze testing requirements and examine different test and reliability methodologies.
- Develop design for testability (DfT) techniques.
- Develop design for reliability (DfR) techniques.
- Become a better VLSI designer and test engineer.
- Do research in the field of VLSI test technology.

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…*
	…….

- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Adapting to new situations
- Analysis of requirements for problem solving
- Abstraction ability for problem modeling
- Combination of existing methods for the synthesis of high quality solutions
- Working independently
- Team work

SYLLABUS

With the continuous scaling of transistor feature size, the chip complexity is dramatically increased since billions of transistors are integrated in a single chip (see the case of Systems-on-Chip – SoCs). Aiming to provide high quality integrated circuits and systems, these must be reliable and fully tested after production. In addition, during their whole operational life time in the field, we must ensure their reliable and uninterruptable operation. Consequently, design for reliability is an integral part of integrated circuits and systems design and manufacturing.

This course covers the fields of integrated circuits and systems testing, design for testability and design for reliability. The topics discussed are: Importance of testing, Defects and fault models, Wear out and aging mechanisms, PVT variations, Test process, Advanced design for testability techniques, Advanced design for reliability techniques, Self-healing systems.

TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face, lectures, lab courses, home-works</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>• Use of e-slides and interactive board during lectures.
• Use of computer-aided design tools at the laboratory (circuit design and simulation).
• Course website maintenance. Announcements and posting of teaching material (lecture slides and notes).
• Use of the ecourse facility.
• Use of email for information exchange and improved communication with students.</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>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>13*3 = 39 hours</td></tr>
<tr><td>Project</td><td>11*1 = 11 hours</td></tr>
<tr><td>Problems solving</td><td>75 hours</td></tr>
<tr><td>Study & bibliography analysis</td><td>75 hours</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Course total</td><td>200 hours</td></tr>
</table>
</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>LANGUAGE OF EVALUATION: Greek - English

METHODS OF EVALUATION

(i) Final examination, which includes problem solving. The exam papers are evaluated based on the correctness and completeness of answers.

(ii) Project which includes bibliography study, design techniques analysis and their application for the development of high reliability VLSI circuits.

The evaluation procedure is accessible to students via the course website.</td></tr>
</table>

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Βιβλίο VLSI TEST PRINCIPLES AND ARCHITECTURES, L-T. Wang, C-W Wu, X. We, Εκδ.: MORGAN-KAUFMANN, 2006.
Βιβλίο SYSTEM ON CHIP TEST ARCHITECTURES, L-T. Wang, C. Stroud, N. Touba, Εκδ.: MORGAN-KAUFMANN, 2008.
Book [41963448]: CMOS VLSI DESIGN: A CIRCUITS AND SYSTEMS PERSPECTIVE, N. Weste and D. Harris, Addison-Wesley, 2011.

Book [13944]: DIGITAL INTEGRATED CIRCUITS, Jan M. Rabaey, A. Chandrakasan, B. Nikolic, Prentice Hall, 2003.
Βιβλίο DESIGN OF HIGH-PERFORMANCE MICROPROCESSOR CIRCUITS, A. Chandrakasan, W. Bowhill, F. Fox, Εκδ.: IEEE PRESS, 2001.

- Related academic journals:

- Design and Test Magazine, IEEE.
- IEEE Transactions on VLSI Circuits and Systems (TVLSI).
- Integration the VLSI Journal, Elsevier
- IEEE Transactions on Circuits and Systems I & II (TCAS).
- IEEE Journal of Solid-State Circuits (JSSC).

H4. Embedded Systems for IoT Applications

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**Y4**	**SEMESTER**	**Fall**
COURSE TITLE	Embedded Systems for IoT Applications		

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**
Lectures / Labs / Tutorials	**3+1**	**7**
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*	Specialized general Knowledge
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK & ENGLISH
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	

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*

The students acquire the basic knowledge on integrated circuit and system design for the Internet of Things (IoT), and in particular for the nodes at its edge.

The students learn what the IoT is from the design point of view and the system point of view, and how the constraints imposed by IoT applications translate into integrated circuit requirements and design guidelines.

After taking this course, beside the state-of-the-art design techniques for IoT applications, the students will learn about the fundamental sub-systems encountered in Systems on Chip for IoT:

- ultra-low power digital architectures and circuits, low- and zero-leakage memories (including emerging technologies)
- circuits for hardware security and authentication
- on-chip power management and energy harvesting
- ultra-low power analog interfaces and analog-digital conversion
- short-range radios
- miniaturized battery technologies
- packaging and assembly of IoT integrated systems (on silicon and non-silicon substrates).

The course also examines how the IoT could evolve based on recent and foreseeable trends in the semiconductor industry, highlighting the key challenges, as well as the opportunities for circuit and system innovation to address them.

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…*
	…….

- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Analysis of requirements for problem solving

SYLLABUS

- The IoT Ecosystem
  - Embedded Computer Devices
  - M2M Communications
  - Smart environments
  - Cyber-physical systems
  - Cloud computing, fog computing, edge computing
  - Fog and cloud interplay
  - IoT Application Constraints
- Energy efficient IoT devices

- Ultra-low power digital architectures and circuits
- Low- and zero-leakage memories (including emerging technologies)
- Ultra-low power analog interfaces and analog-digital conversion
- Short-range radios
- On-chip power management and energy harvesting

- Security in IoT Devices
  - Circuits for hardware security and authentication
- Miniaturized battery technologies
- Packaging and assembly of IoT integrated systems

Terms: Embedded Computer Devices, Energy Efficient IoT Devices, Energy Harvesting for IoT, Internet of Things, Intranet Connected Devices, IoT, IoT Devices, IoT System-on-chip, M2M Communications, Security in IoT Devices, ultra-low power digital architectures and circuits, low- and zero-leakage memories (including emerging technologies), circuits for hardware security and authentication, System on Chip design methodologies, on-chip power management and energy harvesting, ultra-low power analog interfaces and analog-digital conversion, short-range radios, miniaturized battery technologies, packaging and assembly of IoT integrated systems (on silicon and non-silicon substrates), Cyber-Physical Systems, Cloud computing, fog computing, edge computing, fog and cloud interplay, smart environments

TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>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 projector and interactive board during lectures.
• Use of special electronic equipment and software for delivering the project.
• Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs).
• Announcement of assessment marks via the ecourse platform by UOI.
• Use of email and social media for information exchange and improved communication with students.</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,</td><td><table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>13x3</td></tr><tr><td>Tutorials</td><td>13x1</td></tr></table></td></tr>
</table>

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*	Labs	-
	Self-study	123
	Course total	**175 hours**
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.*	LANGUAGE OF EVALUATION: Greek / English METHOD OF EVALUATION: Written Exam	

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Enabling the Internet of Things: From Integrated Circuits to Integrated Systems, Massimo Alioto (Publisher: Springer)
2. Big Data and Internet of Things: A Roadmap for Smart Environments, in book series Computational Intelligence, Volume 546, Nik Bessis, Ciprian Dobre (Publisher: Springer)

-Συναφή επιστημονικά περιοδικά:

- IEEE Transactions on Circuits and Systems I and II,
- IEEE Transactions on Computers,
- IEEE Transactions on Computer Aided Design of Integrated Circuits and Systems,
- IEEE Transactions on VLSI Systems

H5. Robotic Systems

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING

ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**H5**	**SEMESTER**	Spring
COURSE TITLE	**ROBOTIC SYSTEMS**		

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**
Lectures / Labs / Tutorials	**4**	**7**
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*	Specialized general knowledge
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/course/view.php?id=1037

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*

The main course objective is to introduce students with more advanced aspects in selected areas of robotics, such as non-linear control, and motion planning of a robotic platform.

A student that successfully attends this course should be able to:

- Understand, design, and implement advanced control methodologies for robotic manipulators and mobile platforms.
- Demonstrate advanced knowledge in motion planning of a robotic platform or a robotic fleet.
- Study and solve real life complex problems in the control of robotic systems.
- Understand research papers in the field of robotics and try out some innovative ideas.

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 *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Criticism and self-criticism* *Production of free, creative and inductive thinking* *……* *Others…*

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Adapting to new situations
- Decision-making
- Team work
- Working in an interdisciplinary environment
- Production of new research ideas
- Production of free, creative and inductive thinking
- Abstraction ability for problem modeling

SYLLABUS

Kinematics: Direct kinematics, inverse kinematics, differential kinematics, Jacobian matrices, singularities, kinematics of mobile robots.

Sensors and actuators: Actuators in Robotics, electronic subsystem, sensors, amplifiers, control system, PID control of a joint, control architecture of a mobile robot.

Robotic motion planning: Robot planning and control architecture, path planning, the configuration space, obstacles in work-space, roadmap, artificial potential fields, non-holonomic constraints, motion planning of a robotic fleet.

Advanced control of robotic systems: Compliance control, impedance control, non-linear control, visual servoing.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures, lab courses
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector and computer during lectures. • Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, exercises, example programs). • Use of robots in laboratories. • Announcement of assessment marks via the ecourse platform by UOI. • Use of email for information exchange and improved communication with students.
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.*	

Activity	***Semester workload***
Lectures	13*3 = 39 hours
Labs	13*1 = 13 hours
Self-study	123 hours

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		
	Course total	**175 hours**
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.*	LANGUAGE OF EVALUATION: Greek METHODS OF EVALUATION (i) Final written examination. (ii) Project. The evaluation procedure is accessible to students via the course website.	

ATTACHED BIBLIOGRAPHY

-Suggested bibliography in Greek:

- Siciliano, B., Sciavicco, L., Villani, L., Oriolo, G., Ρομποτική: Μοντελοποίηση, Σχεδιασμός και Έλεγχος, Εκδόσεις Φούντας, 2013.
- Craig, J.J., Εισαγωγή στη Ρομποτική, Εκδόσεις Τζιόλα, 2009.
- Δουλγέρη, Ζ., Ρομποτική: Κινηματική, Δυναμική και Έλεγχος Αρθρωτών Βραχιόνων, Εκδόσεις Κριτική, 2007.
- Εμίρης, Δ., Κουλουριώτης, Δ.Ε., Ρομποτική, Εκδόσεις ΣΕΛΚΑ - 4Μ ΕΠΕ, 2006.

-Suggested bibliography in English:

- Siciliano, B., Sciavicco, L., Villani, L., Oriolo, G., Robotics: Modelling, Planning and Control, Springer, 2009.
- Craig, J.J., Introduction to Robotics: Mechanics and Control, Prentice Hall, 2004.
- Corke, P., Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, Springer, 2011.
- Angeles, J., Fundamentals of Robotic Mechanical Systems: Theory, Methods, and Algorithms, Springer, 2014.
- Choset, H., et al., Principles of Robot Motion: Theory, Algorithms, and Implementations, The MIT Press, 2005.

-Related academic journals:

- The International Journal of Robotics Research.
- IEEE Transactions on Robotics.
- IEEE/ASME Transactions on Mechatronics

S0. Introduction to Software Systems

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING

ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	S0	**SEMESTER**	
COURSE TITLE	Introduction to Software Systems		
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**
	Lectures / Labs/ Exercices	3 / 1/ 0	7
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialised general knowledge		
PREREQUISITE COURSES:	NO		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/course/view.php?id=1726		

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*

The course L0 “Introduction to Software Systems” aims to provide post-graduate students with the necessary background on advanced topics in the area of software systems.

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

- Production of free, creative and inductive thinking
- Decision making
- Search for, analysis and synthesis of information, and use of the necessary technology.

- Team work
- Autonomous work
- Ability to apply research results to the solution of practical problems

SYLLABUS

The course covers the following areas of software systems

- Programming languages
- Software technology
- Virtualization
- Security
- Networking
- Fault tolerance and consistency
- Parallelism

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Weekly lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Lecture slides, course Web page maintenance (slides and course notes), e-mail communication
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*	
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,*	Language of evaluation: Greek Methods of Evaluation: Course participation, in-class quizzes, programming exercises The exact evaluation procedure is announced to

Activity	*Semester workload*
Lectures	13x3=39 hours
Laboratory practice	13x1=13 hours
Student's study hours	123 hours
Course total	***175 hours***

other *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	students on the course website

ATTACHED BIBLIOGRAPHY

Proposed bibliography:

Guide to the Software Engineering Body of Knowledge, Version 3.0, P. Bourque and R.E. Fairley, eds., IEEE Computer Society, 2014, ISBN 978-0-7695-5166-1

Ανάπτυξη Προγραμμάτων σε Java: αφαιρέσεις, προδιαγραφές, και αντικειμενοστρεφής σχεδιασμός, B. Liskov and J. Guttag, Κλειδάριθμος, 2007, ISBN 978-960-461-063-1

Software Engineering - Theory & Practice, S. L. Pfleeger, Κλειδάριθμος, 2012, ISBN 978-960-461-477-6

Software Engineering, I. Sommerville, Κλειδάριθμος, 2009, ISBN 978-960-461-220-8

UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design (2nd Edition). Jim Arlow, Ila Neustadt. Addison-Wesley Professional, 2005, ISBN 978-020-177-060-5

Principles of Computer System Design: An Introduction, J. H. Saltzer, M. F. Kaashoek, Morgan Kaufmann/Elsevier, 2009, ISBN 978-012-374-957-4

Introduction to High Performance Scientific Computing, Victor Eijkhout (2nd edition), 2016, ISBN 978-125-799-254-6

S1. Software & Data Evolution

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	**S1**	**SEMESTER**	**Fall**
COURSE TITLE	**SOFTWARE & DATA EVOLUTION**		
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**
Lectures / Tutorials		3/1	7
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*	Special background		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)	http://www.cs.uoi.gr/~zarras/software-data-evol.html		

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*

After successfully passing this course the students will be able to:

- Understand the state-of-the-art and the historical evolution of research in the area under study.
- Understand in depth the critical steps in the process of re-engineering.
- Reverse engineer an existing system and produce (a) an abstract model of the system and (b) the appropriate documentation that goes along with the abstract model.
- Identify symptoms of bad design and rigidity and prioritize them in terms of re-engineering.
- Understand the role of re-engineering patterns in the process of software maintenance, their interrelationships and tradeoffs.

- Design specific solutions for the identified problems and assess both the "forces" that constrain the solution space as well as the trade-offs that each candidate solution incurs.
- Acquire hands-on experience by developing a complete project wherein they apply the design and algorithmic knowledge obtained from the course in order to re-engineer an existing complex software system.

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…*
	…….

- Production of free, creative and inductive thinking
- Decision making
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Team work
- Algorithmic thinking
- Abstraction ability for problem modeling
- Apply research results in solving practical problems
- Literature studying and management

SYLLABUS

The course Software and Data Evolution offers an in-depth coverage of a core topic within the broader field of information systems engineering -- specifically, the evolution and re-engineering of software and data. The course starts by reviewing software evolution in general. Then, it proceeds to cover in an in-depth analysis, the area of the re-engineering of legacy software. The course presents the general method of re-engineering a legacy system into a new, well-designed and maintainable object-oriented system. Then, the particular steps of the method, along with patterns and anti-patterns are covered: reverse engineering, abstract modeling of an OO system, identification of bad design symptoms, re-engineering patterns and forces. The course moves on to cover the evolution of data, and presents typical patterns by which database schemata evolve, and techniques to handle schema evolution.

A team project where a large and complex software system is re-engineered accompanies the theoretical lecturing.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY	Weekly Lectures

Face-to-face, Distance learning, etc.	
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector during lectures. • Course website maintenance. Announcements and posting of teaching material (lecture slides and notes, programs). • Use of email to improve communication with students.
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*	*Activity* / *Semester workload* Lectures: 13*3 = 39 hours Tutorials: 13*1 = 13 hours Self-study: 123 hours Course total: ***175 hours***
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.*	LANGUAGE OF EVALUATION: Greek METHODS OF EVALUATION (i) A large programming assignment in groups (project). (ii) At each lecture, the students are asked to be prepared on the material of the lecture and to participate in the critical discussions that arise concerning their project. Moreover, the students are regularly required to report on intermediate milestones of their project. (iii) Each student is assigned either (a) a data analysis tasks or (b) a literature survey, on topics relevant to the material of the course. The assignment involves the authoring of a report, to be publicly presented in class at the end of the semester The evaluation procedure is accessible to students via the course website.

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

Object-Oriented Reengineering Patterns, S. Demeyer, S. Ducasse, O. Nierstrasz, ISBN 978-3-9523341-2-6.

Working Effectively with Legacy Code, M. Feathers, Prentice Hall, ISBN-13: 978-0131177055.

Refactoring. Improving the Design of Existing Code, Fowler, Addison-Wesley, ISBN 0-201-48567-2.

Refactoring To Patterns, J. Kerievsky. Addison-Wesley, ISBN 0-321-21335-1.

Design Patterns: Elements of Reusable Object-Oriented Software, E. Gamma,R. Helm, Richard, R. Johnson, Ralph, J. Vlissides, Addison-Wesley, ISBN 0-201-63361-2.

S3. Cloud Computing Systems

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**S3**	**SEMESTER**	**Fall**
COURSE TITLE	**CLOUD COMPUTING SYSTEMS**		

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**
Lectures / Labs/ Exercices	4	7

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialised general knowledge
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://www.cse.uoi.gr/~stergios/teaching/l3

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*

- The course covers traditional and latest research publications on cloud computing systems. Examined issues include cluster management, virtualization, data storage and networking, dataflow processing, heterogeneous systems, and cloud security.
- Participating students are expected to actively contribute to the critical discussions during paper reading sessions.
- Additionally, the students under the guidance of the instructor will work on a project of their choice that will explore interesting research directions.
- Overall, the course will help students get familiar with the design, implementation and experimental evaluation of modern cloud computing systems.

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

- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Decision making
- Production of free, creative and inductive thinking
- Team work
- Autonomous work
- Production of new research ideas

SYLLABUS

- The course covers topics in the design and implementation of cloud computing systems, such as communication, synchronization, scheduling, dependability, data storage, security.
- The syllabus is adjusted every year according to the latest publications of the related literature published in international conferences and journals.

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Lecture slides • Web page maintenance with bibliography and other course material. • E-mail communication
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*	

Activity	***Semester workload***
Lectures	13x3=39 hours
Laboratory practice	13x1=13 hours
Student's study hours	123 hours
Course total	***175 hours***

the ECTS	
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.*	Language of evaluation: Greek Methods of Evaluation: i. Participation in paper reading sessions ii. Evaluation of weekly assignments iii. Project or final written examination The evaluation procedure is accessible to students via the course website.

ATTACHED BIBLIOGRAPHY

- ACM Symposium on Cloud Computing
- ACM Symposium on Operating Systems Principles
- ACM SIGCOMM Conference
- ACM European Conference on Computer Systems
- USENIX Annual Technical Conference
- USENIX Symposium on Operating Systems Design and Implementation
- USENIX Symposium on Network Systems Design and Implementation
- IEEE Computer
- Communications of the ACM

S8. High Performance Systems and Software

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**S8**	**SEMESTER**	**Spring**
COURSE TITLE	High Performance Systems and Software		
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**
	Lectures / Labs	**4**	**7**
COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES:	-		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES		
COURSE WEBSITE (URL)			

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*

High performance systems are nowadays synonymous to parallel computers, i.e. computing systems with multiple processors or cores which can work concurrently towards the solution of a problem. This course teaches the organization, the operation and the programming of parallel computers. The basic architectural choices are presented, along with the corresponding problems one has to solve during their design and implementation. In addition, parallel programming is introduced, which is necessary for the full exploitation of these systems. Parallel programming is taught through the use of contemporary programming models. Finally, the course includes a survey of recent research problems and

publications related to high performance systems.

After successfully concluding this course the students will be able to:

- Study, understand and analyze the organization of high performance system.
- Understand the problems of memory hierarchy, cache coherency and memory consistency, and select the most suitable solutions.
- Understand and analyze the topology, the switching scheme and the routing protocols in processor interconnection networks.
- Synthesize parallel software.
- Program in the shared address space model using threads and OpenMP
- Program in the message passing model using MPI.
- Use the international bibliography for related research problems and results.

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…*
	…….

- Working independently
- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Project planning and management
- Adapting to new situations
- Production of new research ideas
- Working in an international environment

SYLLABUS

- History and importance of high performance systems
- Basic principles of parallelism at the hardware and software levels, and fundamental performance laws
- Shared memory organization and multicore architectures.
- The problems of cache coherency and memory consistency
- Distributed memory organization and computational clusters.
- Interconnection networks, topologies, routing, high-performance switching
- Distributed shared memory and non-uniform memory access (NUMA)
- SIMD and GPU organizations
- Principles and languages for parallel programming

- Programming in the shared address space model (threads, OpenMP)
- Programming in the message passing model (MPI)

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face class lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of projector electronic slides. • Use of computers for the Lab exercises. • Course website maintenance with announcements and posting of teaching material (lecture slides and notes). • Use of email for communicating with students.
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*	
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.*	LANGUAGE OF EVALUATION: Greek METHODS OF EVALUATION (i) Homework problems and exercises (ii) Programming assignments (iii) Reading assignments and topic (iv) Term project

Activity	*Semester workload*
Lectures	13*3 = 39 hours
Labs	13*1 = 13 hours
Self-study	123 hours
Course total	**175 hours**

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Thomas Sterling Matthew Anderson Maciej Brodowicz, *High Performance Computing, Modern Systems and Practices*, Morgan Kaufmann, 2017
- Β. Δημακόπουλος, *Παράλληλα Συστήματα και Προγραμματισμός*, Εκδόσεις ΣΕΑΒ, Φεβ. 2016
- P.S. Pacheco, *Εισαγωγή στον παράλληλο προγραμματισμό*, Κλειδάριθμος 2015
- T. Rauber, G. Runger, *Parallel Programming for Multicore and Cluster Systems*,

Springer, 2010

- B. Wilkinson and M. Allen, *Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers*, Pearson, 2004.
- A. Grama, A. Gupta, G. Karypis and V. Kumar, *Introduction to Parallel Computing*, Addison Wesley, 2003.
- Ερευνητικές δημοσιεύσεις από συνέδρια και περιοδικά

- Related academic journals:

- Transactions on Parallel and Distributed Systems, IEEE.
- Journal of Parallel and Distributed Computing, Elsevier.
- International Journal of Parallel Programming, Springer.
- Concurrency and Computation: Practice and Experience, Wiley.
- Parallel Computing, Elsevier
- Journal of Supercomputing, Springer
- ACM Transactions on Parallel Computing