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 2021/2022

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**	Fall
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
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
- 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).

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

- Announcement of assessment marks via the e-course platform by UOI.

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

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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:

- Final written examination with problem solving questions.
- Homework assignments.

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

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</table>

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**	
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*	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure*	Language of evaluation: Greek

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

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.*	Methods of Evaluation: i) Final written examination 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**	
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.

A3. Computational Complexity

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**A03**	**SEMESTER**	
COURSE TITLE	COMPUTATIONAL COMPLEXITY		
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/Exercises		3/1/0	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 (IN GREEK)		
COURSE WEBSITE (URL)	http://www.cs.uoi.gr/~cnomikos/courses/complexity/complexity-main.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*
The course objective is to introduce students in the research area of computational complexity theory and to bring them in touch with the most important open problems in

this area.

After successfully completing this course the students

- will know what a computational problem is.
- will know what a complexity measure is.
- will know the basic deterministic and non-deterministic time and space complexity classes and the relations between them.
- will have clear understanding of what it means that a problem is complete for a class.
- will have the ability to prove that a problem is hard to solve, using a polynomial time reduction.
- will have clear understanding of what it the meaning of randomized computation and how it can be modeled using non-deterministic Turing machines.
- will know the basic randomised complexity classes.
- will have clear understanding of what it means to solve an optimization problem by an approximation algorithm.

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.
- Autonomous work.

SYLLABUS

- Computational problems and formal languages.
- Turing machines.
- Complexity measures: running time and working space.
- Non-deterministic Turing machines.
- Complexity classes.
- Relations between complexity classes.
- Hierarchy Theorems. The Gap Theorem.
- Polynomial time reductions and completeness.
- The class NP.
- Cook’ s Theorem.
- NP-complete problems in logic.

- NP-complete problems in graphs.
- NP-complete problems in sets.
- NP-complete problems in numbers and pseudo-polynomial algorithms.
- The class PSPACE.
- PSPACE-complete problems
- Savitch's Theorem.
- The Immerman-Szelepscenyi Theorem.
- Probabilistic complexity classes: RP, ZPP, PP, BPP.
- The polynomial hierarchy.
- Approximate solution of hard computational problems: positive and negative results.

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*	
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,*	Language of evaluation: Greek Methods of Evaluation: iv) Assignments during semester (25%) v) Public presentation (25%) vi) Final written examination (problem

Activity	*Semester workload*
Lectures	13x3=39 hours
Laboratory practice	13x1=13 hours
Student's study hours	148 hours
Course total	***200 hours***

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.*	solving) (50%)

ATTACHED BIBLIOGRAPHY

-Recommended Bibliography :

"Computational Complexity", Christos Papadimitriou.

"Computational Complexity: A Modern Approach", Sanjeev Arora and Boaz Barak.

"Computability, Complexity and Languages", Martin Davis, Ron Sigal and Elaine Weyuker.

"Computers and Intractability", M. R. Garey and D. S. Johnson.

-Related Journals:

Computational Complexity (Springer)

Journal of Complexity (Elsevier)

Transactions on Computation Theory (ACM)

Journal of the ACM

SIAM Journal on Computing

Theoretical Computer Science (Elsevier)

Theory of Computing Systems (Springer)

Journal of Computer and System Sciences (Elsevier)

Information and Computation (Elsevier)

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**	**SPRING**
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
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*	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,*	

Activity	*Semester workload*
Lectures	13*3 = 39 hours

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*	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: 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:

D2. Data Mining

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF SCIENCES		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**Λ07**	**SEMESTER**	
COURSE TITLE	Data Mining		
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	8
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.cse.uoi.gr/~arly/courses/dm/dm.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 data mining problems and solutions. The main problems presented and studied are related to classification, regression, clustering, feature selection/extraction and discovery of association rules. 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 the data mining 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
- the ability to discover association rules from data
- the ability to handle large scale datasets
- the skill to apply all the algorithmic steps required for extracting useful knowledge 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…*
	…….

- 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

Introduction to data mining problems, learning and generalization, data preprocessing, linear models, decision trees, rule-based classifiers, naïve Bayes, SVM, classifier ensembles, model selection and evaluation, prototype-based clustering (eg. k-means), agglomerative clustering, spectral clustering, association rule mining, feature selection and extraction, scaling issues.

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*	

Activity	*Semester workload*
Lectures	13x3=39 hours
Laboratory practice	13x1=13 hours
Student's study hours	148 hours

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*		
	Course total	***200 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: vii) Final written examination viii) Lab projects examination ix) Evaluation of weekly assignments The evaluation procedure is accessible to students via the course website.	

ATTACHED BIBLIOGRAPHY

Book: P. Tan, M. Steinbach and V. Kumar, “Introduction to Data Mining”, Addison-Wesley 2006.
Book: D. Hand, H. Mannila, P. Smyth, “Principles of Data Mining”, MIT Press, 2001.
Book: I. Kononenko and M. Kukar, “Machine Learning and Data Mining: Introduction to Principles and Algorithms”, Horwood Publishing, 2007.

D3. Optimization

COURSE OUTLINE

GENERAL

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

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:

- 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		**SEMESTER**	-
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**
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://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.

	• Use of email and social media for more effective 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*	
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. 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.

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:

- 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

D6. Online Social Networks and Media

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**D6**	**SEMESTER**	
COURSE TITLE	**ONLINE SOCIAL NETWORKS AND MEDIA**		
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 / Exercises/ Project	3	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/~tsap/teaching/cs-l14/		

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*

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

- knowledge of basic metrics and measurements for real networks, such as power-law degree distributions and clustering coefficient
- knowledge of models for real networks
- the knowledge and ability to find communities in graphs, or dense subgraphs.
- understanding of dynamic processes on networks, such as influence spread, or opinion formation, and algorithms for affecting them
- knowledge of metrics and algorithms for identifying central and influential nodes in a graph.
- Knowledge of different models algorithms for predicting links or understanding their strength and sign
- Knowledge on specialized topics related to networks such as privacy, team formation, small world effects, fairness, content-based analysis
- The ability to process and manipulate large graphs using programming tools

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

- Theoretical problems and applications around the analysis and mining of (online) social networks and media such as Facebook and Twitter.
- Indicative subjects: models for networks, techniques for obtaining, storing and processing networked data, models for information diffusion, algorithms for ranking and selecting of influencers, dynamic processes such as influence spread and opinion formation, team formation and community finding, games over networks, privacy, fairness and diversity.

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*	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions,*	Language of evaluation: Greek or English Methods of Evaluation: x) Assignments xi) Presentation

Activity	***Semester workload***
Lectures	13x3=39 hours
Student's study hours	123 hours
Final Project	13 hours
Course total	***175 hours***

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.*	xii) Final project The evaluation procedure is accessible to students via the course website.

ATTACHED BIBLIOGRAPHY

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**	-	
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.

H3. 3D Systems on Chip

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**H3**	**SEMESTER**	**-**
COURSE TITLE	**3D SYSTEMS ON CHIP**		

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 the design and test of 3-Dimensional Systems-on-Chip. Initially they understand the 2D limitations that led to the 3D integration and then they study the basic mechanisms for solving such problems. The students emphasize on the design, manufacturing and test methods proposed to attack electrical, temperature and power-dissipation issues in 3D stacks, while at the same time they face problems related to the embedding of multiple cores/memory and they understand the proposed solutions for each case. Finally, they study applications of 3D manufacturing.

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 *Working in an interdisciplinary environment* *Production of new research ideas*	*Production of free, creative and inductive thinking* *……* *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

2D Barriers, 3D SoC Integration, 3D Classification, Through-Silicon-Vias, Permanent and Temporary Bonding Technologies, Wafer Thinning, Stress Relief, Wafer Handling, Under-fill, Self Assembly, Thermal Management, Thermal Aware Architectures, Power & Thermal Integrity, Energy & Power Models, Electrothermal Simulation, 3D IC Cooling, Inductive Coupling, Power Delivery, TSV-to-TSV Coupling, TSV Current Crowding & Power Integrity, TSV Placement, Buffer Insertion, Low-Power Clock Routing, Power Network Design, Floorplanning, Gate-Level Placement, Digital/Analog/Mixed-Signal IC Applications, SoCs, GPUs and MicroProcessors, Image Sensor Applications, NoCs, Pre-bond and Post-bond Testability, 3D TAM architectures and optimization, TSV Testing, Test Flows and Cost Models

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	The teaching is performed through powerpoint slides and the communication is conducted by electronic means (ecourse, email etc)
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 / English METHOD OF EVALUATION: Written Exam

Activity	*Semester workload*
Lectures	13x3
Tutorials	13x1
Labs	-
Self-study	123
Course total	**175 hours**

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Design of 3D Integrated Circuits and Systems, R. Sharma, K. Iniewski, CRC Press, 2015
2. 3D Integration for VLSI Systems, C. S. Tan, K. N. Chen, S. J. Koester, Pan Stanford Publishing, 2012
3. Design for High Performance, Low Power, and Reliable 3D Integrated Circuits, Sung Kyu Lim, Springer 2013
4. 3D Stacked Chips, From Emerging Processes to Heterogeneous Systems, I. M. Elfadel and G. Fettweis, Springer, 2016
5. Handbook of 3D Integration, Technology and Applications of 3D Integrated Circuits, P. Garrou, M. Koyanagi, P. Ramm, Wiley-VCH, 2014

-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

H4. Embedded Systems for IoT Applications

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF SCIENCE		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**Y4**	**SEMESTER**	**-**
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

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures
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 and social media 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
	Tutorials | 13x1
	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**	-
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 *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
- 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.* *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 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	POLYTECHNIC		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	L0	**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	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
	Respect for the natural environment

Decision-making *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*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.*	

Activity	***Semester workload***
Lectures	13x3=39 hours
Laboratory practice	13x1=13 hours
Student's study hours	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: Course participation, in-class quizzes, programming exercises The exact evaluation procedure is announced to 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

S3. Cloud Computing Systems

COURSE OUTLINE

GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING		
LEVEL OF STUDIES	GRADUATE		
COURSE CODE	**S3**	**SEMESTER**	
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	*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

- 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*	

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

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*	<table><tr><td></td><td></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>***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: 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

S5. Mobile and Wireless Networks

COURSE OUTLINE

GENERAL

SCHOOL	SCHOOL OF ENGINEERING			
ACADEMIC UNIT	DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING			
LEVEL OF STUDIES	POSTGRADUATE			
COURSE CODE	**S5**	**SEMESTER**		
COURSE TITLE	**Mobile and Wireless Networks**			
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**
COURSE TYPE *general background, special background, specialised general knowledge, skills development*				
PREREQUISITE COURSES:	-			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK			
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES			
COURSE WEBSITE (URL)	http://www.cs.uoi.gr/~epap/L05			

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 offers an insight into wireless and mobile networking. To this end, the course will analyze the most well-known technologies for wireless and mobile networks as well as the users' needs met by each technology. The course also focuses on new trends in building wireless and mobile networks. After successfully completing the course, a student should be able to:

- understand the basic challenges in wireless and mobile networking
- understand the basic architectures and networking technologies implemented in real-life wireless mobile networks as well as the users' needs that each of these technologies meets
- comprehend the basic networking mechanisms and how these mechanisms influence the network's performance
- be able to evaluate the performance of a network in the context of limited resources that are available in a mobile node

- be able to identify open issues and challenges and propose possible solutions

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
- Abstraction ability for problem modeling
- Working independently

SYLLABUS

The course focuses on the key enabling technologies for wireless and mobile networks and delineates their fundamental operating principles. In the first part, the course examines the dominant technologies in the field of wide area and metropolitan area infrastructured networks such as LTE and WiMAX. Then, the course focuses on ad hoc networks, such as Mobile Ad Hoc Networks (MANETs) and opportunistic networks, as well as on Delay Tolerant Networking (DTN). Finally, the course discusses key technologies proposed in the context of 5G networks. Summarizing, the following technologies will be examined during the course:

- 4G Networks and LTE
- Wireless Metropolitan Access Networks (WiMAX)
- Mobile Ad Hoc Networks (MANETs) and Opportunistic Networks, Mobile Social Networks
- Delay Tolerant Networks (DTNs)
- Machine-to-Machine Communication (M2M), Internet of Things (IoT) in 5G Networks,
- Software Defined Networking (SDN), Network Slicing

TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Weekly Lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	• Use of projector during lectures.

Use of ICT in teaching, laboratory education, communication with students	• 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) Final exams
(ii) Project

ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- J. Kurose and K. Ross, Computer Networking: A Top-Down Approach, 7th edition, Pearson, 2017.
- Scholarly articles published in the relevant scientific journals

-Relevant scientific journals

- IEEE/ACM Transactions on Networking
- IEEE Transactions on Mobile computing
- IEEE Transactions on Wireless Communications
- IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS (J-SAC)
- Elsevier Ad Hoc Networks