COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**ECE_INF830**	**SEMESTER**	**8**
COURSE TITLE	Advanced Algorithms & 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	3	
Seminars / Practice exercises	1	
Laboratory		
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).	4	5

COURSE TYPE *general background, special background, specialised, general knowledge, skills development*	Special Background, Skills development
PREREQUISITE COURSES:	No. Students are advised to have already attended the courses: Linear Algebra(ECE_K120), Data Structures & Algorithms (ECE_K320) and Object-Oriented Programming (ECE_K430)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. Maybe offered in English if there are foreign students.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (in English)
COURSE WEBSITE (URL)	https://eclass.uop.gr/courses/ECE119/

(2) LEARNING OUTCOMES

Learning outcomes

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

Consult Appendix A

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

and Appendix B

- *Guidelines for writing Learning Outcomes*

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

- Understand fundamental issues of combinatorial optimization
- Understands the basic concepts of mathematical modeling
- Models practical optimization problems of moderate complexity and analyzing solution properties
- Understands the basic concepts of discrete problem solving techniques
- Understands the basic concepts of heuristic algorithms
- Understands the basic concepts of meta-heuristic algorithms
- Understands the basic concepts of evolutionary optimization
- Choose the appropriate combination of solving methods for complex 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…*
	…….

- *Search for, analysis and synthesis of data and information, with the use of the necessary technology*
- *Decision-making*
- *Working independently*
- *Working in an interdisciplinary environment*
- *Production of free, creative and inductive thinking*
- *Production of new research ideas*

(3) SYLLABUS

The aim of the source is to present students with problems that require the development of advanced algorithms that possess characteristics such as ambiguity, randomness, etc. and occur in areas such as artificial intelligence, machine learning and combinatorial optimization. As part of the course, mathematical modeling and problem solving techniques will be presented from the area of operational research. Furthermore, we will study algorithmic techniques from the areas of heuristics, meta-heuristics and evolutionary algorithms and their applications. In the course, special emphasis is placed on the interoperability of algorithms to solve complex optimization problems. After the successful course completion, students will be familiar with problem definition, development of hybrid optimization techniques and use of advanced solving tools and libraries.

1. Introduction to Optimization.
2. The Basic Properties of Linear Programs, Basic Solutions, The Fundamental Theorem of Linear Programming
3. Introduction to simplex method, Artificial Variables, Variables with Upper Bounds, Dual Linear Programs - Sensitivity and Complementary Slackness, Internal Points Method.
4. Introduction to Integer and Mixed Integer Programming - binary variables in model formatting, branch and bound method, cutting planes and column generation.
5. Design and analysis of combinatorial optimization algorithms.
6. Graph based problems, Shortest path finding techniques
7. Maximum flow and minimum cost problem solving algorithms
8. Problem solving using local search optimization techniques
9. Stochastic and meta-heuristic algorithms
10. Genetic and memetic algorithms
11. Hybrid techniques
12. Applications of optimization I – Problem solving in energy production & transfer.
13. Applications of optimization II – Program scheduling of computer systems

(4) 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

- The e-Class platform is used for asynchronous support of the learning process (course operations regulation, distribution of slides, project related material, complementary material,announcements, links and bibliography, etc.).
- During lectures a projector and presentations in electronic form are used, which are also posted in the eclass platform.
- During lectures and especially at seminars, a computer is used to write and execute example code.

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
Seminars	13*1 = 13
Project	7*4=28
Study and analysis of bibliography	12*3 = 36
Study for final exam	9
Course Total	***125 hours (5 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 if required)

Presentation of team project and oral examination for each student in four phase (40% of final mark).

Final examination (60% of final mark): Written exam that might include multiple choice questionnaires, short-answer questions, problem solving

Grading scale: 1 to 10
Minimum passing mark: 5
Grades < 5 correspond to ECTS grade F.
For the rest of the grades the correspondence is as follows:
>= 9: ECTS A
>= 8: ECTS B
>= 7: ECTS C
>= 6: ECTS D
>= 5: ECTS E

Note: The evaluation criteria are clearly announced during the first lecture of the semester as well as the individual percentages and the rules governing the grading, both of the above evaluation methods and of the individual percentages of the different phases of the work. The project evaluation criteria and the individual percentages are posted on the asynchronous educational platform with the project announcement.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

- Fragos Christos, Introduction to Operations Reasearch, ISBN 960-351-655-4, Stamoulis SA, 2006 (In Greek)
- Ipsilantis Pantelis, Operations Research, ISBN 978-960-7860-66-8, Propobos Publications, 2010 (In Greek)
- T. Cormen, C. Leiserson, R. Rivest, and C. Stein, Introduction to Algorithms, ISBN 978-026-203-384-8, MIT Press, 2009.
- J. Koletso and G. Stoyiannis, Introduction to Operations Research, 3rd edition, Symeon Publishing, 2017.

- Related academic journals:

- European Journal of Operations Research
- Annals of Operations Research
- Computers and Operations Research
- Journal of Optimization Theory and Applications, Springer.
- Operations Research, INFORMS.
- Operational Research, Springer.
- SIAM Journal on Optimization.
- Journal of Scheduling