COURSE OUTLINE

(1) GENERAL

SCHOOLS	NATURAL SCIENCES		
ACADEMIC UNIT/UNITS	MATHEMATICS		
TITLE OF MASTER'S DEGREE	COMPUTATIONAL AND STATISTICAL DATA ANALYTICS (MCDA)		
LEVEL OF STUDIES	POSTGRADUATE		
COURSE CODE	MCDA102	**SEMESTER**	A
COURSE TITLE	OPTIMIZATION AND DECISION MODELS		

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	7.5
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:	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eclass.upatras.gr/courses/MATH1065/

(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*

In this course, a general approach of the most important mathematical techniques for business process modeling is presented, as well as a structured methodology for applying these techniques for optimal decision making. Case studies of business administration problems are analyzed using appropriate software. Also, fundamental optimization methods for nonlinear problems are being developed.

On successful completion of the course a student will be able:

- build a quantitative model based on a real situation,
- develop solutions that provide optimal performance measures according to the desires of the decision-maker,
- compare alternative scenarios based on these measures and systematically approach the exploration of the structure of these solutions by thoroughly analyzing how a system works.

In addition, they are expected to acquire:

- the knowledge to choose the appropriate methodology to solve complex optimization problems,
- the ability to combine different methodologies for their solution,
- the ability to implement algorithms in a programming environment.

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.
- Adapting to new situations.
- Decision making.
- Working independently.
- Team work.
- Working in an interdisciplinary environment.
- Production of free, creative and inductive thinking.

(3) SYLLABUS

PART A: Mathematical Programming

Art of Modeling: more than just mathematics. Introduction to Linear Programming. Linear Programming Applications (case studies in marketing, financial, business and management, etc.). The Simplex Method. Sensitivity Analysis. Duality and Post-Optimal Analysis. Other Algorithms for Linear Programming. Transportation Model and Its Variants (transshipment problem, assignment problem). Network Optimization Models (the shortest-path problem, the minimum spanning tree problem, the maximum flow problem, the minimum cost flow problem, project management with PERT/CPM, the network Simplex method). Goal Programming, Data Envelopment Analysis. Integer Linear Programming (types of Integer Linear Programming Models, modeling flexibility provided by 0-1 integer variables, the Branch-and-Bound Technique, the Cutting-Plane algorithm). Deterministic Dynamic Programming (recursive nature of Dynamic Programming computations, the shortest-path problem, Knapsack model, Equipment Replacement model, Inventory models, Workforce Size model, Traveling Salesman problem). Inventory Theory (static Economic-Order-Quantity models). Decision Analysis and Games (Utility Theory, Nash equilibrium, Cooperative Games, the bargaining set and related concepts, Algorithmic and Evolutionary Game Theory).

PART B: Numerical methods for non-linear unconstrained optimization

The problem of non-linear optimization: mathematical formulation, method categories, local and global optimum, mathematical background. No free lunch theorems for optimization. Conditions for existence of a minimum point. Iterative process, termination criteria. Line Search Methods. Step length determination strategies (exact and inexact). Inexact linear search strategies: Armijo, curvature, Wolfe, Strong Wolfe and Goldstein conditions. Backtracking line search. Methods: Steepest Descent, Newton, Line search Newton, Conjugate Gradient, Quasi Newton. Applications.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Lectures (face to face)</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>• Use of ICT in teaching
✓ Electronic slide presentations,
✓ Use of specific software (Excel, Lingo etc.).
• Support of the course via the online platform eClass of University of Patras.</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail.
Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>39</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Study (no driven)</td><td>100</td></tr>
<tr><td>Solving suggested exercises</td><td>45</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Final examination</td><td>3.5</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Total number of hours for the Course (25 hours of work-load per ECTS credit)</td><td>187.5</td></tr>
</table>
</td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure

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

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Assessment Language: Greek
Assessment Language for Erasmus students: English

Assessment methods:
Oral examination in 3 written projects, announced during the lectures. No extra written exam will be conducted.

Minimum passing grade: 5
Maximum passing grade: 10</td></tr>
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(5) ATTACHED BIBLIOGRAPHY

- Bazaraa, M.S., Jarvis, J.J. and Sherali, H.D. (2010). *Linear Programming and Network Flows*. 4th ed. Wiley.
- Bertsekas, D.P. (1999). *Nonlinear Programming. Athena Scientific; 2nd ed.*
- Chong, K. P. Edwin and Stanislaw, Zak H. (2017). *An Introduction to Optimization.* 4th ed. Wiley.
- Dennis, J. E. and Schnabel, R. B. (1987). *Numerical Methods for Unconstrained Optimization and Nonlinear Equations.* SIAM.
- Griva, I., Nash, S.G. and Sofer, A. (2009). *Linear and Nonlinear Programming*. 2nd ed. SIAM.
- Hillier, F.S. and Lieberman, G.J. (2015). *Introduction to Operations Research.* 10th ed. McGraw-Hill.
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- Nocedal, J. and Wright, S. J. *(2006). Numerical Optimization. 2nd ed.* Springer.
- Rao, S. S. (1992). *Optimization. Theory and Applications. 2nd ed.* Wiley.
- Ravindran, A.R. (ed.) (2009). *Operations Research Methodologies*. CRC Press.
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- Tadelis, S. (2013). *Game Theory: An Introduction*. Princeton University Press.
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- Williams, P.H. (2013). *Model Building in Mathematical Programming*. 5th ed. Wiley.
- Winston, W.L. (2004.) *Operations Research. Applications and Algorithms*. 4th ed. Cengage Learning.