COURSE INFORMATON					
Course Title	*Code*	*Semester*	*L+P Hour*	*Credits*	*ECTS*
Advanced Methods in Operations Research	**ESYE560**	**1**	**3**	**3**	**10**

Prerequisites	None

Language of Instruction	English
Course Level	M.Sc.
Course Type	Elective
Course Coordinator	
Instructors	Prof. Linet Özdamar
Assistants	
Goals	This course aims to present complete and incomplete search methods designed with the goal of identifying global optimum solutions in nonconvex constrained and unconstrained optimization problems.
Content	The first section of this course discusses complexity and classification of problems, classification of algorithms in terms of local, global, complete and incomplete, and several local and global search methods are presented. In the second section, complete search methods that are guaranteed to converge to the global optimum are discussed.

Course Learning Outcomes	**Program Learning Outcomes**	**Teaching Methods**	**Assessment Methods**
1) Student can recognize convex and nonconvex functions, and conduct verification tests.	3	1,2,4	A,C
2) Student can differentiate between local and global optima.	3	1,2,4	A,C
3) Student can use derivative and non-derivative search methods.	3	1,2	A,C
4) Student can develop software for solving a problem locally or optimally.	1,3,5,7	1,2,4	C,D
5) Student can select a branch and bound method to solve a problem optimally.	1,5	1,2	D
6) Student can develop meta heuristics and apply them.	1,2,3,5,9,12	1,2,4	D

Teaching Methods:	1: Lecture, 2: Question-Answer, 3: Lab, 4: Case-study
Assessment Methods:	A: Testing, B: Experiment, C: Homework, D: Project

COURSE CONTENT		
Week	**Topics**	**Study Materials**
1	Complexity Analysis, problem classification and nonlinear programming	Textbook, Notes
2	Nonlinear programming: simple search methods	Textbook, Notes
3	Local and Global search methods: Newton, Random search, Hill climbing, Multi start hill climbing, Simulated Annealing	Textbook, Notes
4	Simulated Annealing for constrained optimization, penalty and non penalty methods	Textbook, Notes
5	Genetic Algorithms	Textbook, Notes
6	Parallel Genetic Algorithms, Tabu Search, Particle Swarm Optimization	Textbook, Notes

7	Combinatorial Optimization: Example problems, B&B, Constructive methods, GRASP, Ant Colony Optimization	Textbook, Notes
8	Complete Solvers: DIRECT, MCS, BARON, TRIOPT, Introduction to interval arithmetic	Textbook, Notes
9	Interval Partitioning for unconstrained, constrained optimization and constraint satisfaction problems	Textbook, Notes
10	Paper presentations	Literature
11	Paper presentations	Literature
12	Paper presentations	Literature
13	Project presentations	Innovation
14	Exam	Textbook, Notes

RECOMMENDED SOURCES	
Textbook	Lecture Notes: on esye421@gmail.com address
Additional Resources	1. **Essentials of Metaheuristics,** by Sean Luke**,** Department of Computer Science George Mason University, **First Edition,** 2011. 2. **Complete Search in Continuous Global Optimization and Constraint Satisfaction**, by Arnold Neumaier, Acta Numerica 2004 (A. Iserles, ed.), Cambridge University Press 2004. Other Papers on Coconut project, DIRECT, MCS, stochastic search, BARON, interval mathematics, LGO, FSQP, are also available on the course web site

MATERIAL SHARING	
Documents	Lecture notes
Assignments	Two projects
Exams	1 midterm, 1 final

ASSESSMENT		
IN-TERM STUDIES	**NUMBER**	**PERCENTAGE**
Mid-terms	1	20
Project	2	80
Total		**100**
CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE		20
CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE		80
Total		**100**

COURSE CATEGORY	Expertise/Field Courses

COURSE'S CONTRIBUTION TO PROGRAM								
No	Program Learning Outcomes	Contribution						
		1	2	3	4	5		
1	Ability to reach knowledge in breadth and depth through scientific research in Systems Engineering field; to have extensive knowledge about current techniques and procedures together with their constraints.					**X**		
2	Ability to complement and apply knowledge by scientific methods utilizing limited or missing data; to use knowledge in different			**X**				

	disciplines effectively by blending them.						
3	Ability to formulate Systems Engineering problems; to develop novel and original ideas and procedures for their solutions and to use innovative procedures in solutions.				**X**		
4	Awareness of new and developing applications in Systems Engineering; ability to investigate and learn these applications when required.						
5	Ability to design and apply analytical, and modeling and experimental based research; to solve and interpret complex situations encountered in this process.			**X**			
6	Ability to lead multi-disciplinary teams; to develop solution approaches in complicated situations and to take responsibility.						
7	Ability to develop novel and/or original ideas and methods; to develop innovative solutions for the design of systems, parts or the processes.					**X**	
8	Ability to communicate orally or in writing the process and the results of Systems Engineering studies systematically and openly in national or international platforms.						
9	Ability to master a foreign language (English) at the European Language Portfolio B2 General Level to communicate orally or in writing.			**X**			
10	Ability to recognize social, scientific and ethical values in the process of collection, interpretation and publishing of data, and in all professional activities.						
11	Ability to visualize social and environmental dimensions of Systems Engineering applications and to observe these dimensions in professional practice.						
12	Ability to develop appropriate methodology and procedures for the modeling, improvement, control and design of complex systems for a specified target.			**X**			

ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION			
Activities	Quantity	Duration (Hour)	Total Workload (Hour)
Course Duration (Excluding the exam weeks: 13x Total course hours)	13	3	39
Hours for off-the-classroom study (Pre-study, practice)	14	11	154
Midterm examination	1	2	2
Project	2	25	50
Final examination	1	3	3
Total Work Load			248
Total Work Load / 25 (h)			9.92
ECTS Credit of the Course			10