I072	**Heuristic algorithms**	L	P	S	ECTS
		2	2	0	6

Course objectives. Students will be introduced to heuristic algorithms which in application find good enough solutions for problems which are too complex to solve it exactly. Students will learn to distinguish concepts of heuristics, metaheuristics and hyperheuristics. Students will study and analyse the most known metaheuristics like Tabu Search, Genetic and Evolutionary Algorithms and Ant Colony optimization algorithm. Students will have an insight into the real-world optimization problems that are solved by these algorithms. Through the implementation of metaheuristic approaches, students will learn how to select the parameters of algorithms which play an essential role in finding good solutions.

Prerequisites Undergraduate study programme in mathematics or computer science.

Course content.

1. Introduction to optimization. Combinatorial optimization problems.
2. Complexity of algorithms and optimization problems.
3. Defining the concepts of heuristics, metaheuristics and hyperheuristics.
4. Constructive and improvement heuristics. Categorization of heuristics.
5. Design of metaheuristics; solution representation and objective function.
6. Local search: elements, algorithm, improvements
7. Nature-inspired metaheuristics: Simmulated Annealing, Tabu Search, Evolutionary algorithms, Ant Colony optimization algorithm
8. Overview of other heuristics.
9. Applying heuristic algorithms to solve real life problems.

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1.	Defining the concepts of heuristics, metaheuristics and hyperheuristics.
2.	Apply heuristic algorithms in solving optimization problems.
3.	Determine when to use exact algorithms and when heuristics.
4.	Explain the methodology of the most commonly used heuristics.
5.	Evaluate the quality of the solutions obtained with heuristic methods.
6.	Describe the application possibilities and limitations of the heuristic algorithms.
7.	Identify optimization problems in different areas and real life and evaluate their complexity.

RELATING THE LEARNING OUTCOMES, ORGANIZATION OF THE EDUCATIONAL PROCESS AND ASSESSMENT OF THE LEARNING OUTCOMES

TEACHING ACTIVITY	ECTS	LEARNING OUTCOME **	STUDENT ACTIVITY*	EVALUATION METHOD	POINTS	
					min	max
Attending lectures and exercises	1	1-7	Lecture attendance, discussion, teamwork and independent work on given tasks	Attendance lists, tracking activities	0	0

Homework Assignments	1	2, 4-6	Solving given tasks independently using a computer	Evaluating solutions	15	25
Written exam (Mid-terms)	2	1-7	Preparing for written exam	Evaluation	25	50
Final exam	2	1-7	Solving real life problems independently	Oral exam and validation of implementation	10	25
TOTAL	6				50	100

Teaching methods and student assessment. Lectures and exercises are obligatory. The exam consists of a written part. Upon completion of the course, students can take the exam. Successful midterm exam scores replace the written exam. Exercises are performed as auditory, and partly as laboratory using computers. During the semester, students are required to write homework assignments and make a final project. Points from the homework assignment and project affect the final grade.

Can the course be taught in English: Yes

Basic literature:

1. J. Dréo, A. Pétrowski, P. Siarry, E. Taillard, Metaheuristics for Hard Optimization: Methods and Case Studies, Springer, 2005.
2. E.G. Talbi, Metaheuristics: From Design to Implementation, Wiley, 2009.

Recommended literature:

1. X.S.Yang, Nature-Inspired Metaheuristic Algorithms, Luniver Press, 2008.
2. Z. Michalewicz, D.B. Fogel, How to Solve it: Modern Heuristics, 2nd Edition, Springer-Verlag, 2004.
3. M. Čupić, B. Dalbelo Bašić, M. Golub, Neizrazito, evolucijsko i neuroračunarstvo, Sveučilište u Zagrebu, Fakultet elektrotehnike i računarstva, 2012.
4. J. Hromkovič, Algorithmics for Hard Problems, 2nd edition, Springer, 2003.