Specification for the book of courses

Study program	Electrical Engineering and Computer Science		
Module	Common		
Type and level of studies	Doctoral studies		
The name of the course	Inverse problems in Electromagnetics		
Lecturer (for lectures)	Raičević B. Nebojša, Perić T. Mirjana		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	10	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The aim of the subject is to acquire the knowledge of solving inverse problems and their practical applications, as well as to learn modern optimization techniques in electromagnetics.		
Course outcomes	Student practically applies optimization algorithms in scientific and research work solving engineering problems. Active use of scientific sources, data processing and writing of papers in the field of doctoral studies.		
Course outline			
Theoretical teaching	• Introduction: Electromagnetic field theory. Static, stationary and dynamic EM fields. Mathematical terms: Jacobi matrix, Hessian matrix, local and global extrema of functions. Direct and inverse problems. The term of objective function. • Establishing the main concepts in inverse problem formulation: defining a task, setting a mathematical model of a physical problem, defining an objective function and boundaries, selecting the optimization method, implementing an algorithm, analyzing the obtained solution, correcting, testing and applying the optimal solution. • Classification of optimization methods. Deterministic methods: Simplex method, Gradient descent algorithm, Newton's method. Variable metric methods: Gauss-Newton and Levenberg-Marquardt algorithms. • Stochastic methods. Evolutionary algorithms: Genetic Algorithm and Evolutionary Strategies. Hierarchical Evolutionary Strategies. Swarm Intelligence Optimization: Particle Swarm Optimization and Ant Colony Optimization. • Multi-criteria optimization. The concept of Pareto optimum. • Application of optimization algorithms to the test functions: Rosenbrock and Rastrigin. Comparison of the methods with respect to the computation time and the parameter variation effects on the optimization results. Inverse problems solving in applied electromagnetics (contactless material testing, electrocardiography, radars, magnetic resonance tomography, etc.). Publishing results in a leading journal.		
Practical teaching (exercises, OFE, study and research			
Textbooks/references			
1	Albert Tarantola, „Inverse problem theory and methods for model parameter estimation“, Society for Industrial and Applied Mathematics – SIAM, 2005.		
2	N. V. Korovkin, V. L. Chechurin, M. Hayakawa, „Inverse problems in electric circuits and electromagnetics“, Springer, 2007.		
3	Z. Michalewicz, „Genetic Algorithms + Data Structures = Evolution Programs“, 3rd edition, Springer, 1995.		
4	David E. Goldbreg, „Genetic algorthms in search, optimization and machine learning“, Addison-Wesley Publishing Company. Inc., 1989.		
5	Z. Michalewicz, D.B. Fogel, „How to Solve It: Modern Heuristics“, Springer; 2nd edition, 2004.		

Number of classes of active education per week during semester/trimester/year

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	0	0	0	0
Teaching methods	PPT presentations, seminars and projects			

Grade (maximum number of points 100)

Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises		**Oral exam**	40
Colloquia			
Projects	60		