

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Metody numeryczne i metody optymalizacji**  
 Name in English: **Numerical and Optimization Methods**  
 Main field of study (if applicable): **Electrical Engineering**  
 Specialization (if applicable): **Renewable Energy Systems**  
 Level and form of studies: **2nd level, full-time**  
 Kind of subject: **obligatory**  
 Subject code: **ELR051330**  
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points for direct teacher-student contact (BK) classes:	1.40		0.70		

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Basic knowledge about the properties of multivariable functions
2. Basic knowledge in the field of calculus
3. Basic knowledge in the field of matrix algebra

**SUBJECT OBJECTIVES**

- C1. Transfer of the basic knowledge and skills needed for correct formulation of optimization problems  
 C2. Ordered presentation of various optimization methods  
 C3. Training the skills in practical use of software packages for solving optimization problems

**SUBJECT LEARNING OUTCOMES***relating to knowledge:*

- PEU\_W01 knows the rules of mathematical formulation of optimization problems  
 PEU\_W02 knows basic methods and algorithms used to solve an optimization problem relating to skills

*relating to skills:*

- PEU\_U01 is able to formulate an optimization problem in mathematical terms  
 PEU\_U02 is able to solve an optimization problem correctly selecting the solving algorithm

*relating to social competences:*

- PEU\_K01 creativity in searching for the solution of a given problem

## PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Introduction. Basic terms. Goal function, constraints, problem parameters. Formulation and classification of optimization tasks. Examples of problems.	2
Lec 2	Elements of calculus and matrix algebra related to optimization problems. Convex sets and convex functions	2
Lec 3	Nonlinear optimization without constraints. Sufficient and necessary conditions for optimization of unconstrained problems	2
Lec 4	Algorithms for unconstrained problems used for minimum search. Steepest descent algorithm. Conjugate gradient algorithm. Newton algorithm and quasi Newton methods	2
Lec 5	Minimum search of a one variable function. Golden section search algorithm	2
Lec 6	Nonlinear optimization with constraints. Kuhn-Tucker conditions. Lagrange function. Duality formulation	2
Lec 7	Penalty function methods. Linear optimization. Integer numbers optimization	2
Lec 8	Final test	1
Total hours:		<b>15</b>

Form of classes - laboratory		Number of hours:
Lab 1	H&S regulations. Laboratory working rules. Rules for working in a group. Rules for final crediting. Preliminary conditions. Presentation of subsequent labs contents	1
Lab 2	Constructing a mathematical model of an optimization problem. Analytical determination of the extremum of a function	4
Lab 3	Research on the effectiveness of numerical algorithms dedicated for problems without constraints	4
Lab 4	Solving problems with constraints	2
Lab 5	Applying the Optimization Toolbox of Matlab	4
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Lecture with multimedia presentations  
 N2. Computer laboratory suitable for group working

## EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation <i>F - forming (during semester) P - concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEU_W01 PEU_W02	Written final test
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02 PEU_K01	Grading the correctness of optimization problem solutions
P(L)	P=F1	

## PRIMARY AND SECONDARY LITERATURE

### PRIMARY LITERATURE:

- [1] .K.P. Chong, S.H. Żak: An Introduction to Optimization, 2nd edition, New York, John Wiley, 2001  
 [2] J.F. Bonnans: Numerical optimization: theoretical and practical aspects, Springer-Verlag, 2003  
 [3] M. Asghar Bhatti: Practical Optimization Methods, Berlin, Springer-Verlag 2000

### SECONDARY LITERATURE:

- [1] J. Nocedal, S. J. Wright, Numerical Optimization, Springer-Verlag, 2000

## SUBJECT SUPERVISOR

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