FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Metody numeryczne w technice**
Name in English:	**Numerical methods in engineering**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR052511**
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):	30			30	
Form of crediting:	crediting with grade			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	1			1	
including number of ECTS points for practical (P) classes :				1	
including number of ECTS points for direct teacher-student contact (BK) classes:	0.70			0.70	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge in the scope of mathematics enabling understanding of basics of optimization and formulating and solution of simple optimization problems.
2. Knowledge of basics of numerical methods.
3. Abilities of developing computer programs and performing calculation in the Matlab environment.
4. The student is able to think and act creatively.

SUBJECT OBJECTIVES

C1. Acquiring knowledge in the scope of optimization calculation.
C2. Acquiring competence in performing optimization.
C3. Acquiring knowledge in the scope of the method of finite elements.
C4. Acquiring competence in using the method of finite elements.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 The student knows optimization without constraints.
PEU_W02 The student knows principles of optimization with constraints.
PEU_W03 The student knows principles of the method of finite elements.

relating to skills:

PEU_U01 The student is able to perform optimization without constraints in the Matlab environment.
PEU_U02 The student is able to perform optimization with constraints in the Matlab environment.
PEU_U03 The student is able to use the method of finite elements in the Matlab environment.

relating to social competences:

PEU_K01 The student is able to think and act creatively.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	An introduction. Non-linear programming: problem formulating; solving of problem without constraints. Non-gradient methods.	1
Lec 2	Non-linear programming: problem without constraints. Gradient methods.	2
Lec 3	Non-linear programming: problem with equality and inequality constraints. The Karush-Kuhn-Tucker conditions of optimality. Special classes of optimization problems.	2
Lec 4	Heuristic optimization algorithms.	2
Lec 5	Dynamic programming: multi-stage problem of dynamic programming, Bellman's principle of optimality, continuous problem of dynamic programming. Multi-criteria programming: methods of multi-criteria programming.	2
Lec 6	The method of finite elements: modelling with use of finite elements, the method of finite elements (FEM) as a method of approximation of partial differential equations, areas of utilization of the method of finite elements.	2
Lec 7	Examples of the application of the FEM.	2
Lec 8	Final test.	2
	Total hours:	**15**

Form of classes - project		**Number of hours:**
Proj 1	Familiarization with OHS regulations and internal regulations of the laboratory. Determining the rules for passing the subject. Discussing the rules of project implementation.	1
Proj 2	Introduction to optimization methods.	2
Proj 3	Implementation of the selected project - optimization in technology.	8
Proj 4	Implementation of the selected project-FEM.	2
Proj 5	Passing the project.	2
	Total hours:	**15**

TEACHING TOOLS USED
N1. Multimedia presentation.
N2. Information lecture.
N3. Preparation in the form of reports.
N4. The Matlab programs.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	grades from the test
P(W)	P=F1	
F1(P)	PEU_U01 PEU_U02 PEU_U03	activity at the classes
F2(P)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	reports
P(P)	P=0.3 F1+ 0.7 F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Bela M., Programowanie nieliniowe, teoria i metody, PWN, Warszawa 1983.
[2] Stadnicki J., Teoria i praktyka rozwiązywania zadań optymalizacji z przykładami zastosowań technicznych, WNT, Warszawa 2006.
[3] Goldberg D. E., Algorytmy genetyczne i ich zastosowania, WNT, Warszawa 1998.
[4] Łodygowski T., Kąkol W., Metoda elementów skończonych w wybranych zagadnieniach mechaniki konstrukcji inżynierskich, Wyd. PP, Poznań 1994.
[5] Chapra S. C., Applied numerical methods with MATLAB for engineers and scientists, McGraw-Hill Education - Europe, 2011

SECONDARY LITERATURE:

[1] Michalewicz Z., Algorytmy genetyczne + struktury danych = programy ewolucyjne, WNT, Warszawa 1996.
[2] Arabas J., Wykłady z algorytmów ewolucyjnych, WNT, Warszawa 2001.
[3] Zienkiewicz O.C., Taylor R.L., The finite element method, Butterworth-Heinemann 2000.
[4] Chandrupatla T.R., Belegundu A.D., Introduction to finite element method in engineering, Prentice-Hall International Editions 1991.
[5] Markiewicz T., Szmurło R.,Winceciak S., Metody numeryczne. Wykłady na Wydzile Elektrycznym Politechniki Warszawskiej, OWPW, Warszawa 2014.
[6] Jin J., The finite element method in electromagnetics, John Wiley & Sons Inc, 2014.

SUBJECT SUPERVISOR
Tomasz Okoń, tomasz.okon@pwr.edu.pl