MODULE DESCRIPTION

Module code	**Z-ZIP2-303z**
Module name	**Zagadnienia optymalizacji**
Module name in English	**Optimization Problems**
Valid from academic year	**2016/2017**

A. MODULE PLACEMENT IN THE SYLLABUS

Field of study	**Management and Production Engineering**
Level of education	**2nd degree** *(1st degree / 2nd degree)*
Studies profile	**General** *(general / practical)*
Form and method of conducting classes	**Full-time** *(full-time / part-time)*
Specialisation	**All**
Unit conducting the module	**The Department of Production Engineering**
Module co-ordinator	**Dariusz Bojczuk, PhD hab., Eng., Professor of the University**
Approved by:	

B. MODULE OVERVIEW

Type of subject/group of subjects	**Basic** *(basic / major / specialist subject / conjoint / other HES)*
Module status	**Compulsory** *(compulsory / non-compulsory)*
Language of conducting classes	**English**
Module placement in the syllabus - semester	**2nd semester**
Subject realisation in the academic year	**Winter semester** *(winter semester/ summer)*
Initial requirements	**No requirements** *(module codes / module names)*
Examination	**No** *(yes / no)*
Number of ECTS credit points	**2**

Method of conducting classes	Lecture	Classes	Laboratory	Project	Other
Per semester	**15**			**15**	

C. TEACHING RESULTS AND THE METHODS OF ASSESSING TEACHING RESULTS

Module target	The aims of the module are as follows: acquiring knowledge and skills about formulating and classification of optimization problems, about methods of their solution and about application of these methods in solving some problems from management, economics and optimal design of structures.

Effect symbol	Teaching results	Teaching methods *(l/c/lab/p/other)*	Reference to subject effects	Reference to effects of a field of study
W_01	A student is knowledgeable about formulating and classification of optimization problems, mathematical and especially numerical methods of their solution.	l/p	K_W01 K_W02	T2A_W01 T2A_W02
W_02	A student has knowledge of application of optimization methods in solving some problems from management, economics and optimal design of structures.	l/p	K_W01 K_W02	T2A_W01 T2A_W02
U_01	A student is able to solve different optimization problems using computer tools.	p	K_U03	T2A_U08 T2A_U09
U_02	A student is able to use methods of solution of optimization problems to analyse some problems from management, economics or optimal design of structures, and assess their suitability.	p	K_U11 K_U12	T2A_U09 T2A_U10 T2A_U16
U_03	A student is able to perform report presenting results of analysed project problems.	p	K_U04	T2A_U08
K_01	A student understands the need of continuous improvement of his/her knowledge from the field of optimization and software serving to solve optimization problems.	l/p	K_K01	T2A_K01 T2A_K06

Teaching contents:

1. Teaching contents as regards lectures

Lecture number	Teaching contents	Reference to teaching results for a module
1	General knowledge, basic notions of theory of optimization, formulation of optimization problems, classification of optimization problems and design parameters. sensitivity analysis.	W_01 K_01
2	Sensitivity analysis, hessian matrix. Formulation of necessary and sufficient optimality conditions for unconstrained optimization problems.	W_01 K_01
3	Formulation of necessary optimality conditions for constrained optimization problems, Kühn-Tucker optimality conditions.	W_01 K_01
4	Algorithms of finding minimum of one-variable function without constraints: method of golden section search, half-interval search algorithm, Newton method. Algorithms of finding minimum of multivariable function without constraints: Gauss-Seidel method, gradient descent method.	W_01 K_01
5	Algorithms of finding minimum for constrained optimization problems: SIMPLEX method, penalty functions method, gradient projection algorithm. Information about genetic algorithms.	W_01 K_01
6	Applications of optimization in management and economics: formulation of minimization of transportation cost problem and minimization of production wastes problem.	W_02 K_01

7	Engineering applications of optimization: formulation and optimality conditions for the problem of the structure cost minimization and the problem of the structure global stiffness maximization.	W_02 K_01
8	Methods of structure sensitivity analysis: finite difference method, adjoint method.	W_02 K_01

2. Teaching contents as regards classes

Class number	Teaching contents	Reference to teaching results for a module

3. Teaching contents as regards laboratory classes

Laboratory class number	Teaching contents	Reference to teaching results for a module

4. The characteristics of project assignments

Project number	Teaching contents	Reference to teaching results for a module
1	Application of Mathcad (MATLAB): preparation of diagrams of functions, determination of zero places, determination of minima of one-variable and multivariable functions.	W_01 U_01 K_01
2	Application of Mathcad (MATLAB): solving of problems of linear programming, quadratic programming and nonlinear programming. Graphic illustration of these problems.	W_01 U_01 K_01
3	Identification of object parameters using data collected during measurements – formulation of the problem and solution using Mathcad (MATLAB).	W_01 U_01 K_01
4	Optimal distribution of production tasks between plants – formulation of the problem and solution using Mathcad (MATLAB).	W_02 U_02 U_03 K_01
5	Optimization of transportation cost between warehouses and plants – formulation of the problem and solution using Mathcad (MATLAB).	W_02 U_02 U_03 K_01
6	Minimization of the cost of a bar structure – formulation of the problem and solution using Mathcad (MATLAB).	W_02 U_02 U_03 K_01
7	Maximization of the global stiffness of truss under constraint imposed on thecost or volume of material and constraint imposed on minimal cross-section area of bars – formulation of the problem and solution using Mathcad (MATLAB).	W_02 U_02 U_03 K_01
8	Summary project classes – submission and defence of projects so far not finished.	U_03 K_01

The methods of assessing teaching results

Effect symbol	**Methods of assessing teaching results** *(assessment method, including skills – reference to a particular project, laboratory assignments, etc.)*
W_01	A test during the lecture, solving of general optimization problems during the project classes.
W_02	A test during the lecture, solving of optimization problems from management, economics and about optimal design of structures during the project classes.
U_01	Solving of general optimization problems during the project classes.
U_02	Solving of optimization problems from management, economics and about optimal design of structures during the project classes.
U_03	Preparation of reports presenting results of project tasks.
K_01	Comments during the lectures and a discussion during the project classes.

D. STUDENT'S INPUT

ECTS credit points		
	Type of student's activity	**Student's workload**
1	Participation in lectures	**15**
2	Participation in classes	
3	Participation in laboratories	
4	Participation in tutorials (2-3 times per semester)	**3**
5	Participation in project classes	**15**
6	Project tutorials	**3**
7	Participation in an examination	
8		
9	**Number of hours requiring a lecturer's assistance**	**36** *(sum)*
10	**Number of ECTS credit points which are allocated for assisted work** *(1 ECTS point=25-30 hours)*	**1.2**
11	Unassisted study of lecture subjects	**8**
12	Unassisted preparation for classes	
13	Unassisted preparation for tests	
14	Unassisted preparation for laboratories	
15	Preparing reports	
15	Preparing for a final laboratory test	
17	Preparing a project or documentation	**12**
18	Preparing for an examination	
19	Preparing for a test during the lectures	**4**
20	**Number of hours of a student's unassisted work**	**24** *(sum)*
21	**Number of ECTS credit points which a student receives for unassisted work** *(1 ECTS point=25-30 hours)*	**0.8**
22	**Total number of hours of a student's work**	**60**
23	**ECTS points per module** *1 ECTS point=25-30 hours*	**2**
24	**Work input connected with practical classes** *Total number of hours connected with practical classes*	**30**
25	**Number of ECTS credit points which a student receives for practical classes** (1 ECTS point=25-30 hours)	**1**

E. LITERATURE

Literature list	A. Lectures 1. Findesein W., Szymanowski J., Wierzbicki A., *Teoria i metody obliczeniowe optymalizacji*, PWN, Warszawa 1980. 2. Seidler J., Badach A., Molisz W., *Metody rozwiązywania zadań optymalizacji*. WNT, Warszawa 1980. 3. Grysa K., Trylski Z., *Zastosowania matematyki w zarządzaniu i ekonomii. Część III. Elementy analizy i problemy optymalizacji*. Politechnika Świętokrzyska, Skrypty 297, Kielce 1996. 4. Kręglewski T., Rogowski T., Ruszczyński A., Szymanowski J., *Metody optymalizacji w języku FORTRAN*, PWN, Warszawa 1980. 5. Rutkowska D., Piliński M., Rutkowski L., *Sieci neuronowe, algorytmy genetyczne i systemy rozmyte*, PWN , Warszawa, Łódź1997.

	6. Stadnicki J., *Teoria i praktyka rozwiązywania zadań optymalizacji z przykładami zastosowań technicznych*, WNT, Warszawa 2006. 7. Ostwald M., *Podstawy optymalizacji konstrukcji*, Wydawnictwo Politechniki Poznańskiej, Poznań 2003. 8. Haftka R. T., Gürdal Z., *Elements of structural optimization*, Kluwer Academic Publishers, 1992. B. Project classes 1. Brdyś M., Ruszczyński A., *Metody optymalizacji w zadaniach*, WNT, Warszawa 1985. 2. Paleczek W., *Mathcad 12, 11, 2001i, 2001, 2000 w algorytmach*, Akademicka Oficyna Wydawnicza Exit, Warszawa 2005.
Module website	