Warsaw University
of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-00000FH-0235	Name of the course	Polish	**Optymalne projektowanie konstrukcji inżynierskich. Sformułowanie teoretyczne i metody numeryczne**
			English	**Optimum design of engineering structures. Theoretical formulation and numerical methods**

Type of the course	specialized				
Course coordinator	prof. dr hab. inż. Tomasz Lewiński				
Implementing unit	Faculty of Civil Engineering	Scientific discipline / disciplines*	Civil Engineering, Geodesy and Transport / Mechanical engineering		
Level of education	Doctoral studies	Semester	Winter		
Language of the course	English				
Type of assessment:	Credit with a grade	Number of hours in a semester	60	ECTS credits	4
Minimum number of participants	10	Maximum number of participants	20	Available for students (BSc, MSc)	Yes/~~No~~

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	2	1	0	1	0
	in a semester	30	15		15	

* does not apply to the Researcher's Workshop

1. Prerequisites

A comprehension of the linear theory of elasticity and the theory of plates and shells.

2. Course objectives

The course is aimed at teaching the contemporary methods of optimum design of elastic structures to minimize their compliance or their weight.

3. Course content (separate for each type of classes)

Lecture

Classification of problems and methods of optimization. The Karush-Kuhn-Tucker optimality conditions. The primal and dual problems. Introduction to linear programming: formulation and numerical methods. The problems of non-linear programming- the solution methods.

The discretized approach towards structural mechanics. Variational formulations of statics of elastic strutcures. The FMD (free material design) method for minimizing the compliance- for optimizing the full anisotropy, isotropy and cubic symmetry. The numerical methods in FMD. The multiple load problems- construction of the Pareto front. Introduction towards global optimization methods, e.g. the Strongin-Sergeev approach and selected genetic algorithms.

Laboratory

Designing bar structures for minimum weight (elastic and plastic approach). Sizing, shape and topology optimization. Introduction to Michell's structures. The ground structure and growth methods. Single or multiple load case. Computational project of shape optimization of a plane truss.

4. Learning outcomes

	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			

K01	Graduates gain knowledge in the optimization of engineering structures	SD_W3	Project evaluation, oral exam
Skills			
S01	Graduates can formulate and solve structural optimization problems	SD_U1	Project evaluation, oral exam
Social competences			
SC01	The graduate is ready to think and act creatively and entrepreneurially	SD_K4	Observation of the student's work during the execution of the project

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Preparing the projects, evaluation of the project, oral exam.

6. Literature
Basic literature:
[1] M. A. Bhatti, Practical optimization methods with Mathematica and applications. Springer, New York 2000.
[2] T. Lewiński, T. Sokół, C. Graczykowski, Michell Structures, Springer International Publishing AG, Cham, Switzerland 2019, str 569.
Additional literature:
[1] M. S. Bazaraa, H. D. Sherali, C.M. Shetty, Nonlinear Programming: Theory and Algorithms. Wiley, 2002.
[2] G.I.N. Rozvany, T. Lewiński (Eds.), Topology Optimization in Structural and Continuum Mechanics. CISM International Centre for Mechanical Sciences 549. Courses and Lectures. Springer Wien Heidelberg New York Dordrecht London, CISM, Udine 2014. 471 pp.

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	60
2	Hours of consultations with the academic teacher, exams, tests, etc.	10
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	30
4	Amount of time devoted to the preparation for exams, test, assessments	10
	Total number of hours	**110**
	ECTS credits	**4**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)