COURSE DESCRIPTION CARD - SYLLABUS

Course name

Virtual design with topology optimization

Course

Field of study

Mechanical Engineering

Area of study (specialization)

Virtual Engineering

Level of study

II

Form of study

full time

Year/Semester

2/1

Profile of study

generally academic

Course offered in

Polish / English

Requirements

mandatory

Year/Semester

2/1

Profile of study

generally academic

Course offered in

Polish / English

Requirements

mandatory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
15	15	0
Tutorials	**Projects/seminars**	
0	0	

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

prof. dr hab. inż. Michał Nowak

email: Michal.Nowak@put.poznan.pl

tel. 61-6652041

Wydział Inżynierii Mechanicznej

ul. Piotrowo 3, 60-965 Poznań

Responsible for the course/lecturer:

Responsible for the course/lecturer:

Prerequisites

KNOWLEDGE: Knowledge of geometry modeling methods in CAD systems.

Basic knowledge of the construction of computer systems.

basic knowledge of structural analysis.

SKILLS: Ability to use computer systems.

Ability to use a basic CAD system.

Ability to model geometry in the CAD system.

Ability to use the finite element method in practice.

SOCIAL COMPETENCES: Ability to work in a team.

Understanding the need for learning and acquiring new knowledge.

Course objective
Transfer of knowledge about methods and processes related to advanced virtual design using CAD design systems. Developing practical skills in creating a virtual project. Indication of the role of structural optimization in the design process. Practical familiarization of students with modern possibilities of optimizing cross-sectional dimensions, shape and topological optimization. Indication of factors stimulating the market need for the development of such design methods, which is the growing production potential of additive methods. With the mastery of the ability to produce additive products directly in metal, the demand for a design process that breaks with traditional technological limitations has increased dramatically.

To familiarize students with the available software for structural optimization.

Course-related learning outcomes
Knowledge

1. The student has ordered, theoretically founded general knowledge covering structural optimization issues.

2. Student has basic knowledge about development trends in virtual design, especially in structural optimization procedures in CAD systems.

Skills

1. The student should characterize the goal of structural optimization.

2. Student should characterize the types of structural optimization.

3. Student is able to apply virtually structural optimization algorithms in a CAD environment.

4. Student is able to describe the available software in the field of structural optimization.

5. Student is able to describe how to use structural optimization methods in the design process.

Social competences

1. The student is able to interact and work in a group.

2. The student is able to properly set priorities for the implementation of themselves and others set task.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:
Oral and written tests. Individual assessment of completed projects.

- To familiarize students with structural optimization procedures that can be used in the virtual design process.

- Transfer of theoretical and practical knowledge about the basics of numerical algorithms of structural optimization.

- Practical exercises using optimization procedures in the CAD environment.

Programme content

Lecture topics:

1. The role of optimization in virtual design.

2. Introduction to the issue of structural optimization.

3. Optimization of cross-sectional sizes and parametric shape optimization.

4. Practical application of methods to optimize cross-sectional sizes and

parametric shape optimization.

5. Topological optimization: the essence and theoretical foundations.

6. Practical application of topological optimization methods.

7. Summary and review of software for structural optimization.

Practical classes (computer laboratory):

1. Parameterization of geometric models.

2. Finite element method and its specificity in the case of procedures

optimization.

3. Construction of the task of optimizing cross-sectional dimensions.

4. Construction of a parametric shape optimization task.

5. Construction of the topological optimization task.

6. Interpretation of topological optimization results.

7. Final test.

Teaching methods

An interactive lecture using multimedia presentations.

Bibliography

Basic
1. Bendsoe M.P., Sigmund O., Topology optimization, Theory, Methods and Applications, Springer-Verlag, Berlin Heidelberg, 2003

2. Bochenek B., Krużelecki J., Optymalizacja stateczności konstrukcji ? współczesne problemy, Wydawnictwo Politechniki Krakowskiej, Kraków, 2007

3. Brandt A. M., Kryteria i metody optymalizacji konstrukcji, P WN, Warszawa , 1977.

4. Brandt A. M., Podstawy optymalizacji elementów konstrukcji budowlanych, PWN, Warszawa 1977

5. Chlebus E., Techniki komputerowe CAx w inżynierii produkcji, WNT, 2000

6. Haftka, R., Gürdal, Z., Elements of structural optimization, 3rd edition, Kluwer, 1992

7. Kirsch U., Optimum Structural Design, McGraw-Hill, New York, 1981

8. Kleiber M. i inni, Mechanika techniczna, tom XI, Komputerowe metody mechaniki ciał stałych, Wydawnictwo Naukowe PWN, Warszawa, 1995

9. Kleiber M., Metoda elementów skończonych w nieliniowej mechanice, PW N, Warszawa, 1985

10. Kutyłowski R., Optymalizacja topologii kontinuum materialnego, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2004

Additional
1. Dzieniszewski W., Zeszyt IPPT PAN, Optymalizacja wytrzymałościowa konstrukcji: Optymalizacja kształtów konstrukcji w założeniach teorii sprężystości, 114-137, Ossolineum, 1983

2. Krog L., Tucker A., Kemp M., Boyd R., Topology optimization of aircraft wing box ribs, AIAA-Paper 2004?4481, 2004

3. Nowak M., Gnarowski W. and Abratowski P., Structural Optimization of Helicopter AirLanding Rope Console with Multiple Loading Conditions, The 40th Solid Mechanics Confrence SolMech2016, 29.08-2.09 2016, Warsaw, 2016

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	4
Classes requiring direct contact with the teacher	30	2
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	30	2

1

 delete or add other activities as appropriate