# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fundamentals of optimal structure design [S2MiBM2>POPK]

## Course

Field of study
Mechanical Engineering

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

## Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

## Number of credit points

2,00

## Coordinators

dr Marcin Rodak
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## Lecturers

## Prerequisites

Basic knowledge in mathematics and other areas in the field of study. Ordered theoretical knowledge in the field of study. Ability to solve mathematical problems in the field of study. Capability to search for necessary information in literature, databases, the Internet and in the given sources. Ability to self-study and self-education. Ability to use information and communication techniques relevant to the implemen-tation of engineering tasks. Understanding the need to learn and expand their knowledge throughout their lives. Understanding non-technical aspects and effects of engineering activities. Willingness to cooperate in a team.

## Course objective

Presentation in a concise and intelligible form basis for optimum design of constructions, as well as other equipment and technical systems. Emphasizing the design process as an action based on a systemic (holistic) approach, using solutions based on the so-called nature lesson. Presentation of the basic concepts of optimal design, discussion of basic optimization procedures. Overview of the basics of multi-criteria optimization. Presentation of modern optimization procedures using a "nature lesson". Acquiring the ability to find optimal solu-tions for simple technical systems within the laboratory.

## Course-related learning outcomes

Knowledge:
1. Possessing the necessary theoretical knowledge on structure optimization to the extent necessary for the field of study.
2. Knowledge of basic concepts and computational procedures necessary for optimal design.
3. Knowledge of development trends, new procedures and calculation methods used in practical design processes.
4. Understanding the systemic aspects of engineering activities, including activities in the field of optimal design.
5. Has structured, theoretically based knowledge of the strength of materials, understands models and computational methods used in construction.
6. Has structured, theoretically based knowledge of the use of information systems in the design of machines and technological processes.

Skills:
1. Ability to apply selected optimization procedures, the ability to use optimization procedures contained in mathematical packages.
2. Finding optimal solutions for simple technical systems.
3. Understanding the importance of a system approach to the problem of optimization.
4. Ability to use methods found in nature to solve complex technical problems.
5. A student is able to assess various design options and identify the optimal solution taking into account many different criteria.
6. Is able to perform strength analyzes of machine elements and mechanical systems using advanced methods. Is able to test the mechanical properties of materials and measure the state of stress in structural elements. He is able to interpret them, draw conclusions and formulate and justify opinions.
7. Is able to use IT systems in the design of machines and technological processes relevant to mechanics and machine construction. Is able to use CAx systems to design machines and simulate engineering issues.

Social competences:
1. Understanding the need for self-study associated with the development of technology.
2. Appreciating and understanding the social and systemic effects of engineering activities.
3. Understanding the importance of teamwork.
4. The ability to make the right decisions and making decisions relevant to the problem.
5. Potrafi określić znaczenie wiedzy w rozwiązywaniu problemów poznawczych i praktycznych oraz zasięgania opinii ekspertów w przypadku trudności z samodzielnym rozwiązaniem problemu.

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: assessment based on oral answers to three questions
Laboratory: assessment based on activity during classes and solving the assigned task
Grades: very good - if the ratio of sums of achieved and total points is bigger than 90,1%; good plus - if the ratio of sums of achieved and total points is between 80,1-90%; good - if the ratio of sums of achieved and total points is between 70,1-80%; satisfactory plus - if the ratio of sums of achieved and total points is between 60,1-70%; satisfactory - if the ratio of sums of achieved and total points is between 50,1-60%; if the sum is smaller than 50% - unsatisfactory.

## Programme content

The subject is the optimal design of engineering structures. The lecture focuses on parametric, continuous, single, and multicriteria optimization.

## Course topics

Introduction to the basics of optimal engineering structure design.
Basic concepts and terms of optimization (criterion, decision variables, and limiting conditions).
Discussion of construction models and optimization models.
Classification of optimization problems.
Optimization of the function of one variable, analytical and numerical methods.
Nonlinear programming without constraints - necessary and sufficient conditions for the existence of

extremum, optimization procedures.
Nonlinear programming with constraints, necessary and sufficient conditions for the existence of an extreme (Lagrange function, Kuhn-Tucker conditions), numerical methods for searching for a minimum of a function (methods with a penalty function).
Multicriteria optimization: Theoretical foundations and explanation of optimization procedures.

## Teaching methods

Live lecture with multimedia illustrations.
Laboratory - tasks solved on the board and using a computer in Matlab.

## Bibliography

Basic:
[1] Marian Ostwald: Podstawy optymalizacji konstrukcji w projektowaniu systemowym. Wydawnictwo Politechniki Poznańskiej, wydanie I, 2016.

Additional:
[1] Eschenauer H., Koski J., Osyczka A., Multicriteria design optimization, procedures and applications. Springer-Verlag, Berlin 1990.
[2] Rao S. S., Engineering optimization - theory and practice, John Wiley and Sons, 1996.

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 50 | 2,00 |
| Classes requiring direct contact with the teacher | 30 | 1,00 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 20 | 1,00 |