**COURSE DESCRIPTION CARD - SYLLABUS**

Course name   
Modelling in machine design  
**Course**

Field of study  
Mechanical Engineering (Erasmus Plus)  
Area of study (specialization)  
-  
Level of study   
  
Form of study  
  
Year/Semester  
2/3  
Profile of study   
  
Course offered in  
english  
Requirements

**Number of hours**

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

**Number of credit points**6

**Lecturers**

Responsible for the course/lecturer:  
dr inż. Dominik Wojtkowiak

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tel. 61 224 4516

Wydział Inżynierii Mechanicznej

ul. Piotrowo 3, pok. 422, 61-138 PoznańResponsible for the course/lecturer:  
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tel. 61 224 4514

Wydział Inżynierii Mechanicznej

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**Prerequisites**  
Knowledge: Basic knowledge of mathematics, materials science, mechanics, the basics of machine design, theory of machines and mechanisms as well as the strength of materials acquired during the 1st and 2nd degree studies.

Skills: Basics of vector and matrix calculus, the ability to solve ordinary differential equations, the ability to solve simple problems in the mechanics and strength of materials, the ability to carry out engineering calculations and selection of elements, the ability to design machines and devices, the ability to create technical documentation, knowledge of CAD programs.

Social competences: The student is creative and consistent in the implementation of tasks, shows independence in solving problems, acquiring and improving the acquired knowledge and skills.

**Course objective**  
The aim of the course is to familiarize students with the mathematical apparatus necessary in the processes of modeling materials and machines (mechanisms), with the basics of physical and mathematical modeling of construction materials, mechanisms and machines, as well as with methods of optimization and computer simulation of both structures and technological processes, with an emphasis on practical using these skills in the design and construction of machines and devices.

**Course-related learning outcomes**Knowledge  
Has in-depth knowledge of engineering applications of mathematics, in particular solving differential equations, discrete equations, determining the eigenvalues of matrices, eigenvectors and modal matrices, and solving basic nonlinear ordinary and partial differential equations. This knowledge enables mathematical modeling of the properties of the mechanical, electrical and control parts of mechatronic devices and the description of digital discrete, impulse and nonlinear systems as well as discrete algorithms. [K2\_W01]

Has an extended knowledge of the strength of materials related to the safety and reliability of mechanical structures, calculation of composite elements, frames and curved bars as well as thin-walled tanks and thick-walled vessels. Has knowledge of the basics of optimal structure design. [K2\_W03]

Has knowledge of computer structure analysis including advanced operations in the CAD environment, regarding 3D visualization and analysis of the cooperation of mechanical elements. [K2\_W15]

Has an extended knowledge of mechatronics, knowledge of the analysis and design of complex mechatronic systems, systems theory and technology, and the application of modeling and simulation in mechatronic design. [K2\_W09]

Skills  
He can visualize a mechanical element in a 3D environment and analyze the cooperation of elements shown in the drawing. [K2\_U19]

He can perform strength calculations allowing to determine the safety and reliability of selected mechanical structures. Is able to determine the strength of basic composite elements, frames and curved bars as well as thin-walled tanks and thick-walled vessels. [K2\_U09]

Can design complex mechatronic devices and systems, using modeling and simulations. He can plan and carry out experiments, including measurements and computer simulations, interpret the obtained results and draw conclusions. [K2\_U14]

He can use computer systems to design and operate mechatronic devices. Can implement control systems in the real-time operating system. He can use the basic methods of image processing and analysis. He can prepare software documentation. [K2\_U15]

Social competences  
Understands the need for lifelong learning; can inspire and organize the learning process of other people. [K2\_K01]

Can set priorities for the implementation of a task set by oneself or others. [K2\_K04]

**Methods for verifying learning outcomes and assessment criteria**Learning outcomes presented above are verified as follows:  
Projects: Evaluation based on an individual project of machine design with using modelling.

Evaluation criteria: the correctness of the construction of models of the designed structure is assessed (50% of the assessment) and their use in the design process of the selected structure (50% of the assessment).

Rating scale: below 50% - 2.0, from 50% - 3.0, from 60% - 3.5, from 70% - 4.0, from 80% - 4.5, from 90% - 5.0.

**Programme content**

Projects:

Project 1 - Introduction to the software used for modeling during laboratory classes. Overview of sample projects.

Project 2-3 - Development of the topic and scope of the project. Modeling of the kinematics of mechanical systems in design. Overview of practical examples of applying simple and inverse kinematics in design.

Denavit-Hartenberg notation - problem of simple and inverse kinematics. Modeling in designing the structure of mechanical systems. Machine movement modeling. Designating the work zone.

Project 4-5 - Modeling of machine dynamics in design. Overview of practical examples of applying simple and inverse dynamics in design.

Dynamics of mechanical systems - type II Lagrange equations. Determination of dynamic substitute parameters. Modeling in the design of damping and drive systems.

Project 6 - Modeling of the stress state in structural elements in design. Modeling of material properties in design. Overview of practical examples of the use of stress state modeling in structural elements in the design of working systems.

Modeling of the stress state in structural elements in terms of designing machine working systems. Derivation of the characteristics of rheological models of materials. Modeling of material properties in computer simulations.

Project 7 - Consultation classes.

Project 8 - Completion of the project.

**Teaching methods**

Projects: Workshop methods of practical design classes. Project methods.

**Bibliography**

Basic  
1. Bishop R.: The mechatronics handbook, CRC Press USA 2002.

2. Collins J. A., Busby H. R., Staab G. H.: Mechanical Design of Machine Elements and Machines, John Wiley & Sons; 2nd Edition, 2009,

3. Lynch K., Modern Robotics Mechanics, Planning, and Control. PWN, Warszawa 2001.

4. Ambrosio J.A.C., Eberhard P.: Advanced Design of Mechanical Systems: From Analysis to Optimization, SpringerWienNewYork 2009.

Additional   
1. Juvinall R.C., Marshek K. M.: Machine Component Design, John Wiley & Sons; 5th Edition International Student Version edition, 2012,

2. Shigley J., Mischke Ch, Budynas R.: Mechanical Engineering Design, 2003 (in Polish)

3. Wojtkowiak D., Talaśka K., Wilczyński D. i inni: Determining the Power Consumption of the Automatic Device for Belt Perforation Based on the Dynamic Model, Energies 14:1, 317, 1-15, 2021.

**Breakdown of average student's workload**

|  | Hours | ECTS |
| --- | --- | --- |
| Total workload | 150 | 6,0 |
| Classes requiring direct contact with the teacher | 15 | 1,0 |
| Student's own work (literature studies, preparation for workshops, project preparation) [[1]](#footnote-1) | 135 | 5,0 |

1. delete or add other activities as appropriate [↑](#footnote-ref-1)