COURSE DESCRIPTION CARD - SYLLABUS

Course name
Design of special purpose and modular machines [N1Mech2>PMSiM]

Course

Field of study
Mechatronics

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
8

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
16

Number of credit points

4,00

Coordinators

Lecturers

Prerequisites

Knowledge: Knowledge of the basics of machine construction and drive systems, basics of electrical engineering, basics of computer science, elements of the mechatronic system. Skills: Ability to independently formulate a technical problem, develop a construction record in accordance with the principles of technical drawing, calculate the strength of machine elements and shape the design features of machine components. Social competences: Understanding the need to expand one's competences, readiness to cooperate within a team.

Course objective

The aim of the course is to become acquainted with the methodology of model-oriented mechatronic design of special purpose machines focused on the implementation of a specific machine function and the methodology of modular design focused on simplifying the structure, standardization of components and faster assembly of a complete machine, as well as acquiring the skills of an interdisciplinary approach to issues related to machine design.

Course-related learning outcomes

Knowledge:
Knows the assumptions and methods used in the methodology of designing modular machines and specialized machines.

Skills:
Is able to use basic methods of automating the design process to construct specialized and modular machines.
Is able to parameterize the structure and create a 3D model of machine parts using parametric modeling.
Is able to determine the workforce in the technological process carried out by the designed machine.

Social competences:
Understands the need for lifelong learning; can inspire and organize the learning process of other people.
Able to cooperate and work in a group, taking on various roles.
Is able to set priorities for the implementation of tasks specified by himself or others.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Written assessment during the last lecture, containing 2 theoretical questions and 2 practical tasks. Duration: 90 minutes.
Assessment criteria: 2 points for each theoretical question, 3 points for each task, points are awarded with an accuracy of 0.5 points, a total of 10 points can be obtained.
Grading 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.
Project: Design of a special-purpose machine (automated mechatronic device) consisting of a working and positioning module, in accordance with the guidelines and design data received by the teacher during the first class. The project is carried out in groups of 2 people. Ongoing verification of the progress of design work.
Assessment criteria: the project is presented to the teacher during the last class (max. 5 minutes per group) and submitted to the teacher in paper form. The final grade is the result of the grade from the project presentation (25% of the grade) and the substantive grade from the completed project (75% of the grade).

Programme content

Methodology of designing modular and special purpose machines, determining the workforce in the technological process, parameterization and typification in machine construction, parametric modeling, basics of automation of the process of designing modular and specialized machines, central and distributed control.

Course topics

Lectures:
Lecture 1 (2) - Introduction to programming using the iLogic module
Lecture 2 (2) - Methodology of designing specialized machines
Definition of a special purpose machine. Discussion of the model-oriented design methodology using the example of simple mechanical structures. Methods of integrating the basic system-sensor-actuator-controller system in design. Discussion of the mechatronic design process on the example of the design of a real specialized machine (automatic industrial device).
Lecture 3 (2) - Modular design methodology
Definition of a modular machine. Discussion of the modular design methodology aimed at simplifying the structure, standardization of components and faster assembly of the complete machine on the example of simple mechanical structures. Methods of integration of the basic system-sensor-actuator-controller in modular design. Discussion of the modular design process based on the example of a real design of an automatic modular industrial device.
Lecture 4 (2) - Modeling of the work process
Determining the labor force on the example of the process of cutting a plastic flat bar and punching a hole - analytical, simulation and experimental methods. Determining the grip force of the manipulator effector.
Lecture 5 (2) - Parameterization of modular machines
Methods of parameterization of modular machines and combinations of modules to configure a

modular machine.
Lecture 6 (2) - Design of drive systems for modular mechatronic devices and module connection mechanisms
Design of working, positioning and transport systems. Synchronization of modules. Methods of connecting modules in modular design.
Lecture 7 (1) - Design of central and distributed control systems
Differences between central and distributed control. Using software libraries. Developing algorithms for the operation of a mechatronic device. Selection of control system components (sensors, regulators, PLC controllers, relays, HMI panels). Communication between modules.
Lecture 8 (2) - Assessment
Projects:
Project 1 (2) - Discussion and distribution of project topics
Project 2 (2) - Structure parameterization and parametric modeling in Autodesk Inventor
Project 3 (2) - Application of the iLogic module in the design of machine parts
Project 4 (2) - Integration of engineering calculations with a 3D model
Project 5 (2) - Basics of automation of assembling machine parts into subassemblies
Project 6 (2) - Basics of automation of generating manufacturing and assembly drawings
Project 7-8 (4) - Analytical considerations and simulation tests to determine the workforce of the designed machine
Conducting calculations to calculate the forces acting in the machine. Planning research to determine the workforce. Determining the workforce based on simulations using the finite element method.
Project 9-10 (4) - Design of drive systems for mechatronic devices
Determining the kinematic parameters of the drive systems of the designed device. Selection of actuators. Strength calculation of drive system components and their selection.
Project 11-12 (4) - Design of the control system and work algorithm
Determining parameters of the control system. Selection of components for the control system of the designed mechatronic device. Development of an operating algorithm for the designed mechatronic device. Selection of communication protocols.
Project 13 (2) - Integration of the mechanical system with the control system
Integration of the designed basic system (mechanical system) with the designed control system. Feedback in the mechatronic design process. Functional analysis of a mechatronic device. Development of documentation for a mechatronic device.
Project 14 (2) - Project consultations
Project 15 (2) - Assessment

Teaching methods

Lecture: Lecture with multimedia presentation, using the case study method - analysis of solutions to real construction problems.
Project: Workshop methods of practical construction classes at computer workstations. Project methods.

Bibliography

Basic:
1. Heimann B., Gerth W., Popp K.: Mechatronika. Komponenty. Metody. Przykłady, PWN, Warszawa 2001.
2. Gawrysiak M.: Mechatronika i projektowanie mechatroniczne, Wyd. Politechniki Białostockiej, Białystok 1997.
3. Ito Y.: Modular Design for Machine Tools, McGraw-Hill Professional 2008.
4. Wcisło G.: Jak budować maszyny modułowe? dostępne w: https://automatykab2b.pl/technika/37587-jak-budowac-maszyny-modulowe
5. Jaskulski A., Autodesk Inventor Professional 2024 PL / 2024+ / Fusion 360. Metodyka efektywnego projektowania, wyd. Helion, Gliwice 2023.

Additional:
1. Uhl T. Projektowanie mechatroniczne zagadnienia wybrane, Kraków 2007
2. Gawrysiak M.: Analiza systemowa urządzenia mechatronicznego, Wyd. Politechniki Białostockiej, Białystok 2003.
3. Olszewski M.: Podstawy mechatroniki, wyd. REA, Warszawa 2006.

4. Kosmol J.: Napędy mechatroniczne, wyd. Politechniki Śląskiej, Gliwice 2013.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	24	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	76	3,00