COURSE DESCRIPTION CARD - SYLLABUS

Course name
Introduction to mechatronics [N1Mech2>WDM]

Course

Field of study
Mechatronics

Year/Semester
1/2

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
8

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

Lecturers

Prerequisites

In terms of knowledge: - Basic knowledge of mathematics in algebra and geometry - Basic knowledge of physics, particularly mechanics and electricity - Knowledge of the basic laws of physics describing motion, forces, and energy In terms of skills: - Ability to perform basic mathematical calculations - Ability to interpret graphs and technical diagrams - Basic knowledge of SI units In terms of tools: - Ability to use basic computer programs (word processor, spreadsheet)

Course objective

The aim of the course is to familiarise students with the basics of mechatronics as a field integrating mechanics, electronics, and computer science. As part of the lecture, students will learn the principles of mechatronic design, construction, and operation of basic mechanical, sensory, and executive components used in mechatronic systems, and the basics of their control. The subject aims to develop the ability to identify and classify components of mechatronic systems and understand the principles of their interaction. Particular emphasis is placed on the practical aspects of the application of mechatronics in various areas of everyday life.

Course-related learning outcomes

Knowledge:
Students, after passing the subject:

1. defines basic concepts of mechatronics and understands the principles of mechatronic design
2. characterise the structure and operation of basic machine parts and mechanisms used in mechatronic devices
3. describes the principles of operation and parameters of sensors and actuators used in mechatronic systems
4. lists and characterises basic control methods and tools in mechatronic systems
5. identifies applications of mechatronic systems in various areas of everyday life

Skills:
Students can:
1. analyse the construction and principle of operation of mechatronic devices
2. select appropriate machine parts and mechanisms for designed mechatronic systems
3. calculate basic parameters of mechanisms (degrees of freedom, gear ratios, efficiency)
4. interpret parameters of sensors and actuators in terms of their application in mechatronic systems
5. distinguish between and select basic control elements in mechatronic systems

Social competences:
The student:
1. understands the need for an interdisciplinary approach to solving technical problems
2. is aware of the fast development of mechatronics and the necessity of continuous updating of knowledge
3. recognises the role and importance of mechatronic systems in the development of modern technologies

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Short tests after the lecture. The test of the lecture at the end of the semester. Oral answers in preparation for laboratories and reports.

Programme content

An Introduction to Mechatronics Covers the Definition, History, and Design of Mechatronic Systems, while Showing the Differences Between Conventional and Mechatronic Design. The chapter discusses key design elements such as mechanical linkages, bearing components, and drive systems that underpin the operation of mechanisms in mechatronic devices. An analysis of degrees-of-freedom and kinematic pairs will provide a better understanding of the principles of cam, crank, and piston, linkage, lever, screw, and gear mechanisms. This knowledge will be complemented by sensorics, covering the classification, parameters, and application of displacement, velocity, force, and torque sensors, as well as actuators whose design and operation, from electromagnetic to fluidic, affect the functionality of the entire system. Inherent is also control, which includes human-machine interfaces, PLCs, microcontrollers, and control algorithms to ensure intelligent operation of mechatronic systems. The course is rounded off with examples of applications in automotive, white goods, and modern technology, showing the practical application of the gained knowledge. The course concludes with an electronic test to verify mastery of key topics.

Course topics

Lectures:
1. introduction to mechatronics (2h)
- Definition and scope of mechatronics as an interdisciplinary field
- Design and characteristics of mechatronic systems
- Fundamentals of mechatronic design
- Comparison of conventional and mechatronic design
- Examples of modern mechatronic design
2. machine parts in mechatronic systems (2h)
- Classification of machine parts
- Fastening elements: bolts, nuts, washers, keys, pins, wedges
- Bearing components: rolling and plain bearings, guides, joints
- Drive train components: shafts, axles, clutches, brakes, gears, belt and chain transmissions

3. Mechanisms in mechatronic devices (2h)
- Basic concepts of machine and mechanism theory
- Analysis of degrees of freedom and kinematic pairs
- Open and closed kinematic chains
- Characteristics of mechanisms: cam, crank-piston, linkage, lever, helical, toothed
- Gear ratios and efficiency of mechanisms
4. Sensors in mechatronic systems (2h)
- Classification and level of integration of sensors
- Parameters and requirements for sensors
- Characteristics of measurement errors
- Linear and angular displacement sensors
- Speed, acceleration, force and torque sensors
- Binary and analogue sensors
5. Actuators in mechatronic systems (2h)
- Structure and function of actuators
- Power transducers and actuators
- Characteristics of power forms in actuators
- Electrodynamic and electromagnetic actuators
- Fluid actuators
- Modern actuator solutions
6. Control in mechatronics (2h)
- Human-machine interface
- Description of the behavioural logic of mechatronic systems
- PLCs and their application
- Arduino and Raspberry Pi microcontrollers
- HMI panels and visualisation systems
- Control algorithms in mechatronics
- Examples of implementation of control systems
7. Mechatronics applications in practice (1h)
- Mechatronics in vehicles
- Mechatronic systems in household appliances
- Examples of innovative mechatronic solutions
8. Credit (1h)
- Knowledge verification in the form of an electronic test (40 questions, 35 single-choice, 5 multiple-choice).
Laboratories:
Laboratory Session 1 Introductory class (1.5h):
- Discussion of exercises
- Division into groups
- Demonstration of the operation of a mechatronic device on the example of a car air-conditioning system
Laboratory Sessions 2 to 6 - are held in rotation, in groups of 2-3.
Laboratory Session 2 (1.5h): Positioning of a screw mechanism based on linear position sensors and proximity limit sensors:
- Analysis of the design of a system with a screw mechanism
- Drawing up a circuit diagram
- Bench testing of various analogue sensors
- Determination of the hysteresis curve of the analogue sensors
- Determination of the hysteresis of the proximity sensors on the basis of the signal from the selected displacement sensor
Laboratory Session 3 (1.5h): Measurement of rotational speed and transmission of rotary motion:
- Analysis of the construction and principle of operation of the station
- Drawing up a diagram of the test rig
- Assembly of a rotary motion gear from available mechanical components (gears, couplings, shafts), transferring the drive from the electric motor to the working system
- Measurement of the rotational speed of the working system by means of contact and non-contact methods
- Familiarisation with DC motor speed control methods
- Measurement of torque
- Determination of transmission ratio and efficiency

Laboratory session 4 (1.5 h): Assembly and disassembly of a mechatronic device:
- Assembly of a friction gearbox with AC motor and clutch, as well as the control system
- Analysis of the construction and principle of operation of the unit
- Dismantling the gearbox with motor and clutch and the control system
Laboratory Session 5 (1.5h): Rotary to linear motion change mechanism:
- Assembly of mechanisms for changing from rotary to linear motion (cam mechanism, crank-piston mechanism, lever mechanism connecting the drive to the working elements)
- Analysis of the construction and principle of operation of the bench
- Drawing up a station diagram
- Determination of movement trajectories for the built station
- Analysis of the influence of geometrical parameters of gear parts on the motion path
- Determination of a mathematical model describing movement of selected mechanisms
Laboratory Session 6 (1.5h): Fluid drives and their control:
- Analysis of the construction and principle of operation of a station
- Drawing up a station diagram
- Using a switch panel - analysing the operation of pneumatic system components
- Measurement of the actuator cyclogram
- Measurement of the force generated by an actuator as a function of the pressure value
Laboratory session 7 (1.5h): Control in mechatronics (analysis of ready-made programmes in ladder language):
- Analysis of the construction and principle of operation of the workstation
- Drawing up a diagram of the workstation
- Analyse the design of a ladder language programme on the basis of the program and the behaviour of the system
- Modification of the programme to achieve the desired effect
- Develop your own control programme
Laboratory session 8 (45min): Credit

Teaching methods

Lecture with multimedia presentation. Manuals for laboratories, laboratory stations.

Bibliography

Basic:
1. Szelerski M. W.: Praktyczne podstawy mechatroniki. Wydawnictwo i Handel Książkami KaBe 2022.
2. Gajek A., Juda Z.: Czujniki. Wydawnictwa Komunikacji i Łączności. 2021.
3. Heimann B., Gerth W., Popp K.: Mechatronika, Komponenty, Metody, Przykłady, PWN, Warszawa 2013.
4. Kosmol J.: Napędy mechatroniczne, Wyd. Politechniki Śląskiej, Gliwice 2013.
5. Świder J.: Sterowanie i automatyzacja procesów technologicznych technologicznych układów mechatronicznych, Wyd. Politechniki Śląskiej, Gliwice 2015.

Additional:
1. Gawrysiak M.: Mechatronika i projektowanie mechatroniczne, Wyd. elektroniczne, Białystok 1997.
2. Olszewski M.: Urządzenia i systemy mechatroniczne: technik mechatronik: podręcznik. Cz. 2, Wydawnictwa Szkolne i Pedagogiczne, 2020.
3. Olszewski M.: Urządzenia i systemy mechatroniczne: technik mechatronik: podręcznik. Cz. 1, Wydawnictwa Szkolne i Pedagogiczne, 2020.
4. Bolton, W. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering. Pearson 2018.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	16	0,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	34	1,50