COURSE DESCRIPTION CARD - SYLLABUS

Course name
CNC machines and CAM [S1Mech2>MCiC]

Course

Field of study
Mechatronics

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
45

Other
0

Tutorials
0

Projects/seminars
15

Number of credit points

5,00

Coordinators

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Lecturers

Prerequisites

A student should have basic knowledge in the following areas: mathematics, physics, strength of materials, technical mechanics, fundamentals of machine design, technical drawing, 3D modeling in CAD systems, material removal and non-removal processing technologies, cutting tools, technical metrology, automation, machine construction, drives and control systems, electrical engineering; structured theoretical knowledge related to their field of study; the ability to use literature and acquire knowledge from various sources (e-resources, the internet, catalogs); teamwork skills; an understanding of the necessity to expand their qualifications; and readiness to independently solve technical problems.

Course objective

Providing students with basic knowledge about the structure and operation of numerically controlled metalworking machines, the fundamentals of their operation, kinematic chains, shaping systems, main and feed drives, control systems, as well as the ability to operate selected numerically control machines. Introducing students to: the design of machining processes using computer-aided manufacturing (CAM) systems, issues linking technology with construction, the structure of the technological process, machining strategies, and cost sources in the machining process. Familiarizing students with the structure, components, and principles of selecting electromechanical drives for technological machines. Developing students' self-learning skills, including independent knowledge acquisition, and fostering technical interests.

Course-related learning outcomes

Knowledge:
A student should be able to define the concept of a machine and provide examples, as well as describe the types of motion occurring in machines and devices.
A student should characterize machine and device drives (understand the key characteristics of different drive systems), list and describe commonly used drive motors, and identify accompanying mechanisms.
A student should be able to recognize, distinguish, list, and describe various types of machines.
A student should be familiar with the basic methods for selecting drive system components for technological machines.
A student knows: the essence and purpose of CAM systems, the principles of designing machining processes, the characteristics of machining strategies, the factors contributing to manufacturing costs, the principles of selecting semi-finished products, the role of technological tooling in machining processes, and the factors affecting machining accuracy.

Skills:
A student is able to select appropriate machines and devices for a given type of technological operation, analyze and evaluate their construction, choose components, plan, and supervise maintenance tasks to ensure reliable operation.
A student can determine the drive requirements for a technological task. They can independently design a drive system diagram for a technological machine and select the appropriate motor, transmission, and guides for a given technological task.
A student is capable of: developing a machining process for machine parts in a CAM environment, selecting tools and technological fixtures for a given task, applying an appropriate machining strategy, interpreting results generated by the CAM system, choosing the correct machining method for a specific task, and interpreting data from technical drawings. Additionally, a student can gather relevant information from the internet regarding the subject matter.

Social competences:
The student is aware of the need for continuous self-education in order to improve qualifications. They are able to creatively solve problems and are determined to seek out technological innovations.
The student is able to work in a team. The student is aware of the possibilities offered by modern technological machine drives. They are able to use catalog data from manufacturers of technological drive components.
The student can communicate technical information in a clear and reliable manner.
The student adheres to fundamental ethical principles.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Acquired knowledge is verified through a pass/fail assessment. The assessment consists of open or multiple-choice questions. The pass mark is achieved by answering at least half of the questions correctly (50% threshold).
Laboratory: Acquired knowledge and skills are verified through oral or written responses related to the theory of the laboratory exercises, and reports from each laboratory exercise. To pass the laboratory, all exercises must be completed and passed (positive grades for responses and reports).
For CAM: based on the current theoretical preparation for the classes and the completeness of the task developed in the CAM environment.
Project: The assessment is based on an individual project involving the selection of drive components for a specified machine.

Programme content

Machines. Technological machines. Machine drives, applications. Mechanisms and machine components. Selection of electromechanical drives for technological machines. Designing machining processes in the CAM environment, structure of the technological machining process, selection of semi-finished products, tools and technological fixtures, machining accuracy and efficiency, machining strategies.

Course topics

Lecture:
Division and comparison of conventional and numerically controlled technological machines. Drives of technological machines: main and feed drives-servo drives. Construction, operation, and purpose of conventional and numerically controlled technological machines for metalworking (lathes, milling machines, grinders, etc.). Control systems. Machines for electrical discharge machining (EDM). Control systems, programming methods for machines, CNC components, measurement of accuracy parameters, and their compensation. Types of work and selection of motors for different types of tasks. Characteristics of mechanisms for converting rotary motion to feed motion and their selection methods. Characteristics of guides used in technological machines and methods of selecting them. Special gear systems used in machine drives.
Laboratory:
CNC Lathe - construction and operation. CNC Milling Machine - construction and operation. Machine threading on CNC machines. Measuring backlash in a mechanical gear system of a rotating axis. Efficiency of the power transmission system in technological machines. Shaping of cylindrical gears. Simulation studies of servo drives. Investigation of the dynamics of positioning a rotary table in the small displacement range. CNC Milling Machine operations. Electronic transmission. Controllers in NC machine tools.
For CAM: Introduction to working in the CAM environment, interpretation of technical drawings, methodology for selecting semi-finished products, structure of the technological process - selecting the machining method for a given task, developing the sequence of operations for a specified procedure, designing machining tasks in the CAM environment, selecting tools and technological fixtures, applying machining strategies, interpreting information generated by the CAM system, evaluating machining process efficiency, and identifying sources of costs.
Project:
An individual project containing: characterization of the movement of a designed element of a technological machine, preliminary selection of the motor and gearbox, determining the load characteristics of the drive during the entire work cycle, checking the motor for overheating conditions, selection of a screw, belt drive, and guides.

Teaching methods

Lectures: multimedia presentations, discussions.
Laboratory: • ndependent execution of practical exercises using devices, materials, tools, equipment, and measuring instruments.
For CAM: multimedia presentations, practical development of the machining process in the CAM environment using specialized software, case discussions, and analysis.
Project: Independent work of the student on the assigned project task.

Bibliography

Basic:
• Kosmol J., Servo Drives for Numerically Controlled Machine Tools, WNT Warsaw, 1998.
• Mierzejewski J., Servo Mechanisms for Numerically Controlled Machine Tools, WNT, Warsaw 1977.
• Müller L., Planetary Gear Transmissions, PWN, 1996.
• Singh N., CNC Programming and Control, John Wiley & Sons, Inc. London, 1996.
• Branowski B., Creative Problem-Solving in Engineering, WKT NOT, 1999.
• Fundamentals of Machine Design (Volume 2), ed. Marek Dietrych, PWN, Warsaw, 1999.
• Osiński Z., Fundamentals of Machine Design, PWN 2012.
• Netter K., Machines and Technological Devices for Metal Cutting. Laboratory, Poznan University of Technology Publishing, 2021.
Materials available on the e-course platform.

Information available on the World Wide Web (WWW).

Additional:
• Mechanical Engineer's Handbook, WNT, Warsaw 1970.
• Kosmol J., Mechatronic Drives, WNT Warsaw, 2013.
• Marciniak T., Cylindrical Worm Gears, PWN, 2006.
• Pritschow G., Control Technology for Machine Tools and Industrial Robots, Wrocław University of Technology Publishing, 1995.
• Pająk E., Advanced Technologies of Modern Production Systems, Poznań University of Technology Publishing, 2000.
• Heidenhain ISO Programming User Manual, 1994.
• Kief H.B., NC/CNC Handbook, Carl Hanser, Munich, 1998.
• Skoczyński W., Sensors in CNC Machine Tools, PWN, Warsaw, 2018.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	90	3,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	35	1,50