COURSE DESCRIPTION CARD - SYLLABUS

Course name
XR techniques in the product lifecycle [N1Mech2>TXR]

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
16

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

Lecturers

Prerequisites

1. The student has knowledge in the field of information technology as well as computer graphics and CAD systems. 2. The student is open to implementing modern information technologies in science and engineering. 3. The student is able to collaborate within a project team. 4.The student can develop a solid model of an object and an assembly in a 3D CAD system. 5. The student has basic knowledge of mechanics, materials science, and material strength. 6. The student is capable of independently searching for and analyzing technical information about modern technologies.

Course objective

To understand the possibilities offered by the application of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) as tools supporting the processes of designing, prototyping, and manufacturing industrial products, including mechatronic devices. To gain knowledge of the state of the art in hardware, methodologies, and capabilities for developing software through various examples of products.

Course-related learning outcomes

Knowledge:
1. Defines and classifies concepts related to Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), identifying their common features and differences in the context of XR technology applications.

2. Dentifies the role of XR technologies in modern manufacturing enterprises, considering their applications within the framework of Industry 4.0 and its characteristic features.
3. Understands the current state of the art in Virtual, Augmented, and Mixed Reality, distinguishes classes of XR systems, defines their basic components, and characterizes available technical solutions and their parameters.
4. Knows the basic methods, tools, and procedures for creating and implementing XR applications in industrial settings.
5. Possesses knowledge of product design processes, including the use of XR technologies in their development and verification.
6. Understands the technical and organizational aspects of implementing XR applications, including hardware requirements, programming environments, and challenges related to integration with existing systems.
7. Is familiar with basic standards and guidelines for integrating XR technologies into design and production processes..

Skills:
1. Selects the appropriate XR technology for a specific stage of the product lifecycle, taking into account its characteristics and industrial requirements.
2. Develops models of activities carried out in design and production processes and creates their simulations using XR technologies.
3. Operates and programs selected XR hardware solutions, adapting them to the needs of specific industrial processes.
4. Independently researches and implements XR solutions based on the latest available technologies, considering user needs and technical constraints.
5. Designs ergonomic and intuitive user interfaces in XR environments, tailored to the requirements of the end user.

Social competences:
1. Understands the need for changes in production processes and enterprise operations, recognizes the importance of continuous learning, and can inspire the team to develop competencies in modern XR technologies.
2. Effectively collaborates within a team, taking on various roles, including that of a leader, and supports other members in achieving shared goals related to the implementation of XR technologies.
3. Creatively and responsibly presents the benefits and limitations of applying XR technologies in modern production processes, considering the needs and capabilities of the enterprise.
4. Is open to criticism and can respond constructively to suggestions regarding the implementation of XR technologies to improve processes and solutions.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Laboratory: credit based on preparation of a report from laboratory exercises (requirement to prepare reports from 100% of exercises - participation in each exercise, the report is credited when at least 50% of points are obtained for the assessment of its content)
Lecture: credit based on a colloquium consisting of open and closed questions; the colloquium is passed after obtaining at least 51% of points. The verification colloquium is held at the end of the semester.

Programme content

The course "XR Techniques in the Product Lifecycle" focuses on both theoretical and practical education related to the application of XR (Extended Reality) technologies-including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR)-in the processes of product design, manufacturing, maintenance, and disposal.
During lectures, students explore fundamental concepts and definitions associated with XR, emphasizing its role in modern manufacturing enterprises and within the framework of Industry 4.0. Special attention is given to identifying the stages of the product lifecycle that can be supported by XR techniques and discussing their potential benefits and limitations.
The covered topics include the classification of XR systems, types of hardware and software, as well as the latest advancements in projection and interaction technologies. Students undertake tasks both individually and in teams, simulating real-world industrial projects. Practical exercises emphasize the use

of modern XR tools and their integration with systems commonly employed in enterprises, with a strong focus on the practical application of theoretical knowledge.

Course topics

Lectures:
1. Fundamental concepts related to Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), as well as the term "XR techniques."
2. The position of various technologies within the XR spectrum. Types of interactive applications.
3. Applications of VR and AR in modern manufacturing enterprises.
4. Industry 4.0: its characteristics and the role of XR techniques within this concept.
5. Applications of XR techniques at various stages of the product lifecycle.
6. XR systems - classes of MR, AR, and VR hardware and software.
7. The state of the art in projection devices and interaction techniques in VR and AR systems.
8. Designing and planning the lifecycle of XR applications in the production domain.
9. Selected case studies of XR implementations in industry.
Lab:
First Half of the Semester:
Individual laboratory exercises - understanding the basics of using software for developing XR applications. During these exercises, students learn the specifics of preparing and importing 3D models for XR environments and independently build simple applications.
Second Half of the Semester:
Laboratory exercises in 2-3 person groups, using selected XR hardware. Example exercise topics:
1. Building a VR application - product visualization.
2. Building a VR application - assembly instruction.
3. Building a VR application - device operation simulator.
4. Building an AR application - machine operation support.
5. Building an AR application - presentation of a selected product.

Teaching methods

- informative lecture
- multimedia presentation
- case study
- laboratory method

Bibliography

Basic:
1. F. Górski, Metodyka budowy otwartych systemów rzeczywistości wirtualnej: zastosowanie w inżynierii mechanicznej, Wyd. Politechniki Poznańskiej, 2019
2. G. Ćwikła, F. Górski, J. Patalas-Maliszewska, Wspomaganie informacyjne menedżerów produkcji, Polskie Wydawnictwo Ekonomiczne, 2021
3. B. Arnaldi, P. Guitton, G. Moreau,Virtual Reality and Augmented Reality: Myths and Realities, Wiley, 2018
4. Chandrashekhar, A., et al., eds. Metaverse and Immersive Technologies: An Introduction to Industrial, Business and Social Applications. John Wiley & Sons, 2023

Additional:
1. S.K. Ong, A.Y.C. Nee, Virtual and Augmented Reality Applications in Manufacturing, Springer, London, 2004

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