COURSE DESCRIPTION CARD - SYLLABUS

Course name
Design in augmented and mixed reality environment [N1ZiIP2>PwSRR]

Course

Field of study
Management and Production Engineering

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
elective

Number of hours

Lecture
8

Laboratory classes
8

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

Lecturers

Prerequisites

The student has knowledge of information technology and knowledge of computer graphics and CAD systems. The student understands the concept of design and its purpose and place in the product development process. The student is able to develop a solid model of an object and assembly in a 3D CAD system. The student is open to the implementation of modern information technologies in science and technology. Is able to independently develop knowledge and skills in the subject. Is able to cooperate in a design team.

Course objective

To learn about the possibilities associated with the use of augmented reality (AR) and mixed reality (MR) as tools for supporting the design and prototyping processes of industrial products and related processes. To learn about the state of the art in terms of hardware and methodologies and possibilities in the field of software development on various examples of products.

Course-related learning outcomes

Knowledge:
1. Defines the concepts of Augmented Reality and Mixed Reality. Is able to distinguish it from Virtual Reality, is able to indicate common features and differences between technologies.
2. Indicates the place of augmented and mixed reality and the types of its applications in a modern

manufacturing enterprise, with particular emphasis on the design and prototyping process.
3. Knows the state of the art in the field of AR/MR - recognizes various classes of systems, defines their elements, is able to indicate currently available technical solutions and provide the scope of their technical capabilities.
4. Knows the basic methods, tools and procedures for creating and implementing AR and MR applications in industrial design, understands the limitations of these technologies compared to VR.

Skills:
1. Has the ability to develop 3D and 2D data for interactive AR and MR applications
2. Is able to design an interactive AR and MR application to present the characteristics of a specific product, activity or position
3. Possesses the ability to program interactions with objects in the MR system using hand tracking and in the AR system using marker recognition.
4. Possesses the ability to perform economic analysis of AR/MR solutions in industrial design.

Social competences:
1. Has the knowledge necessary to understand the social, economic, legal and other non-technical conditions of engineering activities
2. Understands the need to make changes in production processes and in the enterprise. Understands the need for continuous learning; is able to inspire and organize the learning process of team members, especially in the field of modern digital technologies such as AR or MR.
3. Is able to cooperate and work in a team, assuming various roles, including group leader.
4. Is able to present the advantages and disadvantages of using augmented and mixed reality in a modern enterprise in an appropriate and creative way

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Laboratory: crediting based on the preparation of a report on laboratory exercises (preparation of reports from 100% of exercises is required - participation in each exercise, the report is credited when at least 50% of points are obtained for the assessment of its content)
Lecture: assessment based on a colloquium consisting of open and closed questions; the colloquium is passed after obtaining at least 51% of the points. A final colloquium is held at the end of the semester.
Assignment of grades to percentage ranges of results: <90-100> very good; <80-90) good plus; <70-80) good; <60-70) satisfactory plus; <50-60) satisfactory; <0-50) unsatisfactory.

Programme content

The course "Design in Augmented and Mixed Reality Environment" focuses on theoretical and practical education on AR (Augmented Reality) and MR (Mixed Reality) technologies, emphasizing their relationship with virtual reality (VR). Lectures cover basic AR and MR concepts, their application in product design and prototyping, as well as the integration of these technologies within Industry 4.0. The course covers AR/MR systems, including hardware and software classes and the latest technologies of head-mounted devices and interaction systems. In laboratories, course participants learn how to prepare 3D data for import to AR and MR environments, customize visual features of models, program interactions between objects, and create advanced user interfaces in AR and MR technologies. Students work both individually and in teams, using different types of AR and MR equipment, such as cameras, markers, hologram projection devices, and controllers and hand tracking systems.

Course topics

Lecture:
1. Basic concepts of augmented reality (AR) and mixed reality (MR) and their connections with virtual reality (VR). Types of interactive AR/MR applications used in industrial companies.
2. Application of AR/MR environment in designing and prototyping new products and their further development. Virtual prototypes, their types and methods of construction. Application of virtual prototypes at various stages of the product life cycle.
3. Industry 4.0, characteristic features and the place of AR and MR techniques in this concept.
4. Application of XR techniques at various stages of the product life cycle.
5. AR/MR systems - hardware and software classes. State of the art in the field of head-mounted devices

and other projection and interaction systems used in AR/MR.
6. Design and construction of AR and MR applications. Preparation of data for the creation of virtual prototypes. Selected implementation cases.
Laboratory:
1. Methods of preparing 3D data for import into the AR and MR environment. Import and adjustment of visual features of models displayed in the AR/MR application (materials, textures, lighting) taking into account the limitations of available devices.
2. Programming interactions between objects: displacements, rotations, dynamic changes in the shape and visual characteristics of objects.
3. Creating a user interface: graphical interface elements, 2D and 3D interface.
4. Use of AR equipment - use of markers and cameras to display interactive content.
5. Application of MR equipment in video-see-through technology - displaying interactive objects and interacting with them using controllers and hand tracking.
6. Application of MR equipment in optical-see-through technology - hologram projection, interaction using gestures and hand tracking.
Independent work at a computer station (1-3) and work in two-person teams at stations with AR and MR devices (4-6).

Teaching methods

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

Bibliography

Basic:
1. G. Ćwikła, F. Górski, J. Patalas-Maliszewska, Information support for production managers, Polish Economic Publishing House, 2021
2. S. Aukstakalnis, Practical Augmented Reality, Addison-Wesley Professional, 2016
3. F. Górski, Methodology of building open virtual reality systems: application in mechanical engineering, Poznań University of Technology Publishing House, 2019

Additional:
B. Arnaldi, P. Guitton, G. Moreau, Virtual Reality and Augmented Reality: Myths and Realities, Wiley, 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