



Software of Multimedia Systems. Part 2. XR Applications Syllabus

Requisites of the Course

Cycle of Higher Education	<i>First cycle of higher education (Bachelor's degree)</i>
Field of Study	<i>12 Information Technologies</i>
Speciality	<i>121 Software engineering</i>
Education Program	<i>Software Engineering of Multimedia and Information Retrieval Systems</i>
Type of Course	<i>Normative</i>
Mode of Studies	<i>full-time</i>
Year of studies, semester	<i>4 year, 7 semester</i>
ECTS workload	<i>36 hours of lectures, 18 hours of computer classes, 51 hours of self-study</i>
Testing and assessment	<i>Exam, module test</i>
Course Schedule	<i>Classes by the timetable (http://roz.kpi.ua/)</i>
Language of Instruction	<i>English</i>
Course Instructors	Lecturer: PhD, Associate Professor, Oksana Shkurat, shkurat@pzks.fpm.kpi.ua Teacher of computer classes: PhD, Associate Professor, Oksana Shkurat, shkurat@pzks.fpm.kpi.ua
Access to the course	<i>Google classroom. Access is given to registered students.</i>

Program of the Course

1. Course description, purpose, subject of study and learning outcomes

Study of the discipline "Software of Multimedia Systems. Part 2. XR Applications" allows students to develop the competencies necessary for solving practical tasks of professional activity related to the development, quality assurance and support of augmented and virtual reality applications, as well as the implement of augmented and virtual reality elements into software of various purposes.

***The purpose** of studying the discipline "Software of Multimedia Systems. Part 2. XR Applications" is the formation in students of the ability to independently develop applications of augmented and virtual reality, as well as to develop multimedia components using third-party software.*

***The subject** of the discipline "Software of Multimedia Systems. Part 2. XR Applications" are technologies for developing augmented and virtual reality applications.*

Study of the discipline "Software of Multimedia Systems. Part 2. XR Applications" contributes to the formation of students of professional competences (PC) according to the educational program, necessary for solving practical tasks of professional activity, related to the development, quality assurance and support of elements of augmented and virtual reality in software of various purposes:

***PC17** Ability to develop software of multimedia systems.*

***PC18** Ability to apply the acquired fundamental mathematical knowledge for the development of calculation methods in the creation of multimedia and information retrieval systems.*

Study of the discipline "Software of Multimedia Systems. Part 2. XR Applications" contributes to the formation of program learning outcomes (PLO) for students according to the educational program:

PLO05 To know and apply relevant mathematical concepts, methods of domain, system and object-oriented analysis and mathematical modeling for software development.

PLO12 To apply efficient approaches to software design in practice.

PLO18 To know and be able to apply information technologies for data processing, storage and transmission.

PLO25 To know and be able to use fundamental mathematical tools to build algorithms and develop modern software.

PLO26 To be able to develop and use methods and algorithms for the approximate solution of mathematical problems in the design of multimedia and information retrieval systems.

PLO27 To know and be able to apply the latest multimedia technologies, multimedia and immersive technologies for the development of multimedia software.

PLO32 To know the main models of presentation of textual and multimedia information and methods of its pre-processing for use in the design of information retrieval systems.

PLO33 To know and be able to use software resources and libraries for processing text information and multimedia data in information retrieval systems.

2. Pre-requisites and post-requisites of the course (place in the structural-and-logical scheme of the educational program)

Successful study of the discipline "Software of Multimedia Systems. Part 2. XR Applications" precedes the study of the disciplines "Software of Multimedia Systems. Part 1. Computer Graphics", "Algorithmic Support of Multimedia and Information Retrieval Systems" of the curriculum of bachelor's training in the specialty 121 Software engineering.

Received upon learning the discipline "Software of Multimedia Systems. Part 2. XR Applications" theoretical knowledge and practical skills ensure the successful implementation of diploma projects in the specialty 121 Software Engineering. Also, the acquired knowledge and skills are a prerequisite for successfully mastering the discipline "Multimedia Interfaces and 3D Visualization" of the Master's training plan in the specialty 121 Software Engineering.

3. Content of the course

Discipline "Software of Multimedia Systems. Part 2. XR Applications" involves studying the following topics:

Topic 1. Introduction to augmented and virtual reality technologies

Topic 2. Immersive technologies: software and hardware components

Topic 3. Near-real-time image recognition technologies as a component of positional tracking in augmented and virtual realities

Topic 4. Development of multimedia components for scenes of augmented and virtual reality

Module test

Exam

4. Educational materials and resources

Basic references:

1. Educational and methodical materials for the discipline «Software of Multimedia Systems. Part 2. XR Applications».

Get acquainted with sections dealing with the following topics of the discipline: Basics of augmented reality technology; Basics of virtual reality technology; Hardware of the immersive environment; Software tools for developing an immersive environment; Development of augmented reality applications based on Unity; Image recognition technologies for marker augmented reality; Image recognition technologies for positioning augmented and virtual reality objects; Technologies for creating visual elements of augmented

and virtual reality; Audio conversion software tools for augmented and virtual reality; Video conversion software tools for augmented and virtual reality.

The materials are in Google classroom. Access is granted to registered students. Use to master theoretical knowledge and practical skills in the discipline.

2. *Theory and applications of marker-based augmented reality: Licentiate thesis / S. Siltanen. – Licentiate, Aalto University, 2012. – 250 p. URL: <https://publications.vtt.fi/pdf/science/2012/S3.pdf>*

Get acquainted with sections dealing with the following topics of the discipline: Basics of augmented reality technology; Hardware of the immersive environment; Software tools for developing an immersive environment; Image recognition technologies for marker augmented reality. The materials are freely available on the Internet.

Additional references:

3. *Understanding Augmented Reality / Alan B. Craig. – Elsevier Inc., 2013. – 297 p.*

Get acquainted with sections dealing with the following topics of the discipline: Basics of augmented reality technology; Hardware of the immersive environment; Technologies for creating visual elements of augmented and virtual reality; Audio conversion software tools for augmented and virtual reality; Video conversion software tools for augmented and virtual reality. The materials are freely available on the Internet.

4. SDK ARKit. URL: <https://developer.apple.com/augmented-reality/>

Get acquainted with sections dealing with the following topics of the discipline: Software tools for developing an immersive environment; Development of augmented reality applications based on Unity. Use to master the practical skills of the discipline. The materials are freely available on the Internet.

5. SDK ARCore. URL: <https://developers.google.com/ar>

Get acquainted with sections dealing with the following topics of the discipline: Software tools for developing an immersive environment; Development of augmented reality applications based on Unity. Use to master the practical skills of the discipline. The materials are freely available on the Internet.

6. PlugXR. URL: <https://www.plugxr.com/>

Get acquainted with sections dealing with the following topics of the discipline: Software tools for developing an immersive environment. Use to master the practical skills of the discipline. The materials are freely available on the Internet.

7. Blender. URL: <https://www.blender.org/>

Get acquainted with sections dealing with the following topics of the discipline: Technologies for creating visual elements of augmented and virtual reality. Use to master the practical skills of the discipline. The materials are freely available on the Internet.

8. Blender User Manual. URL: <https://docs.blender.org/manual/en/latest/index.html>

Get acquainted with sections dealing with the following topics of the discipline: Technologies for creating visual elements of augmented and virtual reality. Use to master the practical skills of the discipline. The materials are freely available on the Internet.

9. Unity. URL: <https://unity.com/>

Get acquainted with sections dealing with the following topics of the discipline: Software tools for developing an immersive environment; Development of augmented reality applications based on Unity. Use to master the practical skills of the discipline. The materials are freely available on the Internet.

10. Unity User Manual. URL: <https://docs.unity.cn/Manual/>

Get acquainted with sections dealing with the following topics of the discipline: Software tools for developing an immersive environment; Development of augmented reality applications based on Unity. Use to master the practical skills of the discipline. The materials are freely available on the Internet.

Educational content

5. Methodology

№	Type of a class	Description of a class
<i>Topic 1. Introduction to augmented and virtual reality technologies</i>		
1	<i>Lecture 1. Basics of augmented reality technology</i>	<i>Basic definitions of augmented reality (AR) technology. Scheme of operation of augmented reality. Types of augmented reality. Devices implementing augmented reality. Fields of application of augmented reality technology. Functional capabilities of modern augmented reality applications. Materials for self-studying: p.6 № 1.</i>
2	<i>Lecture 2. Basics of virtual reality technology</i>	<i>Basic definitions of virtual reality (VR) technology. Types of virtual reality. Means of immersion in virtual reality. Fields of application of virtual reality technologies. Functional capabilities of modern virtual reality applications. Materials for self-studying: p.6 № 2.</i>
3	<i>Computer class 1. Creating an animated 3D object as a visual component of augmented reality (part 1)</i>	<i>Task: Using the Blender, build a "complex" 3D object. Materials for self-studying: p.6 № 3.</i>
<i>Topic 2. Immersive technologies: software and hardware components</i>		
4	<i>Lecture 3. Hardware of the immersive environment</i>	<i>Digital object visualization devices: VR helmets, augmented reality glasses. Devices for interaction with digital objects: head, eye, body movement tracking systems, gloves. Methods of positioning augmented reality objects. Built-in mobile positioning sensors. Positional tracking technology. Materials for self-studying: p.6 № 4.</i>
5	<i>Lecture 4. Software tools for developing an immersive environment (part 1)</i>	<i>Cloud platforms for AR solutions: PlugXR and Blippbuilder. SparkAR platform. EV Studio platform. Materials for self-studying: p.6 № 5.</i>
6	<i>Computer class 1. Creating an animated 3D object as a visual component of augmented reality (part 2)</i>	<i>Task: Using the Blender, animate a "complex" 3D object. Materials for self-studying: p.6 № 6.</i>
7	<i>Lecture 5. Software tools for developing an immersive environment (part 2)</i>	<i>Software Development Kit (SDK) for augmented and virtual reality: ARKit, ARCore, Vuforia. Materials for self-studying: p.6 № 7.</i>

8	<i>Lecture 6. Software tools for developing an immersive environment (part 3)</i>	<i>Unity as the environment for the development of augmented and virtual reality. The concept of a game engine. Unity 3D. Interface, programming language. ARFoundation and Steam VR. Materials for self-studying: p.6 № 8.</i>
9	<i>Computer class 2. Development of animated augmented reality for MobileAR solutions based on PlugXR (part 1)</i>	<i>Task: develop three scenes of augmented reality using an animated 3D object created in the Blender and the tools of the PlugXR. Materials for self-studying: p.6 № 9.</i>
10	<i>Lecture 7. Augmented reality application development with Unity (part 1)</i>	<i>The main stages of developing augmented reality based on Unity: creating a project, configuring plugins, importing and configuring 3D objects, compiling the project. Materials for self-studying: p.6 № 10.</i>
11	<i>Lecture 8. Augmented reality application development with Unity (part 2)</i>	<i>Augmented reality development based on Unity with image recognition. Unity-based interactive augmented reality development with spatial awareness. Materials for self-studying: p.6 № 11.</i>
12	<i>Computer class 2. Development of animated augmented reality for MobileAR solutions based on PlugXR (part 2)</i>	<i>Task: create an augmented reality book from several developed scenes using the tools of the PlugXR for MobileAR solutions. Materials for self-studying: p.6 № 12.</i>
<i>Topic 3. Near-real-time image recognition technologies as a component of positional tracking in augmented and virtual realities</i>		
13	<i>Lecture 9. Image recognition technologies for marker augmented reality (part 1)</i>	<i>Image recognition technologies. Feature space and image feature vector. Binarization of images. Materials for self-studying: p.6 № 13.</i>
14	<i>Lecture 10. Image recognition technologies for marker augmented reality (part 2)</i>	<i>Recognition of augmented reality markers. Morphological analysis of images. Operations of erosion, dilation. Morphological gradient. Materials for self-studying: p.6 № 14.</i>
15	<i>Computer class 3. Development of animated augmented reality based on Unity (part 1)</i>	<i>Task: create an augmented reality scene and multimedia elements of the scene in the Unity. Materials for self-studying: p.6 № 15.</i>
16	<i>Lecture 11. Image recognition technologies for positioning augmented and virtual reality objects (part 1)</i>	<i>Image feature extraction algorithms. Patterns of images. Compare and contrast image control points. Technologies for recognizing vertical, horizontal, uniform surfaces. Materials for self-studying: p.6 № 16.</i>
17	<i>Lecture 12. Image recognition technologies for positioning augmented and virtual reality objects (part 2)</i>	<i>Computer vision graphics libraries. OpenCV library. Neural network recognition technologies. Materials for self-studying: p.6 № 17.</i>

18	<i>Computer class 3. Development of animated augmented reality based on Unity (part 2)</i>	<i>Task: Develop an augmented reality application based on Unity using the augmented reality SDK (Vuforia, ARKit, ARCore, ARFoundation). Materials for self-studying: p.6 № 18.</i>
<i>Topic 4. Development of multimedia components for scenes of augmented and virtual reality</i>		
19	<i>Lecture 13. Technologies for creating visual elements of augmented and virtual reality (part 1)</i>	<i>Creation of 2D images. Graphic editors: Adobe Illustrator, CorelDraw, Inkscape, Adobe Photoshop. File formats for storing 2D graphics. Concept of index image for data compression. Bit depth. Materials for self-studying: p.6 № 19.</i>
20	<i>Lecture 14. Technologies for creating visual elements of augmented and virtual reality (part 2)</i>	<i>Image depth and volume of 2D objects. The concept of perspective. Illusion of movement in 2D. Global illumination of 3D objects. Types of light sources. Models of diffusely reflected light. Specular models flood and directional light. Ray tracing. Materials for self-studying: p.6 № 20.</i>
21	<i>Computer class 4. Development of interactive virtual reality based on Unity (part 1)</i>	<i>Task: create a virtual reality scene and multimedia scene elements in the Unity. Materials for self-studying: p.6 № 21.</i>
22	<i>Lecture 15. Technologies for creating visual elements of augmented and virtual reality (part 3)</i>	<i>Motion perception. Inertia of vision. The hindsight effect. Laws of subjective perception of brightness. Shooting plans. Alternation of plans. Cartoon. Phases and physical laws of movement of bodies. Principles of animation. Materials for self-studying: p.6 № 22.</i>
23	<i>Lecture 16. Technologies for creating visual elements of augmented and virtual reality (part 4)</i>	<i>3D scene. Ways to create 3D objects. File formats that store 3D objects. Methods of estimating the depth of a 3D scene. The shadows. Environments for the development of 3D objects: OGRE, Maya, 3ds Max, Blender, Cinema 4D, Lightwave 3D, Anim8or, Art of Illusion, Adobe Photoshop Extended. Materials for self-studying: p.6 № 23.</i>
24	<i>Computer class 4. Development of interactive virtual reality based on Unity (part 2)</i>	<i>Task: implement the interaction with the elements of the virtual reality scene based on Unity, using the SDK (Steam VR, XR Interaction Toolkit). Materials for self-studying: p.6 № 24.</i>
25	<i>Lecture 17. Audio conversion software tools for augmented and virtual reality</i>	<i>Creating audio data. Audio data processing. Editors: Audacity, Wavosaur, WavePad, OcenAudio. Materials for self-studying: p.6 № 25.</i>
26	<i>Lecture 18. Video conversion software tools for augmented and virtual reality</i>	<i>Create video data. Video data processing. Editors: Sony Vegas Pro, Movavi, Avidemux, Lightworks, Jahshaka, Adobe Premiere Pro. Materials for self-studying: p.6 № 26.</i>

Module test

6. Self-study

The discipline "Software of Multimedia Systems. Part 2. XR Applications" is based on independent preparations for classroom classes on theoretical and practical topics.

<i>No</i>	<i>The name of a class</i>	<i>Hours of study</i>	<i>References</i>
1	<i>Prepare to lecture 1</i>	<i>0.5</i>	<i>1; 2; 3</i>
2	<i>Prepare to lecture 2</i>	<i>0.5</i>	<i>1</i>
3	<i>Prepare to computer class 1 (part 1)</i>	<i>1</i>	<i>1; 7; 8</i>
4	<i>Prepare to lecture 3</i>	<i>0.5</i>	<i>1; 2; 3</i>
5	<i>Prepare to lecture 4</i>	<i>0.5</i>	<i>1; 6</i>
6	<i>Prepare to computer class 1 (part 2)</i>	<i>1</i>	<i>1; 7; 8</i>
7	<i>Prepare to lecture 5</i>	<i>0.5</i>	<i>1; 2; 4; 5</i>
8	<i>Prepare to lecture 6</i>	<i>0.5</i>	<i>1; 9; 10</i>
9	<i>Prepare to computer class 2 (part 1)</i>	<i>1</i>	<i>1; 6</i>
10	<i>Prepare to lecture 7</i>	<i>0.5</i>	<i>1; 4; 5; 9; 10</i>
11	<i>Prepare to lecture 8</i>	<i>0.5</i>	<i>1; 4; 5; 9; 10</i>
12	<i>Prepare to computer class 2 (part 2)</i>	<i>1</i>	<i>1; 6</i>
13	<i>Prepare to lecture 9</i>	<i>0.5</i>	<i>1; 2</i>
14	<i>Prepare to lecture 10</i>	<i>0.5</i>	<i>1; 2</i>
15	<i>Prepare to computer class 3 (part 1)</i>	<i>1</i>	<i>1; 2; 9; 10</i>
16	<i>Prepare to lecture 11</i>	<i>0.5</i>	<i>1</i>
17	<i>Prepare to lecture 12</i>	<i>0.5</i>	<i>1</i>
18	<i>Prepare to computer class 3 (part 2)</i>	<i>1</i>	<i>1; 2; 9; 10</i>
19	<i>Prepare to lecture 13</i>	<i>0.5</i>	<i>1; 3</i>
20	<i>Prepare to lecture 14</i>	<i>0.5</i>	<i>1; 3</i>
21	<i>Prepare to computer class 4 (part 1)</i>	<i>1</i>	<i>1; 9; 10</i>
22	<i>Prepare to lecture 15</i>	<i>0.5</i>	<i>1; 3</i>
23	<i>Prepare to lecture 16</i>	<i>0.5</i>	<i>1; 3; 7; 8</i>
24	<i>Prepare to computer class 4 (part 2)</i>	<i>1</i>	<i>1; 9; 10</i>
25	<i>Prepare to lecture 17</i>	<i>0.5</i>	<i>1; 3</i>
26	<i>Prepare to lecture 18</i>	<i>0.5</i>	<i>1; 3</i>
27	<i>Prepare to module test</i>	<i>4</i>	<i>1-3; 4-5; 10</i>
28	<i>Prepare to exam</i>	<i>30</i>	<i>1-3; 4-5; 10</i>

7. Course policy

Forms of organization of the educational process, types of training sessions and evaluation of training results are regulated by Regulations on the Organization of the Educational Process at Igor Sikorsky Kyiv Polytechnic Institute (<https://kpi.ua/en/regulations>).

Class attendance policy. Attending lectures is mandatory. Attending computer classes may be occasional and as needed to protect the computer class. If the student cannot attend classes, he is still responsible for studying the theoretical material and completing computer class.

Policy regarding ethical standards at work: discipline; observance of subordination; honesty; responsibility; respect for those present, turning off the phones. The norms of ethical behavior of students and scientific and pedagogical workers are regulated by the provisions set forth in the section 2 of the Code of Honor National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» (https://kpi.ua/files/honorcode_en.pdf).

Policy regarding the assessment of learning outcomes: each assessment is assigned according to the criteria developed by the teacher and announced to the students in advance. If a student does not complete all the types of classes provided by the curriculum (tasks of the computer classes, modular test), he will not be admitted to the exam; missed classes, during which tests were conducted, must be made up (consultation or practice time is agreed with the teacher on an individual basis).

Academic Conduct and Integrity Policy. The policy and principles of academic integrity are governed by the rules set forth in section 3 of the Code of Honor National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» (https://kpi.ua/files/honorcode_en.pdf); Regulations on the Organization of the Educational Process at Igor Sikorsky Kyiv Polytechnic Institute (<https://kpi.ua/en/regulations>). Plagiarism and other forms of violation of the principles of academic integrity are unacceptable. The student must complete all tasks of the computer classes independently using open sources of information and acquired knowledge and skills.

Policy on contesting the results of evaluation of control measures. A student can raise any issue related to the screening process and expect it to be dealt with in accordance with pre-defined procedures.

Incentive and Penalty Points Policy. According to Regulations on the system for evaluating learning outcomes at Igor Sikorsky Kyiv Polytechnic Institute (https://osvita.kpi.ua/sites/default/files/downloads/Regulation_RSO_2022.pdf), incentive and penalty points are not included in the main scale, and their sum cannot exceed 10% of the starting scale (5 points).

Incentive points are awarded for a creative approach in the performance of computer classes (the maximum number of points for all works is 4 points).

Penalty points are awarded for violations of the principles of academic integrity, in particular, plagiarism in the works of the computer classes (the program code does not correspond to the task variant, the identity of the program code among different works), non-independent performance of the modular test, exam (-5 points for each attempt to violate the principles academic integrity).

8. Types of control and rating system for evaluating learning outcomes

During the semester, students complete **4 computer classes**. The maximum number of points for each computer class is **10 points**.

Points for the computer class are awarded for:

- quality of performance of the computer class: 0-4 points;
- presentation of the computer class and answers during the defense: 0-2 points;
- performance of the report for the computer class: 0-2 points;
- timely submission of computer class for defense: 0-2 points.

Quality performance evaluation criteria:

4 points – the work is done qualitatively, in full;

3 points – the work is done qualitatively, in full, but has flaws;

2 points – the work is completed in full, but contains minor errors;

1 point – the work is completed in full, or contains significant errors;

0 points – the work is not fully completed.

Presentation and answers evaluation criteria:

2 points – the presentation is complete, the answers are well-argued;

1 point – in general, the presentation took place, the answers have shortcomings or minor errors;

0 points – there is no presentation, the answers have significant errors.

Report evaluation criteria:

2 points – the report is completed in full;

0-1 points – the report is missing or there are significant deficiencies in the report.

Timely submission of computer class for defense:

2 points – the work is submitted for defense no later than the specified deadline;

0 points – the work is submitted for defense later than the specified deadline.

The maximum points for performing and defending computer classes:

10 points × 4 computer classes = 40 points.

The task for the **module test** consists of 1 practical task. The maximum points for solving a practical task is **10 points**.

Evaluation criteria for the practical task of the module test:

10 points – the answer is correct, the calculations are completed in full;

8-9 points – the answer is correct, but not very well supported by calculations;

6-7 points – in general, the answer is correct, but it has flaws;

4-5 points – there are minor errors in the answer;

2-3 points – there are significant errors in the answer;

0 points – no answer or the answer is incorrect.

The maximum points for a module test:

10 points × 1 practical task = 10 points.

Calendar control is carried out twice a semester as a monitoring of the current state of meeting the syllabus requirements. At the first certification (8th week), the student receives "passed" if his current rating is at least 5 points (50% of the maximum number of points a student can receive before the first certification). At the second certification (14th week), the student receives "passed" if his current rating is at least 15 points (50% of the maximum number of points a student can receive before the second certification).

Semester control: exam

Conditions for admission to the semester control: with a semester rating of at least 30 points and the enrollment of all four computer classes, the student receives admission to take the exam.

The student's rating in the course consists of points that they receive for computer classes ($R_{\text{computer classes}}$), module test ($R_{\text{module test}}$) and exam (R_{exam}).

$R = R_{\text{computer classes}} + R_{\text{module test}} + R_{\text{exam}} = 40 \text{ points} + 10 \text{ points} + 50 \text{ points} = 100 \text{ points}$.

Table of correspondence of rating points to grades on the university scale:

Points	Grade
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Fair
Less than 60	Unsatisfactory
Course requirements are not met	Not Graded

The task for the exam consists of **5 theoretical questions**. The answer to each theoretical question is evaluated by **10 points**.

Evaluation criteria for each theoretical question of the exam:

10 points – the answer is correct, complete, well-argued;

8-9 points – the answer is correct, detailed, but not very well argued;

6-7 points – in general, the answer is correct, but it has flaws;

4-5 points – there are minor errors in the answer;

2-3 points – there are significant errors in the answer;

0-1 points – no answer or the answer is incorrect.

The maximum points for the exam:

10 points × 5 theoretical questions = 50 points.

9. Additional information for the course

When a student takes free online courses on the Coursera platform

Introduction to Augmented Reality and ARCore (<https://www.coursera.org/learn/ar#modules>),

VR with Unity: Build your first Meta Quest VR Project (<https://www.coursera.org/projects/vr-unity-build-your-first-meta-quest#outcomes>),

there is recognition of learning results acquired during non-formal education and their enrollment in accordance with the rating evaluation system as current control from the corresponding component of the educational discipline. The teacher credits the learning results acquired in the informal, provided that there is a certificate of completion of the online course. The semester and current control of the relevant discipline is evaluated by a scientific and pedagogical employee in accordance with the rating system for evaluating learning outcomes and the policy of the educational discipline (writing the module test and passing the exam is mandatory).

The list of questions submitted for semester control is given in Appendix 1.

Syllabus of the course:

Is designed by teacher PhD, Associate Professor, Oksana Shkurat

Adopted by the Computer Systems Software Department (protocol № 14, 15.05.24)

Approved by the Faculty Board of Methodology (protocol № 12, 21.06.24)

Appendix 1. The list of questions submitted for semester control

- 1. Define the terms "augmented reality" and "virtual reality". What is the key difference? What other types of reality exist, define.*
- 2. Types of augmented reality.*
- 3. Describe the working principle of augmented reality.*
- 4. Name the main components of technologies for positional tracking of augmented and virtual reality objects, give a definition.*
- 5. PlugXR as technology for creating an immersive environment.*
- 6. Spark AR as technology for creating an immersive environment.*
- 7. BLIPPBUILDER as technology for creating an immersive environment.*
- 8. SDK AR Foundation.*
- 9. SDK ARCore.*
- 10.SDK ARKit.*
- 11. SDK Vuforia Engine.*
- 12. Unity as environment for creating an immersive environment.*
- 13. Types of digital images. Ways of presenting a digital image.*
- 14. Write the basic steps of converting images for recognition.*
- 15. Describe an approach to image recognition in computer vision systems.*
- 16. The concept of image features in computer vision technologies. Examples of image features.*
- 17. What lighting models are used in 3D scene modeling. What formula is used to calculate object intensity for such scenes?*
- 18. The method of reverse ray tracing.*
- 19. Why is reverse tracing more efficient than forward tracing?*
- 20. What is the stopping criterion for the reverse ray tracing method?*
- 21. Define the concept of color bit depth.*
- 22. What is the bit depth of color?*
- 23. What is the effect of the color depth indicator when converting images?*
- 24. For each color component of a full-color image at a bit depth of 24 bpp, what values can the pixel brightness (range) take?*
- 25. For each color component of a full-color image at a bit depth of 48 bpp, what values can the pixel brightness (range) take?*
- 26. For each color component of a full-color image at a bit depth of 96 bpp, what values can the pixel brightness (range) take?*
- 27. Technologies for creating a 3D scene.*
- 28. The main features of the depth of the scene.*
- 29. Describe the features of scene depth: location of scene objects, size, shadows, perspective, surface texture gradient, observation point.*
- 30. Define the concept of perspective. Types of perspectives. What are perspective technologies used for in augmented/virtual reality scenes?*
- 31. Define the concept of motion parallax.*
- 32. 3ds Max development environment.*
- 33. Maya development environment.*
- 34. Cinema 4D development environment.*
- 35. Blender development environment.*
- 36. Lightwave 3D development environment.*
- 37. Storage formats of 3D objects and animations.*
- 38. .obj storage format for 3D objects and animations.*