Syllabus

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Automation and Computer Science
1.3 Departament	Automation
1.4 Field of study	Systems Engineering
1.5 Cycle of study	Bachelor of Science
1.6 Program of study/Qualification	Automation and Applied Informatics (English)
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Digital Graphics***				Discipline code	**56.40**
2.2 Course responsible/lecturer	Lecturer Eng. Iulia Adina Ștefan, PhD - Iulia.Stefan@aut.utcluj.ro					
2.3 Teachers in charge of applications	*Eng. Nicolae Viorel Costea – Nicolae. Costea@campus.utcluj.ro*					
2.4 Year of study	4	2.5 Semester	2	2.6 Assessment *(E/C/V)*		C
2.7 Type of subject	*DF – fundamental, DS – specialty, DC – complementary*					DS
	DOB – compulsory, DOP – elective, DFA – optional					DOP

3. Estimated total time

3.1 Number of hours per week	3	of which:	3.2 Course	2	3.3 Seminar	-	3.3 Laboratory	-	3.3 Project	1
3.4 Number of hours per semester	42	of which:	3.5 Course	28	3.6 Seminar	-	3.6 Laboratory	-	3.6 Project	14

3.7 Individual study	
(a) Manual, lecture material and notes, bibliography	3
(b) Supplementary study in the library, online and in the field	40
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	30
(d) Tutoring	7
(e) Exams and tests	3
(f) Other activities:	0
3.8 Total hours of individual study (sum of (3.3(a)...3.3(f)))	83
3.9 Total hours per semester (3.2+3.4)	125
3.10 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	Algebra, Matrix Calculus, CAD in Automation Programming in a high-level object language (Java, C++, C#)
4.2 Competence	C1. Use knowledge of mathematics, physics, measurement technique, technical graphics, mechanical, chemical, electrical and electronic engineering in systems engineering. C2. Operating with fundamental concepts from computer science, information and communication technologyC2. Operating with fundamental concepts from computer science, information and communication technology

5. Requirements (where appropriate)

5.1. For the course	Classroom adapted to the number of students, computer and video projector, blackboard, flipchart, markers, which allow the maintenance of the norms imposed by law, due to the pandemic situation.
5.2. For the applications	Room with at least 15 seats, computer and video projector, blackboard, flipchart, markers, which would allow the maintenance of the norms imposed by law, due to the pandemic situation.

6. Specific competences

Professional competences	C3. Use of the fundamentals of automation, methods of modeling, simulation, identification and analysis of processes, computer-aided design techniques. C4. Design, implementation, testing, use and maintenance of systems with general and dedicated equipment, including computer networks, for automation and applied informatics applications.
Cross competences	CT2. Identifying roles and responsibilities in a multi-specialized team, making decisions and assigning tasks, with the application of techniques for networking and efficient work within the team. Written and oral communication skills Relationship and teamwork skills Competence regarding the management of material and time resources Skills in the use of scientific terminology in the field Skills in the interdisciplinary use of knowledge and terminology in the field CT3. Identifying opportunities for continuous training and making effective use of learning resources and techniques for one's own development.

7. Expected learning outcomes

Knowledge	Explain and interpret theoretical and experimental results in mathematics, physics, chemistry, economics, technical drawing and computer science; develops applications and implements algorithms and automated driving structures, using project management principles, programming environments and technologies based on microcontrollers, signal processors, programmable automatons, embedded systems; develops applications for the control of robots and mobile robots, including using artificial intelligence techniques;
Skills	Research skills for understanding main graphic libraries and use cases for impact in job market Application integration of main examples with graphic libraries for different platforms.
Responsibilities and autonomy	The student/graduate applies to the values of ethics and deontology of the engineering profession. Practice logical reasoning, evaluation, and self-evaluation in decision-making. The student/graduate communicates effectively about engineering activities with a wide range of audiences; is committed to lifelong learning for the acquisition and implementation of knowledge as needed, using appropriate learning strategies; promotes dialogue, cooperation, respect for others and interculturality; works effectively as a team member or leader of the team;

8. Course objectives

General objective	Presentation of the problem regarding computer graphics in a technological context of constant presence in the virtual environment, both of human users and of mobile devices.
Specific objectives	At the end of the course, the student will be able to recognize, identify and apply the following: • parameters, functions, libraries and frameworks specific to the development of OpenGL, WebGL, VR&AR, OpenCV applications • presentation of fundamental algorithms in computer graphics • real-time rendering • animations. • identification of technological solutions aimed at IoT and gamification

9. Contents

9.1 Lecture	No.hours	Teaching methods	Notes
Introducere cu prezentarea domeniilor de aplicabilitate. Prezentarea cerințelor si resurselor pentru proiect /teme. Stabilirea posibilitatilor de evaluare finala la alegere conform prezentei fise de disciplina	3	Interactive lecture, brainstorming, learning through discovery, learning through cooperation, argumentation, learning in pairs, debate, video exemplification	In case of force majeure, the courses will be held online on the Teams platform
Intro: OpenGL ES, Vulkan, OpenGL, WebGL. OpenGL pipeline Limbajului GLSL, Utilizarea programelor de tip Shader	1		
Polygons – Clipping. Surfaces	2		
Texture and texturing: definitions, parameters and specific functions. Overlay of multiple textures. Procedural textures. Filters Theoretical aspects: 2D (linear) transformations and 3D (cubic) transformations. Coordinate systems. Projections	2		

Lighting/shading. Processing I/O events	2		
3D & Virtual Reality: intro. Equipment. AI Integration	2		
Getting started with dedicated work platforms: Unity	2		
3D: Stage manipulation. Coordinate systems. Use of integrated resources: Prefabs, GameObjects, Colliders, etc. Integration of predefined components for configuring and defining the movements related to a user	2		
Setting up a VR project. Using Grabbable objects. Sockets. Interactors and Interactables	2		
Augmented reality: intro. Equipment.	2		
edicated platforms. Creating an AR reference example in Unity. AI integration	2		
Using 2D&3D computer graphics in web pages (XML, SVG, Flash, WebGL, ThreeJS)	2		
Introduction to Deep Learning for Computational Vision using OpenCV and Python (Introduction to Deep Leaning for Computer Vision using OpenCV and Python)	4		

Bibliography

1. https://registry.khronos.org/webgl/specs/latest/2.0/, ultima accesare: iunie 2026
2. ThreeJS Docs, https://threejs.org/docs/, ultima accesare: iunie 2026
3. Casey Hardman, Game Programming with Unity and C#, Apress, 2020 2. Unity Manual, https://docs.unity3d.com/Manual/index.html, ultima accesare: iunie 2026
4. Unity VR Documentation, https://learn.unity.com/course/create-with-vr, ultima accesare: iunie 2026
5. Bert Convy, Metaverse for Beginners, 2020, Printed in Great Britain by Amazon 5. Unity, AR development in Unity,
6. https://docs.unity3d.com/Manual/AROverview.html, ultima accesare: iunie 2026
7. Mark Segal, Kurt Akeley,The OpenGL R Graphics System: A Specification, Version 4.6, Core Profile, May 14, 2018
8. Farhad Ghayour and Diego Cantor, Real-Time 3D Graphics with WebGL2, Packt Publishing, 2018
9. Hussain Frahaan, Learn OpenGL, Packt Publishing, 2018
10. David Wolff, OpenGL 4 Shading Language cookbook, third Edition, Pack Publising, 2018
11. Graham Sellers, Richard S. Wright, Nicholas Haemel, OpenGL SuperBible Seventh Edition Comprehensive Tutorial and Reference, Ed. Addison-Wesley, 2016, ISBN-13: 978-0672337475 11. D. Salomon, The Computer Graphics Manual, Springer, 2011, ISBN 9780857298850 12. Samuel R. Buss, 3D Computer Graphics a Mathematical Introduction with OpenGL, ISBN: 9780521821032, 2003 13. P. Shirley, S. Marschner, Fundamentals of Computer Graphics 3rd ed., 2009
12. Erin Pangilinan &all, Creating Augumented and Virtusal Realities, O'Reilly, 2019
13. Tomas Akenine-Moller Eric Haines, Naty Hoffman, Real-Time Rendering, Third Edition, ISBN-13: 978 1568814247, 2008,
14. Peter Shirley Michael Ashikhmin, Steve Marschner, Fundamentals of Computer Graphics, 2009, ISBN-13: 978-1568814698
15. Alan Watt, 3D Computer Graphics (3rd Edition), ISBN-13: 978-0201398557, 1999,
16. https://www.khronos.org/registry/webgl/specs/latest/2.0/ 19. http://www.w3.org/TR/2011/REC-SVG11-20110816/ 20. WebGL Docs,
17. GitHub - opencv/opencv: Open Source Computer Vision Library · GitHub

9.2 Aplications (seminar/laboratory/project/practical work)	No.hours	Teaching methods	Notes
Team choice. Presentation of project/themes directed on content with applicability in education, humanitarian engineering, serious games, digital twin, IoT, information encryption in images, deep learning in computer vision, definition of web interfaces with the user based on simulation and animation, themes directed on the implementation of VR or AR functionalities, themes and projects that bring improvements through the graphic component to their own bachelor's degrees.	1	Interactive lectures, brainstorming, learning through discovery, learning through cooperation, argumentation, learning in pairs,	In caz de forță majoră, cursurile se vor desfășura on-line pe platforma Teams
Presentation of the available materials related to the implementation of graphic elements (for example: Blender or other development framework, assest integration and functionalities in Unity)	1		

Implementation of functional requirements (for example: Unity, Visual Studio)	7	debate, video exemplification	
Functional testing. Evaluation of themes/projects	2		
Motion sensors and graphical transposition of motion based on information taken from sensors. Presentation of an IoT reference example 1 Use of graphics in web structures (XML, SVG, Flash, WebGL, Three.js). Evaluation of themes/projects	2		
Using graphics in web structures (XML, SVG, Flash, WebGL, Three.js)	1		

Bibliography
the minimum bibliography for applications containing at least one bibliographic reference work of the discipline that exists available to students in an appropriate number of copies

1. Casey Hardman, Game Programming with Unity and C#, Apress, 2020
2. Unity Manual, https://docs.unity3d.com/Manual/index.html, last visited June 2026
3. Unity VR Documentation, https://learn.unity.com/course/create-with-vr, ultima accesare: iunie 2026 4. Mark Segal, Kurt Akeley,The OpenGL R Graphics System: A Specification, Version 4.6, Core Profile, May 14, 2018,
5. Hussain Frahaan, Learn OpenGL, Packt Publishing, 2018 4/4
6. David Wolff, OpenGL 4 Shading Language cookbook, third Edition, Pack Publishing, 2018
7. Graham Sellers, Richard S. Wright, Nicholas Haemel, OpenGL SuperBible Seventh Edition Comprehensive Tutorial and Reference, Ed. Addison-Wesley, 2016, ISBN-13: 978-0672337475
8. Dave Shreiner, Graham Sellers, John M. Kessenich, Bill M. Licea-Kane, OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.3 (8th Edition) , 2013
9. WebGL Docs, https://registry.khronos.org/webgl/specs/latest/2.0/
10. GitHub - opencv/opencv: Open Source Computer Vision Library · GitHub, last visited June 2026

10. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

Finally, the trainees will be able to generate and explore possibilities for developing applications with significant impact, by using modern technologies and integrating current market requirements, such as AI tools usage. These include the development of IoT projects, the creation of assets and animations representative of the functionality of applications for different platforms, the development of virtual reality and augmented reality applications, the collection, monitoring and simulation in real time of data and prediction results in graphical interfaces, the development of Digital Twin models, the hiding of information in images through steganography techniques, the use of Deep Learning methods in Computer Vision, as well as the integration of software libraries specific to embedded systems and other application areas.
Also, the possibility to contribute to the elaboration and completion of a scientific article contributes to the development of essential skills, such as critical thinking, the ability to analyze and synthesize, applied research, scientific writing and communication of results in an academic setting.

11. Evaluation

Activity type	11.1 Assessment criteria	11.2 Assessment methods	11.3 Weight in the final grade
11.4 Course	Assessment of knowledge by means of a test based on the knowledge acquired from participation in the course	Written exam with all the cards on the table **or** Submit a 6-page material respecting the IEEE A4 template as a scientific article of your choice in the field of discipline, in a team of 2 or 3 people. The article does not have to be accepted at a conference to be considered as a final deliverable within the discipline. **Note** If the article is accepted at an IEEE conference or peer reviewed journal, the final weight is 100%.	50%-100%

11.5 seminar/ laboratory/ project/ practical work	**The way of analyzing, synthesizing and integrating theoretical information and its application by carrying out a project or several topics of relatively small dimensions.**	At your choice, any of the options below, with final oral presentation and video demonstration, in the case of applications: 1. Proven integration of knowledge in the field of the course and the laboratory in the own bachelor's thesis (development of 2D or 3D graphic digital resources or animations or graphical interface features well documented by the specialized literature, in improving the use, with the integration of specific graphic libraries - individual project) **or** 2. Extension of the above article to 10 pages in a team of 2-3 people, explicitly with application integration **or** 3. Development of an IoT Project with gamification elements – in a team of 2-3 people **or** 4. Development of a VR/AR project – in a team of 2-3 people **or** 5. Development of a project of your choice that demonstrates the use of specific graphic libraries. **Note:** 1. Any of the above points can have a 100% share if the aspects that are defined and implemented through the use of graphic libraries, including with specific integration of representative models based on artificial neural networks or data encryption in images, are defining for the option chosen for the completion of the student and/or team application. 2. If the project is presented in the IoT Student Challenge competition, the weight is 100%.	50% -100%
11.6 Minimum performance standard			

Date of filling in:		**Title Firstname NAME**	**Signature**
	Course	Lecturer Eng. Iulia Adina Ștefan, PhD	
	Aplications	*Eng. Nicolae Viorel Costea*	

Date of approval by the Department Board	Head of Departament Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty Council	Dean Prof.dr.ing. Vlad MUREȘAN