SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Master
1.6 Program of study / Qualification	Artificial Intelligence and Vision
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	**Virtual Reality**			Subject code	**16.00**
2.2 Course responsible / lecturer	Assoc. prof. dr. eng. Victor-Ioan Bâcu - victor.bacu@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Assoc. prof. dr. eng. Victor-Ioan Bâcu - victor.bacu@cs.utcluj.ro				
2.4 Year of study	II	2.5 Semester	3	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary				DS
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)				DI

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	2	Seminars		Laboratory	1	Project	
3.2 Number of hours per semester	42	of which:	Course	28	Seminars		Laboratory	14	Project	
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										20
(b) Supplementary study in the library, online and in the field										25
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										30
(d) Tutoring										5
(e) Exams and tests										3
(f) Other activities:										

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	83
3.5 Total hours per semester (3.2+3.4)	125
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	Programming in a high-level object-oriented language (Ex. C++, Java).
4.2 Competence	The methodology of developing software applications.

5. Requirements (where appropriate)

5.1. For the course	Minimum course attendance of 75% for admission to the final exam.
5.2. For the applications	100% mandatory attendance for admission to the final exam.

6. Specific competence

6.1 Professional competences	Analyse business requirements Analyse big data Define technical requirements Design process Develop creative ideas Deliver visual presentation of data Creatively use digital technologies Use data processing techniques Create data models Assess ICT knowledge Manage database Implement ICT security policies Integrate system components Design enterprise architecture Design information system Use an application-specific interface Manage data collection systems
6.2 Cross competences	Develop an analytical approach Taking a proactive approach Developing strategies to solve problems Being open minded Coordinate engineering teams

7. Expected Learning Outcomes

Knowledge	The student has knowledge of: • algorithms • computer simulation • digital data processing • information architecture • information categorization • information extraction • information structure • systems development life cycle • unstructured data • visual presentation techniques • digital systems • hardware platforms • system design • systems development life cycle • computer programming • information structure • model-based systems engineering • task algorithmicizing

Skills	The student is able to: • creatively use digital technologies • define technical requirements • deliver visual presentations of data • design processes • develop creative ideas • use data processing techniques • apply systemic design thinking • assess ICT knowledge • design application interfaces • design database schemas • identify processes for re-engineering • align software with system architectures • create data models • define technical requirements • integrate system components • manage databases • use an application-specific interface • use markup language
Responsibilities and autonomy	The student has the ability to work independently in order to: • develop an analytical approach • take a proactive approach • develop strategies to solve problems • be open-minded • coordinate engineering teams

8. Discipline objective (as results from the *key competences gained*)

8.1 General objective	The discipline's main objective is to learn the concepts of developing Virtual Reality applications by acquiring the techniques of analysis, specification, design, implementation, and evaluation of the components that ensure interaction with the user in the virtual space. The concepts, techniques, and hardware and software technologies specific to the field of virtual reality are highlighted.
8.2 Specific objectives	To achieve these general objectives, students will learn to: • Design the architecture of interactive virtual reality systems. • Use software tools and current technologies for the development of interactive virtual reality applications; • Carry out a bibliographic and experimental research activity; • Carry out a project in the field of virtual reality according to the methodology of development and evaluation of interactive applications.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction	2	Presentation on the blackboard, presentation with the video projector, discussions	N/A
Conceptual architecture of Virtual Reality systems. The field of virtual reality applications.	2		
Computational architectures for virtual reality. Graphics engines.	2		
Tracking, calibration and registration.	2		
Input devices in virtual reality systems.	2		
Output devices in virtual reality systems.	2		
Interaction techniques with objects in the virtual space.	2		
Situated visualization.	2		
Modelling, processing, and visualization of the virtual spaces.	2		

Physical models. Particle-based models. Modelling of dynamic 3D surfaces.	2		
Augmented reality.	2		
Visual coherence.	2		
Software components for modelling, processing and graphic visualization of virtual space.	2		
Interaction and navigation.	2		

Bibliography (minimum bibliography of the discipline containing at least one bibliographic reference work of the discipline, which is available to students in an appropriate number of copies).
In the UTC-N library:
1. G. C. Burdea, P. Coiffet, Virtual Reality Technology, J. Wiley & Sons, Second Ed., 2003.
2. W.R. Sherman, A.B. Craig, Understanding Virtual Reality. Interface, Application, and Design, M. Kaufmann Publ., 2003.
In virtual libraries: 1. Virtual Reality Course, http://moodle.utcluj.ro/

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Introduction to Virtual and Augmented Reality applications.	1	Case studies on topics in the field of interactive virtual reality applications, examples using software tools and specialized technologies, blackboard presentations, additional explanations, discussions.	N/A
Software components for modeling, processing and graphic visualization of virtual space.	1		
Technologies, tools and environments for the development of Augmented Reality applications.	1		
Technologies, tools and environments for the development of Virtual Reality applications.	1		
Input and output devices in virtual reality systems.	1		
Interaction techniques with objects in the virtual space.	1		
Tracking, calibration and registration.	1		

Bibliography:
Bibliography (minimum bibliography for applications containing at least one reference bibliographic work of the discipline that is available to students in an appropriate number of copies)
In the UTC-N library
1. G. C. Burdea, P. Coiffet, Virtual Reality Technology, J. Wiley & Sons, Second Ed., 2003.
2. W.R. Sherman, A.B. Craig, Understanding Virtual Reality. Interface, Application, and Design, M. Kaufmann Publ., 2003.

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

The course presents the concepts, architectures, technologies, and applications of Virtual Reality. Rendering and graphic visualization techniques, user interaction with 3D objects, navigation in virtual space, modelling of physical systems, modelling of geographic virtual space, user input and output devices, etc. are studied and exemplified. The content of the discipline was discussed with important actors in this field, both from the academic and the industrial environment, from Romania or other countries. The discipline has been evaluated by ARACIS, along with other master's study programs.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	The written exam (E) verifies the acquisition of the knowledge taught in the course.	Written exam	45%
	Course activity (CA) reflects active participation in the scientific presentations and debates in the course.	Checks along the way, discussions	10%

Seminar			
Laboratory			
Project	The project (P) demonstrates the ability to use virtual reality technologies in building interactive applications.	Project	45%
Minimum standard of performance: Final grade: N = 0.45*E + 0.45*P +0.1*AC The condition for obtaining credits: N≥5; E ≥ 5; P ≥ 5; AC ≥ 5.			

Date of filling in: 01.09.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Assoc.prof.dr.eng. Victor-Ioan BÂCU	
	Applications	Assoc.prof.dr.eng. Victor-Ioan BÂCU	

Date of approval in the department 17.09.2025	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council 19.09.2025	Dean, Prof.dr.eng. Vlad Mureșan