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	***Generative Artificial Intelligence***			Subject code	**11.00**
2.2 Course responsible / lecturer	Șl. dr. ing. Andra Petrovai - Andra.Petrovai@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Șl. dr. ing. Andra Petrovai - Andra.Petrovai@cs.utcluj.ro				
2.4 Year of study	I	2.5 Semester	2	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)				

3. Estimated total time

3.1 Number of hours per week	2	of which:	Course	1	Seminars	1	Laboratory	0	Project	0
3.2 Number of hours per semester	28	of which:	Course	14	Seminars	14	Laboratory	0	Project	0
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										15
(b) Supplementary study in the library, online and in the field										25
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										25
(d) Tutoring										-
(e) Exams and tests										7
(f) Other activities:										-

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	72
3.5 Total hours per semester (3.2+3.4)	100
3.6 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	Image Processing, Pattern Recognition Systems
4.2 Competence	Operation with mathematical methods and models, techniques and technologies specific to the field of image processing

5. Requirements (where appropriate)

5.1. For the course	Blackboard, video projector, screen, computer
5.2. For the applications	Computers, equipment and specific software

6. Specific competence

6.1 Professional competences	C1 - Operation with mathematical methods and models, techniques and advanced specific engineering and IT technologies • C1.1 - Demonstration of advanced theoretical and practical concepts and principles related to deep generative models • C1.2 - The use of specific theories and tools (algorithms, schemes, models, protocols, etc.) to explain the structure and mode of operation of the latest deep generative models reported in the specialized scientific literature • C1.3 - Formal and comparative evaluation of the characteristics of complex deep generative models • C1.4 - Theoretical substantiation of the characteristics of designed complex deep generative models, based on modern theoretical and practical trends C2 - The use of computing techniques in the field of deep generative models • C2.1 - Identifying and describing the structure and mode of operation of deep generative models • C2.2 - Explanation of the role, interactions and functional characteristics of the components of the latest deep generative models reported in the specialized scientific literature • C2.3 - Building original components for deep original model-based systems • C2.4 - Evaluation of the functional and non-functional characteristics of deep generative model-based systems, based on specific metrics • C2.5 - Implementation of deep generative models C3 - Specification, analysis, modeling, design, verification, testing and validation of advanced deep generative model systems using field-specific tools • C3.1 - Advanced knowledge, understanding and use of deep generative models concepts and paradigms • C3.2 - Advanced knowledge, understanding and nuanced use of deep generative models • C3.3 - Development and implementation of original solutions for deep generative models-based applications C4 - Contextual integration and integrity of deep generative model-based systems • C4.1 - Using interdisciplinary knowledge to adapt deep generative models in relation to the dynamic requirements of the application field C4.2 - Carrying out interdisciplinary projects, including problem identification and analysis, development of design specifications, development, functional testing and evaluation of specific quality and performance criteria
6.2 Cross competences	N/A

7. Expected Learning Outcomes

Knowledge	The student has knowledge of: • algorithms • artificial neural networks • computer programming (Python) • data models • computer vision • deep learning • image recognition • model-based systems engineering • task algorithmisation
Skills	The student is able to: • create data sets • creatively use digital technologies • deliver visual presentations of data • develop creative ideas • use data processing techniques • utilise machine learning • create data models
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 development of skills and abilities for the development of deep generative models
8.2 Specific objectives	Assimilation of knowledge and skills regarding: - understanding and using deep generative learning concepts, paradigms and models - the nuanced understanding and use of deep generative models - studying, designing, implementing and evaluating deep generative models

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction	2	Systematic exposure, student involvement in presentations and debates	N/A
Autoregressive models	2		
Variational Autoencoders (VAEs), Normalizing Flows	2		
Generative Adversarial Networks (GANs)	2		
Energy-based models, Score based models	2		
Diffusion models for image generation	2		
Generative AI for Large Language Models	2		

Bibliography

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016
2. Kevin Murphy, "Probabilistic Machine Learning Advanced Topics", MIT Press, 2023
3. IEEE Transactions on Pattern Analysis and Machine Intelligence
4. IEEE Transactions on Image Processing
5. IEEE Transactions on Intelligent Transportation Systems
- 6. CVPR, ECCV and ICCV papers

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Modeling Image Prior	2	Case study, Presentation, Debate	N/A
Autoregressive models	2		
Variational Autoencoders (VAEs)	2		
Generative Adversarial Networks (GANs)	2		
Diffusion Models	2		
Applications - Videos	2		
Applications – 3D and Geometry	2		

Bibliography

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016
2. Kevin Murphy, "Probabilistic Machine Learning Advanced Topics", MIT Press, 2023
3. IEEE Transactions on Pattern Analysis and Machine Intelligence
4. IEEE Transactions on Image Processing
5. IEEE Transactions on Intelligent Transportation Systems
6. CVPR, ECCV and ICCV papers

**Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.*

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

It is carried out through periodic meetings with representatives of the economic environment

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Exam	Written examination	50%
Seminar	Individual presentation of a subject in the field	Oral examination	50%
Laboratory	--	-	-
Project	-	-	-

Minimum standard of performance:

Date of filling in: 01.09.2025	Responsible	Title First name Last name	Signature
	Course	Șl.dr.ing. Andra Petrovai	
	Applications	Șl.dr.ing. Andra Petrovai	

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